

**A Mixed-Methods Evaluation Of
Physical Activity Among People With
Chronic Obstructive Pulmonary
Disease (COPD) And People Without COPD In Saudi
Arabia, And Perspectives Of Healthcare
Professionals To Promote Physical Activity**

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Abstract

Background: Chronic obstructive pulmonary disease (COPD) presents with progressive airflow limitations, commonly resulting in breathlessness, coughing, and reduced physical activity (PA). However, PA is essential to manage and improve health outcomes for people with COPD. There is limited research regarding the levels of PA among those with and without COPD in Saudi Arabia or the contributors to PA.

Aim: This thesis explores PA levels in people with and without COPD and determines the barriers to and facilitators of PA among those with and without COPD and healthcare professionals (HCPs) in Saudi Arabia. This is to support the future promotion of PA in COPD.

Methods: This study employed a sequential explanatory mixed-methods approach. Phase 1 was a cross-sectional study which assessed PA, health-related quality of life (HRQoL), and dyspnoea using a validated questionnaire for people with and without COPD. An online survey administered via RECAP included the International PA Questionnaire short form (IPAQ-SF) and QoL (EQ-5D-5L) for both groups. The Dyspnoea-12 (D-12) was only completed by those participants with COPD.

Phase 2 was the qualitative phase. Following the survey, semi-structured interviews were conducted (guided by Social Cognitive Theory (SCT)) with 13 survey participants, some of whom had COPD and others who did not. Additionally, HCPs who had experience of working with COPD were interviewed. The interviews were conducted online in Arabic, transcribed, and then translated into English before reflexive thematic data analysis was conducted.

Results: Phase 1 (quantitative) included 50 people with COPD and 51 without COPD. Mean IPAQ-SF was similar ($p>0.05$) and both groups reported low levels of PA, with 54% of people with COPD and 45% of people without being categorised as inactive ($p>0.05$). The EQ-5D-5L utility index and VAS were lower in the COPD group than in the non-COPD group ($p<0.05$). There was no correlation between IPAQ-SF and quality of life (QoL) but in the COPD group, IPAQ-SF and D-12 were moderately correlated ($r_s = -0.567$, $p<0.01$).

Phase 2 (qualitative) included eight people with COPD, five people without COPD, and six HCPs being interviewed. Thematic analysis identified four main themes: COPD-specific factors, individual factors, environmental and social factors, and HCP factors. People with COPD reported specific factors as barriers, such as COPD symptoms, access to pulmonary rehabilitation (PR), and a lack of social support. However, personal and environmental factors acted as barriers and facilitators to PA for both people with and without COPD. They highlighted cultural and social norms, barriers, and environmental factors such as cost and accessibility. Finally, the themes identified by HCPs included insufficient knowledge, a lack of training, and limited availability of rehabilitation centres as barriers to promoting PA. The themes relating to facilitators were increased awareness of the benefits of PA, educational sessions regarding the importance of PA, and support from HCPs.

Conclusion: The study conducted in Saudi Arabia found that people with and without COPD have low levels of PA. The identification of barriers to and facilitators of PA among people with and without COPD and HCPs in Saudi Arabia through the lens of SCT offers novel insights into the cultural, personal, and environmental factors that affect PA engagement in this population. Understanding these factors is crucial to develop targeted interventions and strategies to promote PA and improve the overall health outcomes of people with COPD in Saudi Arabia.

Publications and Presentations

The conferences at which this thesis has been presented and published are as follows:

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Definitions and Abbreviations

Abbreviation	Term
BTS	The British Thoracic Society
CDC	Centres for Disease Control and Prevention
COPD	Chronic Obstructive Pulmonary Disease
D-12	Dyspnoea 12
EQ-5D-5L	EuroQol-5 Dimensions-5 Levels
EQ-VAS	EuroQol-Visual Analogue Scale
GOLD	Global Initiative for Chronic Lung Disease
HCPs	Healthcare Professionals
HRQoL	Health-Related Quality of Life
IPAQ-SF	International Physical Activity Questionnaire Short Form
IQR	Inter Quartile Range
MET	Metabolic Equivalent of a Task
MoH	Saudi Ministry of Health
PA	Physical Activity
PR	Pulmonary Rehabilitation
SCT	Social cognitive theory
WHO	World Health Organization

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possible. Your contribution is deeply appreciated and has been fundamental to the completion of this thesis.

Thesis Outline

Chapter 1: Introduction

This chapter introduces the thesis by establishing the context of the Kingdom of Saudi Arabia, including its healthcare system, pulmonary rehabilitation services, and the prevalence of chronic obstructive pulmonary disease (COPD). It highlights the alignment of the study with Saudi Vision 2030, emphasising the national priority of promoting physical activity (PA). The chapter then explores COPD's definition, causes, pathophysiology, diagnosis, classification, and management, alongside its broader impact on individuals and healthcare systems. The role of PA is critically examined, including definitions, global recommendations, methods of assessment, and its relationship with COPD. Evidence-based PA interventions for COPD are discussed. Finally, the chapter introduces behaviour change theories for PA promotion, with a particular focus on Social Cognitive Theory (SCT) as the guiding framework for this study.

Chapter 2: Literature Review

This chapter presents a critical review of the literature on physical activity (PA) levels and the associated barriers and facilitators among individuals with and without chronic obstructive pulmonary disease (COPD), with a particular focus on Saudi Arabia. It outlines the methodological approach used to identify, select, and synthesise relevant studies, ensuring a systematic and transparent review process. The chapter synthesises global and regional evidence, highlights key gaps in the literature, and provides the rationale for the study's focus on exploring PA engagement among people with COPD in Saudi Arabia using a mixed-methods approach.

Chapter 3: Methodology

Based on the theoretical foundations presented in Chapter 1, this chapter outlines the methodological approach employed in the thesis. A mixed methods research paradigm is adopted, allowing for the integration of quantitative and qualitative data to provide a

comprehensive understanding of PA in COPD. The chapter is presented and justifies the choice of the SCT as the guiding theoretical framework. Methodological considerations such as the choice of mixed methods sample selection, survey design, and data collection procedures are described, ensuring transparency, rigour and trustworthiness in the research process. Furthermore, ethical considerations inherent in conducting research with vulnerable populations, such as those with COPD, are addressed with sensitivity and diligence. This chapter serves as a roadmap for the empirical investigation undertaken in the subsequent phases of the thesis.

Chapter 4: Quantitative Phase Method

In this section, the methodological approach adopted for the quantitative phase of the research is described. Drawing on insights from the systematic literature review conducted in Chapter 1, this chapter outlines the development and implementation of a structured survey instrument designed to assess PA levels and HRQoL among those with and those without COPD. In addition, dyspnoea severity among those with COPD is considered. The methodological decisions underpinning the survey design, data collection, and analysis are explained, providing a clear rationale for the selected approach. Considerations concerning the sample size, participant recruitment, and survey validity and reliability are addressed, thereby ensuring the robustness and validity of the quantitative findings.

Chapter 5: Quantitative Phase Results and Discussion

This chapter presents the key findings from the survey data. Demographic characteristics are analysed, along with dyspnoea severity in the COPD group. PA levels and HRQoL are compared between those with COPD and those without COPD. One notable outcome highlighted in this chapter is that there is no significant difference in PA between those with and those without COPD.

Chapter 6: Qualitative Phase Method

In this chapter, the methodological approach adopted for the qualitative phase of the research is detailed. Building upon the quantitative findings obtained in Phase 1, the chapter outlines the recruitment strategies, interview protocols, and data analysis procedures employed. The chapter highlights the importance of reflexivity and transparency in qualitative research, elucidating the steps taken to ensure rigour and trustworthiness in the data collection and analysis processes. Considerations such as participant inclusion and exclusion criteria, interview scheduling, and linguistic translation are addressed, facilitating a robust and nuanced exploration of the lived experiences and perspectives of those with COPD and HCPs in Saudi Arabia.

Chapter 7: Qualitative Phase Results and Discussion

This chapter presents a qualitative analysis of the barriers to and facilitators of PA faced by people with COPD, those without COPD, and the perspectives of HCPs. Thematic analysis was used to identify key themes and insights from the data, providing a nuanced understanding of the factors that influence PA behaviour in the Saudi culture and context. The findings are situated within the theoretical framework of SCT to highlight the complex interplay between the personal, environmental, and social factors that affect PA engagement among those with COPD. The chapter also explores potential strategies for intervention and policy development to promote PA and improve COPD management outcomes.

Chapter 8: Integrated Discussion

In this chapter, the findings from both the quantitative and qualitative phases of the research are synthesised and triangulated to provide a holistic understanding of PA behaviour in COPD. Drawing upon the theoretical lens of SCT, the chapter elucidates the mechanisms through which personal, environmental, and social factors interact to shape PA engagement among those with COPD. The implications of these findings for practice, policy, and future research are explored, underscoring the importance of tailored interventions that address the multifaceted barriers to PA faced by those with COPD. Furthermore, this chapter is framed within the broader scope of public health

initiatives, showcasing its capacity to provide insight for strategic efforts aimed at promoting PA and improving outcomes in COPD management, in accordance with the objectives of Saudi Vision 2030.

Chapter 9: Conclusion

This chapter briefly restates the study's main findings, emphasising the most significant results and how they address the research questions and hypotheses.

1. Background

1.1. Introduction

This section provides a comprehensive overview to establish the foundation for the study. It starts by exploring the context of the Kingdom of Saudi Arabia, including its healthcare system, PR services, and the prevalence of COPD in the country. It also highlights the alignment of this research with Saudi Vision 2030, emphasising the promotion of PA as a national priority.

The review then transitions to a detailed examination of COPD, encompassing its definition, aetiology, pathophysiology, and global prevalence. Key aspects such as the diagnosis, classification, signs and symptoms, and management of COPD are reviewed, along with the disease's broader impact on individuals and healthcare systems.

Following this, the section focuses on PA, covering critical concepts such as physical inactivity and sedentary behaviour, global recommendations regarding PA, and methods for assessing PA. Both objective and subjective measurement approaches are described, along with the relationship between PA and COPD. Evidence-based PA interventions for those with COPD are explored, highlighting their role in improving outcomes.

The section concludes with a discussion of the behaviour change theories for PA, with a particular focus on the Social Cognitive Theory (SCT). The potential for SCT to serve as a framework for designing and implementing effective PA interventions for people with COPD is emphasised, outlining its relevance in fostering sustainable behaviour change.

1.2. The Kingdom of Saudi Arabia

The Kingdom of Saudi Arabia, often referred to as Saudi Arabia, holds a significant place in the Middle East, being recognised as the birthplace and capital of Islam. It is renowned as the land of the two holy mosques and a key pillar of Islam due to the pilgrimage (Hajj) (Luz 2020). With a vast and conservative tribal population, Saudi Arabia's geographical expanse is marked by extremely hot summers and cold winters. The country boasts the world's largest petroleum and natural gas reserves, making it the leading global exporter (Saudi Gazette 2019). This economic prowess positions Saudi Arabia among the top ten of the world's wealthiest nations (International Monetary Fund 2023).

As of 2022, the General Authority for Statistics estimated the population of Saudi Arabia to be 32,175,224 million people, with 8,591,74 people living in Riyadh. Approximately 58% of the population are Saudis, with the remainder being non-Saudis. Demographic data indicate that 25.9% of the population is over the age of 40 years (General Authority for Statistics 2023). The country is divided into 13 regions, with major urban centres including Riyadh, Dammam, Makkah, Madinah, and Jeddah (General Authority for Statistics 2023). Transportation primarily relies on private cars, aeroplanes, and, more recently, trains, with a notable insufficiency of public transport, including buses. Notably, Saudi Arabia has embarked on a comprehensive set of socio-economic reforms known as Vision 2030, aimed at reducing the country's reliance on petroleum revenues, fostering economic expansion, and enhancing various public service sectors, including tourism, education, infrastructure, leisure, and health (Kingdom of Saudi Arabia 2030 Vision 2016). This transformative initiative has triggered significant changes in public services and social structures to align with Vision 2030.

1.2.1. The Healthcare System and Pulmonary Rehabilitation Services in Saudi Arabia

The healthcare system in Saudi Arabia is a comprehensive national system which provides free universal healthcare coverage through various government agencies. It

includes primary, secondary, and tertiary healthcare services. Primary healthcare services are offered through primary healthcare centres (PHCs), which provide essential healthcare services such as preventive care, health education, and screening services. Secondary and tertiary services are more specialised and are generally provided in hospitals (Gurajala 2023). Saudi Arabia currently operates a policy whereby healthcare is free to all Saudi citizens and expatriates working in the public sector. Meanwhile, those working for private companies have insurance offered by private hospitals. The Ministry of Health is responsible for the majority of healthcare services with support from other government health facilities (Walston et al. 2008). Recently, the country has undergone a restructuring of its healthcare systems aimed at privatising public hospitals and introducing insurance coverage for citizens and foreign workers (Walston et al. 2008; Gurajala 2023).

Although progress has been made, the Saudi healthcare system still has several challenges to overcome. One of the main problems is the need for more healthcare workers in rural areas, resulting in longer waiting times and limited access to healthcare services. Additionally, there are significant health disparities between urban and rural areas and a lack of focus on preventive care (Gurajala 2023). To address these issues, the Saudi government is implementing reforms and initiatives to improve healthcare services (Almalki et al. 2011). This includes developing a national health strategy, privatising hospitals, and introducing private health insurance. The government also focuses on wellness and preventive care with the aim of raising awareness and controlling chronic diseases (Gurajala 2023).

Pulmonary rehabilitation (PR) services are crucial to manage conditions like COPD. However, PR programmes are scarce or inappropriately used in Saudi Arabia due to various factors. One of the primary reasons is the shortage of trained personnel capable of managing patients with COPD (Aldhahir et al. 2022). Additionally, PR services must be closely supervised by pulmonologists or internists who specialise in pulmonary medicine but the number of chest physicians in Saudi Arabia is relatively low, with

approximately 600 across all sectors (Alsubaiei et al. 2018). As a result, there is a lack of adequate services to cater for the needs of people with COPD (Aldhahir et al. 2022).

This specific challenge within PR services reflects a broader workforce issue within the Saudi healthcare system, particularly the shortage of specialised personnel. As the country undergoes comprehensive healthcare reforms, addressing these specific challenges within PR services is integral to ensuring holistic improvements in healthcare outcomes nationwide. The shortage of chest physicians, a microcosm of the larger workforce issue, underscores a critical gap within the Saudi healthcare system. Therefore, bridging this gap becomes imperative to achieve the overarching goals of an improved and equitable healthcare system in Saudi Arabia.

1.2.2.Prevalence of COPD in Saudi Arabia

Epidemiological research in the Middle East, particularly within Saudi Arabia, is limited but recent studies concerning the prevalence of COPD are challenging previous assumptions (Alqahtani 2022). The disease is often overlooked and frequently misdiagnosed in the region, particularly in the nations comprising the Gulf Cooperation Council (Idrees et al. 2012). Since the 1990s, numerous studies have revealed that smoking is becoming increasingly prevalent in Saudi Arabia, particularly among those in their twenties, regardless of gender (Al Ghobain 2011; Al Moamary et al. 2012a; Al Moamary et al. 2012b). This trend is concerning, highlighting the urgent need for more comprehensive research and effective interventions to address COPD's growing public health challenge.

COPD has become a growing health concern in Saudi Arabia since 1990, with both prevalence and incidence rates steadily on the rise. As of 2019, there were an estimated 434,560 diagnosed cases of COPD in the country, marking a staggering 329.8% increase from the number of cases recorded in 1990. The prevalence of the disease also increased by 49%, from 1,381 cases per 100,000 people in 1990 to 2,053 cases per 100,000 people in 2019 (Alqahtani 2022). This alarming trend can be attributed to

several factors, such as the increasing use of water pipes (shisha), the smoking of cigarettes, exposure to biomass fuel, outdoor air pollution, and an ageing population (Al Ghobain et al. 2011). Notably, with the incidence, morbidity, and mortality of COPD increasing as the population ages, early screening and diagnosis play a pivotal role in managing the disease effectively (Quaderi and Hurst 2018).

Al Ghobain et al. (2011) conducted a study of 501 smokers aged 40 years or over who used primary healthcare services in three of Saudi Arabia's largest cities. The study found that 71 (14.2%) suffered from COPD, which is similar to the prevalence rate in many other countries, including the UK and the US (Al Ghobain et al. 2011). COPD was also identified as one of the main reasons for in-hospital stays among 810 patients with respiratory diseases (Alamoudi 2006). The number of smokers in Saudi Arabia is gradually increasing, with 23.7% of males and 1.5% of females smoking (WHO 2017). An increase in the number of teenage smokers has also been observed, which is concerning because smoking is the leading risk factor for COPD. The prevalence of COPD is 4.2% of the overall population but 14.2% among smokers. These findings suggest that the prevalence of COPD in Saudi Arabia is likely to increase in the coming years (Tageldin 2012; Al Ghobain 2015).

The alarming rise in the number of young smokers poses a significant threat to the health of the upcoming generation. A study conducted in a secondary school in Riyadh revealed that 31% of boys smoke, whereas 8.9% of girls smoke (Al Ghobain et al. 2011b). Besides, the frequent use of water pipes (shisha) and biomass fuels, including wood for cooking and coal, is another risk factor contributing to the increased prevalence of COPD in the country (Al Ghobain et al. 2011b). In contrast, US data for 2021 indicate that there has been a significant decline in adolescent smoking over the past three decades, with the use of cigarettes among high school students decreasing from 70.1% in 1991 to 17.8% in 2021. In addition, occasional use (smoking on at least 1 day in the past 30 days) decreased from 27.5% in 1991 to 3.8% in 2021, whilst daily use declined from 9.8% in 1991 to 0.6% in 2021 (Mejia et al. 2023). It is important to note that these figures vary widely depending on the specific population studied, the definition of

smoking used (e.g., ever use, current use, daily use), and the year of the study. Overall, while there has been a significant decline in adolescent smoking in the US, the prevalence remains relatively high in Saudi Arabia, with considerable variation across different regions and populations.

1.2.3.Saudi Vision 2030 and Physical Activity

Saudi Arabia's Council of Economic and Development Affairs, under the leadership of Crown Prince Mohammed bin Salman, has introduced a national strategic framework known as Vision 2030 (Kingdom of Saudi Arabia 2030 Vision 2016). The strategy revolves around three main themes: a thriving economy, a vibrant society, and an ambitious country. To ensure the successful implementation and measurement of outcomes, the council has developed eleven assistance programmes, including fiscal sustainability, quality of life (QoL), human capability development, and public investment funds, which are short-term plans. However, it is essential to acknowledge that Vision 2030 constitutes a long-term strategy, so immediate positive outcomes should not be anticipated. The outlined targets are predicted to be realised progressively leading up to 2030 (Kingdom of Saudi Arabia 2030 Vision 2016).

In May 2018, the Saudi Arabian government launched the Quality of Life Programme 2020, aiming to enhance the liveability and lifestyles of its citizens (Kingdom of Saudi Arabia 2030 Vision 2016). This programme targets improvements in public services, entertainment, heritage, urban landscapes, culture, tourism, and sport. One of its primary goals is to boost public participation in sport and athletic activities, underscoring the emphasis on promoting PA at the population level. This focus on PA is a key component of the "Living Healthy, Being Healthy" section of Vision 2030, which strives to create a vibrant society with enriched lives.

Summary

Saudi Arabia's healthcare system is undergoing significant transformation as a result of Vision 2030, aiming to enhance public health services and promote a healthier society. Despite these advances, challenges persist, particularly in addressing chronic diseases such as COPD. The increasing prevalence of COPD, influenced by smoking habits, environmental exposure, and demographic shifts, underscores the urgent need for targeted interventions, including improved PR services and preventive healthcare strategies. Given the global burden of COPD and its substantial impact on QoL, the next section delves into the definition, aetiology, and global prevalence of COPD, providing a comprehensive understanding of the disease and its implications on PA.

1.3. Chronic Obstructive Pulmonary Disease

1.3.1. Definition

The 2025 Global Initiative for Chronic Obstructive Lung Disease (GOLD) defines COPD as a heterogeneous lung condition characterised by chronic respiratory symptoms such as dyspnoea, cough, sputum production, and/or exacerbations. These symptoms result from abnormalities in the airways (e.g., bronchitis, bronchiolitis) and/or alveoli (e.g., emphysema), leading to persistent and often progressive airflow obstruction (Global Initiative for Chronic Obstructive Lung Disease 2025).

In addition to COPD, similar conditions are often described using terms such as chronic obstructive airway disease (COAD) and chronic obstructive lung disease (COLD), which are often used interchangeably with COPD in clinical settings (Jindal 2000). In most cases, the development of airway limitations is usually gradual and cannot be reversed. These limitations result from different combinations of airway diseases and emphysema (Siafakas et al. 1995).

COPD is a significant worldwide issue, contributing to mortality, morbidity, and healthcare resource utilisation. According to the World Health Organization (WHO), COPD was the fourth leading cause of death in 2021 worldwide (WHO 2024).

1.3.2. Aetiology

Tobacco smoking is by far the most frequent trigger for COPD. The well-established correlation between smoking and the risk of COPD development among existing and former smokers has been documented in various studies. Evidence suggests that female smokers demonstrate a higher relative risk of COPD than male smokers (Chung et al. 2023). It is estimated that 9 out of 10 people diagnosed with COPD have a history of smoking (Lundbäck et al. 2003). There is a threefold reduction in forced expiratory volume percentage (FEV₁%) triggered by smoking-related lung injury, as well as an

increase in death rates among people diagnosed with COPD which is observed to be linked with their smoking history (Xu et al. 1994; Doll et al. 2004). A major standard for spirometry testing for COPD is at least 15 years of smoking history and being over the age of 40 years (Chang et al. 2021).

Inhaling atmospheric tobacco smoke from other smokers can also contribute to the development of COPD (Yin et al. 2007) and other respiratory symptoms, including reduced lung function, cough, and dyspnoea (Korsbæk et al. 2021). Acetone, acetic acid, ammonia, benzene, and carbon monoxide toxins are all found in cigarette smoke and may damage the lung parenchyma and bronchioles (Kim et al. 2014). Therefore, reducing exposure to these substances can result in a reduction in COPD development (Doo et al. 2023).

The damage resulting from smoking is usually subclinical in the early stages of development, preceding noticeable airway obstruction. Advanced diagnostic techniques such as body plethysmography or spirometry can identify early changes in diffusing capacity, enabling early diagnosis and intervention (Doyle et al. 2012). While tobacco smoking is known to be a key risk factor for COPD, developing evidence highlights the importance of other contributors. Exposure to biomass fuels such as wood, charcoal, and plant-based materials is increasingly recognised as a vital risk factor for COPD development. Approximately 50% of COPD deaths are caused by biomass smoke (Salvi and Barnes 2009). Particular work environments can expose employees to indoor and outdoor toxins that can damage the lungs. Certain occupations can expose workers to indoor and outdoor pollution which can harm the lungs. Notably, wood or biomass smoke is a significant risk factor for developing COPD (Nishida and Yatera 2022).

Genetic predispositions can greatly increase susceptibility to COPD. Alpha-1 antitrypsin deficiency is a hereditary condition that reduces the production of alpha-1 antitrypsin protein. It is accompanied by an increase in the probability of lung damage and conditions such as emphysema and COPD. This deficiency disturbs the proteases and anti-protease balance, resulting in increased neutrophil elastase (NE) activity, a serine

protease produced by neutrophils which plays a critical role in inflammation, bacterial defence, and tissue destruction. Early diagnosis of alpha-1 antitrypsin deficiency, particularly in individuals with a family history of emphysema or COPD, may reduce the probability of lung injuries and COPD development (Nihlén et al. 2004).

Inhaling tobacco smoking and other hazardous materials or the incidence of microorganisms in genetically susceptible individuals induces the activation of important airway cells, compromising alveolar macrophages and bronchial epithelium. These produce a range of stimulatory chemokines and cytokines, of which macrophage chemotactic protein-1 is known to induce changes to the parenchyma and vasculature within the lung and to contribute to airway restructuring (Keatings et al. 1996).

Exposure to these factors accelerates lung damage in individuals with this deficiency. Therefore, early detection and appropriate management are essential to elucidate the underlying mechanisms of COPD pathophysiology.

1.3.3.Prevalence of COPD Globally

COPD is currently among the leading causes of death worldwide. In 2012, more than three million people globally died from COPD, constituting approximately 6% of all deaths worldwide (Agustí et al. 2023). The report highlights that 90% of these deaths occurred in low- and middle-income countries. According to Rodrigues et al. (2021), COPD was estimated to affect 251 million individuals worldwide and, in 2015 alone, 3.17 million deaths were attributed to COPD, ranking it as the third most fatal disease. In the UK, it is estimated that COPD affects approximately 1.3 million individuals, of whom nearly 800,000 or 60% are men (Stone et al. 2023). The Centres for Disease Control and Prevention has stated that 316,023 (10.3%) deaths among ever-employed persons were associated with COPD in 2020 (Syamlal et al. 2022). In 2018, the prevalence of adults diagnosed with COPD was approximately 5.1% of the population (equivalent to approximately 12.8 million individuals). The prevalence of COPD is higher among women than men and increases significantly with age (Carlson et al. 2022). Additionally,

race/ethnicity and socioeconomic status are identified as significant risk factors for COPD.

Research into the epidemiology of COPD indicates that the disease is closely associated with lung ageing and becomes more prevalent with age, thus, it primarily affects elderly individuals (Chung et al. 2023b). Despite being commonly perceived as a disease of the elderly due to its association with lung ageing, COPD is increasingly diagnosed in individuals under 50 years of age, referred to as “young COPD,” “early-onset COPD,” or “early COPD.” Analysis in 2019 revealed that 49.3 million individuals aged 30–39 years had COPD globally, with a prevalence of approximately 4% (3.8% among those aged 30–34 years and 4.9% among those aged 35–39 years) (Chung et al. 2023). Moreover, a systematic review and modelling analysis conducted in 2019, drawing upon 162 articles covering 260 sites in 65 countries, estimated that the global prevalence of COPD among individuals aged 30–79 years was 10.3%, equating to 391.9 million cases (Adeloye et al. 2022). This underscores the extensive impact of COPD on a global scale.

1.3.4.Pathophysiology

COPD involves a complex interplay of physiological and pathological processes, primarily triggered by the chronic inhalation of noxious particles and gases—especially tobacco smoke. This leads to an exaggerated inflammatory response in the lungs, initiating damaging molecular and cellular events (Crapo et al. 2003). The resulting mechanisms include mucus hypersecretion, proteolytic tissue destruction, fibrosis, and chronic inflammation, ultimately leading to structural remodelling and progressive airflow limitations.

1.3.5.Key Mechanisms of COPD

The clinical and pathological features of COPD are heterogeneous and often include overlapping characteristics of emphysema, chronic bronchitis, and asthma. This

complexity is illustrated in Figure 1.1, which presents a conceptual Venn diagram of COPD components (adapted from ATS 1995).

Airflow Obstruction

Airflow obstruction in COPD primarily results from inflammation targeting the small airways, including the bronchioles and surrounding lung parenchyma. This inflammation leads to:

- Structural remodelling of the airway wall
- Excess mucus production
- Mucosal oedema
- Narrowing and possible collapse of small airways (Hogg 2004)

Inflammation in the adventitial compartment can also weaken the alveolar attachments that maintain airway patency. While a reduction in these attachments may contribute to small airway obstruction and correlate with reduced FEV₁, previous research indicates that changes within the airway wall and lumen are more significant contributors to resistance (Hogg 2004).

As the disease advances, airway narrowing, mucus obstruction, and dynamic airway collapse during expiration impair airflow, especially on exertion (Voelkel et al. 2011). These changes manifest clinically as dyspnoea, exercise intolerance, and reduced QoL (Oga et al. 2007). The resulting fear of breathlessness often leads to avoidance of PA, which causes fitness to deteriorate further. Interventions promoting regular PA are essential to mitigate this decline (Holland et al. 2014).

Emphysema

Emphysema is defined by the American Thoracic Society (ATS) (1987) as the permanent enlargement of the airspaces distal to the terminal bronchiole, accompanied

by destruction of alveolar walls (ATS 1987). This process is driven by an imbalance between proteases and antiproteases in the lung. Key pathological outcomes include:

- Breakdown of alveolar walls
- Loss of elastic recoil
- Collapse of small airways during expiration
- Air trapping and lung hyperinflation

These changes impair effective ventilation and contribute to chronic airflow limitations (Voelkel et al. 2011; Petrache and Serban 2023).

Chronic Bronchitis

Chronic bronchitis is clinically defined by a productive cough lasting at least three months over two consecutive years. Pathophysiologically, it is characterised by:

- Airway inflammation and oedema
- Hypertrophy and hyperplasia of mucus glands
- Excessive mucus production
- Airway wall thickening and fibrosis

These processes result in chronic airway obstruction and contribute significantly to the COPD phenotype (Kim and Criner 2013).

Asthma and Asthma-COPD Overlap

Asthma is a chronic inflammatory condition of the airways, characterised by:

- Airway hyperresponsiveness
- Variable and reversible airflow obstruction
- Eosinophilic inflammation involving the entire airway tree, usually sparing the alveoli

Typical symptoms include wheezing, breathlessness, chest tightness, and coughing, particularly at night or early morning (Barnes et al. 2003). While asthma and COPD

share similar symptoms, they differ in terms of their aetiology and reversibility (Spencer and Krieger 2013). Asthma usually presents with reversible obstruction, whereas COPD is defined by irreversible airflow limitations due to emphysema and/or chronic bronchitis (Cukic et al. 2012).

In certain individuals, particularly those with a longstanding history of asthma or smoking, the disease may progress to irreversible obstruction, satisfying the criteria for asthma-COPD overlap syndrome (ACOS). ACOS represents a clinical overlap of asthma and COPD features and these patients typically experience more severe symptoms, frequent exacerbations, and higher rates of hospitalisation (American Lung Association 2024).

Gas Exchange Abnormalities

Gas exchange in COPD is impaired due to ventilation-perfusion (V/Q) mismatch and reduced diffusion capacity, particularly in emphysematous regions. These abnormalities contribute to chronic hypoxemia and exacerbate dyspnoea. During PA, dynamic hyperinflation increases the load on the respiratory muscles, worsening breathlessness. Over time, pulmonary hypertension develops as a consequence of chronic hypoxemia, leading to vascular remodelling and further cardiopulmonary stress (O'Donnell et al. 2020).

Oxidative Stress and Inflammation

There is a recognised association between oxidative stress and protease/antiprotease imbalance, highlighting its role in COPD development (Barnes 2022). Oxidative stress directly damages respiratory tissues, including initiating and exacerbating the inflammatory response and promoting programmed cell death.

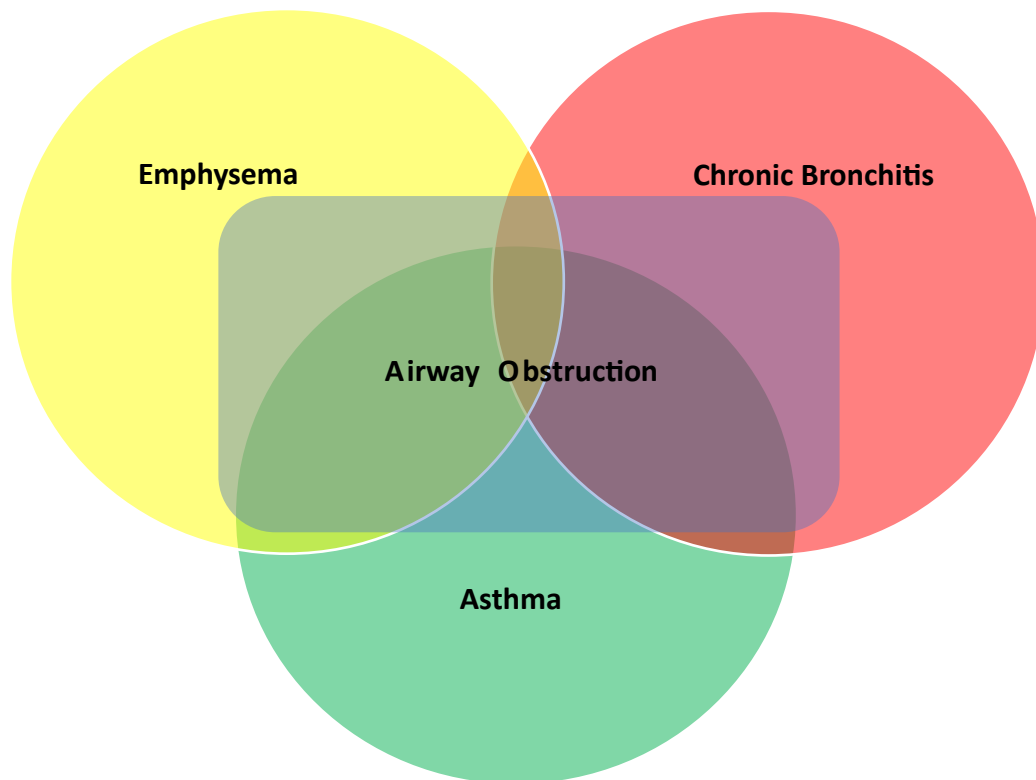


Figure 1.1 Venn diagram of components of COPD (adapted from ATS 1995)

1.3.6. Diagnosis and Classification

Features of airflow limitations typically suggest spirometry testing and the diagnosis of COPD upon expiration. These are described using the following terms:

- **Forced expiratory volume (FEV₁):** FEV₁ is the air volume within the lungs that can be expelled during the first second of a forced exhalation following a maximal inhalation. This parameter reflects airway calibre and the flow of air.
- **Forced vital capacity (FVC):** FVC represents the largest air volume that can be expelled during a forced exhalation.

The FEV₁:FVC ratio provides information regarding airflow obstruction severity and its clinical pattern. It provides a representative index of lung function, with a FEV₁:FVC ratio < 0.70 confirming the presence of COPD. As stated by GOLD (2023), the predicted

value of FEV₁ can provide an estimation of pathological severity according to the following criteria:

GOLD 1: Mild: FEV₁ ≥ 70% predicted

GOLD 2: Moderate: 50% ≤ FEV₁ < 80% predicted

GOLD 3: Severe: 30% ≤ FEV₁ < 50% predicted

GOLD 4: Very severe: FEV₁ < 30% predicted

People with COPD may be categorised by symptoms of dyspnoea (as shown in Table 1.1) or by the number of annual exacerbations of the condition. The GOLD guidelines have developed novel algorithms to enable the appraisal of the patient's symptomatology; i.e., the COPD Assessment Test (CAT) and the COPD Control Questionnaire (CCQ). Additionally, the GOLD 2023 report proposes a redefined classification for initial treatment into three groups (A, B, E) to emphasise the clinical relevance of exacerbations and simplify treatment algorithms, aiming to enhance patient care and outcome. These groups are as follows:

Group A: Oligo-/asymptomatic patients.

Group B: Symptomatic patients.

Group E: Includes characteristics of the former groups C and D (C: high risk, fewer symptoms; and D: high risk, more symptoms), focusing on exacerbations as a significant clinical factor independent of symptom levels.

Table 1.1 Key indicators for considering a diagnosis of COPD (GOLD 2025)

Dyspnoea	Progressive over time. Characteristically worse with exercise. Persistent.
Recurrent wheeze	
Chronic cough	Cough may be intermittent and may be unproductive.
Recurrent lower respiratory tract infections	
History of risk factors	Host factors (e.g., genetic factors, congenital or developmental abnormalities, low birthweight, or childhood respiratory infection). Tobacco smoke, including popular local preparations. Smoke from home cooking and heating fuels. Occupational dusts, vapours, fumes, gases, and other chemicals.

1.3.7. Signs and Symptoms of COPD

The predominant symptoms experienced by people diagnosed with COPD include dyspnoea, cough, sputum production, and exacerbations (GOLD 2025). People diagnosed with COPD may also experience other symptoms, such as wheezing, fatigue, chest tightness, and chest congestion. In addition to these symptoms, patients may experience acute respiratory events characterised by acute worsening of respiratory symptoms that require specific preventative and therapeutic measures (Agustí et al. 2023).

Physical signs associated with COPD include cyanosis, which is a bluish discolouration of the skin and mucous membranes (Sarkar et al. 2019). Cyanosis may be particularly noticeable in the lips and mucous membranes in people with severe COPD and hypoxia. The increase in PaO₂ could be due to acute hyperventilation with the associated increase in the respiratory exchange ratio (RER). The significant increase in PaO₂ when

coughing in those with COPD may lead to increased functional residual capacity (FRC) due to the accumulation of air, thereby enhancing the lung's gas exchange capabilities (Martinez et al. 1988).

A common sign of COPD is hyperinflation in the lungs, which causes the lungs to become overinflated, resulting in increased compliance of the lungs and higher intrathoracic pressure. This increased pressure allows the chest wall to naturally expand outwards, resulting in an enlarged anteroposterior diameter of the chest wall, resembling the shape of a barrel (Sarkar et al. 2019). The continual inflation of the lungs due to hyperinflation contributes to the development of a barrel chest appearance (Sarkar et al. 2019).

COPD patients may also experience a prolonged exhalation phase and breathlessness with exertion. They often experience orthopnoea, which is difficulty breathing while in a supine position. In COPD, a lung ventilation-perfusion imbalance results in impaired pulmonary gas exchange. Lung microvascular dysfunction develops to different degrees over the entire severity range of COPD (O'Donnell et al. 2020b). Elbehairy et al. (2015) found that people with moderate COPD experience an increase in physiological dead space, ventilatory equivalent for CO₂ (VE/VCO₂), and alveolar ventilation (VA) when exercising (Elbehairy et al. 2015). Additionally, people with COPD have a greater association between the severity of their orthopnoea and their oxygen requirement than healthy people (O'Donnell 2006).

However, sitting forward or using the tripod position can ease breathing. When listening to the chest, HCPs may observe diminished breath sounds, prolonged exhalation, and wheezing (Sarkar et al. 2015). Patients with cor pulmonale can experience bilateral crackles and signs of right ventricular failure, such as jugular venous distension and ankle oedema (Agustí et al. 2023). An investigation assessed ten people with cor pulmonale secondary to severe chronic bronchitis and emphysema who were administered 2 litres of oxygen per minute for extended periods throughout the day. However, this did not alleviate the fundamental pulmonary disease (Leggett et al. 1976).

The GOLD 2023 report highlights that people with COPD are at a heightened risk of developing other medical conditions such as cardiovascular issues (e.g., heart failure, ischemic heart disease, and myocardial infarction), pneumonia, and gastroesophageal reflux disease. These conditions can cause symptoms similar to those of COPD, including difficulty breathing, and can lead to adverse outcomes for patients (Agustí et al. 2023).

These comorbidities can further limit the pulmonary reserve of people with COPD (Cavaillè et al. 2013). Anxiety and depression are under-diagnosed comorbidities in COPD (Cavaillè et al. 2013). Depression adversely affects capacity for activity in those with COPD, shown by a reduced 12-minute walk distance. Moreover, depression reduces QoL and reduces compliance with treatment (Stapleton et al. 2005). Depression and anxiety could raise the possibility of hospitalisation and rehospitalisation by affecting an individual's health status (Fan et al. 2002). Depression may serve as a substantial indicator of death after hospitalisation for acute exacerbations (Gudmundsson et al. 2005). Both conditions are associated with poor prognosis, younger age, being female, smoking, lower FEV₁, cough, a higher St George's Respiratory Questionnaire (SGRQ) score, and a previous history of cardiovascular disease (CVD) (Recio Iglesias et al. 2020).

The American Thoracic Society (ATS) and European Respiratory Society (ERS) describe exacerbation as an immediate alteration in a person's baseline dyspnoea, coughing, or mucus that exceeds the normal range and necessitates a modification in treatment (Celli et al. 2004). They categorise it into three distinct groups according to the severity and the clinical significance of the incident and its outcome: Level I: managed at home; Level II: necessitates hospitalisation; Level III: results in respiratory distress. Exacerbations can trigger distinct signs and symptoms, including exacerbated dyspnoea, persistent coughing with mucus, and fever. At the same time, the symptoms may be broader, including malaise, tiredness, sleep deprivation, hypersomnia, and depression (Rodriguez-Roisin 2000).

1.3.8.The Impact of COPD

Physiological Changes

COPD is characterised by a significant decline in lung function, resulting in various physiological changes that profoundly affect respiratory health. This condition, encompassing emphysema and chronic bronchitis, damages the alveoli and bronchi, impairing the exchange of oxygen and carbon dioxide within the lungs (Kacavas et al. 2021). Consequently, blood oxygenation is reduced while carbon dioxide removal becomes inefficient. In emphysema, weakened and ruptured air sacs hinder proper lung expansion and contraction, leading to impaired ventilation and reduced oxygen intake. Additionally, COPD alters lung and airway elasticity, making it challenging for air to flow efficiently, thus contributing to breathing difficulties. People with COPD experience increased work breathing due to damaged lung tissue, requiring greater respiratory effort that can result in fatigue and heightened respiratory distress (Kakamas et al. 2021). As the disease progresses, breathlessness becomes a hallmark symptom, even at rest, reflecting compromised gas exchange capacity. Furthermore, COPD leads to muscle dysfunction, with respiratory muscles weakening from the increased workload and skeletal muscles atrophying due to reduced PA caused by breathlessness and fatigue (Kacavas et al. 2021).

Mixed Impact and Prognosis

Since 2010, several studies have described the mixed impact and prognosis of COPD, with many patients not showing signs of deterioration for several years (Vestron et al. 2011). Nevertheless, the patient's well-being can decline as a consequence of extrapulmonary elements of the disease (e.g., deconditioning and exercise tolerance, dyspnoea, muscle strength and body composition, frailty) (Casanova et al. 2007; Og et al. 2007b; Rutten et al. 2015; Jaschik et al. 2015; Yee et al. 2020). These issues can influence prognosis (Pinto-Plata et al. 2004; Baughman et al. 2012; Rutten et al. 2013;

Wilke et al. 2015). They may also be associated with additional concurrent pathologies (Dermer et al. 2012).

Therefore, a predominant effect of COPD is a gradual deterioration in physical ability, which may result in disability and an inability to manage typical daily tasks (Eisner et al. 2008). Although this is reflected in the patient's level of function, it is also related to diminished HRQoL scores, muscle mass wastage, osteoporosis, and CVD. These are all recognised co-morbidities of COPD (Barnes and Celli 2009). An unhealthy cycle of lack of exercise and body composition alterations that further diminish exercise tolerance develops (Barnes and Celli 2009).

Comorbidities and their Impact

Studies have consistently shown that comorbidities are common among those with COPD and have a negative impact on QoL, exacerbation frequency, and mortality rates. In a clinic-based cohort study, only 28.4% of patients had no comorbidities associated with COPD, and the number of comorbidities increased with the severity of COPD. The most frequent comorbidities were hypertension, obstructive sleep apnoea (OSA), dyslipidaemia, ischemic cardiopathy, and heart rhythm disorder, which were more common in overweight and obese subjects. Additionally, anxiety, depression, and osteoporosis were more common in women, whereas cardiac comorbidities were more common in men (Reversion et al. 2018).

In addition, the presence of comorbidities in those with COPD has been shown to increase mortality, with malignancies, coronary artery disease, and cardiac arrhythmia being particularly significant. Comorbidities also play a role in the frequency and severity of exacerbations, leading to longer hospital stays. Furthermore, comorbidities are associated with increased healthcare costs and a negative impact on QoL, particularly concerning cardiovascular and psychiatric comorbidities (dos Santos et al. 2022).

A cross-sectional analysis demonstrated that the ability to be physically active is diminished almost from the onset of the illness and can be explained by several factors, such as symptoms like shortness of breath, muscle weakness (especially in the respiratory muscles), and increased energy expenditure associated with breathing (Shri Krishna et al. 2012; Waschki et al. 2012; Van Remoortel et al. 2013a; Van Remoortel et al. 2014). Even with mild airflow obstruction, diminished PA is observed. Continuous activity monitoring has demonstrated that people with COPD walk for less time during the day than those without COPD (Watz et al. 2009a; Gouzi et al. 2011). This phenomenon is important because exercise is a predictor of hospital admission, mortality, and QoL (Garcia-Aymerich et al. 2003; Garcia-Aymerich et al. 2007; Garcia-Rio et al. 2012; Vaes et al. 2014; Watz et al. 2014; Wilke et al. 2015). Several studies have documented that people with COPD who perform a significant degree of PA have a lower risk of both COPD-associated death and in-hospital stays (Waschki et al. 2011; Puhan et al. 2013). Regardless of COPD severity, patients have been purported to benefit from physical exercise programmes. Improvement in exercise duration and symptomatology has been demonstrated (O'Donnell and Laveneziana 2007).

Various studies offer valuable insight into the relationship between PA levels and various components of COPD, providing a comprehensive understanding of the disease progression and its impact on patients' well-being (Esteban et al. 2010; Waschki et al. 2015; Demeyer et al. 2019). However, it is necessary to critically assess the study designs and highlight the significance of these research endeavours. Esteban et al. (2010) assessed PA and HRQoL changes over five years in people with COPD. The level of PA was categorised based on the time patients spent walking during their leisure time. It was divided into three categories: low (walking for 2 hours per week), moderate (walking for 2 to 4 hours per week), and high (walking for more than 4 hours per week). The findings highlighted that enhanced or maintained PA levels were associated with clinically relevant positive changes in HRQoL. This longitudinal approach significantly helps to understand the long-term implications of PA in managing COPD and its impact on patients' overall well-being (Esteban et al. 2010). The prospective cohort study by Waschki et al. (2015) employed a rigorous approach by evaluating changes in PA over

three years in people with COPD. Utilising multisensory armband technology and measuring various parameters such as airflow obstruction, health status, exercise capacity, muscle mass, and systemic inflammation, the study demonstrated a substantial decline in PA levels across all severity stages of COPD. The identification of sustained physical inactivity as a key factor associated with the progression of exercise intolerance and muscle depletion adds a crucial dimension to our understanding of COPD (Waschki et al. 2015).

A longitudinal study by Demeyer et al. (2019) assessed the relationship between PA and disease progression in a large COPD cohort (n=177). Using accelerometry and employing multivariable general linear models, the study revealed significant associations between deviations in PA levels and annual reductions in lung function, muscle strength, exercise capacity, and health status. This approach provides a nuanced perspective on the intricate links between PA and various facets of COPD, emphasising the multifaceted impact that PA has on disease progression (Demeyer et al. 2019).

These studies collectively demonstrate the importance of considering PA as an important factor in COPD management. The rigorous methodologies employed, including objective measures such as accelerometry and multisensory armband technology, enhance the reliability of the findings. The identification of specific associations, such as the impact of sustained physical inactivity on exercise intolerance and muscle depletion, provides actionable insights for interventions and highlights the clinical relevance of maintaining or improving PA levels.

The quality of these study designs, incorporating longitudinal approaches and objective measures, strengthens the credibility of the findings. The value of this research lies in its contribution to unravelling the intricate relationships between PA and various components of COPD. However, it is important to note that while objective studies provide valuable insights, they may not fully capture the perspectives of patients and the barriers they encounter when engaging in PA.

1.3.9. Management of COPD

The management of COPD involves a comprehensive approach aimed at controlling symptoms, improving HRQoL, and reducing the risk of exacerbations (Ferrera et al. 2021). The GOLD 2023 report introduces significant updates to the management of COPD, focusing on treatment guidelines, mortality reduction associated with pharmacological therapies, and inhaler device considerations. It replaces the previous ABCD classification system with a new ABE model, simplifying initial treatment recommendations for newly diagnosed patients by merging high exacerbation risk groups C and D into a single group E, thereby facilitating quicker decision-making regarding treatment strategies (Agustí et al. 2023; Terry and Dhand 2023). The management strategies for stable COPD include the following:

Pharmacological Management: This approach is used for symptomatic patients with COPD. The triple therapy involves inhaled corticosteroids, long-acting beta2-agonists, and long-acting muscarinic antagonists, which have been reported to reduce mortality and exacerbations in people with moderate-to-very-severe COPD (Ferrera et al. 2021). Possible enduring benefits for people with severe COPD may be seen in a meta-analysis which found a 29% reduction in mortality rates among people receiving triple treatment compared to those on dual medications (Singh 2023; Terry and Dhand 2023). The report also emphasises the importance of selecting appropriate inhaler devices and improving patient adherence to medication regimens, which are critical to optimise treatment effectiveness and ensure that patients derive maximum benefit from their prescribed therapies. Furthermore, updated guidelines provide clear pathways for follow-up treatment based on patient responses and exacerbation history, reflecting ongoing efforts to refine COPD management strategies and enhance patient outcomes through personalised medicine (Singh 2023; Terry and Dhand 2023).

Non-pharmacological Management: This approach can involve PR, regular PA, smoking cessation, diet, and psychological interventions. Smoking cessation is a critical

component in managing health, particularly for people with COPD and other smoking-related diseases. Quitting smoking can significantly improve lung function, reduce symptoms, and enhance overall QoL (Au et al. 2009). PR, as defined by the ATS (1999), is an integrative approach to therapy for people with a chronic respiratory impairment that is customised to each patient and aims to improve physical and social performance and autonomy (ATS 1999). It is a personalised intervention that includes patient selection and assessment, exercise training, inspiratory muscle training, psychosocial counselling, nutritional evaluation, and education about medication use. The goal is to encourage long-term adherence to behaviours that improve health (Man et al. 2023). PR considers other comorbidities associated with COPD which could affect the prognosis. Therefore, respiratory clinicians tailor a specific PR programme to each person with COPD (Agustí et al. 2023).

It is well-established that PR results in short-term improvements in dyspnoea, exercise capacity, and HRQoL among those with COPD (Beauchamp et al. 2013). To assess the sustained impact of PR, research has conducted follow-up PR programmes. A two-year follow-up of patient-reported outcome indicators after an eight-week PR programme indicated enhancements in dyspnoea and depression (Tonga and Oliver 2023). A sustainable community-centred maintained exercise programme demonstrated clinically significant enhancements in the ability to exercise and overall HRQoL at 6 months and 1 year post-rehabilitation, compared with baseline measurements in people with COPD (Beauchamp et al. 2013).

Regular PA: Lifestyle, particularly physical inactivity, significantly influences death and disability rates (Hanrahan et al. 2021). Engaging in PA outside of a PR programme, including household, job-related, and daily activities for a life of autonomy, as well as PA both indoors and outdoors of mild or moderate intensity can, especially when combined with the cessation of smoking, serve as one of the strongest methods of minimising the development of the condition, complications, and exacerbation of COPD (Araújo 2016). The WHO identifies physical inactivity as a principal contributing factor for non-communicable disorders which is responsible for the majority of unanticipated

deaths globally (WHO 2009). It has become widely known that frequent PA can prevent or postpone the development or progression of specific long-term conditions (Pollock et al. 1998). People with COPD often exhibit significant inactivity in daily functioning, characterised by reduced active duration, decreased activity intensity, and prolonged sedentary periods (Vorrink et al. 2011).

PA plays a crucial role in improving health outcomes for people with COPD. According to Xiang (2022), engaging in regular PA significantly lowers the risk of mortality, with highly active COPD patients experiencing a 47% reduction in the risk of death within 12 months of hospital discharge compared to inactive patients. Additionally, PA improves dyspnoea, health status, and exercise tolerance, improving overall well-being. Notably, reduced PA has been identified as the strongest predictor of all-cause mortality in COPD patients, thereby emphasising the importance of maintaining an active lifestyle (Xiang et al. 2022). Similarly, Yang et al. (2024) reported that increasing PA by 500 MET-minutes per week reduces the risk of all-cause emergency department visits and hospitalisations by 10% and respiratory-related hospitalisations by 14%. Regular PA also has anti-inflammatory and antioxidant effects, which may help to protect against infections and reduce exacerbations. Furthermore, PA enhances peripheral muscle function, improves exercise tolerance, and lowers the likelihood of hospitalisation among COPD patients. These findings underscore the critical role of PA in managing COPD and improving patient outcomes (Yang et al. 2024).

Long-term oxygen therapy (LTOT) for patients with severe hypoxemia can improve survival rates and QoL by ensuring adequate oxygen levels during daily activities (Croxtan and Bailey 2006). Non-invasive ventilation (NIV) is another important intervention that assists patients experiencing respiratory failure, helping to improve ventilation and reduce the work of breathing. The airway clearance techniques (ACTs) approach helps by reducing the airway obstruction caused by secretions occupying the airway lumen, thereby preventing respiratory tract infections and re-expanding the collapsed areas of the lung to improve gas exchange and reduce the inflammatory response (Belli et al. 2021). Neuromuscular electrical stimulation (NMES) management

can also benefit those with severe COPD because it helps to enhance muscle strength and endurance (Safka and Andrew McIvor 2015). Nutritional implementation and proper nutritional support are essential to maintain strength and overall health, especially in patients who may experience weight loss due to increased energy expenditure from breathing difficulties. Psychological consequence and cognitive status, addressing mental health through psychological interventions such as cognitive behavioural therapy or mindfulness can help to manage anxiety and depression commonly associated with chronic illness. Pneumococcus and influenza vaccinations prevent respiratory infections that can exacerbate symptoms and lead to complications (Fekete et al. 2020).

Management of Exacerbation: According to the recommendations for managing COPD, all of those who are hospitalised with acute exacerbations should receive oral corticosteroids in addition to other medications, assuming there are no contraindications (Finch et al. 2016). An investigation revealed that systemic corticosteroid administration resulted in fewer failed treatments, shorter hospitalisation duration, notable enhancements in lung function (FEV_1), and alleviated breathlessness, yet exhibited no significant impact on death rates (Walters et al. 2014). Moreover, existing recommendations promote antibiotic therapy when patients exhibit the three primary symptoms (escalated dyspnoea, increased sputum volume, and sputum purulence) or when there is heightened sputum purulence accompanied by one additional primary symptom (Celli et al. 2004). NIV enhances gas exchange by delivering ventilatory support via a mask through the upper airway and is advised for chronic COPD exacerbations among those with respiratory acidosis (arterial pH ≤ 7.35) when used in conjunction with standard treatment (Celli et al. 2004). Oxygen treatment has been shown to be effective in alleviating hypoxia linked to COPD exacerbations but careful titration of oxygen levels is essential, especially in people susceptible to hypercapnic respiratory failure (Wedzicha and Brill 2014).

1.4. Physical Activity

1.4.1. Physical Activity, Exercise

The term PA encompasses both daily activities and structured exercise, without requiring any specific type, intensity, or form of movement. It includes all levels of activity across various contexts and sectors. PA and exercise are often used interchangeably. Caspersen et al. (1985) define PA as any bodily movement that results in energy expenditure produced by skeletal muscles. PA that has been predetermined and conducted according to a specific programme and on a reiterative basis, and where the purpose is to enhance or to sustain a physical condition, performance or overall well-being is referred to as exercise (Caspersen et al. 1985). In keeping with PA, exercise can include all levels of activity. Although the term has frequently been employed to describe the higher end of the PA spectrum, indicating the actual degree when referring to exercise is helpful. PA is frequently utilised to indicate moderate-to-highly energetic movement. However, in the context of the current topic and discourse, the term is employed to describe movement across the full spectrum of energy expenditure. Qualifying adjectives, including sedentary, light, moderate, or moderate-to-vigorous, can be applied to designate a specific PA level (see Table 1.2).

The type and amount of recommended aerobic PA is known as the dose and is often calculated for a specific period, such as a day or week. This prescription of PA can be used to improve overall well-being for rehabilitation purposes, training, or research studies. The acronym 'FITT' is frequently used to represent frequency, intensity, time (duration), and type of activity. Frequency refers to the number of activities that are performed in a day or week. Intensity refers to the rate of energy expenditure during the session, usually measured in METs. Duration refers to the length of each activity session (Caspersen et al. 1985). Meanwhile, the 'type' indicates whether the activity is aerobic or a muscle-strengthening exercise (Caspersen et al. 1985).

Table 1.2 The variables that determine the recommended amount of PA

PARAMETER	DESCRIPTION
Frequency	How many times the activity is performed, which is usually expressed in sessions per week (CDC 2021).
Intensity	The intensity level of physical activities can be defined using multiple parameters, including metabolic equivalent of a task (MET), rating of perceived exertion, change in heart rate, and breathing rate (Bull et al. 2020).
Duration	The time spent performing the activity (usually expressed in minutes) (CDC 2021).
Volume	The aggregation of the frequency, intensity, and duration, expressed as the volume of the activity (CDC 2021).

1.4.2. Physical Inactivity and Sedentary Behaviour

Physical inactivity and sedentary behaviour are two related but distinct concepts (van der Ploeg and Hillsdon 2017). Between 1996 and 2020, the definition of PA changed from focusing on energy expenditure to recommended levels of PA. In the past, physical inactivity was defined “as a state of minimal bodily movement” (Dietz 1996, p. 829). However, the current definition refers to people who do not meet the recommended levels of PA of 150 minutes per week, according to the WHO (2020). It is important to note that sedentary behaviour is defined as any time spent sitting or lying down while awake, with very low energy expenditure, such as during occupational, educational, home, and community activities or transportation, as defined by the WHO (2020).

1.4.3. Global Recommendations on Physical Activity

The WHO has developed guidelines which outline the recommended amount and type of PA for different age groups (WHO 2020). The main aim of these guidelines is to assist public health practitioners and policymakers in promoting PA levels among different population subgroups (Bull et al. 2020).

To maintain consistency in terminology, this literature review adopts the WHO recommendations on PA as the standard for describing PA and inactivity. The guidelines developed by the WHO are designed to be applicable to all people, regardless of their gender, race, ethnicity, or socioeconomic status, thereby making them suitable for use in low- and middle-income countries (Bull et al. 2020). Other guidelines, such as the Physical Activity Guidelines for Americans and the Australian Physical Activity and Sedentary Behaviour Guidelines, are country-specific.

The WHO guidelines on PA and sedentary behaviour outline various types of PA that contribute to bodily strength, aerobic fitness, and flexibility. These activities can be performed at different levels of intensity, ranging from low-to-moderate and vigorous intensity, as described below:

Light-intensity PA (LPA): These are activities performed between 1.5 and 3 METs. On a rating scale of perceived exertion (0-10), LPA is usually rated 2-4. Examples of LPA include bathing, slow walking, and other incidental activities that do not result in a substantial increase in breathing rate or heart rate.

Moderate-intensity PA (MPA): These are activities performed between 3 and < 6 times the intensity of rest (METs). On a rating scale of perceived exertion (0-10), MPA is usually rated 5 or 6. Examples of MPA include water aerobics, brisk walking at a minimum of 2.5 miles per hour, dancing, tennis, and gardening.

Vigorous-intensity PA (VPA): These are activities performed at 6.0 or more METs. On a rating scale of perceived exertion (0-10), VPA is usually rated 7 or 8 (Bull et al. 2020; WHO 2020). Examples of VPA include hiking, running, vigorous aerobic dancing, rope jumping, and cycling 10 miles per hour.

1.4.4. Physical Activity Recommendations for Adults (aged 18-64 years)

Adults between the ages of 18 and 64 years should engage in at least 150 minutes of moderate-intensity PA per week, 75 minutes of vigorous-intensity PA per week, or a combination of both (WHO 2020). Meanwhile, in order to gain additional health benefits, the WHO recommends that adults engage in 300 minutes of moderate-intensity PA per week, 150 minutes of vigorous-intensity PA per week, or a combination of both.

Based on the STEPS surveillance data for various countries, the global estimate of the prevalence of physical inactivity has been determined (WHO 2021). The WHO (2018) has released multiple reports on this issue and its latest report indicates that approximately 28% of the adult population worldwide is physically inactive. Among adults, females are more likely to be inactive than males, with a 32% and 23% prevalence, respectively. The Americas and the Eastern Mediterranean regions have the highest levels of inactivity, while the Western Pacific region has the lowest level of insufficient PA (WHO 2018).

1.4.5. Assessment of Physical Activity

There are various approaches that can be used to evaluate PA. In the process of choosing a measurement method, both researchers and practitioners must weigh up various factors beyond just feasibility and practicality. Methodological effectiveness, encompassing aspects like validity, reliability, and sensitivity, also plays a crucial role in the selection process. Besides methodological effectiveness, other considerations are required when selecting a method for PA assessment and interpreting the resultant findings. The practicality of a measure often guides its selection in research studies. Factors such as the study setting, the number of participants involved, and the associated cost can influence the feasibility of different measures, making some more viable choices depending on the circumstances (Dowd et al. 2018).

The favoured techniques used to assess the level of PA have been modified over the years. Early research pertaining to epidemiology generally relied upon occupational classifications, grouping employees into broad groups of high or low PA. The advent of mechanisation diminished many workers' degree of PA and, consequently, surveys focusing on recreational PA were utilised (Mannetje and Kromhout 2003). Contemporary technological progress has resulted in devices being developed that are capable of measuring corporeal motion. Their precision has improved and their availability at low cost have engendered them as the favoured instrument to gauge PA levels for the purposes of epidemiological research (Huhn et al. 2022).

Techniques used to Evaluate the Degree of PA (Dowd et al. 2018):

- Objective measurements such as accelerometers and pedometers.
- Subjective measurements such as self-report parameters.

Objective Measurement

Pedometers: These are small, portable devices that can be used to measure the number of steps a patient takes during a specific period. They can provide an estimate

of the distance covered and energy expended (Pitta et al. 2006). Pedometers are designed to detect vertical movement at the hip, measure the number of steps, and estimate the distance walked. There are different types of pedometers available in the market which vary in terms of their cost, method of step detection, data storage, and responsiveness. While pedometers offer high accuracy in terms of step counts, they are less precise at measuring distances and energy expenditure (Schneider et al. 2003). In addition, they may underestimate step counts, distance, and energy expenditure among those with COPD who tend to walk slowly (Furlanetto et al. 2010; Ferreira et al. 2011; Moy et al. 2012). Therefore, their accuracy for people with advanced COPD is questionable.

Accelerometers: These are easily carried pieces of electronic apparatus that the patient can wear. It recognises quickening activity and, thus, indicates bodily motion. They can provide a numerical measure of activity and gauge the length of time an individual has sustained activity over or under a predetermined degree of exercise, the step number, and the energy usage (Pitta et al. 2006). The deployment of accelerometers has attracted attention because they include objective parameters that pedometers and surveys are unable to provide. Accelerometers can be categorised based on the number of axes they recognise motion with respect to.

Accelerometers may be uniaxial, biaxial, or triaxial; recognising motion with respect to one, two, or three axes, respectively. Uniaxial accelerometers measure acceleration along a single axis, biaxial accelerometers measure acceleration along two orthogonal axes, and triaxial accelerometers measure acceleration along three orthogonal axes (Ojiambo et al. 2012).

Objective estimates of PA are useful when evaluating lifestyle interventions but they have certain limitations (Motl et al. 2012; Strath et al. 2013; Baumann et al. 2018), as follows:

- They may not be able to record all types of exercise, such as swimming, cycling, or weight training.

- There may also be limitations in terms of the technology and devices used.
- Individuals may find wearing the devices inconvenient.
- There is a possibility of enhanced reactivity, meaning that the use of pedometers may influence the number of steps a person takes per day.
- There are various output formats for accelerometer data from different manufacturers. This makes it difficult to compare results from numerous studies that use different devices (Butte et al. 2012).
- Obtaining precise data regarding energy utilisation is challenging, especially for people with functional disabilities resulting from chronic illnesses that affect their mobility and movement efficiency (Strath et al. 2012).
- The cost of different devices varies significantly.

Byron and Rowe (2016) conducted a review of studies related to COPD and found that the five most commonly used devices for estimating PA were:

- SenseWear armband
- DynaPort activity monitor
- ActiGraph 7164, GT1M and GT3X+
- RT3 tracker
- Yamax Digiwalker

Out of these, four are accelerometers and the last one is a pedometer. During standardised exercise schedules, the ActiGraph GT3x, DynaPort, and SenseWear armband have been recognised as providing the greatest validity (Van Remoortel et al. 2012).

Wearable Technology for Physical Activity Assessment

Wearable technology plays a dual role in the context of PA, especially in populations with chronic conditions like COPD; it serves both as a tool for assessment and as a potential intervention. The role of this technology became even more important during the COVID-19 pandemic when many in-person healthcare services had to be adjusted to alleviate the strain on healthcare systems. Integrating wearable technology with

smartphone apps offers a promising approach to support these efforts, providing a means to monitor activity and support patient engagement remotely (Barbosa et al. 2020).

According to a systematic review, wearables such as smart bands and pulse oximeters can be integrated with smartphone applications to track PA and health metrics including steps, heart rate, and oxygen saturation (Silva et al. 2023). Eight of the reviewed apps utilised wearables for data collection, providing a continuous and more accurate means of monitoring daily activities compared to manual logging. These devices enable data synchronisation with apps, allowing real-time feedback and tailored exercise recommendations based on the user's physical condition. However, the review also highlighted certain challenges, such as connectivity issues between wearable devices and smartphone apps, which can affect user adherence. Despite these challenges, wearable technology remains a valuable tool for helping patients to maintain active lifestyles by providing personalised insights into their PA patterns (Silva et al. 2023).

Wearable devices such as smart bands and pulse oximeters integrated with smartphone applications have gained popularity for tracking PA and health metrics including step count, heart rate, and oxygen saturation. Hermans et al. (2024) assessed the validity and reliability of the wearable Fitbit Charge 4 band for COPD patients and healthy individuals, revealing that while the device provides moderately accurate readings for certain parameters, its reliability varies depending on the metric being measured. The Fitbit Charge 4 overestimated daily step counts but showed good agreement with a validated accelerometer (ICC = 0.79 in COPD and 0.85 in healthy controls), thereby making it relatively reliable for PA tracking. Similarly, the device demonstrated good agreement with medical-grade devices for resting heart rate (RHR) (ICC = 0.80 in COPD, 0.79 in healthy controls) and respiratory rate (RR) (ICC = 0.84 in COPD, 0.77 in healthy controls), although it overestimated these values in healthy individuals (Hermans et al. 2024).

Crucially, Wilde et al. (2023) explored the experiences of healthcare practitioners (HCPs) supporting COPD patients who used activity monitors. Their findings underscore

that while HCPs view wearables as valuable tools for increasing patient motivation, enabling personalised exercise prescription, and facilitating remote monitoring, significant barriers remain. These include digital literacy challenges, uncertainty about device accuracy, and the absence of formal guidance on recommending or integrating wearables into care pathways. HCPs expressed concerns about inconsistent patient access to technology (digital poverty), and many relied on personal initiative rather than institutional protocols to support patients. Some practitioners were cautious about setting PA goals without formal assessments, while others embraced wearables for enhancing self-efficacy and encouraging pacing based on individual data.

The study also revealed that many HCPs perceived a need for co-developed guidelines and training to standardise support for wearables, reduce risk, and ensure equitable access. Without such frameworks, there is a danger that technology-enhanced care could deepen health disparities if only offered to patients deemed more 'tech-savvy'.

Various techniques are available to assess human PA, including energy expenditure analysis, posture detection, accelerometry, wearable technology, and self-reporting techniques. Each of these tools has its own strengths and limitations. For example, wearable technology, such as smart bands and pulse oximeters, offers real-time monitoring and more accurate data collection, thereby making it especially valuable for remote monitoring and personalised feedback. However, issues such as connectivity challenges can impact their effectiveness. Therefore, researchers must carefully select the method that best aligns with their study objectives and the specific needs of their target population, ensuring that the chosen approach provides the most accurate and relevant insights for their research.

In summary, wearable technology can serve both assessment and intervention purposes in COPD care. However, the successful and equitable integration of such devices into routine practice requires addressing logistical, educational, and systemic challenges. The findings by Wilde et al. (2023) reinforce the importance of involving both

patients and HCPs in co-developing practical, inclusive solutions for the use of wearables in chronic disease management.

1.4.6. Subjective Measurement

Since the 1970s, various methods have been used to collect self-reported data on PA in order to determine the frequency, duration, intensity, and type of exercise performed by people from different communities and with various health conditions (Epstein et al. 1976).

Self-report Parameters

Some of these methods include questionnaires, diaries or journals, surveys, and interviews (Prince et al. 2008). These tools are widely used due to their ease of use, affordability, and ability to provide data on various activities in different situations. They are commonly used in clinical contexts, including large-scale epidemiological research, and allow for comparisons to be made against normative data, which is also frequently obtained in this way (Prince et al. 2008; Helmerhorst et al. 2012).

Although questionnaires have their limitations when applied to single subjects, they can be used to evaluate PA in people with COPD (Rossi et al. 2012). However, the selected questionnaire should be in accordance with its psychometric attributes and the research question being answered. Liao et al. (2014) described the most frequently used non-objective self-reporting tools to assess PA in subjects:

Common Questionnaires

- i. Quantification PA (QUANTAP): This is a technique that employs computer-assisted software to assess an individual's PA in four distinct categories:
 - School sports
 - Recreational sports
 - Work
 - Activities of daily living

The data collected include the nature of the PA, its duration, and frequency in each category. Vuillemin et al. (2000) stated that the QUANTAP software package provides a tool for evaluating the long-term effects of PA on health, particularly in older individuals.

- ii. International PA Questionnaire (IPAQ): This measure is capable of differentiating between three levels of PA and can also measure long-lasting activity. The test-retest reliability of IPAQ was found to be reasonable-to-excellent, with a Spearman's rho of approximately 0.8 (Craig et al. 2003). The questionnaire's criterion validity was considered to be moderate, with a rho value of 0.3 in 12 different countries, including the UK, Australia, Canada, Brazil, Finland, the Netherlands, Guatemala, Japan, Portugal, South Africa, Sweden, and the US (Craig et al. 2003). IPAQ is a suitable tool for measuring PA in adults aged 18 to 65 years (Craig et al. 2003). Although people with COPD are often over 70 years of age, IPAQ can still be used for patients who are younger than this age group.

A recent study in Portugal evaluated the accuracy and reliability of the IPAQ-SF for people with COPD. The study revealed that IPAQ-SF indicates positive and significant correlations with accelerometers, indicating a high degree of test-retest reliability. However, the IPAQ-SF's accuracy may be limited in certain populations and its validity indices may not provide strong empirical support compared to objective measures of PA (Flora et al. 2023). Another study conducted in Chile, which found that IPAQ-assessed PA declined soon after COPD onset, even in the absence of significant breathlessness, raised further concerns regarding the validity of IPAQ-SF in COPD populations (Xiang et al. 2022b). If patients report reduced PA despite not experiencing notable dyspnoea, this suggests that IPAQ-SF may be capturing perceived limitations rather than actual activity levels. This highlights the potential for recall bias and subjective misreporting, which are common limitations associated with self-reported PA questionnaires (Xiang et al. 2022b).

- iii. Sandford 7-day PA Recall questionnaire: Garfield et al. (2012) evaluated four questionnaires against objectively assessed PA using accelerometry. It was found that the Sandford 7-day PA Recall questionnaire was able to differentiate between high and low levels of PA. In contrast, the remaining three questionnaires (PA Scale for the Elderly, Modified Baecke PA questionnaire, and Zutphen PA questionnaire) were uncorrelated with PA, as indicated by the device. Steele et al. (2000) failed to find any correlation between the PA assessment obtained by the Modified Activity Recall questionnaire and accelerometer data, while Rossi et al. (2012) were unable to identify people at the extremely inactive end of the spectrum.

Generally, objective measures of PA exhibit more consistency in methodological effectiveness compared to self-report measures. While there is no flawless tool for assessing PA, researchers are advised to integrate suitable objective measures tailored to the behaviours of interest when studying PA among adults in real-life settings. Factors such as cost and feasibility also play a significant role in the selection of an appropriate tool, in addition to methodological effectiveness.

However, these questionnaire methods are not without their limitations because they are subject to recall bias, which can lead to inaccurate reporting of energy expenditure and activity frequency (Jobe 1989; Prince et al. 2008; Healey et al. 2020). When designing a study, it is important to consider the known limitations. Self-reports are susceptible to reporting errors and are population-specific, thereby making them unsuitable for use in certain settings. Some populations, such as young children, people with dementia, or those with certain mental disorders or low literacy levels, may have difficulty understanding and interpreting questions. Self-reports may also be unresponsive to change in some settings where a tool is used to measure change in PA. Furthermore, certain questions may not be relevant for certain populations or cultures, thereby affecting the comparison and synthesis of results. The measurement quality or lack of evidence of sufficient measurement quality in the target population may make a self-report tool unsuitable (Sattler et al. 2021).

The Gold Standard in Physical Activity Assessment

The Gold Standard, also known as Criterion Methods, can be attained through indirect calorimetry and direct observation of doubly labelled water. These benchmarks are appropriate for studies investigating PA levels by assessing energy consumption (Melanson and Freedson 1996; Strath et al. 2013). Indirect calorimetry, for instance, gauges PA energy expenditure by measuring heat production or monitoring oxygen consumption and carbon dioxide. However, these gold standard methods have their drawbacks; they are not well-suited for population-based studies because they are time-intensive, require expertise in exercise physiology, and are expensive (Vanhees et al. 2005; Westerterp 2009; American College of Sports Medicine 2017).

1.4.7. Relationship Between Physical Activity and COPD

Activities of daily living frequently induce breathlessness in people with COPD and, thus, patients often limit the completion of usual daily activities. There is often a perpetuated decline in activity resulting from a desire to avoid symptoms (Pitta et al. 2006; Hanania and O'Donnell 2019; Xiang et al. 2022).

The 'vicious cycle' or 'vicious circle' in COPD refers to a self-perpetuating process whereby certain factors exacerbate each other, leading to a worsening of the disease (**see Figure 1.3**). This cycle often involves a combination of inflammation, dyspnoea, inactivity, and physical deconditioning. Dyspnoea can lead to inactivity which, in turn, exacerbates physical deconditioning and respiratory symptoms, creating a cycle of reduced PA and worsening symptoms (Ramon et al. 2018; Xiang et al. 2022). This cycle can have significant implications for patients' HRQoL, exacerbating the progression of the disease and increasing the risk of readmission and mortality (Xiang et al. 2022).

Efforts have been made to understand and address the vicious cycle in COPD. Interventions such as PR, exercise training, self-management, and behaviour change

strategies have been recommended to improve PA levels and break the cycle of inactivity among those with COPD (Kim et al. 2019; Xiang et al. 2022).

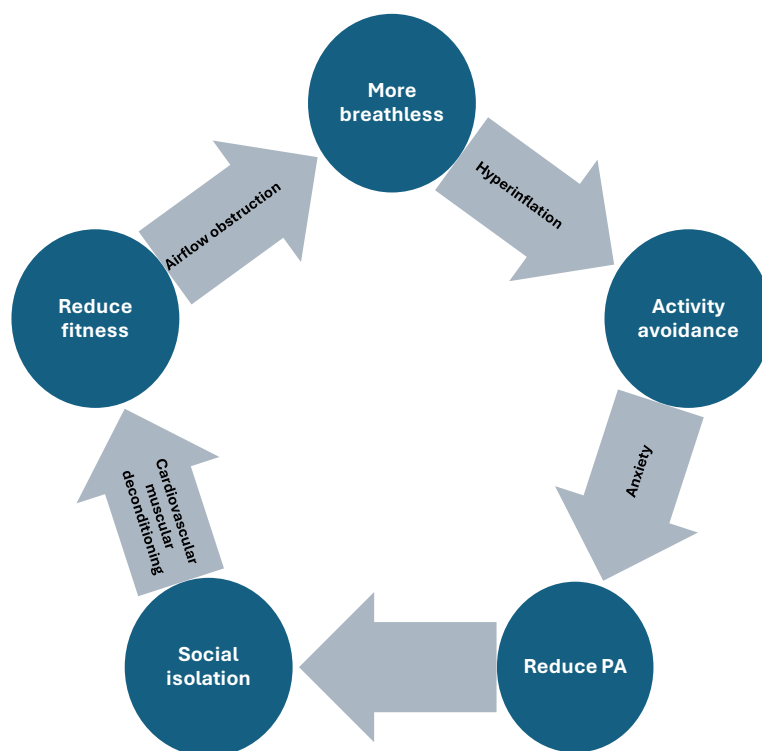


Figure 1.2 PA vicious cycle of inactivity in COPD (adapted from Buttery et al. 2021)

1.4.8. Relationship Between Physical Activity and HRQoL in COPD

PA is associated with positive clinical outcomes, including the prevention of numerous chronic health conditions and increased longevity (Dhuli et al. 2022). Studies have shown that people with COPD who engage in regular PA have a lower risk of death related to COPD and hospitalisation (Waschki et al. 2011; Puhan et al. 2013). Physical exercise protocols have been shown to benefit people with COPD, regardless of the stage of the disease. These benefits include increased exercise tolerance and improved symptoms (O'Donnell and Laveneziana 2007b).

Lacasse et al. (1996; 2007) and McCarthy et al. (2015) undertook meta-analyses which demonstrated that PR programmes including exercise or PA improve symptoms of breathlessness and fatigue, enhance overall well-being and HRQoL, including anxiety and depression, promote feelings of self-control, and improve both exercise and functional abilities.

PA has been identified as an important factor in promoting a better HRQoL for people with COPD. Numerous studies have been conducted to explore the relationship between PA and HRQoL in people with COPD. Esteban et al. (2010b) found that the level of leisure-time PA was strongly linked to HRQoL. The study revealed that patients with low levels of PA or those whose activity decreased experienced a significant decline in HRQoL. These findings illustrate the importance of PA in maintaining a good HRQoL for people with COPD.

1.4.9. Physical Activity Interventions in COPD

Various studies and sources emphasise the significance of implementing strategies to encourage and maintain PA levels in people with COPD. The ERS (Holland et al. 2014) highlights treatment strategies such as PR and behaviour changes, feedback, and counselling as essential components to improve PA in people with COPD.

Pulmonary Rehabilitation

PR has been defined by the ERS and ATS as an evidence-based, multidisciplinary, and comprehensive intervention for people with chronic respiratory diseases who are symptomatic and often have reduced daily life activities (Spruit et al. 2013a; Rochester et al. 2023). The British Thoracic Society (BTS) defines PR as an interdisciplinary programme of care tailored to individuals with chronic respiratory impairment, aiming to optimise physical and social performance and autonomy. This comprehensive approach encompasses supervised exercise training, individualised education, nutritional

counselling, and social and psychological support, as highlighted by Aldhahir et al. (2021), Bolton et al. (2013), and Spruit et al. (2013).

The main objectives of PR are to alleviate symptoms such as breathlessness, improve HRQoL, and enhance exercise capacity. To achieve these, PR focuses on addressing not only respiratory symptoms but also extant pulmonary conditions, including CVD and muscle deconditioning, depression and anxiety, weight loss, social isolation, and skeletal muscle wasting (Bolton et al. 2013; Spruit et al. 2013b). Although it is widely believed that PR has a positive impact on PA, the data from various studies assessing its impact is inconsistent. Some studies have indicated a positive effect of PR (Mercken et al. 2005; Sewell et al. 2005; Pitta et al. 2008; Walker et al. 2008), whereas others found that although exercise capacity improved, daily PA did not (Whyte et al. 2012; Watz et al. 2014b; Spruit et al. 2015).

Several systematic reviews have investigated the effects of exercise training on PA levels, with Cindy Ng et al. (2012) and Spruit et al. (2015) reporting limited effects of PR on PA levels. Cindy Ng et al. (2012) reviewed seven studies with a total sample size of 472 patients but none were randomised controlled trials (RCTs). Similarly, Spruit et al. (2015) reviewed six additional studies not included in Ng's review but found inconsistent results overall. Some studies reported increased activity levels immediately following a PR programme, whereas others found no improvements in PA levels.

However, despite the inconclusive effects of PR on PA levels, an earlier systematic review and meta-analysis conducted by Nguyen et al. (2009) evaluated single cohort and randomised trials related to the impact of exercise training on PA. They found that although these studies did not necessarily encompass PR, exercise training did have a modest positive benefit. It has been acknowledged that individual differences in PA in response to PR suggest that a 'one size fits all' approach to maintaining short-term benefits may not be effective (Robinson et al. 2018). The study highlights that while PR improves the HRQoL and exercise capacity of people with COPD, it does not consistently lead to increased PA (Spruit et al. 2013). The reasons for this are poorly

understood, despite the belief that a comprehensive PR programme, which encompasses all necessary tools to enhance PA in people with COPD, should frequently lead to improvements. However, given the complexity of PA as a health behaviour, it is probable that additional specific strategies incorporating theoretical constructs to facilitate behaviour change in PA are needed (Lahham et al. 2016; Mantoani et al. 2016a; Lahham et al. 2020).

Behaviour Changes, Feedback, and Counselling

Several studies have investigated the efficacy of counselling and BCTs in promoting positive health behaviour changes in those with COPD. A systematic review by Mantoani et al. (2016) included 60 interventional studies—comprising RCTs, non-randomised trials, pilot studies, and cohort designs—assessing PA outcomes in people with COPD. These studies evaluated a wide range of interventions, including PA counselling, PR, nutritional supplementation, LTOT, bronchodilators, and NMES. Notably, programmes that combined counselling with coaching—particularly those using objective activity monitors—were more effective at increasing PA levels. However, the authors graded the overall quality of evidence as very low, citing methodological limitations such as small sample sizes, high risk of bias, inconsistent findings, and substantial heterogeneity in intervention duration and PA measurement tools. These findings underscore the need for more rigorously designed trials to confirm the effectiveness of counselling and coaching interventions in this population (Mantoani et al. 2016b).

Counselling and Coaching Programme

An activity counselling programme is a structured intervention designed to increase PA, especially in individuals with chronic conditions like COPD. It includes individual assessment, specific-measurable-achievable-relevant-time-bound (SMART-EST) goal setting, self-monitoring with tools like pedometers, motivational interviewing, action planning, education on activity benefits, and ongoing feedback and support (Lahham et al. 2016). Often integrated with other treatments such as PR, these programmes aim to

equip individuals with the skills and motivation to adopt and maintain healthier activity levels, delivered over weeks or months in various settings (Lahham et al. 2016).

Williams et al. (2017) conducted a systematic review demonstrating that counselling interventions offer an effective strategy for promoting positive health behaviour changes, including PA, among people with COPD. The review included 22 RCTs and identified two main counselling targets: PA and smoking cessation. Interventions varied in terms of their format and delivery but often included one-on-one or group sessions that used techniques such as motivational interviewing, cognitive behavioural strategies, and structured problem-solving. Common behaviour change techniques (BCTs) included goal setting, problem-solving, self-monitoring, action planning, and providing instruction on how to perform the behaviour. For example, some studies used health coaches to deliver personalised PA counselling based on Self-Determination Theory (SDT) or the Trans-Theoretical Model, whereas others embedded counselling into multicomponent programmes involving PR or pedometer use. Although counselling showed promise—especially for smoking cessation—the review noted that most interventions had methodological limitations and the overall quality of evidence was low, thereby limiting the strength of the conclusions drawn (Williams et al. 2017). The use of regular activity monitoring and incentives as part of a coaching programme is particularly effective in enhancing PA among people with COPD (Mantoani et al. 2016). Coaching is typically action- and goal-oriented, aiming to help individuals achieve personal health goals through structured guidance, motivation, and accountability. It often complements counselling by focusing on future aspirations and behaviour change for sustained self-management (Benzo et al. 2016). Moreover, Armstrong et al. (2021) demonstrated that behavioural modification interventions—when integrated with PR—amplify the programme's benefits by reinforcing behaviour change strategies and supporting long-term adherence to PA in this patient population.

Behaviour Change Theories for Physical Activity in COPD

Selecting an appropriate behaviour change theory is recommended when developing interventions to enhance PA in people with COPD (Hanrahan et al. 2021). Theoretical models provide frameworks to understand the determinants of behaviour and guide intervention design. In the context of COPD, where lifestyle changes and adherence to PA are crucial to improve health outcomes and prevent disease progression, understanding the strengths and limitations of various theories is critical.

1.4.10. Overview of Behavioural Theories

Early behavioural models, such as Social Learning Theory (Bandura 1977) and the Health Belief Model (HBM) (Rosenstock 1974), have been widely applied in public health research (Prestwich et al. 2018). These models offer simple frameworks by focusing on the role of beliefs, intentions, and cognitive processes in shaping behaviour. However, they have limitations because both models neglect important factors including motivation, emotional regulation, and social influences which are crucial for sustained behaviour change (Conner and Norman 2005). These shortcomings make them less suitable for complex, chronic conditions like COPD, where long-term engagement in PA is needed.

More advanced theories, such as the Transtheoretical Model (TTM) (Prochaska and Diclemente 1984) and SCT (Bandura 1986), attempt to address these gaps by acknowledging the dynamic and multi-faceted nature of behaviour change. For instance, TTM introduces the concept of stages of change, allowing for the recognition that individuals may move back and forth between stages (Prestwich et al. 2018). However, TTM has been criticised for oversimplifying the complexity of behaviour change and for not sufficiently addressing the role of external factors, such as socioeconomic status.

On the other hand, SCT accounts for the reciprocal relationship between individual, behavioural, and environmental factors, making it more comprehensive. However, SCT also has its limitations, such as its limited focus on emotions and habitual behaviours, which can influence adherence to PA (Bandura 1986). Despite these drawbacks, SCT's

emphasis on self-efficacy—the belief in one’s ability to perform a behaviour—aligns closely with the challenges faced by people with COPD in maintaining PA levels. This makes SCT particularly relevant for exploring and targeting PA adoption and maintenance.

1.4.11. Classification of Behavioural Theories

Stuart and Nanette (2007) categorise behaviour change theories into five key frameworks (see Table1.3). Each framework offers unique insights into the mechanisms underlying behaviour change:

Table 1.3 Framework for classifying theories of PA (Biddle and Mutrie 2008)

Theories of PA behaviour				
Belief/attitude theories	Competence-based theories	Control-based theories	Stage-based theories	Hybrid models
Example: Theory of planned behaviour	Example: Self-efficacy theory	Example: SDT	Example: TTM	Example: SCT

- I. **Belief/Attitude Theories:** These theories focus on the role of individual beliefs and attitudes in shaping behaviour and performance. They emphasise the importance of understanding an individual's beliefs, values, and attitudes towards a particular task or situation because they can significantly influence their motivation, engagement, and overall success.
- II. **Competence-Based Theories:** These theories focus on the skills, knowledge, and abilities required to perform a task or activity effectively. They emphasise the importance of mastering specific competencies to achieve desired outcomes.
- III. **Control-Based Theories:** These theories focus on the role of perceived control and autonomy in shaping behaviour and performance. They emphasise the importance of providing individuals with a sense of control over their work environment and decision-making processes because this can enhance their motivation, engagement, and overall success.
- IV. **Stage-Based Theories:** These theories focus on the developmental stages individuals go through as they acquire new skills, knowledge, and abilities. These theories emphasise the importance of recognising and addressing the unique challenges and opportunities associated with each stage of development.
- V. **Hybrid Models:** These combine elements from different theoretical perspectives to provide a more comprehensive understanding of behaviour and performance.

Other Behavioural Theories

Theory of Planned Behaviour

The Theory of Planned Behaviour (TPB) posits that an individual's intention to perform a behaviour is the immediate precursor to that behaviour and this intention is shaped by three key factors: attitude toward the behaviour, subjective norms, and perceived behavioural control (Albuluwi et al. 2020). Attitude reflects one's positive or negative evaluation of engaging in PA; subjective norms involve the perceived social pressure or support from important others to be active; and perceived behavioural control, similar to self-efficacy, refers to one's perceived ease or difficulty in performing the activity, including the available resources and any barriers (Albuluwi et al. 2020). The TPB has been widely applied in PA research to predict exercise intentions and participation across various populations (Albuluwi et al. 2020). Studies generally find that the TPB constructs explain a substantial portion of the variance in intentions to exercise, although they often account for a more modest portion of actual behaviour, thereby indicating that factors beyond intention can affect whether intentions are carried out (Wang and Wang 2015). For example, research using TPB in Saudi female adolescents showed that while a majority had positive attitudes and felt capable of exercising, social norms and intentions did not always translate into adequate activity levels, highlighting the need to address cultural and environmental factors alongside TPB constructs in interventions (Albuluwi et al. 2020).

Self-Determination Theory

SDT is a broad theory of motivation that differentiates forms of motivation based on the degree of self-determination or autonomy. It is based on the idea that humans have three basic psychological needs: autonomy (a sense of volition and control over one's actions), competence (feeling effective and capable), and relatedness (feeling socially connected and supported) (Chen et al. 2024). When these needs are satisfied, individuals are more likely to adopt autonomous motivation (e.g., exercising for enjoyment or personal value rather than controlled or external motivation) which, in turn, leads to more persistent and meaningful engagement in PA (Teixeira et al. 2012; Chen et al. 2024). In the context of PA, SDT suggests that interventions should foster a supportive environment that enhances autonomy (e.g., giving individuals choice in

activities), builds competence (e.g., setting achievable exercise goals and feedback), and nurtures social support, thereby shifting motivation towards more intrinsic reasons to be active (Chen et al. 2024). Empirical research strongly supports SDT's relevance to exercise; for instance, a systematic review found that more self-determined (autonomous) forms of regulation are consistently associated with greater participation in exercise and better long-term adherence (Teixeira et al. 2012). In chronic illness contexts like COPD, SDT-based approaches such as motivational interviewing that support patients' autonomy and competence have led to improvements in PA behaviour and health outcomes, with one study reporting that a 10-week SDT-guided programme improved patients' satisfaction of basic needs, reduced exercise-related breathlessness, and enhanced functional status compared to usual care (Chen et al. 2024).

Transtheoretical Model

The TTM, often called the Stages of Change model, regards behaviour change as a process that unfolds over time through a series of stages rather than a single event (Chen et al. 2024). TTM typically delineates five stages of readiness to adopt a new behaviour: precontemplation (not considering PA or unaware of the need), contemplation (aware of the benefits of PA and considering change but not yet ready), preparation (intending to start being active soon and perhaps taking small steps), action (currently engaging in regular PA but for less than 6 months), and maintenance (sustaining regular activity for 6 months or more) (Chen et al. 2024). Progression through these stages is guided by cognitive and behavioural processes such as raising awareness, seeking social support, and managing barriers. TTM emphasises that effective interventions must be stage-matched (i.e., tailored to an individual's current readiness to help them move to the next stage) (Chen et al. 2024). This model has been widely used in PA promotion; for example, a randomised trial in COPD patients found that a PR programme structured around TTM stages significantly improved patients' exercise adherence, QoL, and lung function compared to standard rehab by gradually transitioning them from inactivity towards regular exercise maintenance (Chen et al.

2024). TTM's stage-based approach helps practitioners to focus on achievable incremental changes such as motivating sedentary individuals to begin contemplating and preparing for activity, although it has also faced criticism, with researchers noting that staging can be somewhat subjective and overlapping (Chen et al. 2024). Consequently, ongoing refinements are suggested to enhance its predictive power and applicability (Chen et al. 2024).

Health Action Process Approach

The Health Action Process Approach (HAPA) is a theoretical framework that divides health behaviour change into two main phases: a motivation (pre-intentional) phase and a volition (post-intentional) phase (Schwarzer 1992). In the motivation phase, an individual develops an intention to be physically active based on factors like perceived risk (awareness of health threats associated with inactivity), outcome expectancies (believing that exercise will lead to desired outcomes such as better health or fitness), and action self-efficacy (confidence in one's ability to start exercising) (Schwarzer 1992). Once the intention is formed, the model moves into the volition phase, which involves planning and action: individuals make concrete action plans (when, where, and how to exercise) and coping plans (how to overcome anticipated barriers), and they rely on volitional self-efficacy (confidence to maintain exercise and recover from lapses) to translate intentions into sustained behaviour. HAPA thus explicitly addresses the intention–behaviour gap by highlighting self-regulatory strategies and self-efficacy at multiple stages (before initiating action, during maintenance, and after interruptions) as key determinants of the successful adoption of PA. This approach has been applied in various PA studies and interventions. For instance, research focused on inactive middle-aged adults showed that increases in action self-efficacy led to higher exercise intentions and that maintenance self-efficacy and detailed planning were significant predictors of subsequent PA levels. Accordingly, HAPA-based interventions typically focus on building participants' confidence and planning skills – an approach that has shown promise in chronic illness settings (e.g., improving exercise frequency and

duration in people managing long-term conditions by guiding them through motivational and planning processes) (Parkinson et al. 2023; Silva-Smith et al. 2024) .

Health Belief Model

The HBM explains health-related behaviours (including exercise uptake) through individuals' perceptions of health threats and the evaluation of the costs and benefits of action. It encompasses several core constructs: perceived susceptibility (belief about one's personal risk of experiencing a health problem) and perceived severity (belief in the seriousness of the consequences of that problem) which together form the perceived threat; perceived benefits (belief in the effectiveness of the advised behaviour to reduce risk or severity); perceived barriers (perceived obstacles or downsides to the behaviour); cues to action (external or internal triggers that prompt the behaviour); and later versions include self-efficacy (confidence in one's ability to perform the behaviour) (Chen et al. 2024). The HBM posits that an individual is more likely to engage in a health behaviour such as regular PA if they perceive a serious health threat that exercise can mitigate, expect that taking action will indeed help to avoid that threat and bring other benefits, and believe that they can successfully perform the activity despite any barriers (Chen et al. 2024). For example, someone who believes they are personally at a heightened risk of heart disease (high susceptibility) and that exercising will significantly lower that risk (high benefit) – and who perceives few barriers such as believing they have the time and physical ability to exercise, and receiving reminders or encouragement as cues – would be predicted by the HBM to be more inclined to exercise regularly (Chen et al. 2024). The HBM has been used in numerous PA studies and public health programmes to identify why people may fail to exercise and how to motivate them. For instance, when examining a sample of Saudi university students, researchers found that most students acknowledged the seriousness of obesity and believed in the benefits of PA for weight control but only approximately half felt personally susceptible to becoming obese (Albasheer et al. 2024). This gap in risk perception helped to explain why many were not engaging in preventive exercise, underscoring the HBM's point that even if benefits are recognised, low perceived risk can dampen motivation (Albasheer et al. 2024). By

targeting these beliefs – for instance, educating about the personal risk, highlighting success stories (benefits), reducing practical barriers, and boosting confidence – interventions based on the HBM aim to encourage individuals, including those with chronic conditions, to adopt and maintain PA as a preventive health behaviour.

Social Ecological Model

The Social Ecological Model (SEM) is a framework (rather than a single theory) which examines how multiple levels of influence shape an individual's health behaviours, including PA. It recognises that a person's activity levels are not determined solely by personal motivation or knowledge but also by factors in their social environment (family, peers, cultural norms), community and organisational context (schools, workplaces, neighbourhood characteristics), and the broader environment and policy context (access to parks or gyms, urban design, safety, and health policies) (Al-Nuaim and Safi 2023). As such, SEM situates individual behaviour within a larger system: for someone to be physically active, supportive conditions across these levels, such as having safe places to walk, social support for exercise, and cultural acceptance of recreational activity, greatly facilitate the behaviour. This model has been widely used in PA research to design comprehensive interventions and to understand disparities in activity levels across populations (Al-Nuaim and Safi 2023). In Saudi Arabia, for instance, a qualitative study of youth PA used an ecological lens to identify barriers at different levels – students reported individual-level barriers including lack of time and motivation; interpersonal barriers such as limited parental support or social encouragement; and environmental barriers including insufficient sports facilities, unsafe streets, and extreme climate conditions (Al-Nuaim and Safi 2023). The SEM approach underscores that multi-level interventions are often necessary to effectively promote PA: combining strategies to educate and motivate individuals, engage families and communities, improve infrastructure (e.g., building gyms or playgrounds), and implementing supportive policies can create an environment in which active lifestyles are easier to start and sustain.

Summary

This section outlined several behavioural theories that have been widely used to understand and promote PA in various populations, including those with chronic health conditions. The TPB emphasises the role of intention, attitudes, social norms, and perceived behavioural control in shaping PA engagement. SDT focuses on the importance of intrinsic motivation and the satisfaction of basic psychological needs—autonomy, competence, and relatedness—for sustained PA. The TTM views behaviour change as a staged process and supports stage-matched interventions, whereas the HAPA bridges the gap between intention and action through planning and self-efficacy. The HBM explains PA adoption based on individuals' perceptions of health risks, benefits, and barriers. Lastly, the SEM provides a multi-level perspective, highlighting the interaction between individual, social, and environmental influences on PA behaviour.

Each of these models offers valuable insights into the determinants of PA and has been applied in various cultural and clinical contexts, including some within the Saudi population. However, as discussed in the following section, SCT provides a particularly comprehensive and practical framework for examining the interplay between personal, behavioural, and environmental factors and is thus most appropriate for the current study's focus on the barriers to and facilitators of PA for individuals with and without COPD.

1.5. Social Cognitive Theory

Origin and Development

SCT originated from Albert Bandura's work in the 1960s as an extension and refinement of Social Learning Theory, which he had been developing since the 1950s. Bandura's early research focused on observational learning and modelling, demonstrating that people can learn behaviours by observing others, even without direct reinforcement. This shift challenged earlier behaviourist theories by highlighting the role of indirect learning. As Bandura's research progressed, he incorporated cognitive elements, recognising the importance of thought processes in shaping human behaviour and learning.

In 1977, Bandura introduced the concept of self-efficacy, which became a key component of SCT. Self-efficacy refers to an individual's belief in their ability to successfully perform specific tasks. This addition marked a significant departure from traditional behaviourism, shifting the focus towards the influence of beliefs, attitudes, and cognition on behaviour.

In 1986, Bandura published a seminal work that fully articulated SCT, focusing on reciprocal determinism—the idea that personal factors, environmental influences, and behaviour interact dynamically to shape outcomes. During the 1990s, SCT was refined and applied across multiple fields, including health behaviour, education, and organisational psychology. Bandura expanded the theory to include detailed explanations of how cognitive, vicarious, self-regulatory, and self-reflective processes influence human behaviour. This framework became highly relevant for designing interventions that promote behaviour change.

Fundamental Concepts

SCT explains that behaviour change arises from the interaction between individual, behavioural, and environmental factors (Glanz et al. 2008). These three dimensions influence each other in a reciprocal manner, continuously shaping behaviours over time. Several key concepts contribute to this process:

1. **Behavioural ability:** The knowledge and skills needed to perform a behaviour.
2. **Outcome expectations:** Beliefs about the likely results of the behaviour.
3. **Outcome evaluation:** The value placed on the anticipated outcomes.
4. **Self-efficacy:** Confidence in an individual's ability to perform the behaviour.
5. **Self-regulation:** The ability to set goals, plan, and monitor progress.
6. **Reinforcement:** Rewards or consequences that influence future behaviour.

In health interventions, SCT recognises that both individual factors (e.g., attitudes, beliefs, and self-efficacy) and environmental factors (e.g., social support and access to resources) play crucial roles in promoting behaviour change (Glanz et al. 2008).

In educational and health interventions, SCT highlights that several interacting elements shape individual behaviour. Observational learning allows individuals to acquire new behaviours by watching others, whereas environmental factors such as family, peers, and social conditions, shape and reinforce these behaviours. Self-regulation helps individuals to control their actions by setting goals and monitoring their progress. Additionally, social support plays a critical role in encouraging and sustaining behaviour change, while outcome expectations influence motivation by shaping the anticipated behaviour results. Self-efficacy is particularly significant because individuals with greater self-efficacy are more likely to persist in achieving their goals, even in the face of challenges (Aliakbari et al. 2020).

Figure 1.5 illustrates the core concepts of SCT and their interrelationships in driving behaviour change. This model's centre is self-efficacy, which directly influences behaviour, goal setting, outcome expectations, and the ability to overcome socio-structural barriers. Outcome expectations (the anticipated positive or negative consequences of behaviour) motivate individuals to pursue specific goals. These expectations are closely linked to self-efficacy because individuals with greater

confidence in their abilities are more likely to expect favourable outcomes. Socio-structural factors, such as social support, environmental opportunities, or barriers, further shape behaviour by either facilitating or hindering the achievement of goals. These factors also interact with self-efficacy, meaning that individuals with stronger support networks and fewer barriers are more likely to sustain their efforts.

Goals are central in translating personal beliefs into actions, providing motivation and direction. Individuals with greater self-efficacy tend to set ambitious goals and persist in their efforts to achieve them. The culmination of these processes results in behaviour that forms part of a continuous feedback loop—successful performance reinforces self-efficacy, creating a positive cycle that encourages further engagement. This interconnected system reflects SCT's principle of triadic reciprocal causation, whereby personal factors, environmental influences, and behaviour interact continuously to shape health-related behaviours over time (Bandura 2004; Sebastian et al. 2021).

Chapter 8 further discusses the findings from Phase 2 of the current research, examining them through the lens of these SCT concepts and offering insights into how these theoretical components relate to the participants' experiences and behaviour patterns.

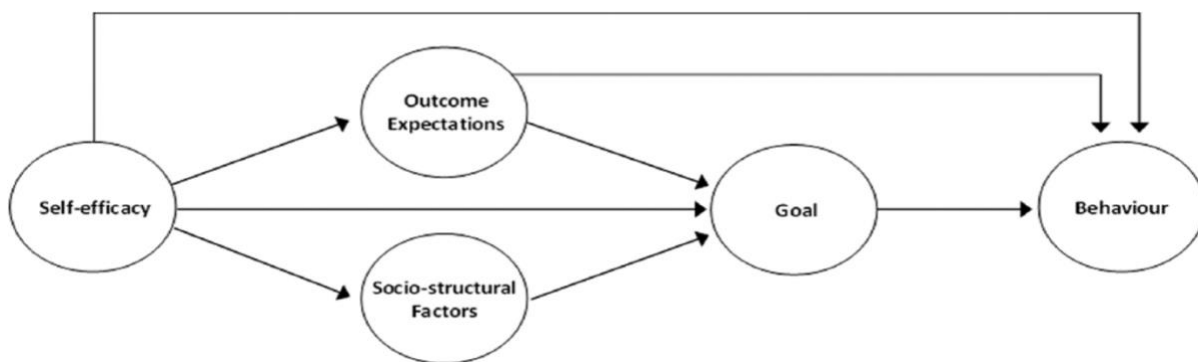


Figure 1.3 THE SOCIAL COGNITIVE THEORY MODEL OF HEALTH BEHAVIOUR (adapted from Bandura 2004)

Justification for Focusing on Social Cognitive Theory

The current research aims to explore the barriers to and facilitators of PA for people with COPD. SCT offers the most appropriate theoretical framework for this purpose. SCT addresses the dynamic interaction between personal, environmental, and behavioural factors, which aligns with the complexity of COPD management. For example, self-efficacy plays a crucial role in overcoming barriers such as breathlessness or fatigue, which frequently discourage PA among those with COPD. In addition, SCT accounts for the role of social support and environmental facilitators, such as access to suitable exercise facilities or community-based programmes, which can enhance PA participation.

In contrast, other theories have limitations that make them less suitable for this research. The TPB focuses primarily on intention as a predictor of behaviour. Still, it overlooks the importance of self-efficacy, which is critical for people with COPD dealing with physical limitations. Similarly, TTM identifies behaviour change stages but provides limited insights into the external factors influencing PA engagement in chronic disease contexts. Hybrid models, such as the HAPA, offer a broader perspective but are complex to implement in clinical settings. SCT, with its practical focus on self-efficacy and environmental influences, provides a balanced framework for understanding both the barriers to and facilitators of PA.

1.5.1. The Role of Social Cognitive Theory in promoting Physical Activity

Using theory in behaviour change interventions helps researchers to identify the key factors influencing PA behaviour, such as motivation, environmental constraints, and social support. For instance, interventions grounded in SCT can enhance self-efficacy through goal setting, feedback, and encouragement. Engaging family members or peers can also foster social support, which has been shown to improve PA adherence. Despite the importance of theory-based approaches, Prestwich et al. (2014) found that only 50% of PA and dietary interventions were informed by behavioural theories, thereby

indicating a gap between theory and practice. This highlights the need for further research to explore how theory can be better integrated into intervention design and evaluation.

In summary, understanding the barriers to and facilitators of PA for those with COPD requires a theoretical framework that accounts for personal, social, and environmental factors. SCT provides a comprehensive approach, addressing the complexities of COPD and offering practical insights for intervention development. Its focus on self-efficacy, outcome expectations, and environmental influences makes it particularly relevant for the current study. By employing SCT, this research aims to explore the specific barriers to and facilitators of PA for those with COPD and inform the development of targeted strategies to enhance PA participation and improve health outcomes.

Summary

PA is essential to manage COPD because it improves health outcomes, reduces the sensation of breathlessness, and enhances overall QoL. However, symptoms associated with COPD, such as dyspnoea and fatigue, frequently result in reduced PA levels, leading to physical deconditioning and perpetuating a detrimental cycle of declining health. While structured interventions, including PR, have demonstrated efficacy in enhancing exercise capacity and functional status, maintaining long-term engagement in PA poses significant challenges.

This chapter has highlighted the significance of employing behaviour change frameworks, notably SCT, to address PA barriers and effectively promote sustained participation. The subsequent chapter examines the existing literature regarding levels of PA among people with COPD in Saudi Arabia in comparison to healthy populations. Additionally, it investigates the barriers and facilitators that influence PA among people with COPD and the HCPs involved in their care within both a local and global context to inform strategies to enhance PA participation.

2. Literature Review

2.1. Introduction

This chapter presents a comprehensive review of the literature relevant to PA levels and the associated barriers and facilitators among individuals with and without COPD, with a particular focus on the Saudi Arabian context. The chapter begins by outlining the methodological approach taken to identify, select, and synthesise the relevant literature, including the rationale for the adopted search strategy, the information sources consulted, eligibility criteria, and data management procedures. These steps ensure that the review is systematic, transparent, and reproducible.

The review was conducted to support the study's aim of exploring PA engagement among those with COPD in Saudi Arabia by providing a critical examination of the existing research. The search strategy was designed to capture both global and regional evidence concerning PA levels in the general population and among people with COPD, as well as studies investigating the barriers to and facilitators of PA, drawing from both global literature and studies conducted in Saudi Arabia.

By synthesising the available evidence, this chapter identifies key gaps in the literature and establishes the justification for the current study's focus on the Saudi Arabian COPD population using a mixed-methods approach.

2.1.1. Methods

A narrative review methodology was deemed appropriate due to the complexity and multifaceted nature of the research topic, which required a more flexible and interpretive strategy (Greenhalgh et al. 2018). Conducting a full systematic review was beyond the scope of this work due to resource limitations and the broad, exploratory nature of the questions. While scoping reviews are effective for mapping the extent and types of literature available, they typically lack in-depth synthesis or critical analysis. Due to the fact that this review sought to explore and interpret differences in PA levels between people with and without COPD in Saudi Arabia, as well as to understand the barriers,

facilitators, and the role of HCPs in promoting PA, a narrative review was deemed to be best suited to synthesise diverse sources and develop a more conceptual understanding of the topic.

The review is divided into two sections with the following research questions:

- Is there a difference in PA level between people with COPD and people without COPD in Saudi Arabia?
- What are the barriers to and facilitators of PA that people with COPD and people without COPD in Saudi Arabia encounter?
- What is the role of health professionals in promoting PA for people with COPD in Saudi Arabia?

To achieve the study's objective, two distinct search strategies were employed. Both strategies used the PRISMA (Page et al. 2021) guidelines to ensure methodological rigour and reproducibility.

2.1.2. The Rationale for Adopting Search Approaches

The first approach establishes the 'what' by investigating the PA levels of people with and without COPD, thus providing a quantitative overview of PA levels. The second approach investigates the 'why' by examining the barriers and facilitators, allowing for a deeper understanding of the factors influencing PA behaviours in people with and without COPD.

Together, these approaches offer a comprehensive perspective of the issue, ensuring that the study addresses both the descriptive and explanatory aspects of PA in people with COPD. This dual approach is particularly significant in Saudi Arabia, where research on PA in people with COPD is limited, highlighting the need for both regional and global perspectives.

2.1.3.Information Sources

The databases used were CINAHL, MEDLINE, PubMed, Cardiff University Library, and internet searches, including Google Scholar. Google Scholar was employed to find studies not identified in the sources mentioned earlier. Different sources, including journals, government statistics, books, and references from retrieved articles, were used.

The preliminary search covered the period 2015-2020. Due to a lack of recent studies, back-chaining and hand searches of reference lists were conducted. References dating back to the year 2000 were included to provide historical background and identify long-term trends. This approach also sought to ensure continuity in the literature, address gaps in recent research, and include methodologically robust studies. These steps were essential to develop a comprehensive understanding of the topic. Additionally, the literature was updated in 2023/4 while writing the thesis and more studies were added.

2.1.4.Search Terms and Search Strategy

To identify relevant studies, search strategies to identify relevant literature were developed using the 'PICO' and 'PEO' approaches (Bettany-Saltikov 2012). PICO is a model designed to help develop a useful search strategy where: P= patient/population/problem; I = Intervention; C = Comparison; O = Outcome. PICO is helpful for identifying quantitative studies. PEO is a model that is used to facilitate the search of the qualitative literature: patient/population; exposure/condition; outcome/theme (Bettany-Saltikov 2012). The search terms were combined using the Boolean operators AND and OR to ensure a comprehensive and focused search.

Search strategies were developed using the PICO and PEO frameworks to address the quantitative and qualitative literature. The keywords and Boolean operators employed for each research objective are as follows:

Search 1. Level of PA in People with COPD in KSA and Globally

PICO Framework:

Population: People with COPD.

Intervention: Not included.

Comparison: People without COPD.

Outcome: PA measurement/assessment using a valid tool.

Keywords:

("Chronic Obstructive Pulmonary Disease" OR "COPD")

AND ("PA" OR "PA" OR "Sedentary Behaviour")

AND ("Saudi Arabia" OR "Global" OR "Worldwide")

Boolean phrases such as 'AND,' 'OR,' and 'NOT' were used to refine the results.

Search 2. Barriers and Facilitators to PA in People with COPD in KSA and Globally

PEO Framework:

Population: People with COPD and HCPs caring for them.

Exposure: Any definition of PA, including exercise, sport, leisure activities, walking.

Outcome: Any outcome relating to barriers and facilitators influencing PA engagement; challenges and enablers for HCPs promoting PA.

Keywords:

("Chronic Obstructive Pulmonary Disease" OR "COPD")

AND ("PA" OR "PA")

AND ("Barriers" OR "obstacles" OR "challenges" OR "Facilitators" OR "Enablers")

AND ("HCPs" OR "HCPs" OR "Healthcare providers")

AND ("Saudi Arabia" OR "Global" OR "Worldwide")

A PRISMA flow diagram (see Figures 1.3 and 1.4) illustrates the study selection process, from the number of records identified to the final set of included studies.

Both approaches were used and the search terms used are listed in each relevant literature review section. Searches for the study were limited to full text, human studies published in English, with no geographic restrictions because studies based on the KSA population were deemed to be particularly relevant. The search was not limited by study design and included cross-sectional studies, case studies, RCTs, case-control studies, and systematic reviews. Studies in other respiratory conditions or not including COPD were not included (e.g., stroke, cancer, osteoarthritis).

2.1.5. Eligibility Criteria

Inclusion Criteria:

Population

Adults aged 18 years and older with a confirmed diagnosis of COPD.

Adults without COPD (for comparative analysis of PA levels).

Qualified HCPs (e.g., doctors, nurses, physiotherapists) involved in managing or supporting people with COPD.

Focus of Study

Studies reporting on PA levels in people with and without COPD.

Studies identifying barriers to and/or facilitators of PA engagement.

Studies exploring the role of HCPs in promoting PA in the context of COPD care.

Methodology

All study designs were eligible, including qualitative, quantitative, and mixed-method research, as well as systematic reviews.

Geographic Focus

Studies conducted in Saudi Arabia were prioritised.

International studies were included, where relevant, to provide broader insights and contextual comparisons.

Exclusion Criteria:

Studies involving only paediatric populations (under 18 years of age).

Studies not addressing at least one of the core components: PA levels, barriers/facilitators, or professional roles related to COPD and PA.

2.1.6.Data Management

All references were exported and stored in Mendeley for further analysis to assess the included studies' relevance, significance, and limitations; a critical appraisal was conducted using the Critical Appraisal Skills Programme (CASP) checklist (2016) for qualitative, systematic reviews, cross-sectional studies, and cohort studies (see Appendix 1-4).

2.1.7.Selection Process

The titles and abstracts were screened by the researcher (RA) to determine their relevance to the research. Any duplicated studies found in more than one database were removed to ensure the accuracy and reliability of the results. Lastly, the full texts of the selected studies were retrieved and assessed to determine their eligibility based on the stated inclusion and exclusion criteria.

Studies were deemed eligible if they investigated the levels of PA in people with and without COPD, explored the barriers to or facilitators of PA among people with and without COPD, and HCPs or the methods for measuring PA. Studies conducted in Saudi Arabia were specifically sought for inclusion, alongside international studies, to provide a comprehensive view of both local and global perspectives on these issues.

2.1.8.Data Collection and Synthesis

For both search strategies, data were extracted using a standardised form, which included:

- a) Study characteristics (e.g., authors, year, location).
- b) Population details (e.g., age, gender, COPD severity).
- c) PA measures (e.g., step count, METs).
- d) Barriers, facilitators, or HCPs' experiences (where relevant).

The findings were synthesised using a narrative approach, with quantitative data summarised descriptively and thematic analysis used for the qualitative results.

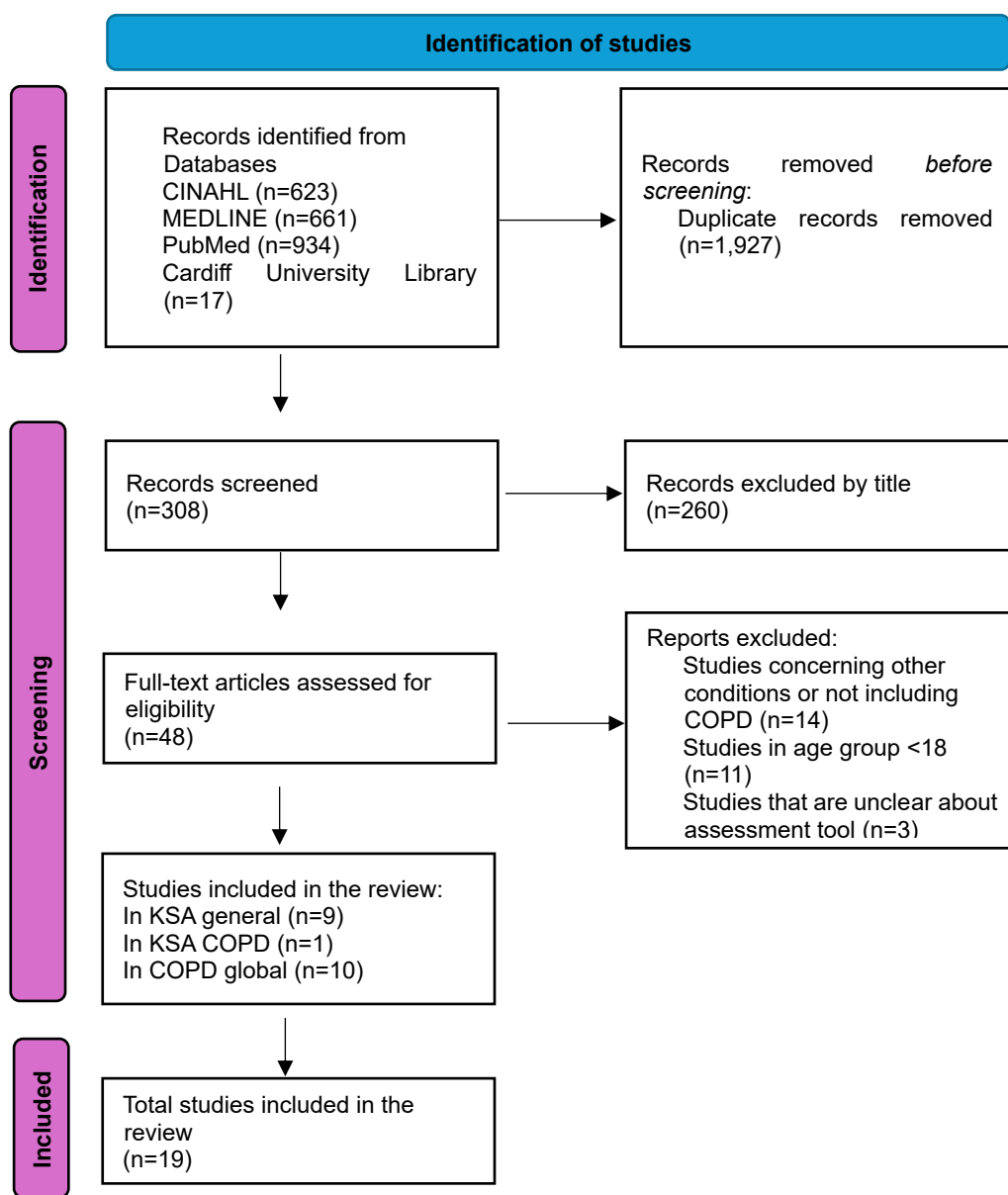


FIGURE 2.1 PRISMA FLOW DIAGRAM OF STUDY SELECTION FOR SEARCH 1

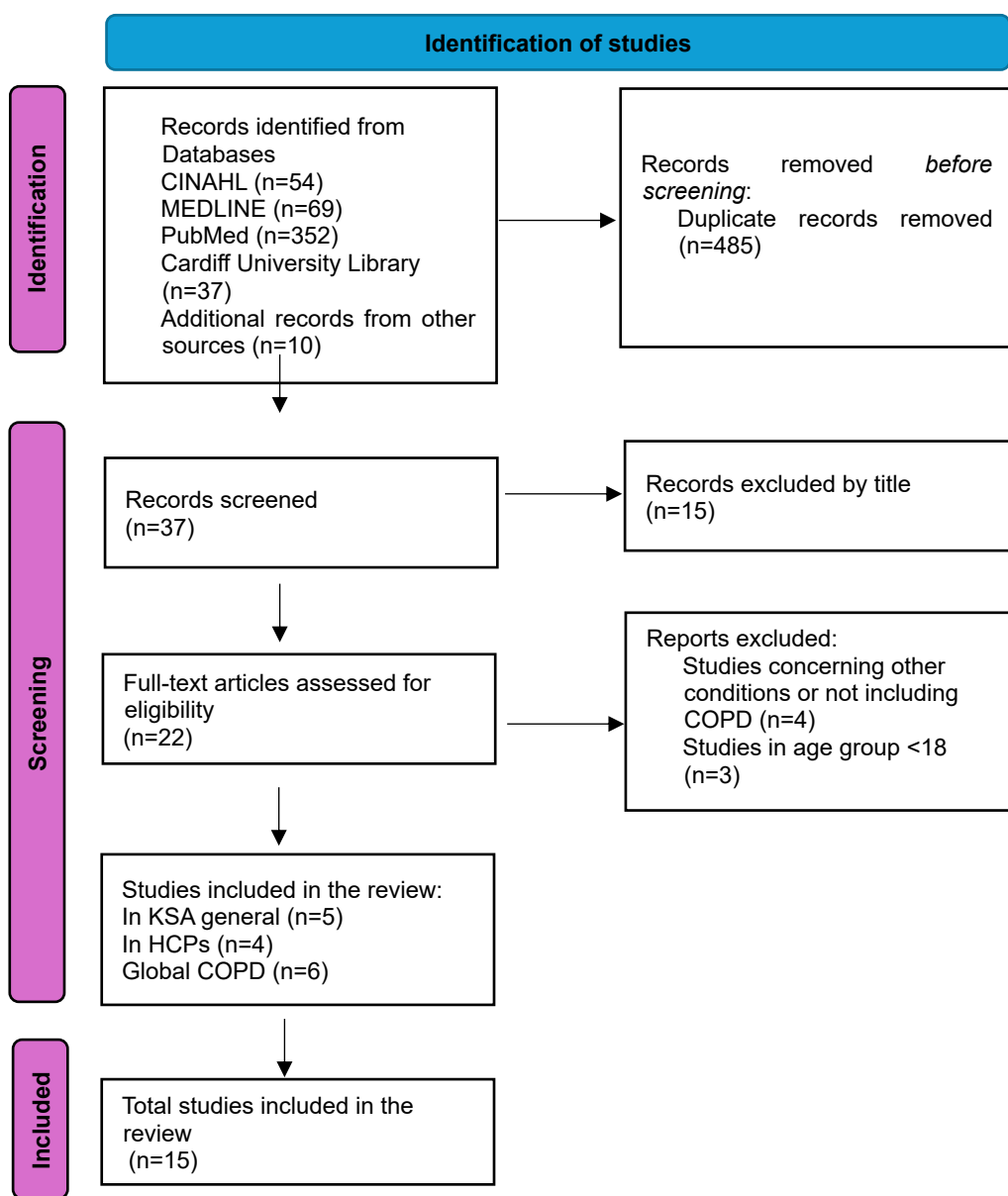


FIGURE 2.2 PRISMA FLOW DIAGRAM OF STUDY SELECTION FOR SEARCH 2

2.2. Level of PA

2.2.1. Level of PA in the General Saudi Population

This section provides a review of the levels of PA in the general population of Saudi Arabia, highlighting key trends and prevalence rates. Understanding the level of PA in the Saudi population is crucial to evaluate public health trends, identify areas for intervention, and establish a baseline for addressing PA in specific groups, such as people with COPD. Several studies have investigated PA patterns and trends in Saudi Arabia, illustrating various aspects of this important health behaviour.

The WHO (2016) estimates that 58.5% of Saudis are physically inactive, a figure further exacerbated by findings from the Saudi General Authority for Statistics (2019), which reported inactivity rates as high as 78% (General Authority for Statistics 2019). Several studies have shown a large portion of the population being classified as physically inactive (**see Table 2.1**) (Al-Refaee and Al-Hazzaa 2001b; Al-Nozha et al. 2007; Al-Eisa and Al-Sobayel 2012; Al-Zalabani et al. 2015; Bcheraoui et al. 2016; Althumiri et al. 2020; Alqahtani et al. 2021), in addition to two reviews by Al-Hazzaa (2018) and Evenson et al. (2023).

This persistent inactivity is confirmed by a systematic review by Al-Hazzaa (2018) of the available studies concerning PA among the Saudi population. After examining 65 studies, the findings indicated that the occurrence of physical inactivity varied, with rates ranging from 26% to 85% among males and from 43% to 91% among females. Notably, the southern, northern, and central regions were found to have the highest levels of physical inactivity. Specifically, among adolescents, 55.5% of males and 21.9% of females were inactive. A more recent scoping review of population-based PA and sedentary behaviour in Saudi Arabia was conducted by Evenson et al. (2023). Through a comprehensive search strategy spanning six databases and a thorough screening process, the authors identified 19 pertinent studies focusing on age groups from children

to adults. Utilising predominantly cross-sectional designs and self-reporting measures, the included studies revealed concerning trends: a significant proportion (94.9%) of the participants failed to meet the recommended PA levels, with many individuals engaging in prolonged periods of sedentary behaviour. Notably, among adults, approximately half reported insufficient PA, while a significant portion (approximately 50% to 80%) spent an excessive amount of time sedentary each day. These findings underscore the urgent need for targeted interventions and national strategies to promote PA and reduce sedentary behaviour across all age groups in Saudi Arabia. However, the review also acknowledges several limitations, including that the featured studies utilised various self-report tools, often did not differentiate between PA and exercise, and did not focus on tracking physical behaviours, resulting in a lack of data concerning important factors such as age and gender (Evenson et al. 2023). In addition, there was the potential for publication bias, as well as variations in sampling and data collection methods.

Several cross-sectional and case-control studies using different methods among a range of demographic groups in Saudi Arabia provided valuable insights into the current level of PA (see **Table 2.1**). Al-Nozha et al. (2007) conducted a cross-sectional study using data from the Coronary Artery Disease in Saudis Study (CADISS), a national epidemiological health survey, to assess the prevalence of physical inactivity among 17,395 Saudi people between the ages of 30 and 70 years. Their findings revealed high rates of physical inactivity (96.1%) in the population. There were considerably ($p < 0.001$) more inactive females (98.1%) than males (93.9%). The lack of activity frequency did not substantially differ between BMI in active and inactive groups in males ($p = 0.468$) or females (0.176). However, the active group had a considerably lower mean BMI than the inactive group among males (27.0 vs. 27.5) and females (28.5 vs. 29.7).

Similarly, Al-Zalabani et al. (2015) utilised the STEP-wise method of Surveillance (STEPS) supported by the WHO and surveyed 4,758 participants between the ages of 15 and 64 years, reporting that the frequency of physical inactivity was 66.6% in males and 72.9% in females. This study supported the pattern of behaviour reported in Al-Nozha et al.'s findings, which stated that physical inactivity was more common among

females than males. These findings align with those of Bcheraouiet al. (2016), who conducted a large-scale household survey using the IPAQ long form to assess PA levels in the Saudi population aged 15 years and older, revealing that 34.5% of participants stated being inactive, while only 12.9% met the recommended levels of moderate PA (150 to 300) MET-minutes per week. Althumiri et al. (2020) used the National Health Interview Survey (NHANES) and found that among 3,699 participants aged 18–64 years, 33.5% met the WHO's guidelines for moderate PA (150 min/week), 18.8% met the WHO's guidelines for intensive PA (75 min/week), and 28.1% met the recommended weekly combined amount of intensive and moderate PA (150 min/week) (Althumiri et al. 2020). While these investigations evaluated a broad sample of Saudi males and females, thereby enhancing the generalisability of the results, they evaluated PA using a survey, thereby resulting in potential bias, social desirability, or a lack of participation, any of which could influence the relevance of the reported data (Wang and Cheng 2020).

Additional evidence was provided by Al-Eisa and Al-Sobayel (2012) who demonstrated low PA levels among Saudi women, with an average of only 5,114 steps per day using the Omron HJ-152K-E pedometer, which falls below the international reference for minimum activity. This study highlighted a significant association between self-efficacy and PA levels. Young, educated Saudi females showed a higher internal health locus of control (HLC), indicating that they take more accountability for their activities. Nevertheless, this study relied on a small sample of young, educated women aged 18 to 45 years, which hinders the findings' generalisability to the wider population of Saudi women (Etz and Arroyo 2015) and may compromise the study's validity on an internal and external level (Faber and Fonseca 2014). Aside from that, the investigation was conducted in a university setting with a uniform and self-selected sample, and a sizeable proportion of the participants withdrew.

Al-Refaee and Al-Hazzaa (2001) surveyed adult males living in Riyadh and the questionnaire collected extensive details regarding PA habits, including type, frequency, duration, and intensity. The criteria for PA defined an inactive person as one who does not engage in any PA regularly. In contrast, an active person was deemed to be one

who engages in PA for 30 minutes or more for at least 2 days per week. They found that over 53% of Saudi males were physically inactive, which is lower than the inactivity rates reported by Al-Nozha et al. (2007) and Al-Zalabani et al. (2015). These discrepancies may be due to differences in the research population and the choice of methodology but the finding of excessive inactivity remains consistent. However, Al-Refaee and Al-Hazzaa's (2001) study focused on Saudi males, which limits the generalisability of the findings (Etz and Arroyo 2015). Furthermore, they utilised children to administer the questionnaire to their parents, which may result in lower participation and biased results. Furthermore, the investigation was carried out in 1996 and, therefore, the findings may be inaccurate and outdated because lifestyle patterns and public health goals have developed since then.

A more recent study conducted by Alqahtani et al. (2021) employed a national survey approach to assess the prevalence and patterns of PA among adults aged 18 years or older in KSA by analysing data from the Household Sports Practice National Survey and General Authority for Statistics. According to the findings, PA levels have increased in KSA since the report by Bcheraoui et al. (2016). However, they are still very low; only 17.40% of adults were physically active, while 82.6% were physically inactive across a sample of 26,000 families. Alqahtani et al.'s (2021) study highlighted that walking remained the most common activity (56%), although overall PA levels were significantly lower among women (8.9%) than men (28.3%). However, Alqahtani's study failed to investigate the risk factors associated with physical inactivity in the Saudi population, which may have influenced the validity of the findings.

Several common characteristics were identified in these investigations as contributing to low PA levels in Saudi Arabia. Age-related declines in PA were evident, with inactivity increasing with age, particularly among males (Al-Nozha et al. 2007). The 55-64 year age group were found to have a higher prevalence of physical inactivity than the other age groups (Al-Zalabani et al. 2015). Al-Refaee and Al-Hazzaa (2001) reported that the proportion of inactive young males aged 19 to 29 years has surpassed 50%. Inactivity rates rise to 60% in middle-aged people. Inactivity then drops to 53% among those aged

50 to 59 years and to a low of 47% among those aged 60 and older. While inactivity declines in older age groups, the overall likelihood of meeting the recommended minimum-to-moderate weekly PA levels remains low across all ages (Bcheraoui et al. 2016)Click or tap here to enter text..

With regards to gender, it is recognised that males are more likely to be physically active than females (Al-Nozha et al. 2007; Al-Zalabani et al. 2015; Bcheraoui et al. 2016). In contrast, Althumiri et al. (2020) found no significant difference in the frequency of PA between males and females. Females' lower levels of PA are likely to be due to cultural and social factors rather than biological factors. Saudi culture is that women are not supposed to engage in physical activity in public. Walking for exercise is usually acceptable for women living in cities, although it may not occur in rural areas (Al-Zalabani et al. 2015). However, these research studies examined sports and leisure-time PA. They did not quantify all physical activities, including those conducted at home, such as carrying children and cleaning (Al-Nozha et al. 2007).

Socioeconomic and regional differences also played a role in PA levels. Al-Nozha et al. (2007) showed that the prevalence of inactivity declined with increasing education levels, a finding supported by Al-Zalabani et al. (2015), who concluded that men with moderate education and those in non-governmental jobs are less likely to be physically inactive. Meanwhile, Al-Refaee and Al-Hazzaa (2001) found that the proportion of high education levels is larger among the frequently active than among the inactive (49% versus 36%). Researchers also found that those who are married, have jobs in the private sector, work multiple shifts, or have just one day off per week had fewer opportunities for PA. These findings do not align with those of Bcheraoui et al. (2016), however, who reported that PA is low among more educated Saudis because PA is not regarded as a health benefit among those educated in Saudi Arabia.

Regional variations indicated that the northern and central regions reported the highest proportion of no PA at work, leisure, or transportation. The highest proportion of participants achieving a high level of PA was reported in the southern region (23%). The

participants from the southern region, those who are retired or unemployed, and people aged 55 to 64 years are more likely to have more sedentary time. Meanwhile, women from the central, eastern, and northern regions are more likely to be physically inactive (Al-Zalabani et al. 2015).

When considering the factors explaining why Saudis avoid engaging in PA, the most prevalent cause is a lack of motivation due to time limitations, hesitation to participate in PA, a lack of facilities, and a lack of confidence in the benefits. Other factors include a lack of accessible facilities, time, and injury or disabilities (Al-Refaee and Al-Hazzaa 2001b; Alqahtani et al. 2021).

Despite differences in study design and methodology, these findings underscore the urgent need to address the public health challenge of physical inactivity in Saudi Arabia. Common methodological drawbacks include reliance upon self-reported data, which is susceptible to bias and may not adequately represent participants' engagement levels (Sedgwick 2013). Cross-sectional studies restrict the ability to arrive at causal conclusions regarding the association between inactivity and health consequences. Despite the large sample size of many of these studies, outcomes are limited in their applicability to other populations or global situations. Furthermore, the lack of longitudinal data in these research studies restricts the capacity to observe changes in the population's patterns and behaviours over time. Moreover, self-report measures are subject to reporting bias and may be less valid than objective measures such as pedometers, which add cost and complexity in large studies.

Despite these limitations, the reviewed studies collectively highlight important findings regarding PA levels in Saudi Arabia. Low levels of PA was common, with inactivity rates ranging from 66.6% to 96.1%, influenced by sociocultural barriers, a lack of facilities, and limited opportunities. Addressing these issues will require tailored public health strategies considering the unique cultural, social, and demographic factors influencing PA in Saudi Arabia.

Table 2.1 Studies investigating PA in the general Saudi Population

Author/ year	Study design	Population (gender, age)	Outcome measure and categories of PA	Results
Al-nozha et al. (2007)	Cross-sectional study	General population of Saudi Arabia (n=17,395); Males: 8,297; Females: 9,098 Aged 30-70 years	- PA questionnaire was taken from the Coronary Artery Disease in Saudis Study (CADISS) which is a national epidemiological health survey compiled through interviews by trained primary care physicians. The survey covered basic demographic and socioeconomic information, along with individuals' medical history, leisure-type PA and sports, including walking. It gathered details on participants' PA habits, including types, frequency, and the duration of participation. Classification of PA: PA classified into five intensity categories and assigned (MET) values according to the compendium of PA	- Very high prevalence of inactivity, especially among females (98%). - Activity inversely related to age ($p>0.05$). - Prevalence of inactivity highest in central region and lowest in southern region of Saudi Arabia. - Active people recorded lower BMI and waist circumference.

Al-Eisa and Al-Sobayel (2012)	Cross-sectional study	General population of Saudi Arabia; Females n=105; Aged 19-44 years	PA measured using a pedometer over two weeks. HLC, and self-efficacy. Daily step count using a pedometer; categories based on step count: <5,000 = sedentary; 5,000–7,499 = low active; 10,000 = active	- Average step count: 5,114 steps/day, categorised as 'low active.' - Strong correlation between step count and self-efficacy ($r_s = 0.75$).
Al-Zalabani et al. (2015)	Cross-sectional design	General population of Saudi Arabia n= 4,758; Males 2,340; Females 2,418 Aged 15-64 years	Global PA Questionnaire (GPAQ). GPAQ classifications: High ($\geq 3,000$ MET-min/week); Moderate (≥ 600 MET-min/week); Low (< 600 MET-min/week)	66.6% reported low levels of PA. 16.8% reported moderate PA, 16.6% reported high PA. Higher PA in the southern region due to less urbanisation and more work-related activity.
El Bcheraoui et al. (2016)	Cross-sectional study	Saudi households n=10,735; 49.4% female Age ≥ 15 years	Participants completed the Saudi Health Interview Survey PA assessment using IPAQ to classify respondents into four groups: (a) vigorous (≥ 300 MET-min/week); (b) moderate (150–300 MET-min/week); (c) insufficient (0–<150 MET-min/week); (d) inactive (0 MET-min/week).	- 34.5% of Saudis reported no PA. - Only 12.9% achieved moderate PA levels; 26.8% achieved vigorous PA levels. - PA levels decreased with age and education and were lower among women (AOR = 0.23).

Althumiri et al. (2020)	Cross-sectional (secondary analysis)	General population of Saudi Arabia n=3,699; Males 1,893; Females 1,806 Aged ≥ 18 years	PA assessment survey adopted from questions on the National Health Interview Survey (NHANES). WHO guidelines: Moderate PA (≥150 min/week); Intensive PA (≥75 min/week); Combined PA (≥150 min/week).	- PA inactivity prevalence: 66–81%. - 33.5% achieved moderate PA guidelines, 18.8% met intensive PA, and 28.1% achieved combined PA. - No significant difference in the frequency of PA between females and males ($p>0.05$).
Alqahtani et al. (2021)	Cross-sectional (national survey)	Families across Saudi Arabia n= 26,000 Aged ≥15 years	The survey consisted of six sections in Arabic. It assessed individuals' engagement in sporting activities, including frequency, duration, location, past participation, reasons for discontinuation (if applicable), and barriers to PA. PA defined as ≥150 min/week of moderate to vigorous PA.	PA prevalence: 17.4%; 82.6% of participants did not meet PA guidelines. - Males were more active (28.3%) than females (8.9%). - Walking was the most common activity (56%). - PA decreased with age and was higher in urban regions.

COPD: Chronic obstructive pulmonary disease; GPAQ: Global PA Questionnaire; IPAQ: International PA Questionnaire; MET: Metabolic Equivalent; MVPA:

Moderate to Vigorous Intensity PA; ND: No Data; PA: PA; SAM: Step Watch Activity Monitor; VPA: Vigorous-Intensity PA; WC: waist circumference.

2.2.2. Level of PA in People with COPD

The level of PA in Saudi Arabia is generally low and limited research has been conducted into PA patterns among people with COPD. Alyami (2018) is the only research to date that examines PA patterns in people with COPD in Saudi Arabia, making it a crucial reference for understanding PA levels in this population (see **Table 2.2**).

Alyami et al. (2018) used tracking devices to analyse walking and sedentary behaviour among 30 Saudi retired males aged ≥ 40 years with COPD and healthy controls. A StepWatch Activity Monitor (SAM) was utilised, a compact tracker that connects to the right ankle with a Velcro strap and responds to time, acceleration, and position, to quantify walking-based activity and sedentary behaviour among subjects. Cindy Ng et al. (2012) found that the SAM device was sensitive and reliable even when the step rate changed somewhat. Alyami et al. (2018) also measured functional exercise capacity using 6MWD over a 45-metre level straight course within an enclosed corridor.

Alyami et al. (2018) found that males with COPD spent only 22% of their waking hours engaged in walking-based activities, compared to 37% for healthy controls, and that they spent 78% of their time sedentary, compared to 63% for healthy individuals. Additionally, the participants with COPD accumulated significantly fewer daily steps, averaging 4,124 steps per day versus 7,472 steps per day for healthy controls. These findings underscore the prevalent sedentary lifestyle of people with COPD in Saudi Arabia.

These results are consistent with the findings reported by Pitta et al. (2005) and Hernandez et al. (2009) who investigated PA using triaxial accelerometers. Alyami et al. (2018) observed that Saudi males with COPD spent 78% of their waking hours in sedentary pursuits, notably higher than the 64% reported by Pitta et al. (2005) for Belgian patients. The findings are similar to those of Hernandez et al. (2009) in Brazil,

where people with COPD also spent most of their day seated or lying down. These discrepancies may be attributed to regional differences in lifestyle, such as limited opportunities for outdoor PA due to extreme weather conditions in Saudi Arabia, in contrast to the temperate climates of Belgium and Brazil. Additionally, participants' cultural and occupational profiles, particularly the high prevalence of retired individuals among the Brazilian cohort, may contribute to these variations.

Walking time per day was lowest in Alyami's cohort, with people spending 22 minutes of their waking hours walking, which is less than Pitta's observation of 44 minutes per day for Belgian people with COPD and Hernandez's 55 minutes per day for Brazilian people. Both males with COPD and healthy people in this research engaged in walking-based activities at cadences ≥ 100 steps/min. This justifies the lack of distinction between these two groups at high cadences (Alyami et al. 2018). These data indicate that males with COPD, as well as healthy controls in Saudi Arabia, may be at risk of developing persistent health conditions.

Alyami et al. (2018) assessed the association between walking-based exercise and sedentary behaviour comparing males with COPD and healthy controls. In addition, they investigated the correlation between dyspnoea and these behaviours in people with COPD. A total of 34 males diagnosed with COPD were included in the study, with a mean age of 61.9 years compared to healthy participants. The study was limited to male COPD patients, thereby restricting the generalisability of the findings to females. The COPD group reported an average age of 62.0 ± 5.0 years, whereas healthy controls reported an average age of 63.0 ± 4.3 years, demonstrating similar ages across the groups. The majority of the participants had moderate-to-severe COPD, with an average FEV_1 of $46 \pm 15\%$ predicted. The study assessed 6-minute walk distance (6MWD) in a 45-metre straight path within an enclosed hallway among people with COPD and found that these participants dedicated less time to walking-based activities ($22 \pm 8\%$ of waking hours) compared to healthy controls ($37 \pm 7\%$ of waking hours), thereby demonstrating decreased capacity for functioning.

The sample size was small and relied on males entirely because there are cultural barriers to enrolling females, thereby limiting the findings' application to the wider community, particularly females with COPD. Likewise, limiting participants to retirees reduced possible confounding from employment activities, while also narrowing the research group. Several concerns regarding methodology must be addressed because healthy participants were recruited through family talks and brochures, which may result in biased selection.

Both Pitta et al. (2005) and Hernandez et al. (2009) utilised triaxial accelerometers, which provide a more detailed measurement of PA and sedentary time (Pitta et al. 2005; Hernandez et al. 2009). In contrast, although reliable, Alyami's reliance on the StepWatch monitor may have overlooked other forms of activity, such as cycling, which were included in the analyses by Pitta and Hernandez.

Globally, numerous studies have assessed PA levels in people with COPD, often by comparing them to people without COPD. Factors such as disease severity, activity patterns, and the challenges associated with evaluating and encouraging PA in people with COPD are emphasised in the literature. Although people with COPD often exhibit reduced PA levels, the previous research shows different activity patterns depending on how the disease progresses and methodological variations. It is crucial to recognise these differences to create personalised interventions to increase PA levels in this group (Pitta et al. 2005b; Hernandez et al. 2009b; Watz et al. 2009b; Vorrink et al. 2011b; Donaire-Gonzalez et al. 2013; Waschki et al. 2015b; Demeyer et al. 2019; Koreny et al. 2021; Xiang et al. 2022c; Aiello et al. 2024) (**see Table 2.2**).

To evaluate step counts in people with COPD, Donaire-Gonzalez et al. (2013) utilised the SenseWear® Pro2 Armband Accelerometer which displays a minute-by-minute analysis with representations for the number of steps and METs. The study indicated that more than 98% of people with COPD engaged in regular PA, with approximately 25% achieving the requirement of ≥ 30 continuous minutes of moderate physical exercise with a daily mean of 95%. Researchers also discovered that as COPD severity

increased, the number of steps and duration of participation in PA declined significantly and consistently. Additionally, people diagnosed with severe-to-very severe COPD exhibited reduced levels of participation and spent less time on certain leisure activities (Donaire-Gonzalez et al. 2013). Similarly, Koreny et al. (2021) assessed step counts in people with COPD using the Dynaport MoveMonitor. The active improver and active decliners groups were identified based on levels and changes in the number of steps/day. The inactive 173 people (59%) had a low step count of 4,621 steps/day, with a 487 step reduction annually. Meanwhile, the Active Improver group increased their daily step count by 3,378 steps. Active decliners, however, recorded significant reductions from higher initial levels from 11,267 steps/day to 2,217 steps (Koreny et al. 2021). Both investigations examined PA levels in COPD male participants, thereby affecting the ability to apply the findings to females with COPD who may have different activity behaviours. While the use of devices to track step counts in people with COPD is valid in both studies, it may reflect a healthier group of COPD people, which could introduce selection bias (Donaire-Gonzalez et al. 2013; Koreny et al. 2021). It has been noted that the SenseWear® Pro2 Armband tends to underestimate the number of steps taken during treadmill walking and appears to overestimate steps in other circumstances (Lee and Laurson 2015).

Watz et al. (2009) and Waschki et al. (2015) investigated the relationship between PA levels and the severity of COPD. Among the many clinical variables used to determine the severity of COPD, the restrictions of PA are most noticeable in people with the condition at GOLD stage II and this is especially relevant when considering a wide range of disease severity (Watz et al. 2009). In GOLD stage I, there was a significant increase in the prevalence of sedentary COPD people and in the proportion of COPD people who reported only experiencing shortness of breath after vigorous activity. Individuals reporting dyspnoea of MMRC grade 2 or above, as well as those in GOLD stages III and IV, had a significantly higher percentage of highly inactive individuals. Watz et al. found that the severity of dyspnoea was correlated with a decline in PA. This research underscored the association between disease severity and PA, with advanced stages predicting higher levels of inactivity. Following this, Waschki et al. (2015b) discovered

that PA declines substantially over time, irrespective of the initial severity of COPD. This reduction in PA is associated with airflow restriction and a deterioration in health status. Exercise intolerance and muscle loss are two outcomes that all people with COPD experience when their PA levels remain low for a prolonged period. The investigators observed that people with GOLD stage IV took 3,073 steps/day after starting the trial, which was reduced to 1,602. Nonetheless, people with mild-to-severe COPD experienced a notable reduction in PA. In addition, Demeyer et al. (2019) investigated the relationship between PA and disease development. Demeyer et al. (2019) utilised the Sensewear PRO armband to measure PA. They stated that people with COPD have significantly lower activity levels compared to those without COPD, averaging approximately 3,000–5,000 steps per day, with those experiencing more severe COPD symptoms typically being at the lower end of this scale due to increased respiratory problems and physical limitations.

In contrast, healthy people frequently achieve 7,000 to 10,000 steps per day. The study's findings that even early-stage (GOLD I-II) people with COPD had lower PA levels than healthy people confirm that inactivity develops early in the disease. It was underlined by the investigators that inactivity is not only correlated with poorer clinical results but also promotes the development of the disease, hence generating a vicious cycle of deconditioning and diminished exercise tolerance. They also observed a correlation between PA and lung function decline. For every 1,000 extra baseline steps, the yearly decline was slower: FEV₁ by 7 mL, FVC by 9 mL, and DLCO by 0.10 mL/min/mmHg (all $p < 0.05$). Respiratory symptoms worsened 0.4 points less per year ($p = 0.03$), according to the SGRQ. However, the study indicated that there was no notable correlation between PA levels and changes in functional exercise capacity, muscle strength, various health status domains, or body composition (Demeyer et al. 2019). The longitudinal design, use of objective PA measures, and validated assessment tools such as the SGRQ and lung function tests (FEV₁) are considered strengths of this study. However, the study focused on lung function and symptoms, it did not comprehensively assess other important outcomes, such as exacerbation rates or hospitalisations. Also,

the reliance on baseline PA without considering changes over time or specific PA interventions limits its scope (Demeyer et al. 2019).

Vorrink et al.'s (2011) systematic review aimed to measure the impact of COPD on the duration, intensity, and counts of daily PA. They found that people with COPD only achieved 57–75% of the PA levels observed among healthy controls (Vorrink et al. 2011). Daily PA duration, intensity, and counts are all lower in people with COPD compared to healthy controls. This indicates that COPD considerably influences daily PA. The mean percentage of daily PA for people with COPD compared to controls was 57% for duration, 75% for intensity, and 56% for activity counts. The included studies also reported longer durations of inactivity. Those with COPD tended to spend more time seated than controls ($p = 0.004$). Furthermore, they reported a lower standing time (191 ± 99 vs. 295 ± 109 min/day; $p < 0.0001$). The study analysed data from various sources and found that people with COPD seldom exercise more than 30 minutes daily. In contrast, people without COPD often exceed the recommended 150 minutes per week (Vorrink et al. 2011). Regarding the link between PA and disease severity, some people cease exercising because of dyspnoea. In contrast, some cease because of leg exhaustion. This suggests that there are times when more oxygen is supplied to the leg muscles, while other times it flows towards the respiratory muscles. This would explain this modest association between the severity of COPD based on the GOLD classification and PA. The study's comprehensive methodology, which evaluated various aspects of PA, such as duration, intensity, and frequency, offers a detailed insight into how COPD affects PA. The study evaluates the reduction in PA by comparing people with COPD to non-COPD people, clearly illustrating the disease's impact on daily life. However, the cross-sectional design of the research is a considerable issue. Although it may indicate a correlation between COPD and reduced PA, it fails to establish causality. The study cannot definitively determine whether reduced PA exacerbates COPD symptoms or whether the disease itself results in lower activity levels. Moreover, the study inadequately considers possible confounding variables affecting PA levels. The study also fails to investigate the way in which various stages of COPD influence PA levels in greater depth. Regardless of these challenges,

the study emphasises the need for interventions to enhance PA among those with COPD across all disease stages and proposes that subsequent research may focus on longitudinal studies to better understand the long-term impacts of PA on COPD progression (Vorrink et al. 2011).

Furthermore, Yang et al. (2024b) assessed the correlation between the presence or absence of COPD and PA levels with the probability of hospitalisation due to COPD. The investigators discovered that people with COPD were more sedentary than those without COPD, with a significantly lower PA level (35.4% vs. 24.1%, $p < 0.001$). The hospitalisation rate was significantly higher in the COPD group compared to the control cohort ($p < 0.01$). Notably, increasing PA by 500 METs-min/week in people with COPD reduced all-cause and respiratory ED visits or hospitalisation by 10% and 14%, respectively. Compared to the cohort comprising of people without COPD with $PA \geq 1500$ METs-min/week, the people with COPD exhibited an elevated risk of all-cause emergency department visits and hospitalisations across all PA levels, with the most significant risk observed among sedentary people. Likewise, the continuous PA model indicated that a 500 METs-min/week increase in PA was correlated with a 14% reduction in respiratory emergency department visits or hospitalisations in people with COPD and a 7% reduction in the control group. However, the reliance on self-reported PA data introduces recall bias and the study's exclusion of non-aerobic activities may cause PA levels to be underestimated (Yang et al. 2024b).

Xiang et al. (2022) added a broader perspective through a scoping review which sought to evaluate the 12-month impact of the Urban Training intervention on PA among people with COPD. People with COPD experienced a significant reduction in PA duration, intensity, and frequency compared to the healthy, age-matched control group because of breathlessness during activity and reduced exercise capacity. They found that regular PA was significantly associated with peoples' health outcomes, which may promote their ability to exercise, increase QoL, and prevent disease development. Nonetheless, in reality, sustaining PA in those with COPD is challenging. The analysis highlighted considerable variability in PA measuring techniques, thereby limiting the ability to make

direct comparisons. Several studies implemented questionnaires such as the IPAQ, Yale PA Survey (YPAS), the PA Scale for Elderly (PASE), the Longitudinal Ageing Study Amsterdam PA Questionnaire (LAPAQ), and Clinical-PRO active PA. Other studies utilised PA monitors as pedometers and accelerometers. The persistent observation of reduced PA levels across all research underscores the universal aspect of this problem. The research highlighted the need for standardised PA assessment and comprehensive management techniques customised to the specific needs of people with COPD (Xiang et al. 2022c).

Aiello et al. (2024) evaluated the correlation between daily PA and the ability to exercise in a substantial sample of people with COPD, emphasising the reserve of the cardiopulmonary system (Aiello et al. 2024b). They particularly investigated whether COPD patients, classified into active and inactive groups, exhibited differences in exercise ability, as assessed by a cardiopulmonary exercise test (CPET) (Aiello et al. 2024). The study consisted of 214 people with COPD aged 41 to 85 years, categorised by FEV₁-predicted values as mild (14.9%), moderate (44.1%), severe (34.8%), and very severe (6.2%). Mild-stage COPD was relatively common among both active (54.3%) and inactive (41.0%) participants. Active individuals had substantially reduced dyspnoea and muscular fatigue ratings in conjunction with workload when compared with sedentary participants (Aiello et al. 2024b). Moreover, active COPD patients had improved cardiometabolic parameters following maximum activity, shown by increased oxygen uptake at peak exercise and the anaerobic threshold, despite no changes in anthropometric features, resting lung function, or ventilatory responses. On the other hand, experiences of dyspnoea and leg fatigue during progressive exercise were negatively correlated with DPR and HRR values (Aiello et al. 2024b).

The studies reviewed consistently demonstrate that people with COPD engage in significantly lower levels of PA than their non-COPD counterparts. However, the extent of this reduction, its variability, and contributing factors differ across studies, reflecting the complex interplay of disease severity, behavioural patterns, and methodological approaches. The consistent reduction in PA highlights the progressive nature of COPD

and its impact on physical function and QoL. Variability in PA trajectories within COPD populations underscores the need for personalised interventions. Standardised PA metrics, such as step count, provide a valuable tool for monitoring and managing PA levels in clinical practice. Early interventions to promote PA among those with COPD could mitigate disease progression, reduce hospitalisations, and improve overall outcomes.

A potential limitation with the previous literature is that much of the research concerning PA levels in COPD has been conducted outside of the Middle East. While the findings provide valuable insights, cultural and environmental differences may influence PA behaviours, meaning that similar research conducted in other contexts might yield different results. Additionally, there appears to be limited research focusing on the lived experiences of those with COPD in relation to PA levels. Despite these gaps, the existing literature offers important insights into the impact of COPD on PA, highlighting consistent trends of reduced activity compared to people who do not have COPD. Understanding how to help people raise their activity levels requires the factors that promote and hinder PA among those with COPD to be identified.

Table 2.2 Summary of Studies Examining PA Levels in COPD Patients Compared to Non-COPD Populations

Author/ year/ location	Location	Study design	Population (gender, age)	Outcome measure and categories of PA	Results
Alyami et al. (2018)	Saudi Arabia	Cross-sectional study	30 COPD male and 29 healthy male controls Age: 62.0±5 and 63.0±4.3 years	- Walking-based activity using the SAM, which is a small monitor that attaches to the right ankle. PA defined as ≥7,000 steps/day	- Males with COPD, in comparison to healthy controls, spent 15 ± 12% fewer waking hours engaged in walking-based activity and 15 ± 13% more waking hours engaged in sedentary behaviour. - Moderate-to-strong associations between the scores of the quality and emotional response components of the D-12 questionnaire and time spent engaged in walking-based activities and sedentary behaviour in males with COPD.
Pitta et al. (2005)	Belgium and Brazil	Comparative cross-sectional study	50 COPD patients (aged 64± 7 years and 25 healthy elderly individuals	- DynaPort Activity Monitor used to assess daily time spent walking, standing, sitting, lying, cycling.	- COPD patients walked less (44 ± 26 vs. 81 ± 26 min/day; p<0.0001) and had lower walking intensity (1.8 ± 0.3 vs. 2.4 ± 0.5 m/s ² ; p<0.0001). - They spent more time sitting (374 ± 139 vs. 306 ± 108 min/day; p = 0.04)

			(age 66 ± 5 years)	- Movement intensity whilst walking measured in m/s^2 .	and lying (87 ± 97 vs. 29 ± 33 min/day; $p = 0.004$). - Strongest correlate of PA was 6MWD ($r = 0.76$, $p < 0.0001$), while lung function and muscle force had moderate correlations.
Hernandes et al. (2009)	Brazil	Comparative observational study	40 COPD patients (18 males, mean age 66 ± 8), 30 healthy elderly controls matched for age and gender	- PA assessed using a multi-axial accelerometer (DynaPort Activity Monitor) for 12 h/day over 2 weekdays - Categories: walking time/day, movement intensity, time spent seated, standing, or lying	- COPD group walked significantly less (55 ± 33 min/day) than controls (80 ± 28 min/day; $p = 0.001$). - Movement intensity was lower (1.9 ± 0.4 vs. 2.3 ± 0.6 m/s^2 ; $p = 0.004$). - COPD patients spent more time seated (294 ± 114 min/day vs. 246 ± 122 ; $p = 0.08$). - 72% of COPD patients met ACSM guidelines (≥ 30 min/day walking) vs. 93% of controls.
Watz et al. (2009)	Germany	Cross-sectional study	$n=192$ participants (163 with COPD; 29	Steps per day was measured using a multi-sensor armband (SenseWear Pro	- PA significantly reduced in COPD from GOLD stage II onwards compared to controls.

			with chronic bronchitis) Age for COPD: 64 ± 6.4	armband), minutes of moderate activity (>3 METs), PA level (PAL), and 6MWD PA classified as: - Moderate activity: ≥3 METs. - PAL: <1.4 = very inactive; 1.4–1.69 = sedentary; ≥1.7 = active.	- Steps/day, moderate activity, and PAL declined by 69%, 69%, and 61%, respectively, from GOLD II to IV. - GOLD stages III and IV best predicted very inactive patients.
Donaire-Gonzalez et al. (2013)	Spain	Cross-sectional study	177 people with COPD; 166 were males aged 71 years old	Accelerometers (SenseWear Pro2 Armband) for eight consecutive days. PA defined and characterised based on energy expenditure and activity intensity measured in METs.	With increasing COPD severity, time in PA, proportion of time in bouts, and frequency of bouts decreased.
Waschki et al. (2015)	Germany	Prospective observational cohort study	163 patients (137 with COPD, 26 with chronic	Steps per day, total daily energy expenditure (TDEE),	- PA declined by 393 steps/day annually, and PAL decreased by 0.04 per year across all COPD severity stages.

			bronchitis); mean age: 63.6 years	PAL, moderate activity (minutes). PAL defined as: TDEE divided by resting energy expenditure. - Inactivity: PAL < 1.4,	- Sustained inactivity was associated with faster declines in exercise tolerance (6MWD) and muscle mass (FFM).
Demeyer et al. (2019)	Spain (multiple sites)	Longitudinal study	n= 177 patients; representative of full PAC- COPD cohort	lung function (FEV1, FVC), symptoms (SGRQ), body composition (BMI, FFM), PA (steps/day).	Higher PA associated with slower decline in lung function (FEV ₁ : 7 mL/year decline, FVC: 9 mL/year decline) and symptoms domain deterioration (0.4 points less/year).
Koreny et al. (2021)	Europe (Spain, Greece, UK, Netherlands, Belgium)	Observational cohort study	291 people with COPD; 237 males with a mean age of 68 years.	Steps/day was measured using the Dynaport MoveMonitor, MVPA (≥ 3 METs), sedentary time, walking intensity. PA levels categorised into clusters based on step count: 1. Inactive: <5,000 steps/day. 2. Active improvers: Baseline >5,000	- 59% of patients were Inactive, walking $4,621 \pm 1,757$ steps/day at baseline, with an annual decline of $487 \pm 1,201$ steps/day. - 17% were Active Improvers, increasing by $3,378 \pm 2,203$ steps/day over 12 months. - 24% were Active Decliners, recording an average reduction of $2,217 \pm 2,085$ steps/day despite starting with higher activity levels.

				steps/day with significant improvement. 3. Active decliners: Baseline >5,000 steps/day with subsequent decline.	
Yang et al. (2024)	South Korea	Retrospective population-based cohort study	296,666 individuals (3,308 with COPD, 293,358 without COPD) Age ≥40 years	Did not specify tool. PA intensity quantified using MET-min/week: - Sedentary: <500 MET-min/week. - Low activity: 500–999 MET-min/week. - Moderate activity: 1000–1499 MET-min/week. - Highly active: ≥1500 MET-min/week.	- COPD patients exhibited lower median PA levels (280 MET-min/week) compared to people without COPD (414 MET-min/week). - 35.4% of COPD patients were classified as sedentary, compared to 24.1% of non-COPD participants. - A 500 MET-min/week increase in PA reduced ED visits and hospitalisations by 10% for all-causes and 14% for respiratory-related outcomes in COPD patients.
Aiello et al. (2024)	Parma, Italy	Retrospective cohort study	214 COPD patients aged 41–85 years	PA level (minutes/day, days/week), exercise	- 39% of patients were Active, whereas 61% were inactive.

				capacity, VO2 peak, dyspnoea ratings. PA classified as: - Active: ≥ 30 min/day, 5 days/week - Inactive: < 30 min/day, 5 days/week	- Active patients had significantly higher exercise capacity (VO2 peak) and better cardiometabolic responses. - Active patients reported less dyspnoea and fatigue during daily activities.

6MWD (6-Minute Walk Distance); COPD (Chronic Obstructive Pulmonary Disease); D-12 (Dyspnea-12 Questionnaire); ED (Emergency Department); FFM (Fat-Free Mass); GOLD (Global Initiative for Chronic Obstructive Lung Disease); METs (Metabolic Equivalent Tasks); MVPA (Moderate-to-Vigorous PA); NHANES (National Health and Nutrition Examination Survey); PA (Physical Activity); PAL (PA Level); SAM (Step Activity Monitor); SOPs (Standard Operating Procedures); TDEE (Total Daily Energy Expenditure); VO2 peak (Peak Oxygen Uptake).

2.3. Barriers to and Facilitators of PA

Barriers and facilitators are key factors that can influence the success or failure of a particular health intervention or behaviour. This review explores the barriers to and facilitators of PA in COPD, with a focus on comparative studies within the general population. Emphasis is placed on comparative studies within the general population to provide a broader context. The primary objective of this part of the review is to identify studies that have investigated the barriers to and facilitators of PA experienced by people with COPD, those without COPD, and the perceptions of HCPs who work on promoting PA for people with COPD in Saudi Arabia. By synthesising this information, this section aims to provide valuable insights into the unique challenges and opportunities for promoting PA in this population.

2.3.1. Barriers to and Facilitators of PA in the Saudi Population and Global Context

Numerous parameters contribute to physical inactivity between both healthy people and individuals with health conditions. Influences represent technological advances affecting daily habits, urban transportation methods, time barriers, obesity, weather changes, insufficient social support, and lack of motivation (Pate 1995). Physical inactivity is a critical public health issue in Saudi Arabia, with particularly high rates among women compared to men (Al-Hazzaa 2018). Various studies conducted in Saudi Arabia have explored the barriers to and facilitators of PA, providing a deeper understanding of the sociocultural and environmental factors influencing PA behaviours (Al-Otaibi 2013; Alsubaiei et al. 2016a; Al-Ghamdi et al. 2018; Alahmed and Lobelo 2019; Aldhahir et al. 2022b; Almaqhawi 2022; Alrimali 2023). The focus of this thesis is on improving PA among people with COPD in Saudi Arabia because there is a lack of research concerning PA in this population. Analysing the challenges and perspectives of people diagnosed with COPD regarding PA can assist healthcare practitioners in building focused and customised PA recommendation programmes for the Saudi population.

The primary objective is to identify the barriers and facilitators that people with COPD face in relation to PA. The intention is to identify possible measures to enhance the efficacy of and adherence to PA among the Saudi population.

2.3.2. Barriers to and Facilitators of PA in Saudi Arabia

Key similarities and differences emerge when comparing these findings with those of global studies, offering insights into tailored approaches for promoting PA. Several studies have investigated the barriers to and facilitators of PA among the Saudi population, although none of them specifically focused on people with COPD (Al-Otaibi 2013; Almaqhawi 2022; Alrimali 2023) (**see Table 2.3**).

A systematic review by Al-Hazzaa (2018) demonstrated that physical inactivity is a widespread concern throughout the Saudi population. The review identified multiple barriers to PA, including urbanisation, heavy traffic, extreme weather, and cultural barriers such as traditional roles for women, a lack of social support, and the use of housemaids. Inactive habits are common among Saudi adults, with 84% of males and 91.2% of females engaging in more than two hours of screen time daily. Unhealthy lifestyle behaviours, such as physical inactivity and excessive exposure to screens, are linked to the development of several long-term diseases such as CVD, cancer, and diabetes (Alshaikh et al. 2017; Patterson et al. 2018). Al-Hazzaa (2018) found that Saudi adults' primary motivations for exercise are weight loss or maintenance, leisure, and social interaction. Al-Hazzaa (2018) identified that the barriers to PA participation for healthy Saudi adults were insufficient time, unsuitable settings, poor facilities, and inadequate resources. The factors that were determined to be positively associated with adults' PA include a higher education level, a high salary, the excitement of PA, self-efficacy, social support, and an environment that is safe. The lack of PA programmes in female institutions, insufficient social support, and limited time and resources were recognised as substantial barriers. However, the study did not thoroughly examine potential solutions to these barriers. Additionally, the review indicated a broad spectrum of physical inactivity prevalence (26% to 91%) linked to differences in the studied

populations, which could reduce efforts to arrive at conclusive insights regarding the issue in Saudi Arabia (Al-Hazzaa 2018).

Al-Otaibi (2013) conducted a cross-sectional study in Al-Ahsa, Saudi Arabia, to examine PA participation among 242 adults (118 men, 124 women) using an 18-item questionnaire. The study explored the relationship between PA stages of change, self-efficacy, and perceived barriers, revealing significant gender differences. Males demonstrated higher self-efficacy scores than females (33.1 ± 6.9 vs. 29.3 ± 7.4 , $p=0.001$) and greater confidence in exercising under stress (12.3 ± 3.5 , $p=0.048$), thereby indicating greater confidence in their ability to engage in PA. In comparison, females encountered more external barriers, particularly time constraints and limited social support. Females experienced limited resources for exercise (6.3 ± 1.5), social support (6.6 ± 1.7), and time for exercise (7.2 ± 1.4), whereas male ratings were 4.86 ± 1.89 , 5.88 ± 2.33 , and 6.01 ± 2.11 , respectively. The results were expected because more than 90% of the female participants were married and approximately two-thirds were working, resulting in limited social support and resources. The findings suggest that self-efficacy plays a crucial role in PA engagement, with males being more confident in maintaining PA, despite the obstacles faced.

It is essential to recognise the geographical characteristics of the study, which was carried out in Al-Ahsa, Saudi Arabia. Al-Hasa, located in Eastern Saudi Arabia, has experienced significant urbanisation since 2015. Al-Ahsa has a dry, tropical climate with a five-month summer and a moderately cool winter (Abdalla et al. 2017). The findings from this localised study should be interpreted with caution regarding their generalisability to wider populations or urban settings. The unique characteristics and demographic composition of Al-Ahsa may influence PA behaviours differently compared to larger cities or other regions within the country (Al-Otaibi 2013).

A cross-sectional evaluation of the PA status of women in Saudi Arabia determined the impact of socio-demographic characteristics, self-efficacy, and perceived barriers on PA levels (Alrimali 2023). The participants completed a Web-based survey to report their

confidence in consistently practising 18 exercises on a scale from 0 to 100. They were also required to provide their evaluation of the barriers to PA which were classified into seven categories: insufficient time, absence of social influence, deficiency of energy, scarcity of resources, inadequate willpower, fear of damage, and insufficient skill. To determine the level of PA, the researcher transformed the reported minutes per week into METs (Alrimali 2023). The questionnaires used in this study have previously undergone extensive validation in the previous research. In addition, internal consistency was confirmed through a reliability analysis using Cronbach's alpha, which yielded values of 0.95 for the self-efficacy scale and 0.86 for the barrier scale, thereby indicating high internal reliability. The results indicated that the average self-efficacy score was 38.2, suggesting that, on average, participants had moderate-to-low self-efficacy. When categorised, 57.2% of participants reported moderate self-efficacy, 38.7% had low self-efficacy, and only 4.1% exhibited high self-efficacy. This distribution suggests that while most participants had moderate confidence in their ability to engage in PA, a substantial proportion experienced low self-efficacy, which may act as a barrier to participation. The investigator determined that self-efficacy significantly affects the degree of PA ($p=0.001$, R^2 value: 0.071) (Alrimali 2023). The study observed no influence of socio-demographic variables, such as caregiving, work status, marital status, education level, age, and area, on PA levels among participants ($p > 0.05$). The primary barrier to PA was lack of willpower (68.7%, $p=0.004$), followed by resource limitations (67.1%, $p=0.911$), whereas religious limitations were the least frequently reported (35.6%, $p=0.858$). Nonetheless, many limitations must be acknowledged when analysing the data (Alrimali 2023).

While both studies provide important insights into PA behaviours in Saudi populations—particularly the role of self-efficacy and perceived barriers—they share several notable limitations. Both Al-Otaibi (2013) and Alrimali (2023) employed cross-sectional designs, which limit the ability to infer causality between variables such as self-efficacy and actual PA engagement. Additionally, both relied on self-reported data, which is subject to recall and social desirability bias and may result in over- or under-estimations of PA levels (Alrimali 2023).

A qualitative study conducted by Almaqhawi (2022) examined potential barriers to and facilitators of PA among Saudi Arabian women over the age of 18 years living in the East Midlands region of the UK. The investigator examined similarities and differences in PA between Saudi Arabia and the UK. The IPAQ was utilised to assess PA levels, with the semi-structured interviews being digitally recorded, transcribed, and analysed using a narrative thematic approach. The IPAQ data were descriptively analysed. The findings indicated that ideal weather, the accessibility and practicality of gyms, reasonable gym costs, a safe environment, the availability of transport options, and a sense of independence were all variables that motivated individuals to engage in PA in the UK (Almaqhawi 2022). The participants identified numerous barriers in the UK, including mixed gyms, academic or parental responsibilities, and gym facilities that have outdated equipment. Conversely, regarding the barriers to PA in Saudi Arabia, the participants indicated that excessive gym fees, limited access to well-equipped gyms, insufficient facilities, environmental factors, a lack of public transport, and cultural habits restricted their engagement in PA. However, the primary motivator individuals identified as promoting their engagement in PA was Islam, because several Saudi women stated that neither dress codes nor the hijab prevented them from engaging in PA (Almaqhawi 2022). Almaqhawi (2022), offers valuable insight into the lived experiences of Saudi women in the UK regarding PA. While this approach enables rich, context-sensitive data collection, the study lacks several elements that underpin qualitative rigour. No details were provided regarding pilot testing of the interview guide or interviewer training, raising concerns about the consistency and dependability of the data collection process. Furthermore, the absence of inter-coder reliability or member checking reduces the study's credibility and confirmability, leaving the findings vulnerable to researcher bias. Although the thematic analysis was appropriate to capture nuanced perspectives, the lack of reflexivity (i.e., acknowledgment of the researcher's positionality) further weakens the study's transparency. Additionally, the absence of a guiding theoretical framework limits the interpretive depth of the findings. While the small, non-random sample of 12 participants is consistent with qualitative research, it constrains transferability beyond the specific subgroup of Saudi women living in the UK.

Nevertheless, the study contributes practical insights relevant to culturally tailored interventions, especially for policymakers aiming to support women's engagement in PA across different sociocultural contexts (Almaqhawi 2022).

In summary, PA in Saudi Arabia is affected by an array of cultural, environmental, and personal factors that pose considerable challenges, especially for women. Previous research indicates that inadequate time, poor facilities, social limitations, and diminished self-efficacy are prevalent barriers. Meanwhile, motivations include weight control, leisure activities, and beliefs that encourage commitment. Gender differences underscore the need for customised methods to help women overcome resource constraints and cultural norms.

TABLE 2.3 SUMMARY OF THE STUDIES CONCERNING THE BARRIERS TO AND FACILITATORS OF PA IN SAUDI ARABIA

Author/ year/ location	Study design	Population (gender, age)	Outcome measure	Results
Alotaibi (2013) Al-Ahsa (Saudi Arabia)	Cross-sectional study	242 participants, 118 were male and 124 were female aged 20-56 years.	A multi-section questionnaire was developed to measure the following: Demographic data; Anthropometric data; Self-efficacy; Perceived barriers.	Males had significantly higher self-efficacy scores (33.1 ± 6.9) than females (29.3 ± 7.4) ($p=0.0001$). Internal barriers: -Lack of energy -Lack of motivation External barriers: -Lack of time -Family responsibilities -Employment -Difficulty finding time to exercise without social support and resources

Alrimali (2023) Unspecified parts of Saudi Arabia	Cross-sectional study (survey)	509 Saudi women aged over 18 years.	Online questionnaire consisted of 4 parts: - Socio-demographic - IPAQ-SF - The exercise self-efficacy scale developed by Bandura. - Centers for Disease Control and Prevention questionnaire	Self-efficacy significantly influenced PA levels ($p=0.001$). Barriers to PA: - Lack of willpower: 68.7% - Lack of resources: 67.1% - Lack of energy: 66.9% - Religious barriers: 35.6% - Fear of injury, lack of willpower, and environmental barriers had significant effects on PA levels ($p=0.004$, $p=0.043$, $p=0.021$, $R^2=0.070$). - Demographics did not significantly affect PA levels.
Almaqawi (2022) East Midlands, UK	Qualitative study (interpretive phenomenology)	12 interviews with Saudi females living in the East Midlands with a mean age of 31.8 years.	IPAQ-SF Semi-structured interviews	- Identified barriers in the UK: limited women-only gyms, academic/family commitments. - Facilitators in the UK: better climate, affordable gyms, flexible schedules, good transport, cultural freedom. - Barriers in Saudi Arabia: high gym costs, limited facilities, cultural and parental constraints, environmental barriers, and lack of transport options.

COPD: Chronic obstructive pulmonary disease, IPAQ-SF: International PA questionnaire short form.

2.3.3. Comparison of Saudi Studies with Global Studies

Globally, studies have identified barriers to and facilitators of PA that are similar to those reported in the Saudi studies (**see Tables 2.4 and 2.5**), albeit with contextual variations. A systematic review by Peng et al. (2023) synthesised qualitative findings across 23 studies and applied the Social-Ecological Model (SEM) to interpret multilayered influences on PA among young adult women aged 18–40 years. The review employed PRISMA and ENTREQ guidelines and appraised the included studies using the CASP tool, thereby adding methodological credibility. However, many of the included studies lacked thorough descriptions and failed to report detailed sociodemographic data, thereby limiting transferability. While Peng et al. (2023) successfully clustered findings across SEM domains, their thematic discussion leaned towards aggregation rather than interpretation, missing an opportunity for deeper theoretical engagement—particularly from feminist or intersectional lenses which could have unpacked the sociocultural power dynamics underpinning barriers such as body image, gender norms, and family obligations.

The review highlighted that many women participate in PA to improve their body image rather than for positive health benefits, resulting in stress, shame, and lower self-confidence. Many cultures, particularly Western and industrialised societies, usually associate thinness with wellness, physical attractiveness, and productivity, thereby exacerbating these pressures (Merino et al. 2024). Meanwhile, gendered narratives represent sports as male-dominated, limiting women from participating in PA (Pankowiak et al. 2024). Familial responsibilities often prevent women from prioritising PA, exacerbated by social judgement and shame about abandoning family tasks, yet familial support may serve as a motivating factor.

The absence of culturally appropriate PA facilities, such as women-only gyms, minimises the leisure requirements of Muslim women, particularly those who wear hijabs. This is the most common barrier that Saudi women face because the lack of resources and facilities plays a role in physical inactivity among women, with several

women reporting that wearing athletic clothes may be inappropriate (Al-Otaibi 2013). This difference between contextually religious versus secular environments is crucial and not sufficiently theorised by Peng et al. (2013). Saudi women in the UK did not report this barrier because the accessibility of gyms in the UK was good, the gym costs were much cheaper than in Saudi Arabia, and the availability of personal trainers encouraged women by providing clear explanations about exercises and the equipment. However, the limited availability of separate gyms for women in the UK hindered women's ability to exercise (Almaqhawi 2022). Despite the availability of separate-sex gyms in Saudi Arabia, the lack of well-equipped gyms was regarded as a crucial barrier that prevented women from being active (Almaqhawi 2022). Therefore, it is essential to emphasise the need for well-equipped gyms for women and to respect their values and beliefs in order to encourage women to be more active.

Cultural and religious traditions, reinforced from an early age, significantly limit young women's engagement in PA in the Middle East (Peng et al. 2023). It is worthy of note that this does not indicate that Muslim women are opposed to PA, rather, they usually perceive PA as a means for improving overall health, shaping their bodies, and engaging in social activities (Peng et al. 2023). However, the lack of cultural and parental awareness significantly influences the level of PA among Saudi women (Almaqhawi 2022). While the SEM was appropriately applied in Peng et al.'s review, the analysis would have benefitted from a deeper contextualisation using religion- or culture-sensitive lenses to better interpret the nuances of these findings. Several studies contained insufficient sociodemographic data, limiting the analysis of factors such as income, education, and urban vs rural environments. Moreover, the focus on research from high-income nations limits the worldwide relevance of the results (Peng et al. 2023).

Another systematic review by Christoforetti et al. (2022) emphasised the significance of environmental factors in Brazil, including the availability of outdoor spaces, secure public places, and recreational venues, in facilitating leisure-time PA. This illustrates the importance of supporting infrastructure for promoting activity and suggests that areas with diversified land use provide greater accessibility for walking or cycling. However,

their focus primarily on environmental factors within the SEM overlooked individual-level variables such as motivation and knowledge. This is not the case in Saudi Arabia, where extreme temperatures for more than four months of the year prevents engagement in walking or cycling, despite the availability of free sidewalks around Al-Ahsa which is located at the Eastern Province of the country (Al-Otaibi 2013). Furthermore, the lack of transportation in Saudi Arabia contributes to physical inactivity (Almaqhawi 2022). The severe temperatures and car-dependent infrastructure in Saudi Arabia prevent outdoor PA (Al-Hazzaa 2018), while inadequate urban planning and restricted access to safe areas exacerbate these difficulties. Another study reported that 43% of the participants recognised weather as a significant barrier in India because the participants stated that they may fall because of the rain and become dehydrated during summer (Patel et al. 2024). Meanwhile, good weather, the availability of parks or natural landscapes, and the feasibility and availability of transportation encourage people to walk in the UK (Almaqhawi 2022).

While Christofolletti et al.'s (2022) findings are valuable, the absence of a rigorous methodological critique reduces the trustworthiness of their synthesis. The predominance of cross-sectional studies in their review also limited causal interpretations.

An additional systematic review by Mbabazi et al. (2023) evaluated the barriers to and facilitators of PA among adults in the UK. They identified that awareness of the benefits of PA is a crucial intrapersonal facilitator, while social support and interaction are important interpersonal facilitators (Mbabazi et al. 2023). The study investigated the impact of adequate support from HCPs on PA and how it can be both a barrier to and facilitator of PA. When HCPs provide assistance, insight, and recommendations, they promote engagement in PA. Conversely, a lack of focus on PA, limited knowledge, or insufficient guidance may deter people from participating in regular PA. However, this review lacked transparent reporting of qualitative rigour, such as reflexivity or triangulation, which raises questions about confirmability. These findings are in accordance with studies conducted among Saudi HCPs; the low number of HCPs and

lack of trained HCPs contribute to the lack of support for people with COPD (Alsubaiei et al. 2016a; Aldhahir et al. 2022b). Approximately 59.2% of physicians in Saudi Arabia reported that they have poor knowledge of PA and only 5.4% have excellent knowledge (Alahmed and Lobelo 2019). These findings highlight the need to increase the knowledge of Saudi HCPs as a crucial primary approach to promote the implementation of PA and PR programmes in Saudi hospitals.

Perera et al. (2022) conducted a study in Sri Lanka involving 77 adults aged between 20 and 60 years, further exploring this population's barriers and motivators. Lack of time was the expressive barrier between males and females (Perera et al. 2022). In the Saudi population, a lack of time was observed more significantly among females than males ($p=0.000$) (Al-Otaibi 2013). Similarly, Patel et al. (2024) found that 33% of participants reported a lack of time as a barrier to PA (Patel et al. 2024). Perera et al. (2022) observed that there is a misconception regarding PA that reducing calorie intake is more beneficial than PA for maintaining health (Perera et al. 2022). Similarly, 17% of participants in India were unaware of the health benefits of PA (Patel et al. 2024).

However, the Saudi population addressed the positive impacts of PA in terms of enhancing overall health, increasing metabolism, preventing disease, and promoting weight loss (Almaqawi 2022). Some participants reported that a lack of support from family or friends presents a major barrier (Perera et al. 2022) and this was also reported among the Saudi population (Al-Otaibi 2013).

Nevertheless, both Perera et al. (2022) and Patel et al. (2024) relied heavily on self-reported data without deeper qualitative follow-up or member checking. This limits the trustworthiness of their findings, especially when discussing complex social constructs such as motivation, awareness, or social support.

In conclusion, the analysed research highlights the complex barriers to and facilitators of PA, with cultural and environmental limitations significantly influencing the situation in Saudi Arabia. Although global studies provide significant insight into the widespread

problems, the distinct sociocultural environment of Saudi Arabia requires customised techniques. Incorporating global best practices, such as enhancing infrastructure and promoting social support, with localised measures, such as gender-segregated facilities and culturally relevant programmes, is crucial to increase PA. However, many of the reviewed studies fell short in terms of methodological rigour, often omitting tools such as CASP or strategies including triangulation and reflexivity, thereby limiting the dependability and transferability of the findings. Although obstacles to and facilitators of PA in the general Saudi population have been well examined, research concerning PA among people with COPD is still limited. PA is essential to COPD care, yet patient and systemic variables limit its successful implementation. There is a paucity of research investigating this topic in Saudi Arabia, underscoring a significant gap in the literature. Future studies need to investigate the obstacles to and enablers of PA for people with COPD, considering the region's distinct cultural and healthcare environment while also using worldwide knowledge to guide possible interventions for the Saudi context.

TABLE 2.4 SUMMARY OF GLOBAL STUDIES CONCERNING THE BARRIERS TO AND FACILITATORS OF PA

Author/ year/ location	Study design	Populatio n	Barriers	Facilitators	Key insights/considerations
Patel et al. (2024) Ahmedab ad, Gujarat, India	Cross- sectional using a questionnair e to assess the facilitators and barriers to PA.	Older adults aged >60 years; 150 participant s Of unknown gender.	Health problems, lack of motivation, weather, lack of guidance, time constraints, lack of social support.	Belief in health benefits, social interaction, enjoyment, professional guidance, family involvement.	Convenience sampling and urban focus limit generalisability; findings emphasise the importance of accessible environments for older adults.
Perera et al. (2022) Colombo District, Sri Lanka	Qualitative study using in-depth interviews among adults living in urban areas.	Urban adults aged 20– 60 years; varying socioecon omic groups.	Time constraints, negative experiences (fatigue, discomfort), misconceptions, lack of support, weather, safety concerns.	Health benefits, social interaction, family support, psycho-social well-being.	Focused on urban adults; limited applicability to rural populations; offers rich qualitative insights.

TABLE 2.5 SYSTEMATIC REVIEWS CONCERNING THE BARRIERS TO AND FACILITATORS OF PA

Author/ year/ location	Study Design	Study Design	Barriers	Facilitators	Key Insights/Considerations
Mbabazi et al. (2023) UK	Systematic review of three studies and the quality of the papers was evaluated using the AMSTAR.	UK-based adults aged 18+ years.	Language barriers, time constraints, health problems, loss of social support, unsafe environments.	Knowledge of health benefits, social interaction, safe environments.	Highlights underrepresentation of BAME groups; limited generalisability due to small number of SRs.
Christofol etti et al. (2022) Brazil	Systematic review of 78 studies including cross- sectional studies, longitudinal studies, descriptive studies,	Brazilian population across various life stages and domains.	Lack of time, competing priorities, unsafe travel environments, poor access to destinations.	Social support, better skills, motivation, belief in capabilities, walkable neighbourhoods.	Focus on domain-specific barriers (leisure, travel, work/study, household); identifies research gaps in work/study PA contexts.

	and one cluster randomised controlled trial.				
Peng et al. (2023) Global	Systematic review and thematic synthesis of 23 studies. The quality of the included studies was evaluated using the CASP tool. The data from the studies were thematically analysed	23 qualitative studies of young women aged 18–40 years.	Lack of time, competing roles, fear of judgement, body image dissatisfaction, low self-efficacy.	Health benefits, stress relief, body image improvement, social support, accessible and culturally sensitive facilities.	Strong focus on intrapersonal and interpersonal factors; overrepresentation of Western perspectives; lacks meta-analytic insights.

	based on the tenets of the SEM.				

AMSTAR: A MeaSurement Tool to Assess systematic Reviews; BAME: black, Asian, and ethnic minorities; CASP: Critical Appraisal Skills Programme; SEM: social-ecological model.

2.3.4. Global Studies of PA Barriers and Facilitators in People with COPD

Due to the limited research available in Saudi Arabia regarding the barriers to and facilitators of PA for people with COPD, it is necessary to draw insight from global studies (**see Table 2.6**). These studies provide valuable perspectives on the factors influencing PA participation in this population. Examining these barriers and facilitators can build a foundational understanding that informs future research and addresses gaps in the local context. Barriers are classified as personal, environmental, or social factors and can be either real or perceived (Dishman et al. 1985). People with chronic diseases like COPD face similar barriers and enablers as healthy older adults, but they also encounter unique challenges (Booth et al. 2000).

Barriers to and Facilitators of PA

Robinson et al. (2018) conducted a systematic review which enhanced understanding of patients' subjective PA experiences following PR and presented thorough evaluations of the facilitators of and barriers to PA for people with COPD (Robinson et al. 2018). They included 17 studies from Canada, Norway, the Netherlands, England, the US, and Sweden. A total of 167 people were diagnosed with COPD throughout the studies after finishing the course of PR. The duration of PR varied between 4 to 12 weeks, with most people not engaging in PA maintenance interventions, although some participated in post-rehabilitation programmes. Seven key sub-themes relating to PA during PR were identified: a) Self-efficacy refers to individuals' beliefs in their ability to participate in PA; b) Intentions highlight the role of education and information in shaping attitudes toward PA; c) The relationship with HCPs emphasises the influence of interpersonal connections on PA behaviours post-rehabilitation; d) Feedback on capabilities and improvements involves evaluations of PA performance to track progress; e) Peer interaction underscores the importance of peer support as a facilitator for sustained PA participation; f) Opportunities post-PR stress the significance of structured and unstructured PA sessions after PR. Finally, routine highlights the need to establish a

consistent PA regimen to maintain long-term adherence (Robinson et al. 2018). The study highlighted that social support, beliefs, and the environment were the main barriers to and facilitators of PA after PR. This highlights the complexity of PA behaviours post-PR, suggesting that a uniform 'one size fits all' approach to increasing uptake is unlikely to succeed. Instead, tailored strategies that consider patients' existing routines, beliefs, and external factors, such as access to activity maintenance programmes, are recommended to support long-term behaviour change (Robinson et al. 2018).

Self-efficacy is a prevalent topic in the research. The confidence and perceived capacity of people with COPD to participate in PA after PR may be influenced by negative perceptions of previous PA experiences (Robinson et al. 2018). Similarly, in healthy Saudi females, self-efficacy significantly affects the amount of PA, indicating that the higher the self-efficacy rate, the more motivated women are to engage in PA and be more active (Alrimali 2023). Additionally, Saudi males demonstrated higher self-efficacy scores than females due to external factors such as a lack of resources or time, familial commitments, or cultural factors such as the need to maintain gender segregation when participating in athletic activities that expose the skin (Al-Otaibi 2013).

Dyspnoea and exacerbations are symptoms that often induce psychological distress and adversely affect peoples' confidence in engaging in PA. However, confidence in applying stress and breathing management strategies is identified as a facilitator for sustaining PA during PR. The value of information and instruction to enhance comprehension of the health benefits of PA has been recognised (Al-Otaibi 2013; Almaqhawi 2022; Alrimali 2023). Guidance from HCPs was often noted as crucial for people because their authority promoted confidence, enabling individuals to feel secure and reassured by their presence after PR, whereas insufficient assistance from HCPs led people to express feelings of demotivation (Robinson et al. 2018). People tend to be more invested in or driven by the results and feel encouraged to continue PA when they see their progress or acknowledge their abilities. Failure to acknowledge progress was perceived as a barrier to PA maintenance because people were discouraged, believing

that the exercises were neither valuable nor beneficial. Moreover, people valued the accessibility of engaging with peers to discuss symptoms and exchange insights in comparable circumstances, alleviating the distress linked to symptoms. Nonetheless, people reported experiencing an overwhelming sense of loneliness that was difficult to cope with after PR, and the absence of social connection post-PR was seen as a barrier to PA. Social isolation may lead to anxiety among people with COPD because their restricted connections may predominantly occur in medical settings or support groups where they encounter others suffering more severe stages of the disease. This contact may serve as a distressing reflection of the ongoing progression of their disease, amplifying concerns for their future health and capacity to maintain an active lifestyle (Robinson et al. 2018).

Furthermore, people often articulated the significance of structured and unstructured PA sessions after PR, especially when seeking to sustain PA (Robinson et al. 2018). However, unclear details regarding maintenance activities limited their ability to explore alternative methods of PA and were seen as a barrier to participation in PA. In addition, reported barriers to attending maintenance sessions included financial constraints, exercise setting, and limitations caused by parental and work commitments. The people across the investigations recognised routine as a significant facilitator. Continued interaction with healthcare experts and colleagues via maintenance groups offered a sense of stability post-PR. Moreover, developing an effective routine was regarded as a prolonged process requiring patience, highlighting the difficulty that many people experience in resisting returning to pre-PR behaviours (Robinson et al. 2018).

The significance of this research lies in its systematic methodology for examining the qualitative literature, offering an in-depth understanding of the many aspects influencing PA maintenance in people with COPD after PR. The focused analysis is a significant strength, providing essential insights for HCPs to develop targeted interventions. However, variability in study methodologies, participant characteristics, and settings may affect the consistency of the findings. Moreover, limited detail with regards to

reflexivity, triangulation, and member checking across the included studies may reduce the overall trustworthiness and transferability of the review (Robinson et al. 2018).

Another systematic review by Thorpe et al. (2012) identified the disease-specific barriers in COPD, such as shortness of breath and negative experiences with PR programmes. However, the review provided only a limited critique of the qualitative rigour of the included studies, which may limit the credibility of the synthesised themes (Thorpe et al. 2012). Exacerbations of disease, clinical fluctuations, and the presence of associated diseases restricted participation in PA and PR for those with COPD. Commitment to PA and PR programmes was avoided owing to numerous factors indicated by people with COPD, including anxiety, depression, challenges sustaining self-motivation, and adverse outcomes such as worsening of the disease and fatigue (Thorpe et al. 2012). Environmental factors, including air pollution, limited opportunities to exercise, poor transport, and financial constraints adversely affected people's engagement in PA and PR.

This aligns with the environmental barriers encountered by the general Saudi population. Therefore, it is essential to develop infrastructure that enhances accessibility in Saudi Arabia. This involves developments in urban architecture, transportation systems, and recreational areas to promote walking and cycling among the general population (Almaqhawi 2022; Alrimali 2023).

The primary factor affecting the ability of people with COPD to engage in PA and PR was nervousness regarding the programme because people expressed worries about HCPs' lack of familiarity with COPD symptoms, the impact that a lack of familiarity has on their health conditions, and uncertainty around the possible advantages of PR (Thorpe et al. 2012). People with COPD reported anxiety that the severity of the PR programme may be excessively demanding and exceed their skills, as well as the duration of the programme. Thorpe et al. (2012) also identified the enablers for participation in PA and PR programmes. People with COPD reported that being committed to a programme, self-motivation, positive prior experiences with PA,

determination, and positive perceptions of PR significantly contributed to sustained engagement in exercise. Moreover, managing their disease facilitates engagement in exercise, as shown by setting targets, improving physical health, and managing the condition (Thorpe et al. 2012).

Barriers to and Facilitators of PR

Sami et al. (2021) investigated the challenges that people with COPD face in accessing and adhering to PR services using a qualitative descriptive design. The study recruited participants from two teaching hospitals in Iran and included 19 people with COPD, 11 family caregivers, and 12 healthcare providers. Data were collected through semi-structured interviews and analysed using conventional content analysis. Semi-structured interviews facilitated a comprehensive examination of participants' experiences while preserving a flexible yet organised methodology for data collection. Nonetheless, the study's results may be affected by the recruitment method because selection bias could occur if participants were not representative of the wider COPD population. While the study offers detailed thematic insights, it does not elaborate on reflexivity or data saturation, which are essential to establish the study's credibility and robustness. The study offered significant insights into the barriers faced by people with COPD regarding PR, which were classified into three categories: patient and family-related barriers; inefficiencies within PR services; and unsuitable organisational contexts for PR (Sami et al. 2021). PR for those with COPD is more challenging and complex owing to the disease's complications and chronic nature, the insufficient understanding of people with the condition and their families, the substantial financial cost associated with COPD treatment, and people's disappointment leading to the abandonment of PR. The second primary area of the research was the inefficacy of PR services, which relates to inadequate multidisciplinary coordination among PR team members, insufficient focus on patients and their requirements, and a lack of professional competence among PR professionals (Sami et al. 2021).

These barriers may influence Saudi HCPs' decisions when referring people with COPD to PR programmes (Alsubaiei et al. 2016; Aldhahir et al. 2022). Thus, the Ministry of Health should establish PA counselling education programmes for medical personnel. These training courses would significantly enhance the application of physical counselling. The WHO's Global Action Plan on PA 2018-2030 endorses the awareness and encouragement of PA by health professionals as one of its 20 policy measures aimed at achieving a 15% relative reduction in the global prevalence of physical inactivity by 2030 (WHO 2019). The intention is that doctors will be able to devote more time to lifestyle counselling. Improving healthcare infrastructure by hiring more HCPs with PA training and increasing the number of doctors available at PHCs is also important.

The majority of the participants and family carers observed that, throughout the decision-making process linked to PR, the PR staff failed to take into account the patients' preferences and requirements and did not conduct a thorough examination of the patients. Finally, the unsuitable organisational environment of the healthcare system has an effect. People with COPD have restricted access to PR services owing to the limited availability of such services, insufficient numbers of rehabilitation centres, absence of facilities in some cities and regions, lack of resources in certain centres, and limited governmental and social support for people with the disease. Also, people's experiences revealed inadequacies in PR organisation and planning, attributed to unclear job descriptions for PR personnel, the absence of definitive PR procedures, and the ineffectiveness of the PR record-keeping system. The absence of follow-up evaluations and services outside of hospital environments, coupled with insufficient oversight of PR services, disrupts the continuity of treatment (Sami et al. 2021).

Hartman et al. (2013) conducted a mixed-method study in the Netherlands which identified key facilitators and barriers to PA among people with mild-to-severe COPD (Hartman et al. 2013). The investigators implemented a triaxial accelerometer (DynaPort) to analyse PA. The average locomotion duration over 24 hours was 6.8%, indicating limited PA levels among the people participating. They found that increased PA was significantly correlated with enhanced functioning and maximum fitness levels,

reduced obstruction of the airways, static lung hyperinflation, dyspnoea severity, improved leg strength, fewer exacerbations, higher illness perception scores, lower depression scores, elevated self-efficacy, and greater autonomous motivation to exercise (Hartman et al. 2013). In people with mild-to-moderate COPD, self-efficacy and the weather were significantly correlated. People with early-stage COPD were likely to be less constrained by their condition and more affected by external variables (Hartman et al. 2013). They also assessed the parameters related to sitting time. Extended sitting time was substantially correlated with more exacerbations, reduced functional exercise ability, and reduced motivational desire for exercise. The study's emphasis on modifiable variables related to PA in COPD corresponds with the primary goal of discovering implementable techniques that motivate and maintain PA in this demographic. The research promotes the development of effective methods customised for people with COPD by acknowledging the possibility of improvement in self-efficacy and understanding the advantages of PA. A noteworthy aspect of this investigation was the use of a triaxial accelerometer, which yielded precise, objective assessments of PA and sedentary duration, thereby increasing the accuracy of the results. The analysis of both physical and psychological aspects provided thorough knowledge of the determinants of PA among people with COPD. Nonetheless, the research lacked a control group to examine the characteristics relating to PA that vary between healthy people and those with COPD. Additionally, they conducted backward regression analysis which was constrained by variable selection, relying on automated statistical criteria (Hartman et al. 2013).

Other qualitative investigations examined the barriers to and facilitators of PA for people with COPD to gain better insight into the unique factors that affect PA (Thorpe et al. 2014; Kosteli et al. 2017). In this study, the SCT was implemented to develop the intervention, which aimed to improve self-efficacy and behaviour change (Kosteli et al. 2017). It also led the investigation by evaluating SCT components such as self-efficacy and outcome expectations to determine their effect on COPD outcomes (Kosteli et al. 2017).

Approximately 26 people aged 50 to 89 years participated in the research. A semi-structured interview guide was developed based on SCT, with questions designed to align with its key constructs, such as self-efficacy, perceived barriers, self-regulatory behaviour, and outcome expectations, with 42.3% exhibiting moderate-to-severe dyspnoea (MRC grades 3–5), thereby indicating a wide range of severity regarding airway restriction (Kosteli et al. 2017). The research highlighted personal barriers such as physical limits, psychological distress, lack of commitment, and negative attitudes towards PA. The participants reflected on their health concerns associated with COPD, including discomfort and rehabilitation from dyspnoea, mobility difficulties, and the possible influence of the weather (Kosteli et al. 2017). People with COPD reported that personal barriers involving advancing age, the intensity of PA, not being followed-up regularly, and limited access to oxygen therapy all prevent people with COPD from committing to PA programmes (Thorpe et al. 2014). Health concerns such as shortness of breath, hospital admission, lack of oxygen, and physical injury influenced their decision to participate in PA (Thorpe et al. 2014). Besides their health concerns, most people emphasised the psychological implications of the physical constraints linked to their COPD, including embarrassment, anxiety, frustration, and disappointment (Kosteli et al. 2017). The participants reported experiencing stressful feelings and a reduced drive to engage in PA owing to the irreversible characteristics of their condition (Kosteli et al. 2017). The participants' opinions about their condition and capacity to change it determined their involvement in PA. Several people perceived PA as irrelevant, rationalising their inactivity by making comparisons with others. Within the framework of personal facilitators, autonomous motivation, controlled motivation, attitudes/perceptions, self-regulation, and accomplishment were also recognised (Kosteli et al. 2017). Although grounded in SCT, the study would benefit from a clearer explanation of analytical procedures, such as inter-coder reliability or how saturation was achieved, to strengthen dependability.

The predominant motivation for engaging in PA was the significance of social interaction with others via participation in such activities (Thorpe et al. 2014; Kosteli et al. 2017). People's perceptions of COPD and its impact on them significantly shaped their

behaviour and, therefore, their capacity to participate in PA (Kosteli et al. 2017). Maintaining an optimistic perspective of their disease facilitated their ability to manage the associated pressures, leading to enhanced perceptions of life (Kosteli et al. 2017). People used various self-regulatory techniques to integrate PA into their daily routines following hospital admission while adapting to the characteristics of their condition (Thorpe et al. 2014). The majority of people said that establishing personal objectives for PA encouraged them and served as a motivator (Thorpe et al. 2014; Kosteli et al. 2017). Most people reported feelings of satisfaction and fulfilment upon setting and achieving a PA goal. In the context of social barriers, several people reported that family members with ongoing needs hindered them from participating in PA, while others, particularly those who were employed, expressed a perceived lack of time for exercise (Kosteli et al. 2017). However, some reported that social and environmental elements influence PA behaviour (Kosteli et al. 2017). Support and encouragement from family and those facing comparable barriers prompted some to increase their PA (Kosteli et al. 2017).

Adherence to PA is essential to enhance overall wellness in people with COPD. However, the factors affecting adherence are poorly comprehended. Xia et al. (2023) conducted a cross-sectional study investigating exercise compliance in a sample of 270 stable people with COPD through a questionnaire that evaluated the following aspects: PA, the impact of supervision, and advice-seeking. The study also implemented the Modified Medical Research Council (mMRC) Dyspnoea Scale, Social Support Rating Scale (SSRS), Self-Rating Anxiety Scale (SAS), and Self-Rating Depression Scale (SDS) (Xia et al. 2023). The total exercise compliance score was 54.1 ± 6.5 , with dimension values of 26.9 ± 3.9 for PA, 9.6 ± 1.9 for supervision, and 17.7 ± 1.1 for advice-seeking (Xia et al. 2023). There was lower adherence in 123 patients (45.9%), while 146 patients (54.1%) exhibited sufficient adherence. Patients with two chronic comorbidities exhibited considerably better adherence than those with one ($OR = 17.13$, $p < 0.05$), and severe dyspnoea was more highly correlated with increased adherence relative to mild dyspnoea ($OR = 16.87$, $p < 0.05$) (Xia et al. 2023). However, severe dyspnoea and multiple comorbidities hindered compliance ($OR = 0.02$, $p < 0.01$), while

higher depression scores were linked to poorer compliance (OR = 0.84, $p < 0.01$) (Xia et al. 2023). Socioeconomic variables contributed significantly because those earning lower incomes were less aware of exercise's positive consequences and restricted their participation in rehabilitation programmes. Similarly, a cross-sectional study by Sritharan et al. (2021) revealed limitations to PA in people with COPD, emphasising forced expiratory volume (FEV₁) and smoking status (Sritharan et al. 2021). The univariate analysis found that a lack of motivation ($p < 0.001$), complications ($p = 0.035$), and fear of breathlessness ($p = 0.009$) represented major obstacles, with a lack of motivation ($p = 0.009$) and complications ($p = 0.016$) being significant in multivariate analysis. In contrast, fear of breathlessness became insignificant ($p = 0.385$) (Sritharan et al. 2021). Lacking motivation surfaced as a key barrier, affected by the accessibility of training, comorbid conditions, and fear of breathlessness. Apprehension about dyspnoea often resulted in reduced motivation because patients considered themselves to be incapable of handling respiratory problems, hence, prompting them to reduce their participation in PA (Sritharan et al. 2021).

To summarise, these studies provide valuable perspectives on the factors influencing PA participation in this population. Examining these barriers and facilitators can help to develop a foundational understanding that informs future research and addresses gaps in the local context. Barriers are classified as personal, environmental, or social factors and can be either real or perceived (Dishman et al. 1985). People with chronic diseases like COPD face similar barriers and enablers as healthy older adults. However, they also encounter unique challenges (Booth et al. 2000). The limited research available in Saudi Arabia concerning the barriers to and facilitators of PA for people with COPD necessitates the leveraging of global evidence to develop a foundational understanding. Studies from diverse settings, including systematic reviews and qualitative investigations, underscore the multifaceted nature of PA behaviours in this population. Barriers such as dyspnoea, psychological distress, lack of motivation, and environmental constraints are consistently identified, while facilitators include self-efficacy, social support, routine, and structured post-rehabilitation programmes. The findings reveal that effective PA interventions must account for individual,

environmental, and social factors, as well as the unique challenges posed by COPD. Tailored, patient-centred strategies addressing these elements are essential to foster sustained PA. However, the qualitative studies reviewed varied in terms of their methodological quality, with many lacking clear descriptions of reflexivity, data saturation, or triangulation, which may affect the credibility and transferability of their findings. The variability in terms of the methodology, participant characteristics, and settings across studies highlights the need for culturally and contextually relevant research to develop effective, localised solutions. Future studies should incorporate rigorous qualitative appraisal frameworks, such as CASP or Lincoln and Guba's criteria, to enhance the trustworthiness and applicability of the findings. By synthesising global insights, researchers and HCPs can better design interventions to address the barriers and leverage the facilitators to improve PA participation and adherence among those with COPD in Saudi Arabia and beyond.

TABLE 2.6 SUMMARY OF GLOBAL STUDIES CONCERNING THE BARRIERS TO AND FACILITATORS OF PA IN PEOPLE WITH COPD

Author/ year/ location	Study design	Population	Data collection method	Results
Sami et al. (2021) Iran	Qualitative study	19 people with COPD (15 male, 4 female), 11 family carers for patients with COPD, and 12 healthcare providers.	Semi- structured personal interviews.	Patient and family-related barriers: - Characteristics of patients and COPD - Financial burden (medications, PR services) - Psychological burden imposed by family members - Inability to cope effectively with COPD dependence on others for daily activities Inefficiency of PR services: - Inadequate professional competence of PR staff
Hartman et al. (2013) The Netherlands	Mixed- method study	115 people with COPD: 68% male, mean age 65 years.	PA was measured with a triaxial accelerometer. Semi-structured interviews.	Most frequent reasons for sedentary behaviour: - Poor weather - Health problems - Lack of intrinsic motivation Most frequent reasons for PA: - Health benefits - Enjoyment - Previous lifestyle - Functional reasons
Thorpe et al. (2014) South Australia	Qualitative study	28 people with COPD (22 male, 6 female) aged ≥ 18 years.	Semi structured telephone interviews.	Barriers: - Self barriers: Subcategories: age, PA or PR, oxygen therapy - Health Subcategories: comorbidities, COPD, physical health - Environment Subcategories: participants' surroundings, transport/finance Enablers:

				- Social Subcategories: support, routine, extracurricular activities - Personal Subcategories: feeling better, goals and motivation - Access Factors include access to equipment and healthcare providers
Kosteli et al. (2017) Birmingham, UK	Qualitative study	26 people with COPD (15 male, 11 female) aged 50–89 years.	Semi-structured interviews.	Main barriers: - Health-related (fatigue, mobility issues, weather-induced breathing problems) - Psychological (embarrassment, fear, frustration/disappointment) - Attitudinal (perception of control over condition, perception of PA, perception of older age) - Motivational Main enablers - Motivation (autonomous or controlled) - Performance - Self-regulation - Attitudes - Accomplishments
Sritharan et al. (2021) Denmark	Quantitative cross-sectional study	493 COPD patients (324 female and 169 male).	Questionnaire regarding the barriers to PA in COPD.	Low motivation was the most significant barrier, influenced by fear of breathlessness and comorbidities.
Xia (2023) Haikou, China	Cross-sectional	270 elderly COPD patients with stable disease (164 male) with a mean age of 68.6±5.3 years.	Exercise compliance and related factors using validated scales.	45.9% had poor exercise compliance, while 54.1% showed good compliance. Predictors of higher compliance included moderate dyspnoea, higher income, and the presence of two comorbidities. Barriers included severe dyspnoea, depression, and being female.

COPD: Chronic obstructive pulmonary disease.

2.3.5. The Experiences of Healthcare Services in Saudi Arabia

When people consult with doctors and other healthcare providers, they have access to health information that may guide them in prioritising the improvement of their health. According to Berra et al. (2015), patients may greatly benefit from PA therapy regarding their health and overall wellness (Berra et al. 2015). The focus of this section is to explore the barriers and facilitators that HCPs in Saudi Arabia face when attempting to promote PA among COPD patients. It seeks to identify strategies to empower HCPs to provide effective promotion of PA, including counselling advice, strategies for motivation, and personalised recommendations to assist patients in integrating PA into their daily routines, even within the constraints of busy clinical environments (**see Table 2.7**).

The systematic review by AlMarzooqi and Saller (2022) found that PA counselling in Saudi Arabia is primarily used in intervention studies and often incorporates health education components and behaviour-based strategies. Despite its demonstrated effectiveness in improving PA levels and clinical outcomes, such as reducing blood pressure and improving glycaemic control, significant barriers hinder its routine implementation. These include a lack of time for counselling, insufficient training for healthcare providers, inadequate educational materials, and patient non-compliance (Almarzooqi and Saller 2022). Cross-sectional research involved a survey being conducted by the National Institute of Health (NIH) to examine the relationship between the knowledge, attitudes, and behaviours of PHC doctors and their offering of PA therapy, in addition to investigating how the physicians' lifestyles, personal health, and demographic factors affect their ability to provide PA counselling (Alahmed and Lobelo 2019). Approximately 46.9% of the participants were general practitioners, whereas 45% were family practitioners. More than half (59.9%) of physicians saw themselves as the main health professionals responsible for encouraging PA. Additionally, 58.5% concurred that they were proficient in facilitating patients' PA, while 53.7% expressed confidence in their capabilities. Moreover, 84.4% of physicians acknowledged that their own appropriate PA enhanced their capacity to provide credible and valuable guidance.

Unfortunately, just 5.4% of the participants had considerable information about PA guidelines or recommendations. Moreover, only 21% had received training on PA counselling whilst at medical school. The three leading obstacles identified by physicians that prevented them from offering PA counselling to patients were: insufficient time (70.1%), inadequate referral services for PA (54.4%), and a lack of proper PA training (38.1%).

However, the findings of this study cannot be generalised to a larger population due to the sampling method used because they surveyed physicians from four cities in the Eastern Province. In addition, the self-reported survey may have overestimated the efficacy of the physician's methods (Alahmed and Lobelo 2019).

Given the established advantages of PA counselling, significant barriers limit its regular use, such as insufficient time, poor training, and insufficient funding. These issues are not exclusive to PA counselling but also extend to other established therapies, such as PR, which also requires committed assistance from HCPs. PR is essential to enhance respiratory function and overall QoL. Building on the previous section, PR offers a structured approach to exercise, education, and breathing techniques specifically designed for patients with COPD. Another study was conducted in the Eastern Province of Saudi Arabia by Alsubaiei et al. (2016). This cross-sectional study used a questionnaire to determine the main barriers to establishing PR programmes in Saudi Arabia. Healthcare providers involved in the treatment of patients with COPD from 22 general government hospitals were recruited for the study, including 123 HCPs: physicians $n = 44$, nurses $n = 49$, and respiratory therapists/technicians $n = 30$. The results showed that most of the healthcare providers (91%) thought that people with COPD would be willing to participate in a PR programme if they were offered a place. However, the main barriers to setting up PR programmes, as reported by healthcare providers, included a lack of hospital capacity 75.6%, trained healthcare providers 72.4%, and funds 48%. The study also found that there is a lack of knowledge among Saudi healthcare providers regarding the content and benefits of PR programmes for people with COPD (Alsubaiei et al. 2016b).

Similarly, Al-Ghamdi et al. (2018) used a survey to assess the knowledge and perceptions of PA to identify the barriers to PR programmes among 803 HCPs in Riyadh, Saudi Arabia, including doctors, nurses, and health educators (HEs). The researchers determined that the majority of respondents agreed that health promotion ($p=0.106$) and encouragement ($p=0.014$) of PA are fundamental to the provision of primary care and they also considered that they had sufficient expertise to counsel patients regarding the advantages of PA ($p=0.02$). The study found that nurses were more likely to report cost as a barrier compared to physicians. The study also highlighted the lack of knowledge among HCPs treating people with COPD regarding the content and benefits of PR programmes in Saudi Arabia. The barriers particularly concerned hospital capacity, the lack of trained HCPs, and the inadequate financial resources.

Alsubaiei et al. (2016b) and Al-Ghamdi et al. (2018) highlight the challenges associated with establishing PR programmes in the Eastern Province of Saudi Arabia. These studies used comprehensive questionnaires to gather HCPs' perspectives on promoting PA and PR. However, a significant limitation lies in their reliance on self-reported data, which can introduce reporting bias and affect the reliability of the findings. Furthermore, the reliance on self-reported measures does not provide a comprehensive understanding of the operational and structural challenges faced by HCPs in diverse settings. Additionally, the generalisability of these findings to other regions in Saudi Arabia is limited.

A further study examined the perspectives and beliefs of HCPs regarding the promotion of PR programmes for people with COPD in Saudi Arabia (Aldhahir et al. 2022). Aldhahir et al. (2022) conducted a cross-sectional study involving 980 HCPs in Saudi Arabia, including nurses (40.1%), respiratory therapists (32.1%), and physiotherapists (16.5%) who completed an online PR questionnaire. The study sought to explore the barriers to PR referrals for COPD patients. The findings revealed that 44.3% of the participants identified a lack of authority to refer patients as a significant barrier, while 61.8% cited

the limited availability of PR centres. Additionally, 52.7% reported a lack of trained HCPs to effectively manage COPD patients.

Despite these challenges, a significant majority stated that such programmes would enhance PA in people with COPD (60.1%) and they believed it would alleviate symptoms of dyspnoea and restlessness (55.6%) (Aldhahir et al. 2022b). Furthermore, they suggested that PR programmes would diminish hospital readmissions (52.8%), reduce the future risk of COPD exacerbation (53.9%), and enhance the management of the disease among people with COPD (60.1%). Concerning other health factors, the majority of HCPs concur that participation in PR programmes may diminish levels of anxiety and depression (48.9%), enhance overall wellness (58.3%), and improve patients' nutritional condition (44.9%). The majority of HCPs (76.3%) favoured in-hospital monitored PR as the optimal delivery option, whereas 56.8% chose home-based PR. Some of the participants preferred personalised PR with HCP help via phone, accounting for 28.1% (Aldhahir et al. 2022). To address the referral gap, the study recommended training HCPs in PR and increasing awareness among physicians about its benefits. Moreover, expanding PR centres and exploring alternative delivery models, such as home-based PR, could enhance accessibility.

Considering these results, the research had many limitations (Aldhahir et al. 2022). The cross-sectional approach collects attitudes and beliefs at a certain moment, restricting the assessment of developments over time or the effects of interventions to alter these perspectives. Response bias may occur when participants in survey-based research provide socially desired responses instead of accurately representing their personal views or behaviours (Aldhahir et al. 2022). Moreover, while the study explores the barriers, it fails to investigate the fundamental causes of these barriers. Qualitative approaches, such as interviews or focus groups, may have yielded more in-depth insights into the difficulties HCPs encounter in recommending patients to PR (Aldhahir et al. 2022).

In summary, promoting PA among COPD patients in Saudi Arabia is essential to improve patient outcomes, yet it faces considerable challenges. Previous studies have revealed that HCPs recognise the benefits of PA and PR programmes, with many acknowledging their role in empowering patients to engage in healthier lifestyles. However, barriers such as a lack of hospital capacity, limited trained personnel, insufficient funding, and inadequate knowledge of PA guidelines persist, thereby hindering the implementation of effective PA counselling and PR programmes. Structural and systemic issues such as insufficient referral pathways, a lack of PR centres, and time constraints pose significant obstacles. Additionally, the lack of formal training in PA counselling for many HCPs emphasises the need for educational interventions to bridge knowledge gaps and foster confidence in the provision of PA guidance.

Despite these barriers, evidence suggests the potential for PR programmes to alleviate symptoms, reduce hospital readmissions, and enhance the QoL of COPD patients. To address the challenges, strategies such as increasing PR training for HCPs, expanding PR facilities, and adopting alternative delivery models such as home-based PR should be explored. Further qualitative research is needed to delve deeper into the underlying causes of these barriers and develop tailored interventions that enable HCPs to effectively integrate PA counselling into routine care.

TABLE 2.7 SUMMARY OF STUDIES CONCERNING THE BARRIERS TO PA AMONG HCPS IN SAUDI ARABIA

Author/ year/ location	Study design	Population	Outcome measure	Results
Alahmed Id and Lobelo (2019) 4 main cities of Eastern Province, Saudi Arabia	Cross- sectional study	147 physicians: 43 males and 104 females, aged 25-60 years.	Adapted survey developed by the NIH (the Physician survey of Practices on Diet, PA, and Weight Control)	More than half of participants had poor knowledge of recognised PA guidelines.
Alsubaiei et al. (2016) Eastern Province of Saudi Arabia	Cross- sectional study	123 HCPs: 44 physicians, 49 nurses, and 30 respiratory therapists/technicians.	Two-part questionnaire with four questions evaluating their knowledge about PR programmes. 13 questions explored: (1) the structure of the PR programme offered; (2) perceived barriers to setting up a PR programme; (3) perceived preventers of participation in a PR programme for COPD patients.	Barriers to establishing a PR programme: - Lack of hospital capacity. - Lack of knowledge about PR in HCPs. - Lack of trained HCPs.

Al-Ghamdi et al. (2018) Five districts of Riyadh, Saudi Arabia	Cross-sectional study	803 HCPs: 304 physicians, 424 nurses, 26 nurse assistants, 31 dieticians, and 13 HEs.	Self-report survey (15 questions) exploring primary HCPs' attitudes and perceptions regarding routine advice on PA.	Barriers that HCPs face: - Lack of time - Patients' motivation - Patients' preference for drug treatments - Lack of health education materials Limited specific training programmes and guidelines
Aldhahir et al. (2022) Various regions of Saudi Arabia	Cross-sectional study	980 HCPs: 53.1% men, 40.1% nurses, 32.1% respiratory therapists, 16.5% physiotherapists, and 11.2% other healthcare specialties such as nutritionists and occupational therapists.	Questionnaire including nine multiple-choice closed-ended questions and free text fields for additional comments.	Barriers: - Lack of PR centres - Insufficiently trained staff Limited authority to refer COPD patients.

COPD: Chronic obstructive pulmonary disease; ND: no data

2.3.6.Literature Summary and Gap

The existing body of literature reveals significant gaps in understanding regarding PA levels, barriers, and facilitators among people with COPD in Saudi Arabia. While numerous studies have assessed PA patterns in the general Saudi population, such as Alqahtani et al. (2021) and El Bcheraoui et al. (2016), these studies indicate alarmingly high levels of physical inactivity but lack specificity in addressing individuals with chronic diseases like COPD. The limited research concerning people with COPD in Saudi Arabia, such as Alyami et al. (2018), shows that this population has markedly low PA levels, with patients engaging in significantly less walking-based activity and more sedentary behaviour compared to healthy controls. However, such studies fail to provide a comprehensive understanding of PA levels across different domains of activity (e.g., household, leisure, occupational).

Globally, studies consistently report reduced PA levels in COPD populations compared to healthy individuals, highlighting the progressive nature of the disease. Watz et al. (2009) and Waschki et al. (2015) demonstrate that PA levels decline as disease severity increases, even in the early stages. Additionally, sedentary behaviour and low activity levels have been shown to contribute to worsening health outcomes, including reduced exercise tolerance, muscle mass, and overall QoL. While these insights are valuable, their generalisability to the Saudi context is limited due to cultural, environmental, and healthcare system differences.

In Saudi Arabia, cultural and environmental factors further compound the challenge. Studies based on the general population highlight gender-specific barriers, with women consistently exhibiting lower PA levels due to sociocultural restrictions, limited access to gender-segregated facilities, and traditional norms. These barriers are likely amplified for female COPD patients, yet no research has specifically explored this subgroup. Similarly, while walking is reported to be the most common form of PA in Saudi Arabia, extreme weather conditions and urban infrastructure that prioritises vehicular

transportation discourages outdoor PA, particularly for vulnerable populations such as those with COPD.

Additionally, existing research concerning the PA barriers and facilitators in Saudi Arabia, such as Alsubaiei et al. (2016) and Aldhahir et al. (2022), focuses on systemic issues such as the lack of PR programmes, insufficiently trained HCPs, and limited awareness of the benefits of PR. However, these studies primarily address PR access rather than PA as a broader lifestyle component for COPD management. Global research, such as Robinson et al. (2018) and Thorpe et al. (2014), identifies factors including self-efficacy, social support, and environmental conditions as being crucial for promoting PA in COPD patients, yet these insights are not well-integrated into Saudi-specific research.

This gap extends to the perspectives and practices of healthcare providers in Saudi Arabia. While Aldhahir et al. (2022) reveal deficiencies in training and the authority to promote PA, there is minimal exploration of how these systemic issues affect PA counselling and support for COPD patients in the Saudi context.

In conclusion, there is a clear need for comprehensive, context-specific research that integrates an understanding of PA levels, as well as the barriers and facilitators for people with COPD in Saudi Arabia. Such studies should consider diverse perspectives, including those of patients, healthcare providers, and caregivers, and address the unique sociocultural, environmental, and systemic factors influencing PA. This research is needed to design culturally sensitive and evidence-based interventions to improve PA engagement and health outcomes for COPD patients in Saudi Arabia.

2.3.7. Research Purpose, Aims, Objectives and Research Questions

The current study's purpose is to identify approaches for improving PA levels among people with COPD in Saudi Arabia. The overall aim was to determine the difference in PA levels between people with and without COPD in Saudi Arabia and explore the barriers and facilitators affecting PA engagement among people with and without COPD. In addition, the research aims to establish the role of health professionals in promoting PA among those with COPD in Saudi Arabia.

Quantitative Phase

Phase one of the current study sought to determine the difference in PA levels between people with and without COPD in Saudi Arabia by answering the following research question:

1. Is there a difference in PA levels between people with COPD and people who do not have COPD in Saudi Arabia?

The objectives of the first phase of the study were as follows:

- To compare self-reported PA levels and HRQoL between people with COPD and people who do not have COPD in Saudi Arabia.
- To evaluate the relationship between PA and HRQoL in both groups and dyspnoea levels in people with COPD.

Hypotheses:

- There is a statistically significant difference in PA levels between people with COPD and people who do not have COPD in Saudi Arabia.
- There is a statistically significant difference in HRQoL between people with COPD and people who do not have COPD in Saudi Arabia.
- There is a statistically significant relationship between PA and HRQoL in people with COPD in Saudi Arabia

- There is a statistically significant relationship between PA and dyspnoea level in people with COPD in Saudi Arabia

Null hypotheses:

- There is no statistically significant difference in PA levels between people with COPD and people who do not have COPD in Saudi Arabia.
- There is no statistically significant difference in HRQoL between people with COPD and people who do not have COPD in Saudi Arabia.
- There is no statistically significant relationship between PA and HRQoL in people with COPD in Saudi Arabia
- There is no statistically significant relationship between PA and dyspnoea level in people with COPD in Saudi Arabia

Qualitative Phase

Phase two of this study aimed to explore the barriers and facilitators affecting PA engagement among people with and without COPD and the role of health professionals in promoting PA for people with COPD in Saudi Arabia by answering the following research questions:

1. What are the barriers to and facilitators of PA that people with COPD and people without COPD in Saudi Arabia encounter?
2. What is the role of health professionals in promoting PA for people with COPD in Saudi Arabia?

The objectives of phase two are as follows:

The primary objective of this phase was to explore the barriers and facilitators influencing PA engagement among people with COPD.

- To explore PA behaviours in Saudi Arabia by interviewing people who do not have COPD to more fully explore PA behaviours and contributory factors.
- To explore the perspectives of HCPs regarding promoting PA for people with COPD.

Researcher's Stance

Due to the fact that the study applies a mixed methods approach, it is important to recognise the researcher's role as the data collection instrument, contributing to research rigour and aiding readers in considering how the researcher's background might influence the study's findings (Creswell 2014; Greenbank 2003; Patton 2002). It is recommended that the researcher's formative culture, language, professional background, and life experiences be acknowledged to enhance the reflexivity of the research (Dickson-Swift et al. 2006). To adhere to this practice, a brief overview of my background follows.

I am a Saudi woman born and raised in Riyadh, the capital of Saudi Arabia, where I completed my education from primary school to university. I come from a large family of six siblings, with a father who is a retired water company employee and a mother who is a retired teacher with a bachelor's degree in history. Education was highly valued in my family and my siblings and I all received a quality education. My siblings pursued careers in medicine, business, finance, project management, and fashion design.

I hold a bachelor's degree in physical therapy and interned in two Riyadh hospitals. After marrying at 23, my husband and I moved to the US for further education. During this period, I gave birth to my first daughter. Subsequently, we moved to the UK where I completed my master's and PhD in healthcare at Cardiff University while my husband earned his PhD. I also gave birth to my second daughter during my master's degree.

Prior to embarking on my academic journey abroad, my internship experience exposed me to the cardio PR department, an area that I perceived to be underappreciated and limited in resources. When visiting specialised hospitals, I was struck by a small room

with minimal equipment which, in my opinion, deserved greater attention and resources. This observation ignited my determination to contribute to the enhancement of this crucial field.

Moreover, my personal connection to COPD significantly influenced my academic path. Having witnessed the impact of this condition on my grandmother and two uncles, I felt a deep personal connection to the subject matter. Their struggles motivated me to specialise in COPD during my PhD degree, turning my academic pursuit into a mission with profound personal significance.

My journey in PA, both in Riyadh and abroad, has further enriched my understanding. Engaging in efforts to improve my activity level, I gained first-hand insight into the motivators and barriers that individuals face, particularly women in my home country. This experience proved invaluable during my research, especially when conducting interviews in Saudi Arabia. By sharing similar experiences, I could empathise with participants, fostering a deeper connection and understanding of their stories.

Additionally, my knowledge of the socio-cultural aspects of Saudi society played a pivotal role in shaping my research approach. This understanding enabled me to connect with participants on a more profound level during interviews, unravelling perspectives and beliefs that might have been overlooked without this cultural context. It has been instrumental in drawing out nuanced insights that contribute to the richness of my research findings.

In essence, my journey from witnessing the limitations of cardio PR to the personal impact of COPD on my family, coupled with my experiences in PA and cultural insights, underscores my unique perspective and positions me to make meaningful contributions to the understanding of PA in COPD, particularly within the context of Saudi Arabia.

Influence of the COVID-19 Pandemic

I commenced my PhD studies just before the outbreak of the COVID-19 pandemic, which significantly affected my research engagement. The initial stages of doctoral studies involve substantial interaction with supervisors and peers but the COVID-19 restrictions disrupted this. However, online events helped me to stay connected and improve my understanding of research methodologies, ethics, academic writing, and exam preparation.

During this time, I returned home and used the lockdown period to refine my study protocol through extensive reading. However, personal challenges arose when my father required intensive care due to COVID-19, thereby affecting my emotional well-being and prompting a temporary hiatus from my studies until I felt emotionally ready to resume.

Living with family and managing childcare made it difficult to create a conducive study environment. Upon returning to the UK, fluctuating lockdown measures and online schooling further disrupted our routine. Despite these challenges, I learned valuable lessons in adaptability during uncertain times like these.

The shift to remote learning diminished collaborative experiences with supervisors and peers. Additionally, COVID-19 forced me to alter my data collection plans from physical measurements to online surveys and interviews, ensuring research continuity despite the challenges presented by the pandemic.

3. Methodology

3.2. Introduction

The research methodology encompasses understanding various research approaches that involve philosophical assumptions and different methods. It also entails identifying the suitability of these approaches for evaluating a research problem (Creswell 2014; Creswell and Plano Clark 2017). As discussed in Chapter 1, the current research focuses on identifying approaches for improving PA levels among people with COPD in Saudi Arabia. To achieve this, a mixed-methods approach was employed. This approach was deemed appropriate because the study required the collection of both quantitative and qualitative data: quantitative data to compare PA levels between individuals with and without COPD, and qualitative data to explore the barriers and facilitators influencing PA engagement, as well as the role of health professionals in promoting PA among those with COPD.

This chapter presents the underlying philosophical assumptions and the researcher's ontological and epistemological positions. It also explains how a mixed method framework guided the research design to answer the research question and provides an overview of the methods applied in each part of the thesis.

3.2.1. Research Design

Mixed methods research designs were first proposed by Greene et al. (1989). They combine quantitative and qualitative methods to generate a more profound insight into the research question. This approach is not linked to any paradigm exclusively and has evolved over time. Creswell and Plano Clark (2017) further defined mixed methods research as a design with specific key features. The data must be collected and analysed in both a quantitative and qualitative manner, and the research design and process must be logical and grounded within theory and philosophy (Terrell 2012). Mixed methods are considered appropriate for the current study because they give researchers an opportunity to explain quantitative results and provide additional insights that would not be possible using other methods (Borkan 2004). However, the most

significant limitation with this approach is that it is time-consuming because there are two research phases that must be completed.

There are four main ways to customise mixed methods research designs to meet particular study goals: convergent, embedded, sequential, and multi-phase designs (Creswell and Plano Clark 2017). When researchers want to combine and contrast concurrent quantitative and qualitative data, they use the convergent design. Qualitative data can be integrated into a study that is largely experimentally quantitative through embedded design. In a sequential design, quantitative and qualitative components are executed in successive phases, offering flexibility when choosing the starting point to best address the research question. Sequential designs can be either explanatory or exploratory. Explanatory designs start with a quantitative phase followed by qualitative inquiry to elaborate on the results, whereas exploratory designs are initiated with qualitative exploration, informing subsequent quantitative investigation. The multi-phase design encompasses a single mixed-methods study, often employing convergent or sequential approaches alongside a standalone quantitative or qualitative study (Creswell and Plano Clark 2017).

The current study adopts an explanatory sequential mixed methods approach, as outlined by Creswell and Plano Clark (2011). This design employs both quantitative and qualitative research designs, with the former being followed by the latter. The first phase of the study utilises a cross-sectional design, which involves a survey that seeks to explore the level of PA among people with and without COPD in Saudi Arabia at a single point in time. Although this design has its limitations, it is capable of accommodating a large number of participants and identifying general trends within the population. However, the study also recognises the potential limitations associated with cross-sectional studies, which may not be able to fully identify a phenomenon. It is from a pragmatist perspective that the study aligns with the belief in the existence of reality but acknowledges the possibility of different interpretations by different individuals (Morgan 2014).

To gain a more in-depth understanding of the phenomenon and to explore different perspectives, the study employed a semi-structured qualitative interview design in the second phase. This approach enabled the study to delve deeper into the reasons behind the possible factors and to identify nuanced perspectives.

Overall, the study includes a mixed methods design to provide clear answers to the research questions. As Branen (2005) and Bryman (2006) suggest, a mixed methods design is more suitable for research questions that cannot be fully addressed using a single research design. It is important, however, to consider the research questions when selecting a research design because not all research questions are suitable for a mixed methods approach (Creswell 2014). While the time-consuming nature of mixed methods research is a recognised drawback, this method is more direct and has the potential to yield findings from different perspectives.

The reason for selecting a sequential explanatory research design is the paucity of data relating to the PA levels among people with COPD in Saudi Arabia, as well as the limited investigation into the barriers and facilitators they encounter. Assessing the present PA levels could be accomplished by surveying a substantial sample from the two primary cities in Saudi Arabia.

3.2.2.Philosophical Assumption

It is essential for all research to have a philosophical foundation that shapes its aim, which is also known as a 'paradigm worldview' or 'worldview' (Creswell and Plano Clark 2017). According to Creswell and Plano Clark (2007), a paradigm is a system of beliefs that directs a research endeavour or the researcher's perspective on the nature of reality. These paradigms have their roots in epistemology (which focuses on how knowledge is acquired) and ontology (which addresses the nature of reality) (Guba 1990; Guba and Lincoln 1994). Therefore, these ontological and epistemological

presumptions should guide the selection of the research design and related methodologies (Creswell 2009; Creswell 2014).

Various paradigms exist for consideration depending on the research question, with constructivism, post-positivism, and pragmatism being the most commonly discussed, as per **Table 3.1** which was adapted from Creswell (2014). Post-positivism posits the existence of a single objective reality or truth, utilising quantitative methods to test theories and hypotheses (Creswell 2014). Constructivism, on the other hand, suggests that reality is subjective and constructed based on individual interpretations, favouring qualitative methods to explore diverse meanings derived from personal experiences (Creswell 2014). Pragmatism, which views reality as both objective and subjective, advocates for a problem-oriented approach that flexibly combines qualitative and quantitative methods to better understand research problems (Tashakkori and Teddlie 2003; Creswell 2014). This paradigm facilitates the use of multiple methods and data collection approaches tailored to the research purpose, thereby making it particularly well-suited for mixed methods research (Johnson and Onwuegbuzie 2004; Johnson et al. 2007; Creswell 2014).

Table 3.1 Overview of the common paradigms in research (adapted from Creswell 2014)

Paradigms	Post-positivism	Constructivism	Pragmatism
Ontology	There is one objective reality or truth, which is the perspective of reality that exists independently of personal opinions or biases.	There can be multiple realities or truths depending on one's subjective perspective of reality. It is important to acknowledge that everyone's perception of reality may differ and there may not be a single objective truth that applies to all situations.	The concept of reality or truth can be a subject of debate or interpretation because it lies somewhere between subjective and objective reality.
Epistemology	One way in which to determine truth or reality is by using reliable tools to test and potentially reject certain hypotheses.	To investigate the meanings of multiple participants towards certain objects, truth or knowledge needs to be interpreted.	The investigation of truth or knowledge can be undertaken using methods that are best suited to the research problem at hand.
Researcher position	To ensure unbiased results, it is crucial for researchers to thoroughly examine the data collection method they use.	The researchers actively interact with human beings and analyse the data they collect.	Researchers choose the subject matter and methodology for their research based on the intended outcomes.
Research type	Quantitative	Qualitative	Mixed methods (quantitative and qualitative)
Research strategy	Survey and experimental research	Phenomenology Narrative Case study Ethnography Grounded theory	Multi-phase (convergent or sequential) Sequential explanatory Convergent Embedded
Data collection method	Experiments and numeric surveys	Interviews focus on group observations	Both quantitative and qualitative methods
Data analysis	Statistical analysis	Text and image analysis	Statistical and text analysis

For researchers aiming to generate credible and trustworthy research, it is crucial to thoughtfully select appropriate and effective methodologies. This requires consideration of the most suitable methods to address the specific research question. Creswell and Plano Clark (2017) recommend that researchers should assess the suitability of methods based on their ability to fulfil the study's stated purpose. Furthermore, the pragmatism paradigm underscores the significance of opting for specific methods over others based on the nature of the research questions (Morgan 2014).

According to several authors, employing a mixed methods design can yield more comprehensive and valuable results by integrating data from various methods (Johnson et al. 2007; Alise and Teddlie 2010; Teddlie and Tashakkori 2009; Morgan 2007). Moreover, a researcher's beliefs and perspectives regarding the practicality of methods can influence their method selection. Embracing a pragmatic paradigm allows researchers to carefully assess the effectiveness of each method and choose the most suitable ones to achieve their research objectives (Shannon-Baker 2016).

Some criticisms have been raised regarding pragmatism and one notable concern is its inability to elucidate the workings of a solution within a specific context. Essentially, a researcher may propose a solution without delving into the reasons behind its effectiveness (Hall 2012; Taylor and Medina 2013). This critique is pertinent, particularly when employing various mixed methods approaches such as convergent mixed methods.

Even though a researcher may corroborate data through diverse methods, there remains the possibility of not obtaining confirmatory results (Morgan 2014). This scenario could result in constrained integration and difficulties in comprehending the underlying reasons for a particular phenomenon. Consequently, in the current study, an explanatory sequential mixed-methods approach was embraced. Aligned with the approach of Creswell (2003), qualitative results can provide a more in-depth understanding, allowing the formulation of research questions based on the analysis of

quantitative findings. This methodological choice aims to address the criticism of limited explanatory mechanisms and offer a comprehensive explanation for the obtained results.

Researchers have the flexibility to select methods from quantitative and qualitative designs, aiming to leverage the strengths of each and mitigate their respective weaknesses, thereby enhancing the comprehensiveness of their findings. The predominant influence of pragmatism on mixed-method approaches is underscored by Creswell and Clark (2018), reflecting the paradigm shaping researchers' methodological choices and interpretation of results. In the current study, the quantitative phase utilised surveys to assess PA, QoL, and dyspnoea levels. The qualitative phase involved conducting subjective interviews to delve into individual experiences with PA, focusing on identifying the barriers and facilitators in Saudi Arabia. By exploring perspectives and engagement with PA among people with and without COPD, as well as HCPs, the research sought to address practical issues aligning with a pragmatic viewpoint.

In the postpositivist paradigm, there is one objective reality or truth bias in data that can be tested, whereas in the constructivist paradigm, it is subjective with multiple realities that may exist. Because it is problem-oriented, the researcher can adopt the most appropriate methods to seek answers to the research questions.

The study initially employed a quantitative phase to measure and compare PA levels between people with and without COPD in Saudi Arabia. While the quantitative findings provided insight into overall trends and differences in PA levels, they did not fully explain why people with COPD were less physically active or which specific barriers or facilitators were influencing their behaviour. These unexplained differences raised further questions that could not be answered through quantitative analysis alone. Therefore, a second, qualitative phase was undertaken to explore in-depth the personal, social, and environmental factors affecting PA engagement and to gain insight into the perspectives of both individuals with COPD and health professionals involved in their care.

The integration of both phases offered a more comprehensive understanding of the research problem. The challenges associated with using a mixed-methods approach—particularly those related to the integration and interpretation of findings across paradigms—are discussed later in this chapter.

As per Polit and Beck's (2014) perspective, researchers typically align themselves with a paradigm that mirrors their worldview. This study applies a pragmatic approach with the aim of enhancing decision-making throughout the research process. Pragmatism, being a problem-oriented philosophy that centres around the research problem, appears to be a fitting choice. Additionally, Dewey's (1998) assertion that pragmatism is concerned with practical issues suggests its suitability for exploring both the barriers to and facilitators of PA in Saudi Arabia to encourage its promotion. Hence, the design of this study is rooted in the pragmatist paradigm and the methodology is elaborated upon in the subsequent section.

In summary, this study was conducted using assumptions of pragmatism. In research, it is critical to comprehend the nature of reality (ontology). There are several realities in the qualitative phase, as opposed to a single reality in the quantitative phase. This may offer a deeper comprehension of the goals of the research. For example, when studying the barriers to PA, attitudes, experiences, and healthcare management for people with COPD, individual characteristics and personal experiences may influence the results. These factors may differ from one participant to another, which means that multiple realities can exist. From an epistemological perspective, the current research employed both quantitative and qualitative methods. The qualitative phase involved conducting subjective interviews that were linked to individual experiences. Through participant selection and data analysis techniques, the researcher had more control over the data during this phase. However, the quantitative phase included questionnaires measuring dyspnoea, HRQoL, and PA. Due to the fact that objective tools were being employed, the researcher was more distanced from the data during this phase.

The next section describes how the researcher's decision to perform sequential mixed methods was affected by the mixed method, which also informed the thesis's objectives and study design. The objectives of this thesis were guided by the mixed methods framework which influenced three main components: the philosophical or theoretical underpinning, the research design, and the data analysis procedures.

3.2.3. Research Methods

Based on the stated purpose of the current study to identify approaches for promoting PA among people with COPD in Saudi Arabia, a sequential explanatory design was used (**see Figure 3.1**). This starts with a quantitative phase (online survey) to evaluate self-reported PA levels and QoL, followed by qualitative phase to further explore contributors to PA (online interviews).

The thesis comprises two phases, as illustrated in **Figure 3.1**, with the aim of achieving specific objectives. This section provides an outline of the methods used in each phase. More detailed information regarding the study design and methods can be found in Chapter 3 (quantitative phase) and Chapter 5 (qualitative phase), with a primary focus on the qualitative phase.

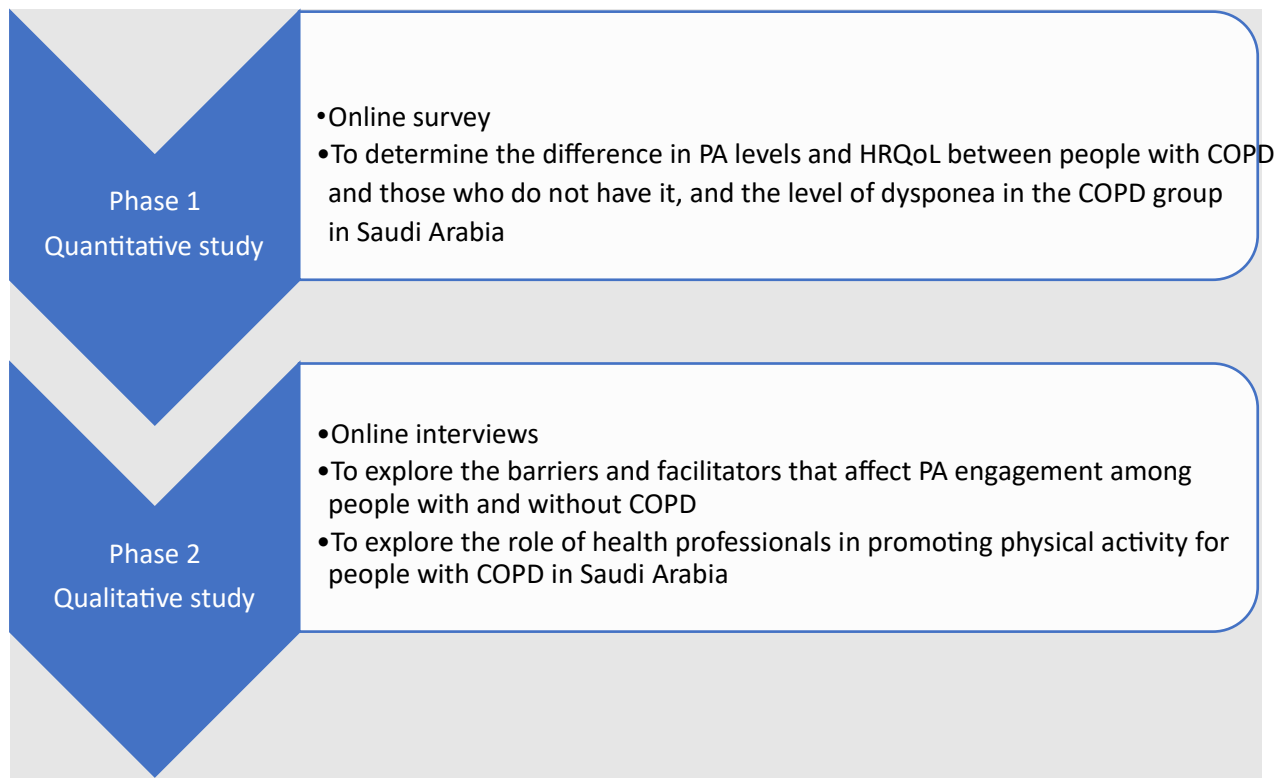


Figure 3.1 Phases of the PhD thesis

3.2.4.Phase 1 - Quantitative Methods

Quantitative research involves collecting and analysing numerical data to answer research questions. It focuses on quantifying the relationship between variables and uses statistical analysis to draw conclusions. In experimental studies, researchers manipulate variables to observe the effect on outcomes, aiming to establish cause and effect relationships. On the other hand, non-experimental studies, including observational studies, do not involve the manipulation of variables but rather observe and analyse naturally occurring phenomena without interference (Chew 2019).

There are three key types of observational studies: case-control, cohort, and cross-sectional studies. Case-control studies are a type of retrospective study which initially categorises participants into two groups: one group with the specific outcome or disease being investigated and another group without the outcome or disease. They

retrospectively evaluate if there is a statistically significant difference in the rates of exposure to a specific risk factor. This implies potential connections between the risk factor and the onset of the specific disease, while no definitive causation can be established. Case control studies are valuable for investigating infrequent diseases or diseases with extended latency periods. They allow for the evaluation of various exposures to provide a more comprehensive understanding of potential risk factors for the specified result or condition. Nevertheless, they are more susceptible to bias, specifically recall bias, which arises when participants are requested to self-report their exposure to a certain component (Mann 2003).

Cohort studies can be retrospective or prospective. Retrospective cohort studies are conducted on data that already exists and the exposures and outcomes have already happened. Prospective cohort studies include enrolling people without considering their exposure or outcome status and, thereafter, tracking them over a specific period to determine the percentage who develop the desired outcome or disease. Cohort studies are valuable for evaluating prognosis, risk factors, and potential harm. They can assess a range of outcomes, allowing an exposure to be rigorously assessed for its impact in developing a disease. They are also useful for rare exposures. However, they can be expensive and time-consuming, and attrition can affect the validity of the study if a significant number of participants are not followed-up (Mann 2003).

Cross-sectional studies are a type of observational study that examine the relationship between a disease and other variables of interest at a single point in time. This design is useful for determining the prevalence of a condition or outcome in a specific population at a given time and for evaluating multiple outcomes. Cross-sectional studies have several strengths, including being relatively quick, cheap, and easy to conduct; measuring the prevalence for all factors under investigation; and studying multiple outcomes and exposures. However, they also have weaknesses, including the inability to determine whether the exposure or outcome came first, being unsuitable for studying rare diseases or diseases with a short duration, and potential bias due to non-response and recall (Mann 2003; Wang and Cheng 2020).

Therefore, the cross-sectional survey is an appropriate method to answer the research question of this study to determine the difference in PA levels and HRQoL between people with COPD and those without COPD in Saudi Arabia because it allows the researcher to collect data only once and evaluate multiple outcomes simultaneously. This is helpful when determining the impact on PA levels and HRQoL in the population under study.

3.2.5.Phase 2 - Qualitative Methods

To provide participants the opportunity to share their views and potentially clarify the outcomes of phase one, a qualitative approach was selected. Various methods and data analysis techniques are utilised in qualitative research (Creswell 2013), with the primary goal being to gain a deeper understanding of a subject by exploring the opinions and perceptions of those involved (Taylor et al. 2016). Qualitative data analysis is inductive, meaning that theories are developed based on patterns found in the data (Taylor et al. 2016). This type of analysis aims to derive meaning from the data to gain a deeper insight into the topic from the participants' perspectives (Flick 2014).

Qualitative data often include images and words rather than numbers, which are more typical of quantitative research (Ritchie et al. 2014). The main advantage of qualitative research is that it provides rich, detailed, and complex data (Ritchie et al. 2014), allowing for a deeper understanding of the topic from the participants' perspectives, which might not be achievable through quantitative methods (Punch 2005). Ritchie et al. (2014) identify four key types of qualitative research based on research purpose: contextual (describing what exists), evaluative (assessing effectiveness), generative (developing theories and strategies), and explanatory (understanding why something happens or the relationship between variables).

Different qualitative research data collection methods, such as in-depth interviews, focus groups, ethnographic research, content analysis, and case studies, have been outlined (Sutton and Austin 2015). These methods aim to uncover the behaviour and perceptions

of a target audience and are used in social and behavioural sciences. The results from these methods are descriptive, and inferences can easily be drawn from the data (Sutton and Austin 2015).

Additionally, other qualitative research methods mentioned include action research, phenomenological, ethnographic, case study, narrative model, and grounded theory. These methods aim to understand the experiences and perspectives of individuals and groups and to develop theories and strategies based on these insights (Grossoehme 2014).

Explanatory research was selected because the second phase of this study aims to explain the results of the first phase. According to Ritchie et al. (2014), this method works well for analysing participant decisions, behaviours, and attitudes toward the subject.

Within a pragmatic framework, systematic procedures like thematic analysis and qualitative content analysis are frequently employed to analyse qualitative data (Savin-Baden and Major 2013). There is sometimes confusion regarding the distinctions and similarities between 'thematic analysis' and 'qualitative content analysis' due to their frequent interchangeability (Vaismoradi et al. 2013).

According to similar meanings and frequency of occurrence, textual material is systematically coded in qualitative content analysis to create categories (Savin-Baden and Major 2013; Joffe and Yardley 2004). Systematic coding is additionally used in thematic analysis, including 'reflexive thematic analysis,' to find patterns or themes in the data that are relevant to the research problem (Braun and Clarke 2006; Clarke and Braun 2013; Clarke and Braun 2021).

Despite their similarities, the choice between these analyses depends on the research context (Vaismoradi et al. 2013; Clarke and Braun 2021). Qualitative content analysis often focuses on the frequency of participants' words in reporting sensitive phenomena, aiming to identify common themes (Vaismoradi et al. 2013; Braun and Clarke 2021).

Because more frequent codes do not always signify more value to the study question, this strategy has been criticised for potentially stripping data of its contextual meaning (Joffe and Yardley 2004). In contrast, a rich description of the data is provided by reflexive thematic analysis, which prioritises the intended meaning of the data relevant to the research question (Braun and Clarke 2021) and this approach was applied in the current study to explore the data. This approach is particularly useful for exploring poorly understood events within healthcare practice and understanding people's perspectives and needs, such as their concerns about an event or the types of people who benefit from a particular service and when they use it (Vaismoradi et al. 2013).

3.2.6. Ethical Considerations

Ethical approval for both the quantitative and qualitative phases of the study was granted by the Ethics Committee of the School of Healthcare Sciences at Cardiff University on 12th May 2021 (**see Appendix 11.1.1**). Additional approval was obtained from King Saud University on 8th July 2021 (see **Appendix 11.1.2**), and from King Fahad Medical City on 13th April 2022 (**see Appendix 11.1.3**). However, amendments were submitted to the Ethics Committee to seek permission to conduct online interviews with people who do not have COPD because the initial results from the quantitative phase indicated no statistical difference between people with and without COPD in terms of their PA levels. Both groups showed similar levels of inactivity which may have similar barriers to PA in the qualitative phase. These changes were approved by the Ethics Committee on 4th August 2022 (**see Appendix 11.1.4**).

Due to the coronavirus pandemic, minimising contact with individuals, especially those with respiratory diseases, was necessary to reduce transmission risks. Consequently, the study was conducted virtually. All of the participants received an information sheet about the study. Personal data, including responses to the online survey and recordings of the online interviews, were securely stored on a password-protected server at Cardiff University. To maintain confidentiality, names, locations, and institutions were anonymised and stored separately from the data. Access to the data via Teams was restricted to the researcher (RA) and supervisors (NG, UJ, AA, DP).

3.2.7. Informed Consent

The participant information sheet was sent out, allowing sufficient time to read it and ask questions before consent was provided (further detail was provided in each phase method). In Phase 1 (quantitative), an electronic consent form was part of the online survey, which needed to be completed before accessing the questions. For Phase 2 (qualitative), the consent form was sent to all participants, in addition to HCPs and they signed, scanned, and emailed it back before the interview. In addition, a verbal summary of the research was provided by the researcher and verbal consent was obtained from the participants in the interview and recorded at the beginning of the interview.

3.2.8. Data Management and Storage

All information collected during the study was stored securely on a password-protected OneDrive cloud service offered by Cardiff University. Data were stored securely in accordance with the General Data Protection Regulation (GDPR) and Research Governance policies at Cardiff University for up to five years after the study has ended. Personal data such as names were excluded and the results were presented in a group format to ensure confidentiality.

The personal data collected was limited to age, gender, weight, height, diagnosis, and duration of disease for people with COPD and were coded and destroyed at the end of the study to ensure anonymity, with pseudonyms used to present data in reports or publications. In addition, contact information (e.g., email addresses) were destroyed at the end of the study.

3.2.9. Risk Management

The study was conducted online with minimal risk associated with completing the questionnaire. The participants may have become anxious that they were not engaging in sufficient PA or distressed when discussing the barriers and facilitators. If that

happened, the interview could have been paused and the participants could contact the researcher after completing the questionnaire if they wanted to discuss anything. The participants were informed that taking part in the study was voluntary; free of cost, apart from giving their time to complete the study; that they could withdraw from the study at any point without the need to provide an explanation; and that their data would not be used in the study without their permission.

3.2.10. Data Collection Process

A sequential explanatory study was conducted to achieve the thesis objectives. The study was carried out in two phases. In the first phase, a quantitative online survey was conducted to investigate levels of PA, breathlessness, and HRQoL in people with COPD as well as PA and HRQoL in people without COPD. In the second phase, people with and without COPD and HCPs were interviewed online to explore in-depth the barriers and facilitators they faced and the role of HCPs in promoting PA for people with COPD. The data from the two phases were combined for interpretation (see **Figure 3.2**).

In mixed methods research, there are two types of sequential explanatory designs: the follow-up explanations model and the participant selection model. The current study utilised the participant selection model, which involves using quantitative data to identify and select individuals for a more detailed qualitative study, with a primary focus on the qualitative phase (Creswell and Clark 2007).

Integrating data from various methods is essential during the interpretation stage of mixed methods studies (Creswell and Creswell 2018). In the current research, the findings were interpreted using a sequential explanatory approach, combining quantitative and qualitative data, with a particular emphasis on the qualitative insights.

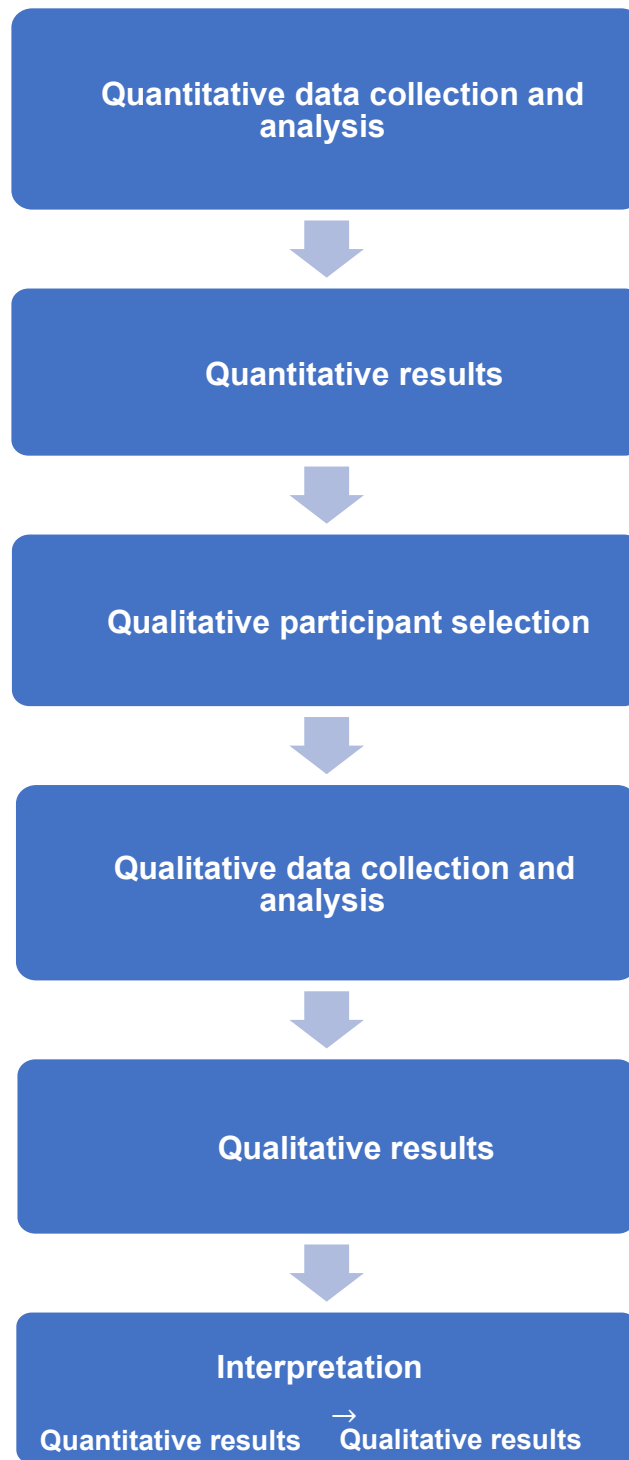


Figure 3.2 Sequential Explanatory Design (participant selection model) (adapted from Creswell and Clark 2007 p.73)

3.2.11. Research Rigour

Quantitative Data

The quantitative online survey data were analysed using descriptive statistics and the results were reported as the mean and standard deviation for continuous data or median and interquartile range (IQR), depending on the data distribution. To ensure data quality, pilot testing was conducted to enhance survey flow and identify any poorly worded questions. Responses to all questions were mandatory to ensure data completeness (Burns et al. 2008).

Qualitative Data

The questions asked in this phase were aligned with the study's objectives to explore the facilitators and barriers. Additionally, this phase involved examining different aspects of the SCT (Bandura 1986). These aspects include self-efficacy, outcome expectations, and socio-structural factors. SCT was selected as the theoretical framework because it emphasises the interplay between personal, behavioural, and environmental factors, making it particularly relevant for understanding the complex influences on PA behaviour. By examining these factors, the research sought to identify the barriers and facilitators to find approaches that could improve PA among the Saudi population. To achieve this, the preferred method is reflexive thematic analysis, which can provide rich insights into the barriers and factors that affect PA implementation in practice.

Two coding approaches are commonly used in reflexive thematic analysis: deductive (theory-driven) and inductive (data-driven) (Braun and Clark 2021; Vaismoradi et al. 2013; Byrne 2022). According to Braun and Clark (2013) and Byrne (2022), the inductive approach involves codes that are generated from the data in answer to specific questions posed to the participants. Conversely, the deductive method develops codes that are influenced by the study field's theoretical frameworks (Clarke and Braun 2013; Byrne 2022). As a result, inductive coding focuses on the meanings participants convey, whereas deductive coding seeks to uncover theoretical themes (Braun and Clark 2013).

The inductive technique was deemed appropriate for analysing the data collected through the online interviews due to the limited investigation of the barriers and facilitators for PA among Saudi people with COPD and the lack of a recognised underlying theory (qualitative phase). Identifying themes that accurately represent participants' perspectives is made straightforward by this process, which does not rely on theories or prior assumptions.

3.2.12. Application of the Theoretical Framework

The SCT was used to guide the interview questions of the qualitative phase by providing a framework for understanding the factors that influence PA behaviour among people with COPD in Saudi Arabia. The theory was used to identify the personal, behavioural, and environmental factors that affect PA behaviour among people with COPD in Saudi Arabia.

The SCT is a theoretical framework that explains how individuals acquire and maintain behaviours through cognitive, behavioural, and environmental factors (Bandura 1986). According to the theory, behaviour is influenced by personal, behavioural, and environmental factors, which interact with each other to determine behaviour (Bandura 1986). The SCT has been used in various studies to understand PA behaviour among individuals with chronic diseases, including COPD (Lorig et al. 2001; Effing et al. 2011). Linking research findings with a theoretical framework enhances knowledge development by facilitating effective connections between researchers and clinicians.

3.2.13. Rigour and Trustworthiness

Qualitative Data

Rigour is an essential aspect of qualitative research. It signifies how trustworthy, credible, and sound the research is. In order to achieve this, it is necessary to provide detailed information about the study process, including the methods and context of data

collection. It is necessary to ensure theoretical rigour in qualitative research from the outset by clarifying the suitability of the chosen research method for the research question/s and the aim of the study. To achieve this, a comprehensive literature review of the PA status of people with COPD in Saudi Arabia was conducted, which led to the identification of a research gap, the formulation of research questions and objectives, and the selection of appropriate quantitative and qualitative research methods. Lincoln and Guba (2000) propose four criteria for assessing research quality: credibility, transferability, confirmability, and dependability. The following sections explain how these criteria were met in the qualitative part of this research (Lincoln and Guba 1986; Shenton 2004).

Credibility

Credibility is an important aspect of research that determines the extent to which the research findings are representative of the study participants. It is crucial to ensure the trustworthiness of the research (Shenton 2004). To achieve credibility, researchers can take several steps, including member checking, triangulation, tape recording, and respondent validation. Member checking is a process that involves verifying with the participants that their responses have been accurately interpreted and that their intended meaning has been preserved. In the current study, the researcher regularly summarised the participants' statements during the interviews, ensuring that the interpretations were accurate and reflective of their views. While member checking is often considered a method for enhancing the credibility and validity of qualitative research (Lo 2014), its effectiveness remains a matter of debate because some scholars argue that it does not necessarily ensure research accuracy (Thomas 2017). In the current study, member checking was attempted by sharing interview transcripts with the participants for confirmation and feedback. This process, however, proved time-consuming because it involved waiting for responses, which ultimately did not result in any modifications to the original transcripts (Birt et al. 2016). However, due to practical constraints, it was not feasible to follow-up with all participants to discuss their interview findings and obtain their feedback. Given these challenges, the accuracy of the findings

was checked through data triangulation across two phases which is explained in the next section.

According to Tuckett (2005), the use of a tape recorder and field journal can help to maintain the credibility of research during data collection by eliminating any potential bias. All of the interviews were recorded with the participants' consent in the current study. After each interview, a summary of the key points and the researcher's feelings during the interviews was created in the field journal.

A process of self-evaluation and reflection known as reflexivity entails the researcher looking at how their own background or viewpoint may have affected the study process and results (Ben-Ari and Enosh 2010). Utilising diaries throughout the research process proved effective in uncovering personal biases and devising strategies to address them (Ortlipp 2008). Detailed diaries covering each meeting with supervisors, project stage, and reflective notes were maintained, which served as valuable tools for fostering reflexivity. Several crucial facets of reflexivity that helped to recognise and address my pre-existing assumptions were emphasised.

Researchers argue that prior beliefs and experiences significantly influence the interpretation of findings because these elements are inseparable from the researcher's mindset (Creswell and Miller 2000; Johnson et al. 2020). The possible influence of a researcher's personal opinions, background, and experiences on data interpretation is demonstrated by Johnson et al. (2020). Acknowledging this influence represents the initial step in distancing oneself from personal interpretation, allowing the data to authentically reflect the participants' voices (Finlay and Gough 2003). Writing reflexively makes it possible for others to evaluate the credibility and dependability of the findings. Prior to starting the investigation, I thought back on my past and opinions, which helped me to identify patterns in the interpretation of the results and shape the outcome from my point of view.

Triangulation was utilised to enhance the credibility and transferability of this research. This involved conducting interviews with people with COPD, people who did not have COPD, and HCPs who had varying perspectives on the subject and comparing their responses (Lincoln and Guba 1986; Thurmond 2001; Tuckett 2005). To achieve data source triangulation, two types of data were used: surveys in the quantitative phase and interviews in the qualitative phase to analyse and interpret the data. An additional supervisor (DP) with experience of qualitative research analysed three interviews independently, compared the coding with the researcher's analysis, and identified similarities or differences. This approach helped to establish a shared interpretation of the results, which increased their dependability.

Transferability

In qualitative research, transferability refers to the degree to which the findings can be applied to other populations or situations (Shenton 2004; Cypress 2017). To achieve transferability, researchers need to provide a comprehensive description of their methods, including the study context, the participants involved, and the data collection and analysis procedures. This detailed information can help other investigators to understand and apply the findings to their own research. In the next chapter, the methods used for the online interviews (qualitative phase) are described in detail.

Dependability

Dependability concerns the consistency of research results across different contexts and over time. This indicates that other researchers should be capable of reproducing the study and achieving comparable outcomes. One way to achieve this is by providing a detailed description of the research methods, as well as having a colleague who is not directly involved in the project to assist in the analysis and interpretation of the data. In the current study, the research process was documented in the minutes of meetings with supervisors, emails to supervisors to discuss the research, reflective notes taken after each interview and group discussion, and notes of meetings with the supervisors to discuss the fieldwork. During the coding process, codes were revised and adjusted

several times, and all of the steps of the analysis were documented in the journal to keep track of any changes and the reasons for making them. During the analysis, to eliminate any possibility of mistakes, the data were re-checked, the literature was searched for explanations of the findings, and meetings with the supervisors were held to discuss the analysis.

Confirmability

Confirmability is a crucial aspect of the methodology which ensures the impartiality and objectivity of the findings. It denotes the researcher's ability to maintain neutrality and avoid any form of bias during the research process by solely relying on the participants' responses (Cypress 2017). It is essential to ensure that data analysis and interpretation are not influenced by the researcher's preferences (Connelly 2016). It is also necessary to document each step of the analysis process to ensure that the research findings can be confirmed and verified. In the current study, the methodology chapter provides a detailed explanation of the entire analysis process with the aim of maintaining transparency and avoiding any personal biases or motivations. Multiple investigators were involved in the process and an inductive approach was used to further enhance the credibility of the findings (Connelly 2016). The analysis of the interview transcripts involves coding to identify patterns and emerging themes in the data.

Integration of Mixed Methods

Depending on the research design and aims, mixed methods data can be integrated either simultaneously or sequentially using techniques such as narrative reporting, data comparison, or transformation (Doyle et al. 2009; Creswell and Plano Clark 2017). The current study collected quantitative and qualitative data separately, applying a sequential explanatory research methodology and driven by the pragmatism paradigm, which influenced both stages of the investigation. Although one possible means of data integration is to combine or convert qualitative findings into quantitative ones (Terrell 2012), the current study did not follow this approach because the two stages were conducted separately and there was no need to reduce the data. Nevertheless, the

merging of the quantitative and qualitative components took place at the concluding phase of the study, specifically during the interpretation step, as suggested by Creswell and Plano Clark (2017). The study sought to combine quantitative and qualitative results in order to synthesise the findings and generate a comprehensive understanding of the research issue. Specifically, the study sought to explore how qualitative insights provide insight into quantitative outcomes (Ivankova et al. 2006).

Creswell and Plano Clark (2017) explained how to present integrated mixed methods results in a sequential design using a joint display. This strategy seeks to explain the correlation between the two phases and illustrate how qualitative insights enhanced the understanding of the quantitative data.

Commencing with quantitative phase outcomes requiring thorough explanation and exploration in the qualitative phase, it was observed that there existed no statistically significant disparity in PA between people with COPD and those without, contrary to expectations. The literature indicates that COPD patients typically experience physical inactivity due to dyspnoea and muscle weakness, and studies have shown them to be less active compared to their non-COPD counterparts. Thus, it was anticipated that COPD patients would encounter greater physical barriers to PA in comparison to healthy individuals.

3.2.14. Mixed Methods: Weaknesses/Challenges

A mixed-method design is a hybrid approach that combines unrelated paradigms in each design. While a mixed-method design offers numerous advantages, it also has a number of limitations. There are two main reasons why conducting both quantitative and qualitative research can be challenging. Firstly, it requires a significant amount of time. Secondly, the researcher must have knowledge of both types of research methodology. These limitations are particularly noticeable when using a convergent mixed-method design which necessitates an experienced researcher to carry it out concurrently.

In order to deal with these issues, the decision was taken to first carry out the quantitative phase, followed by the qualitative phase after analysing the data obtained from the first phase. Creswell (2014) proposes a method to address these challenges which involves the researcher's preparation and assistance from those with expertise in each specific design. This approach was suitable for me because I am a PhD student who receives support and guidance from a supervising team.

An additional obstacle frequently faced in mixed method designs is the researcher's determination of the relative importance assigned to data collection and analysis for each design, the order of the design process, and the integration of the findings. To address these problems, researchers frequently cite the studies conducted by Morgan (1998) and Creswell et al. (2003). Researchers follow practical recommendations to effectively handle potential challenges, thereby, improving the design and execution of a specific mixed-method approach.

The current study employs a process of inquiry that is aligned with Dewey's (1998) approach. This process involves taking an action, evaluating the sequences that follow, and adjusting the action based on warranted beliefs (Mertens 2015; Morgan 2014). The pragmatic approach of the study aims to investigate issues related to the utilisation of PA and to identify practical solutions to enhance engagement with it. The mixed methods design used in the current study provides a comprehensive understanding of the topic which may lead to more useful knowledge and be accepted by both HCPs and people with COPD.

Summary

This chapter outlined the underlying assumptions of the researcher's paradigm and elucidated the rationale for employing a mixed methods approach. The theoretical framework was introduced and acknowledged for its pragmatic orientation and the development of the survey instrument. Additionally, the decision to adopt a mixed methods approach was justified. The integration of mixed methods in this study was

planned and implemented, adhering to established protocols and best practices. The next chapter explains the detailed rationale for utilising the survey as a data collection method and other aspects of the quantitative phase.

4. Quantitative Method (Phase 1)

4.1. Introduction

This chapter outlines the method employed in the quantitative phase, with a specific focus on the survey methodology. By describing the survey methodology, including its design, implementation, and data collection procedures, this chapter aims to provide transparency and clarity regarding the quantitative phase of the study. Additionally, key considerations such as the sample selection, survey validity and reliability, ethical considerations, and potential limitations are discussed to ensure a thorough understanding of the research methodology and its implications.

4.1.1. Aim of Phase 1

- To compare self-reported PA levels and HRQoL in people with COPD and people who do not have COPD in Saudi Arabia.
- To evaluate the relationship between PA and HRQoL for both groups and dyspnoea level for those with COPD.

Hypotheses:

- There is a significant difference in the level of PA between people with COPD and people who do not have COPD in Saudi Arabia.
- There is a significant difference in HRQoL between people with COPD and people who do not have COPD in Saudi Arabia.
- There is a statistically significant relationship between PA and HRQoL in people with COPD in Saudi Arabia.
- There is a statistically significant relationship between PA and dyspnoea level in people with COPD in Saudi Arabia.
- There is a statistically significant relationship between HRQoL and dyspnoea level in people with COPD.

Null Hypotheses:

- There is not a statistically significant difference in the level of PA between people with COPD and people who do not have COPD in Saudi Arabia.
- There is not a statistically significant difference in the HRQoL of people with COPD and people who do not have COPD in Saudi Arabia.
- There is not a statistically significant relationship between PA and HRQoL in people with COPD in Saudi Arabia.
- There is not a statistically significant relationship between PA and dyspnoea level in people with COPD in Saudi Arabia
- There is not a statistically significant relationship between HRQoL and dyspnoea level in people with COPD.

4.1.2.Design and Methods

The primary objective was to compare the level of PA among individuals with and without COPD in Saudi Arabia using a cross-sectional design. For quantitative data collection, a survey serves as the tool, allowing respondents to provide answers remotely. Following Neuman's (2014) guidance, the survey questions were carefully crafted to ensure high quality, promoting reliable and valid measurement. A validated and reliable tool specific to the Arabic population was employed for this purpose. The survey-based component of the study was reported following the Consensus-based Checklist for Reporting of Survey Studies (CROSS) (**see Appendix 11.1.5**).

The cross-sectional survey collected data from individuals previously diagnosed with COPD and those without COPD, utilising validated Arabic questionnaires. The self-reported demographic data and PA levels of both groups were assessed to compare PA between the groups. To explore the contributing factors, the study examined the relationship between PA and HRQoL (in people with COPD and comparators), and the relationship between HRQoL and dyspnoea in the COPD group.

Participants with and without COPD completed a questionnaire encompassing demographic characteristics, the IPAQ-SF, and the EQ-5D-5L survey. Additionally, people with COPD completed the Dyspnoea-12 (D-12). A convenience sample of people with COPD was drawn from a pre-existing database, ensuring confirmation of lung function criteria (FEV_1/FVC ratio < 0.70) and hospital care. The data collected included age, gender, height, and weight, with the latter two used to calculate Body Mass Index (BMI).

4.1.3. Sample Size

The sample size was calculated using G-power statistical analysis software version 3.1.9.4. based on the primary outcome of PA to identify differences between COPD and the comparators. The parameters used to calculate the sample size were as follows: using the t-test (2-tailed) with a medium effect size is 0.5 α at 0.05 and power (1-B) level at 80%.

Therefore, 64 participants in each group should be recruited and a total of 128 people were required to complete the study (**see Appendix 11.1.26**). It is important to note that the sample size was powered specifically to detect between-group differences in PA levels. The correlational analyses conducted in the study were exploratory by nature and not specifically powered.

4.1.4. Participants

To ensure the appropriateness and comparability of the participants in both groups, specific inclusion and exclusion criteria were developed (**see Table 4.1**). For individuals with COPD, only participants aged 40 years or older were included. This age threshold aligns with the GOLD criteria, which recognises that COPD is predominantly diagnosed in individuals over the age of 40 years (Raheison and Girodet 2009). While the non-COPD comparison group was recruited with the aim of achieving similar age characteristics, no formal matching procedure was implemented. As a result, the COPD group was older and had a higher proportion of male participants. This demographic

variation is acknowledged and was considered in the interpretation of findings, particularly when examining factors influencing PA levels and health outcomes.

Participants in both groups were required to provide informed consent and be capable of participating in interviews. Exclusion criteria were designed to eliminate conditions that could confound the study's focus on PA. These criteria ensured a more homogenous sample and allowed for a clearer interpretation of the factors influencing PA in people with and without COPD.

Table 4.1 Inclusion-exclusion criteria

	People with COPD	People without COPD
Inclusion criteria	• Aged 40 years or older. • People with a current diagnosis of COPD at any stage. • Able to give informed consent and willing to participate.	• Aged 40 years. • Free from any respiratory diseases. • Able to give informed consent and willing to participate.
Exclusion criteria	• LTOT. • Cognitive impairment. • Diseases affecting mobility (e.g., Parkinson's disease), cerebrovascular accident, or anatomical abnormality. • Pregnancy. • Psychological disorders. • Thyroid disorders.	• Any respiratory conditions. • Diseases affecting mobility (e.g. Parkinson's disease), cerebrovascular accident or anatomical abnormality. • Pregnancy. • Cardiac disease. • Psychological disorders. • Thyroid disorders.

4.1.5. Recruitment

The following approval documentation was in place before each centre commenced recruitment:

- Research ethical approval: School of Healthcare Sciences, Cardiff University.
- Research ethical approval: King Saud University and King Fahad Medical City, Saudi Arabia.

A convenience sample of people with a confirmed diagnosis of COPD (defined as FEV_1/FVC ratio < 0.70 , verified through spirometry at the clinic) who were under the care of King Saud University Medical City was recruited for the current study. Recruitment was conducted using an existing clinical database of over 100 individuals who had previously consented to be contacted for research purposes at King Saud University Medical City and King Fahad Medical City, Saudi Arabia. All eligible individuals in the database were invited to participate. The recruitment site and process were coordinated with Dr Albarrati (AA) who acted as the gatekeeper and distributed invitation emails to potential participants. A total of 105 people with COPD were contacted via email and invited to reply to the primary researcher (RA) if they were interested in participating.

The comparator group consisted of individuals who did not have COPD, recruited through the Public Pension Agency in Saudi Arabia. Similarly, the gatekeeper (AA) sent email invitations to 100 people who were eligible based on the inclusion and exclusion criteria described above. Individuals in this group were not patients with any known respiratory conditions or other exclusionary diseases. However, because this population primarily comprised of older adults, some of the participants reported having other chronic conditions (e.g., hypertension or diabetes), which were noted in the survey responses but did not satisfy the exclusion criteria for the current study.

Recruitment for both groups was constrained by the COVID-19 pandemic which restricted the ability to interact face-to-face and necessitated the use of existing online databases. As such, the study was unable to utilise alternative recruitment strategies such as outreach through social media platforms, community groups, or patient advocacy organisations, which may have enhanced the diversity of the sample.

Each person who met the inclusion criteria—specifically, individuals aged 40 years or older—had an equal opportunity to participate in the study. Within this eligible group, there was no discrimination based on gender, sexual orientation, or ethnicity. When the researcher received an email of interest from potential participants, they were sent an information sheet (**see Appendix 11.1.13-11.1.14**) in English and Arabic by email about the study and given at least 24 hours to consider whether they would like to participate and were offered the opportunity to ask questions by contacting the researcher.

Those who agreed to participate were then asked to complete an electronic consent form as part of the online survey (**see Appendix 11.1.24**). The form stated that participants could withdraw from the study at any time, that participation was voluntary, and that it would not affect their usual care as COPD patients. Moreover, upon completion of the study, those with COPD would continue their usual care. The results were available upon request and, importantly, all information would be handled confidentially and securely.

4.1.6. Online Survey

The utilisation of Web-based surveys has been recommended as a cost-efficient and effective means of collecting data, with comparative response rates to paper-based surveys (Kaplowitz et al.2004). A report by the Communications, Space, and Technology Commission (CST 2022), stated that the percentage of internet use in Saudi Arabia has reached 98.6% of the population. Therefore, online surveys can be deemed a valuable tool for data collection in populations with internet access in Saudi Arabia.

The survey data were collected online using Google Forms. The participants in this study were recruited and surveyed online using a structured questionnaire administered through a digital platform. Before commencing the survey, the participants provided informed consent by ticking a checkbox indicating their agreement to participate in the study (**see Appendix 11.1.24**). The consent form outlined the purpose of the research,

confidentiality measures, and participant rights. Upon giving their consent, the participants self-reported their demographic information, including their age, height, weight, existing medical conditions, and number of years since COPD diagnosis. The participants then completed the IPAQ-SF online, replicating the paper version. This section of the survey included questions about their PA levels over the previous seven days, specifying the number of minutes spent undertaking various activities (e.g., walking, moderate and vigorous PA), as well as the number of days per week engaged in these activities. Participants with COPD completed the D-12 using a tick-box format. Upon completing the online survey, the participants were directed to a link leading to the REDCap platform to fill out the EQ-5D-5L survey (**see Appendix 11.1.25**) which assesses HRQoL. In order to minimise any missing data or incomplete responses, it was deemed advantageous to integrate all survey tools into a single online platform for participant convenience and data accuracy. However, the inclusion of the EQ-5D-5L survey posed a unique challenge due to licensing and approval requirements. To address this, various platforms were considered that allow for the online administration of the EQ-5D-5L survey. Ultimately, REDCap (Harris et al. 2019) was selected as the preferred platform due to its accessibility through Cardiff University and the provision of a license to utilise the EQ-5D-5L survey in the research study. This strategic choice ensured compliance with licensing regulations while streamlining the data collection process within a unified and user-friendly digital environment.

At the end of the survey, the participants were given the opportunity to express interest in participating in future stages of the investigation. Those interested provided consent for potential inclusion in the qualitative phase (interviews) by providing their contact information (e.g., phone number or email address).

The participants were able to choose to complete the form in either English or Arabic. Translation of study materials was essential to accommodate participants who may not be proficient in the survey's primary language. This included translating the information and consent form introduction, demographic questions, and other survey components. The translated materials were carefully checked by a qualified translator (AA) to ensure

accuracy and clarity. Additionally, the survey underwent a pilot testing phase before dissemination to the participants. This pilot testing helped to identify and address any potential issues with the translated content, thereby ensuring that the survey was culturally appropriate and comprehensible to the target audience. The Arabic versions of the surveys, including the IPAQ-SF, EQ-5D-5L, and D-12, were utilised in the current study to accommodate participants whose primary language was Arabic.

4.1.7. Pilot Study

A pilot study was conducted to refine the methodologies and test procedures before full-scale implementation of the online survey. Leon et al. (2011) emphasised that pilot studies focus on refining procedures rather than generating statistically significant data. In accordance with this perspective, the pilot study in the current research effectively achieved its objectives, despite its smaller sample size, by identifying necessary steps and ensuring the clarity of the survey questions for the participants.

The survey was tested on five participants and sought to achieve the following objectives:

- Familiarise the researcher with the survey protocol and online administration methods.
- Determine the time required for data collection.
- Identify and address any issues with the survey questions or instructions.

The key outcomes to emerge from the pilot study included that the estimated time required for the participants to complete the survey was approximately 8 minutes, informing expectations for future participant engagement. The insights derived from the pilot study were instrumental in refining the survey methodology, ensuring efficient data collection, and addressing logistical considerations for subsequent phases of the research study. This approach aligns with the principles outlined by Leon et al. (2011), emphasising the importance of pilot studies in optimising research procedures and

enhancing data quality. However, the data for the five participants were not included in the data analysis to prevent any influence on the final outcomes.

4.1.8. Outcome-Measure Data Collection

The survey administered in the current study comprised several components. First, a self-reported personal profile section was used to collect socio-demographic data, including sex, age, height, body weight, and general health status. BMI was calculated by dividing a participant's weight (in kilograms) by their height (in metres squared) to estimate their relative weight-to-height ratio. The participants were also invited to provide their contact information if they were willing to participate in the qualitative interview phase. Secondly, the Arabic short version of the IPAQ-SF was used to assess the participants' PA levels. Thirdly, the participants completed the Arabic version of the EuroQOL (EQ-5D-5L), including the EQ-VAS, to evaluate their HRQoL.

Due to the COVID-19 pandemic, the study employed self-report questionnaires as a practical and safe alternative to direct assessments. This approach allowed for the efficient collection of data while minimising face-to-face contact and reducing the risk of virus transmission, particularly in a clinical population that may have been at higher risk of COVID-19 complications.

4.1.9. PA Level

The IPAQ is a well-established tool that is widely used to assess PA levels among individuals aged 15 to 69 years (The International Physical Activity Questionnaire 2005). As per the IPAQ, vigorous-intensity physical activities require hard physical effort and cause the individual to breathe much harder than usual. Moderate-intensity physical activities require moderate physical effort and cause individuals to breathe somewhat harder than usual. Notably, neither vigorous- nor moderate-intensity physical activities include walking activities. Walking is captured in a separate section of the survey, wherein participants are asked to report all walking-related activities, including walking at work/home, walking as a mode of transportation, and any other walking undertaken exclusively for recreation, sport, exercise, or leisure.

The tool is available in two versions: a short version and a long version. The lengthy version is most commonly utilised at first to collect more comprehensive data concerning PA behaviour. The tool is a self-reporting instrument comprising of 27 items that assess PA across five distinct activity areas. However, in accordance with pretesting recommendations, the longer version was substituted with a short version. This shortened version comprises seven questions that inquire about the duration of PA in the past week, specifically focusing on walking, moderate-intensity physical activities, and vigorous physical activities in various contexts such as work, house and yard work, transportation, and recreation or exercise. The IPAQ's completion provides data that may be compared in terms of the length and frequency of walking, as well as moderate- and vigorous-intensity activities. These data are subsequently utilised to compute overall PA scores, which are stated in MET-minutes/week.

The choice of the IPAQ-SF (**see Appendix 11.1.17**) was also influenced by the practical constraints imposed by the COVID-19 pandemic, which necessitated a shift from objective to subjective measures of PA to ensure participant safety and compliance with public health guidelines. The IPAQ-SF offers a streamlined approach to assess PA levels, making it particularly suitable for studies where minimising the participant burden and maximising response rates are important considerations. Its ease of administration and completion compared to the longer versions of IPAQ ensure that data collection is efficient, which is especially beneficial in large-scale studies or those involving repeated assessments over time. Furthermore, the IPAQ-SF has been validated and shown to offer good reliability for assessing PA across different populations, including individuals with chronic conditions like COPD. By focusing on core components of PA, such as the duration and frequency of moderate and vigorous activities, the IPAQ-SF provides essential information while avoiding overwhelming participants with lengthy questionnaires. Overall, the use of IPAQ-SF aligns with the stated research objectives, allowing for valid and reliable assessment of PA levels among COPD patients in a practical and effective manner (The International Physical Activity Questionnaire 2005).

However, it is important to acknowledge that self-report tools like the IPAQ-SF are subject to recall and social desirability biases, potentially leading to the overestimation or misreporting of PA levels. Several studies have demonstrated that the IPAQ-SF tends to overestimate PA compared to objective measures such as accelerometry. For instance, a systematic review reported that the IPAQ-SF overestimated PA by an average of 84% compared to accelerometer data. Similarly, another study found that the IPAQ-SF had low-to-moderate correlations with accelerometer-measured PA, thereby indicating limited validity in accurately capturing actual activity levels (Lee et al. 2011).

Despite these limitations, the IPAQ-SF remains one of the most widely used and internationally validated tools for PA assessment, facilitating comparisons across populations and aligning with global PA surveillance standards. Its widespread use allows for benchmarking against population data, which is valuable for public health research and policy-making.

The IPAQ has been widely used in Arabic, including Saudi Arabia, and has been shown to be an acceptable and reliable instrument for assessing PA levels (Abdel-Salam and Abdel-Khalek 2016; Samir et al. 2011). In Saudi Arabia specifically, the Arabic version of the survey has been validated and used in several studies, one of which examined the PA levels of university students in Abha (Awadalla et al. 2014; Al-Hazzaa 2007). Recently the validity and reliability of the Arabic version of the IPAQ short form has been tested among young females in Saudi Arabia (Bajamal and Robbins 2022). The study found that the Arabic version of the IPAQ-SF was valid and reliable for assessing PA in this population.

In the COPD context, there is a lack of studies investigating the validity and reliability of the Arabic version. However, the IPAQ-SF has demonstrated acceptable validity and reliability as a self-administered questionnaire to assess the PA level among COPD patients in Portuguese (Flora et al. 2020; Flora et al. 2023). In addition to its applicability in traditional settings, recent studies have highlighted the validity and reliability of remote

assessments using the IPAQ. Remote assessment methods, including online administration of the IPAQ, have demonstrated comparable validity and reliability to in-person assessments (Nascimento-Ferreira et al. 2022).

The MET is a valuable measure for quantifying PA and assessing exercise intensity by estimating energy consumption. Engaging in physical exercise results in a higher calorie burn compared to being at rest. The amount of energy expended is directly related to the level of PA (Hills et al. 2014). A MET represents the energy expended by an individual while at rest, specifically while sitting quietly. It is approximately equivalent to one calorie per every 2.2 pounds of body weight per hour, or 1 kcal/kg/hour for adults. For example, an individual weighing 180 pounds would expend approximately 82 calories per hour during sedentary sitting. According to the World Confederation for Physical Therapy (2017), activities with higher MET values are more intense and require a greater expenditure of energy and calories.

Thus, IPAQ-SF was used to compare PA with the purpose of estimating total METS/min consumed per week and categorising PA levels accordingly. Data collected with IPAQ-SF can be reported as a continuous measure and reported as median METminutes. Median values were computed for walking (W), moderate-intensity activities (M), and vigorous-intensity activities (V) using the following formulas:

MET values and the formula for the computation of MET-minutes:

(W) MET-minutes/week = 3.3 * W-min * W-days

(M) MET-minutes/week = 4.0 * M-min * M-days

(V) MET-minutes/week = 8.0 * V-min * V-days

A combined total PA MET-min/week was computed as the sum of W+ M + V MET-min/week scores.

The MET values used in the above formula were derived from the IPAQ validity and reliability study undertaken in 2000-2001 by Craig et al. (2003). IPAQ's test-retest reliability was found to be satisfactory-to-outstanding in one of the studies (Spearman's

rho centred around 0.8), whilst its criterion validity was found to be modest ($\rho = 0.3$). It is thus considered to be an acceptable measure of PA in individuals aged 18 to 65 years (Craig et al. 2003).

IPAQ-SF demonstrates varying levels of sensitivity and accuracy when compared to other PA measurement tools. In terms of intensity levels, the IPAQ-SF exhibits higher sensitivity to vigorous-intensity PA than to moderate-intensity activity or walking, with correlation values reported as $\rho = 1.00$ for vigorous activity, $\rho = 0.995$ for moderate activity, and $\rho = 0.99$ for walking (Shenoy et al. 2014). However, when compared to accelerometer data, the IPAQ-SF tends to underestimate MVPA, with a mean difference of -13.4 minutes per day (Rääsk et al. 2017). This underestimation is more pronounced among active individuals, particularly boys who engage in at least 60 minutes of MVPA daily (Rääsk et al. 2017). Similarly, the IPAQ-SF also underestimates sedentary time, showing a mean difference of -27.1 minutes per day compared to accelerometer data (Rääsk et al. 2017). In terms of sensitivity and specificity, the Hausa version of the IPAQ-SF demonstrated good sensitivity (76.2%) in identifying insufficiently active individuals but had low specificity (33.3%), thereby indicating poor accuracy in correctly classifying sufficiently active individuals (Oyeyemi et al. 2011).

Categorisation of PA Level

The participant's PA levels were classified into low, moderate, or high categories based on the total volume of PA and the frequency of engagement over a seven-day period. The breakdown of the categorisation criteria was sourced from IPAQ (2005):

- A high level of PA is defined as engaging in vigorous activities for a minimum of three days per week, with an attainment of at least 1,500 MET-minutes per week. Alternatively, achieving a combination of activities throughout the entire week with a minimum of 3,000 MET-minutes per week also qualifies for the high category.
- Moderate PA entails participating in vigorous activities for a duration of at least 20 minutes on three days per week or 30 minutes on two days per week. Additionally,

engaging in moderate or walking activities for a minimum of five days per week or a combination of various activities for at least five days, resulting in a minimum of 600 MET-minutes per week, falls within the moderate category.

- Low PA is defined as not meeting any of the criteria for high or moderate levels.

Finally, the duration of time spent sitting on weekdays over the preceding seven days was derived. Recognising its purpose as an indicator of sedentary behaviour, it was deliberately excluded from the overall summary score of PA (The International Physical Activity Questionnaire 2005).

Assessing adherence to the WHO guidelines for PA and health involves analysing the reported weekly minutes of both moderate and vigorous activities. The WHO recommends that adults should strive for a minimum of 150 minutes of moderate-intensity or 75 minutes of vigorous-intensity PA per week (WHO 2020).

In the current study, the IPAQ-SF criteria were used to classify individuals' activity. Additionally, the WHO recommendations for PA were employed as guidelines for assessing activity levels using the cutoff of 150 minutes of activity per week.

4.1.10. HRQoL Questionnaire

The selection of a valid and reliable tool for assessing HRQoL is critical in research, particularly when comparing COPD patients with healthy controls. In the current study, the EQ-5D-5L was chosen over disease-specific tools due to its generic nature, improved sensitivity, ease of use, and applicability across diverse populations (Engström et al. 2001). Unlike disease-specific instruments such as the SGRQ or the CAT, which focus primarily on respiratory symptoms, the EQ-5D-5L allows for comparisons between the COPD group and the non-COPD group. This is essential for the study's objective of evaluating overall HRQoL rather than focusing exclusively on disease-specific impairments. Additionally, the EQ-5D-5L improves upon its predecessor (EQ-5D-3L) by offering five response levels per dimension, which enhances sensitivity and reduces

ceiling effects (Van Hout and Shaw 2021). This is particularly beneficial when capturing subtle differences in HRQoL across study groups. Furthermore, the tool's short format and ease of administration minimise participant burden, increasing response rates and ensuring reliable data collection (Nolan et al. 2016). Although the EQ-5D-5L lacks disease-specific detail and may not fully capture symptoms such as fatigue or breathlessness, its ability to assess mobility, self-care, usual activities, pain/discomfort, and anxiety/depression provides a broad yet meaningful assessment of HRQoL (Lin et al. 2014). However, in the current study, an additional tool was included for the COPD group to measure dyspnoea (more details are provided in the next section). Given the study's focus on comparing COPD patients with healthy controls, the EQ-5D-5L was the most appropriate tool, offering a standardised, validated, and widely applicable measure of QoL.

The EQ-5D-5L comprises two components: the descriptive system and the visual analogue scale (VAS) which rates health on a scale of 0 to 100. The descriptive system comprises five dimensions: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression, which are assessed using a 5-point Likert scale (**see Appendix 11.1.19**). Elevated scores on these five questions signify greater difficulties in these five domains. The response patterns for the numerical values of the five questions are provided in ascending order, ranging from ideal health status (1) to significant difficulties in all categories (5). The EQ-5D-5L utility index value calculator version 1 developed by Van Hout and Shaw (2021) is used to determine an index value based on the response patterns. A lower score on the EQ-5D-5L utility index reflects a poorer subjective health condition. A separate score is documented based on the VAS scale, where a lower value signifies poorer perceived health. A health state index score can be calculated from individual health profiles by selecting a country/region-specific value set and reference. It is stated that where a value set is not available for the country/region, it may be possible to use a value set for a country/region that most closely approximates to yours or, alternatively, a crosswalk value set can be used. Due to the fact that Saudi Arabia was not available, the value set of Egypt was used for numerous reasons. Firstly, Egypt and Saudi Arabia share a common language, Arabic. Secondly, Egypt and Saudi Arabia

share similar cultural and social norms. The EQ-5D-5L value set is based on social preferences which reflect the values and priorities of a particular population. Thirdly, Egypt was the most closely associated country (Van Hout and Shaw 2021).

The Arabic version of the EQ-5D-5L was used, which is known to be valid and reliable (Bekairy et al. 2018). Nolan et al. (2016) found the EQ-5D-5L to be a valid and responsive measure of health status in people with COPD. The EQ-5D-5L has previously been used in the COPD population (Briggs et al. 2010; Cross et al. 2010; Gillespie et al. 2013). In addition, the validity and reliability of the Arabic Eq-5D-5L were tested on different Arabic-speaking countries (Al Shabasy et al. 2022; Al-jedai et al. 2024). All of the participants self-completed the EQ-5D-5L, which takes approximately three minutes to complete.

4.1.11. Dyspnea-12

People with COPD completed an additional scale to assess the level of dyspnoea. In the current study, D-12 was used for several reasons. D-12 measures both the physical and affective components of dyspnoea, providing a comprehensive understanding of the patient's experience. The D-12 comprises of 12 items: seven related to the quality of the sensation of dyspnoea and five related to the emotional response to this sensation (Yorke et al. 2010). Each item is graded in terms of its intensity using a 4-point scale ranging from 0 (none) to 3 (severe dyspnoea) (**see Appendix 11.1.21**). The D-12 total scores range from 0 to 36, with higher scores corresponding to greater dyspnoea severity (Yorke et al. 2010). This multidimensionality is particularly valuable in COPD, where breathlessness often affects both physical function and emotional well-being (Yorke et al. 2010; Alyami et al. 2015). In addition, the D-12 has demonstrated excellent validity and reliability across various cardiorespiratory diseases, including COPD (Alyami et al. 2015). It has been correlated with other clinical measures such as the MRC scale, forced expiratory volume, and 6-minute walk test, ensuring its robustness as a tool for assessing the severity of dyspnoea (Yorke et al. 2010; Alyami et al. 2015; Sundh and Ekström 2017). The D-12 is concise, consisting of only 12 items, making it

quick to administer (2-3 minutes) and easy for patients to complete. This simplicity reduces the patient burden compared to more time-consuming tools like the SGRQ, which has 50 items (Jo et al. 2018). The Arabic version of the D-12 has been found to be reliable and valid in Arabic-speaking people with COPD (Alyami et al. 2015).

4.1.12. Data Analysis

The data were analysed using the latest version (27) of the SPSS software package (Chicago, Illinois, US). For all analyses, the level of statistical significance was set at $p < 0.05$. Descriptive data and continuous data were described as mean, standard deviation ($\pm$ SD), median (IQR) depending on the distributions of the data. The distribution of continuous data was examined using the Shapiro-Wilk test. Normally distributed data were analysed using parametric tests. Data that did not follow a normal distribution were analysed using nonparametric statistical tests. Data were compared between the two groups using either independent-sample t-tests for parametric data or Mann-Whitney U tests for nonparametric data.

For IPAQ-SF, the results were presented as the median values and IQR (for total MET-minutes results) and proportions, as recommended by the IPAQ manual (Craig et al. 2003). In addition, the EQ-5D-5L data were considered to be not normality distributed (skewed). The median and IQR were used. The EQ-VAS score (between 0 and 100) was summarised using the median and IQR. The D-12 data were not normally distributed and the data were presented as the median and IQR. The chi-squared statistic was used to compare the proportion of participants.

Exploratory Analysis

Interpreting Spearman's rho (r_s) coefficients involves assessing both the magnitude (strength) and direction (positive or negative) of the correlation. A positive r_s value indicates a positive association (as one variable increases, the other tends to increase), whereas a negative r_s value indicates a negative association (as one variable increases,

the other tends to decrease). The significance level (p-value) associated with Spearman's rho indicates whether the observed correlation coefficient is statistically significant, providing evidence of a true association between the variables.

The use of Spearman's rank correlation analysis enhances the understanding of how PA levels relate to health-related outcomes and dyspnoea severity among people with COPD, providing valuable insight into the potential contributors to PA behaviour and overall HRQoL in this population. These results, along with their implications, are presented and discussed in detail in the following sections.

Although not part of the original hypothesis, gender-based comparisons were conducted as part of exploratory analysis to examine potential variations in PA levels, HRQoL, and dyspnoea across male and female participants. This decision was made post hoc in response to patterns observed during data analysis in this study, where gender-specific differences appeared to influence participants' perceptions of disease, social responsibilities, and engagement in PA. These observations, combined with supporting evidence from existing literature, prompted further analysis to explore how gender-related factors may inform tailored interventions. The findings are presented in the Results and discussed accordingly.

4.1.13. Data Management for the Survey

Survey data were collected using Google Forms, with responses processed according to the IPAQ-SF data processing and analysis guidelines (The International Physical Activity Questionnaire 2005). The following steps were applied to ensure accuracy and consistency in data management:

- Duration formatting: All responses for activity duration were recorded in minutes.
- Error correction in time entries: To prevent misclassification, values of '1' or '2' entered in the 'hours' field were reassigned to the 'minutes' field to correct potential data entry errors.

- Handling missing data: Cases with missing time entries or responses marked as 'don't know/unsure' were excluded from the analysis.
- Outlier removal: Entries where the total time spent undertaking walking, moderate, and vigorous activities exceeded 960 minutes (16 hours per day) were excluded because such values were considered implausible.
- Recoding short activity durations: Reported activity durations of less than 10 minutes were recoded as 0 minutes based on evidence suggesting that PA in bouts of at least 10 minutes is necessary to achieve health benefits (The International Physical Activity Questionnaire 2005).

The EQ-5D-5L survey was administered on a separate platform (REDCap). To ensure completion, the survey link was displayed to the participants before submitting their responses via Google Forms, directing them to complete the EQ-5D-5L questionnaire. Additionally, all survey questions were set as mandatory, thereby helping to avoid any missing responses and ensuring data completeness.

5. Quantitative Findings and Discussion

5.1. Introduction

The initial phase of this study aimed to evaluate the difference in PA and HRQoL in people with COPD compared to people without COPD and to explore the relationships between variables including dyspnoea in COPD. The first section describes the participant characteristics, demographics, and descriptive data, including PA measurement and HRQoL for those with COPD and people without COPD. The last section describes the dyspnoea level for people with COPD.

5.1.1. Participant Demographics

In conducting this study, it is important to acknowledge the consideration of sample size relative to the statistical power required for robust findings. A priori power analysis using G* Power software indicated a recommended sample size of 64 participants in each group. However, the actual number of participants included in this study was 54 individuals with COPD and 65 individuals without COPD.

The recruitment of participants was approached by the gatekeeper (A.A) from King Saud University Medical City (n=70) and King Fahad Medical City (n=35), However, only 30 from King Saud University Medical City and 24 from King Fahad Medical City participated. The data were collected within the constraints of the available resources and time, which may have contributed to the smaller-than-anticipated sample size. It is important to acknowledge that the achieved sample size may affect the statistical power of the study to detect significant differences.

After data cleaning, four COPD participants (incomplete data) and 14 people without COPD (eight did not satisfy the inclusion criteria of being aged under 40 years; five had incomplete data) were excluded. Therefore, a total of 101 participants were included in the study results, 50 with COPD and 51 without COPD. The age and BMI of each group

were normally distributed, as assessed by the Shapiro-Wilk's test (see **Appendix 11.1.27**).

Participant demographics are displayed in **Table 5.1**. There was a statistically significant difference in gender with a greater percentage of males (80%) in the COPD group than in the non-COPD group (55%) ($p < 0.05$). The COPD group were older (mean $\pm$ SD = 64.2 ± 10.2 years) than the people who did not have COPD (50.2 ± 8.6 years) ($p < 0.05$). These differences are likely to be due to both groups being recruited concurrently, rather than through age- and gender-matched sampling, which may have contributed to the observed variation.

However, BMI was similar between the groups ($p > 0.05$). The data show that only 16% (eight people with COPD) and 29% (13 people without COPD) were classified as normal BMI (**Table 5.2**).

To ensure adherence to the inclusion and exclusion criteria, participants were asked to indicate whether they had been diagnosed with any of a predefined list of health conditions. This step was essential to confirm eligibility for the study. Participants who reported health conditions that met the exclusion criteria were excluded from participation. **Tables 5.3 and 5.4** present a summary of the health issues reported by participants, detailing the frequency of each condition among those included in the study.

Table 5.1 Demographic data for people with COPD and people without COPD

Variable	People with COPD n= 50		People without COPD n= 51		T-test	p-value
Gender	Male	Female	Male	Female	Chi-Square	<0.001
	40	10	28	23	12.129	
Age	64.2 ± 10.2		50.2 ± 8.6		7.44	<0.001
BMI	30.3 ± 5.6		28.4 ± 4.7		1.87	0.064

Data presented as mean $\pm$ standard deviation.

$p < 0.05$ statistical significance between groups, independent t-test, and chi-squared test for categorical data.

Table 5.2 BMI classification for people with COPD and people without COPD

BMI classification	COPD n (%)	people without COPD n (%)	Chi-Square	p-value
Normal 20-25	8 (16)	13 (29)	4.833	0.305
overweight 25.0-29.9	18 (36)	23 (45)		
obese class 1³ 34.9-35	16 (32)	10 (20)		
obese class 2³ 35-40	4 (8)	4 (8)		
obese class 3³ >40	4 (8)	1 (2)		

Data presented as frequency and percentage (%)

Table 5.3 Health Issue in people with COPD

Health Issue in people with COPD	Number of People
Circulatory diseases (e.g., hypertension)	31
Hypertension (duplicate, should be merged)	31
Heart disease	25
Osteoarthritis	15
Anxiety or depression	11
Arthritis	7
Sleep disorder	8
Cancer	3
no health issues	7

Table 5.4 Health Issue in people without COPD

Health Issue in people without COPD	Number of People
Circulatory diseases (e.g., hypertension)	8
Hypertension (duplicated term, appears redundantly with circulatory diseases, needs merge)	8
Malnutrition	3
Bone and joint diseases (osteoarthritis affecting mobility)	3
Cancer	2
Heart disease	3
Arthritis (not osteoarthritis)	1
no health issues	30

5.1.2.PA Level

The measurement of PA level (IPAQ-SF) included total MET minutes per week (MET-min/week) and the time (minutes/week) in PA categories. PA levels for each group were not normally distributed, as assessed by the Shapiro-Wilk's test ($p < 0.05$) (**see Appendix 11.1.27**). Therefore, Mann Whitney U was used for the analysis.

Table 4.3 shows the distribution of walking, moderate, and vigorous activity among people with COPD and comparators based on the median (IQR) of MET minutes per week and PA minutes per week. People in both groups appeared to spend more time walking than undertaking moderate or vigorous activity. There was no significant difference between total PA METs or minutes per week between the groups, including walking activity ($p > 0.05$). However, while the median values for both moderate and vigorous activity were 0 in both groups, the IQR was notably higher in the non-COPD

group, thereby indicating that some individuals engaged in considerably more moderate and vigorous PA than others ($p < 0.05$).

This large variation in PA levels (**see Table 5.5**) suggests that while many participants, particularly those with COPD, reported little-to-no engagement in higher-intensity PA, a subset of participants in the non-COPD group were able to participate in substantial amounts of moderate and vigorous activity. This variability highlights the heterogeneity in PA behaviours, potentially influenced by individual health status or other sociodemographic factors. Consequently, relying solely on median values may not fully capture the distribution of PA levels within each group.

Table 5.5 Median and interquartile ranges for participants who reported engaging in any PA

PA domains (MET-min/week)	COPD median (IQR)	Non-COPD median (IQR)	p-value
Vigorous PA (MET-min/week)	0 (0;0)	0 (0;480)	0.005
Moderate PA (MET-min/week)	0 (0;130)	100 (0;480)	0.035
Walking PA (MET-min/week)	462 (148.5;693)	396 (259.9; 837.4)	0.356
All domains PA (MET-min/week)	518.5 (160.9;1157.3)	735 (288.8;1993.5)	0.107
PA domains (in min/week)	COPD median (IQR)	Comparators median (IQR)	p-value
Vigorous PA (min/week)	0 (0;0)	0 (0;60)	0.006
Moderate PA (min/week)	0(0;32)	25 (0;120)	0.023
Walking PA (min/week)	140 (45;210)	120 (78.8;253.8)	0.356
All domains of PA (min/week)	160 (48.8;330)	225 (87.5;435)	0.156

Data presented as median (IQR), MET-min/week, metabolic equivalent minutes per week, p<0.05 statistical significance between groups, Mann Whitney U.

A comparison of PA categories based on IPAQ-SF classifications (**see Figure 5.1**) showed that, among individuals with COPD, 27 (54%) were classified as having low activity levels, 21 (42%) were moderately active, and 6 (11.8%) engaged in a high level of PA. In the non-COPD group, 23 (45%) had low activity levels, 22 (43.1%) were moderately active, and only 2 (4%) reported a high level of PA.

However, when using the WHO recommendations for PA levels, which suggest that adults should engage in at least 150 to 300 minutes of moderate-intensity aerobic activity per week or 75 to 150 minutes of vigorous-intensity aerobic activity per week, the distribution was slightly different: 27 (54%) of participants with COPD and 29 (57%) without COPD met these guidelines. Conversely, 23 (46%) of those with COPD and 22 (43%) of those without COPD did not meet the WHO-recommended PA levels ($p > 0.05$).

Interestingly, while a substantial proportion of the participants in each group met the recommended levels of PA according to the WHO guidelines, they were classified as having low PA levels according to the IPAQ-SF assessments. This discrepancy may arise because the IPAQ criteria for classifying PA levels (low, moderate, high) might be stricter or more detailed than the general recommendations of the WHO guidelines. Such differences in assessment criteria can lead to discrepancies in how participants' activity levels are categorised (Lee et al. 2011).

In addition, there was no statistically significant difference in the level of total PA (METs min/week) for males and females in the COPD and non-COPD groups ($p=0.65$, $p=0.15$), respectively, and there was no statistically significant difference between males and females in all participants ($p=0.65$) (**see Table 5.6**).

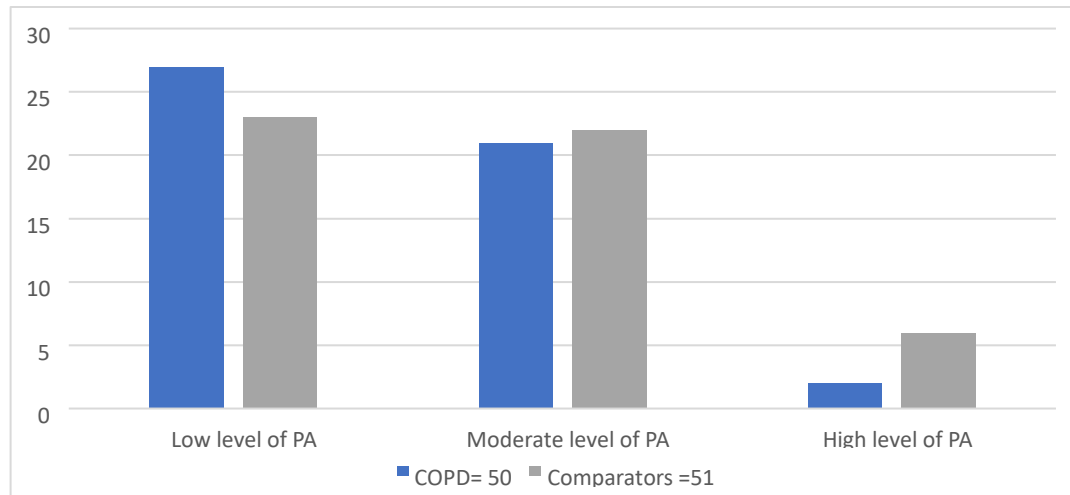


Figure 5.1 A comparison of the number of people in each PA category

Table 5.6 Difference between males and females in COPD and non-COPD groups through all tools

Tools	COPD				Non-COPD			
	Male median (IQR)	Female median (IQR)	Mann-Whitney U	p-value	Male median (IQR)	Female median (IQR)	Mann-Whitney U	p-value
IPAQ-SF	568 (882)	462 (1341.4)	181.5	0.65	1147 (1719)	396 (1398)	246.5	0.15
EQ-5D-5l	0.82 (0.441)	0.534 (.451)	109	0.03	0.926 (.162)	0.926 (.186)	313.5	0.87
EQ-VAS	70 (35)	45 (23)	116	0.04	82 (21)	85 (20)	322	1
D-12	13 (17)	16 (9)	181.5	0.65	N/A	N/A	N/A	N/A

N/A, not applicable

5.1.3. HRQoL

The EQ-5D-5L utility index score (derived using an Egyptian population based value set valuation study) and EQ-VAS for each group were not normally distributed, as assessed by the Shapiro-Wilk's test ($p < 0.05$) (**see Appendix 11.1.27**). There was a statistically significant difference in EQ-5D-5L between people with and without COPD ($p < 0.05$). The median index value in the COPD group was 0.766 (IQR = .441), which was lower than the non-COPD median of 0.926 (IQR = .181). Meanwhile, EQ-VAS was lower in the COPD group (median 67, IQR= 39.75) than the non-COPD group (median 82, IQR= 20) ($p < 0.05$).

The distribution of responses to the EQ-5D-5L domains can be seen in **Table 5.7**. The distribution of scores for all dimensions was statistically different between the COPD and without COPD groups ($p < 0.05$). The description for each domain shows that the COPD group reported no problems for all domains less frequently than the group without COPD. In addition, the group without COPD did not choose 'severe' or 'extreme problems' for all questions.

In the COPD group, the 'usual activities' and 'pain' dimensions showed the greatest self-reported impairment, with 66% and 70% of the cohort reporting at least 'slight problems,' respectively. However, in the group without COPD, the 'anxiety and depression' dimension showed the greatest self-reported impairment, with 51% of the cohort reporting at least 'slight problems.'

The Eq-5D-5L utility index value and VAS in all COPD and non-COPD groups had statistically insignificant differences between males and females. However, within the COPD group, females had significantly lower EQ-5D-5L utility index values (0.534 ± 0.451) compared to males (0.82 ± 0.441) ($p = 0.03$), thereby indicating worse HRQoL. Similarly, females reported lower EQ-VAS scores than males ($p = 0.04$), suggesting poorer self-perceived health status (**see Table 5.9**).

Table 5.7 The distribution of responses to the EQ-5D-5L domains

Dimension	COPD (n=50) n (%)	Non-COPD (n =51) N (%)	Chi-square	p-value
Mobility			14.6	0.002
No problems	25 (50%)	33 (65%)		
Slight problems	6 (12%)	13 (25%)		
Moderate problems	9 (18%)	5 (10%)		
Severe problems	10 (20%)	0		
Extreme problems/unable	0	0		
Self-care			10.9	0.012
No problems	34 (68%)	47 (92%)		
Slight problems	6 (12%)	3 (6%)		
Moderate problems	4 (8%)	1 (2%)		
Severe problems	6 (12%)	0		
Extreme problems/unable	0	0		
Usual activities			19.9	<0.001
No problems	17 (34%)	37 (72%)		
Slight problems	20 (40%)	9 (18%)		
Moderate problems	7 (14%)	5 (10%)		
Severe problems	5 (10%)	0		
Extreme problems/unable	1 (2%)	0		
Pain			14.1	0.007
No problems	13 (26%)	33 (65%)		
Slight problems	22 (44%)	12 (23%)		
Moderate problems	12 (24%)	6 (12%)		
Severe problems	3 (6%)	0		
Extreme problems/unable	0	0		
Anxiety and depression			16.6	<0.001
No problems	26 (52%)	25 (49%)		
Slight problems	9 (18%)	22 (43%)		
Moderate problems	9 (18%)	4 (8%)		
Severe problems	5 (10%)	0		
Extreme problems/unable	1 (1%)	0		

5.1.4. Dyspnoea

In people with COPD, dyspnoea was measured using the Arabic D-12. D-12 was normally distributed in the COPD group, as assessed by the Shapiro-Wilk's test ($p = 0.06$) (**see Appendix 11.1.27**). The mean score for the COPD group was 15.12 ± 9.7 . The maximum score was 36, whereas the minimum score was 0.

The median (IQR) score for the physical domain of the D-12 was 9.98 (5.4), indicating the extent of physical symptomatology related to dyspnoea among COPD participants. The affective or emotional domain median score was 5.1(5.03), highlighting the psychological impact and emotional distress associated with dyspnoea in this population.

The D-12 questionnaire was administered to the COPD group and the results indicate that there is no significant difference between men and women in terms of their level of dyspnoea ($p=0.65$) (**see Table 5.8**).

Table 5.8 Proportion (%) of COPD participants' responses to the D-12 domains

D-12 domains	None (0)	Mild (1)	Moderate (2)	Severe (3)
Physical domain				
1. My breath does not go in all the way	4 (8%)	24 (48%)	19 (38%)	3 (6%)
2. My breathing requires more work	8 (16%)	18 (36%)	20 (40%)	4 (8%)
3. I feel short of breath	5 (10%)	19 (38%)	16 (32%)	10 (20%)
4. I have difficulty catching my breath	8 (16%)	17 (34%)	19 (38%)	6 (12%)
5. I cannot get enough air	7 (14%)	20 (40%)	18 (36%)	5 (10%)
6. My breathing is uncomfortable	8 (16%)	19 (38%)	18 (36%)	5 (10%)
7. My breathing is exhausting	12 (24%)	19 (38%)	12 (24%)	7 (14%)
Affective or emotional domain				
8. My breathing makes me feel depressed	26 (52%)	10 (20%)	7 (14%)	7 (14%)
9. My breathing makes me feel miserable	27 (54%)	9 (18%)	8 (16%)	6 (12%)
10. My breathing is distressing	15 (30%)	19 (38%)	9 (18%)	7 (14%)
11. My breathing makes me agitated	20 (40%)	11 (22%)	12 (24%)	7 (14%)
12. My breathing is irritating	18 (36%)	16 (32%)	10 (20%)	6 (12%)

5.1.5. Relationships Between IPAQ and Other Tools

There were no significant correlations between IPAQ-SF using the MET and EQ-5D-5L variables ($r_s = -0.29$ and $r_s = 0.107$, respectively). Moreover, there were no significant correlations between people with COPD ($r_s = -0.135$) and those without COPD ($r_s = -0.081$) in the EQ-VAS score. There were significant and negative moderate correlations between IPAQ and the D-12 questionnaire in the COPD group ($r_s = -0.567$) ($p < 0.05$), showing an inverse relationship between HRQoL and breathlessness (see Table 5.7 and Figure 5.2). In addition, there is an insignificant correlation between the EQ-5D-5L variables and D-12 ($r_s = -0.176$) and between EQ-VAS and D-12 ($r_s = -0.088$) in the COPD group.

Table 5.9 Relationships Between IPAQ-SF and Age, EQ-5D-5L utility index, EQ-VAS, and D-12

Tools	People with COPD		People without COPD	
	r_s^*	p-value	r_s^*	p-value
EQ-5D-5L	-0.29	0.844	0.107	0.455
VAS	-0.135	0.349	-0.081	0.571
D-12	-0.567	<0.001	-	-

r_s^* , Spearman's rank correlation coefficient (Spearman's rho, ρ)

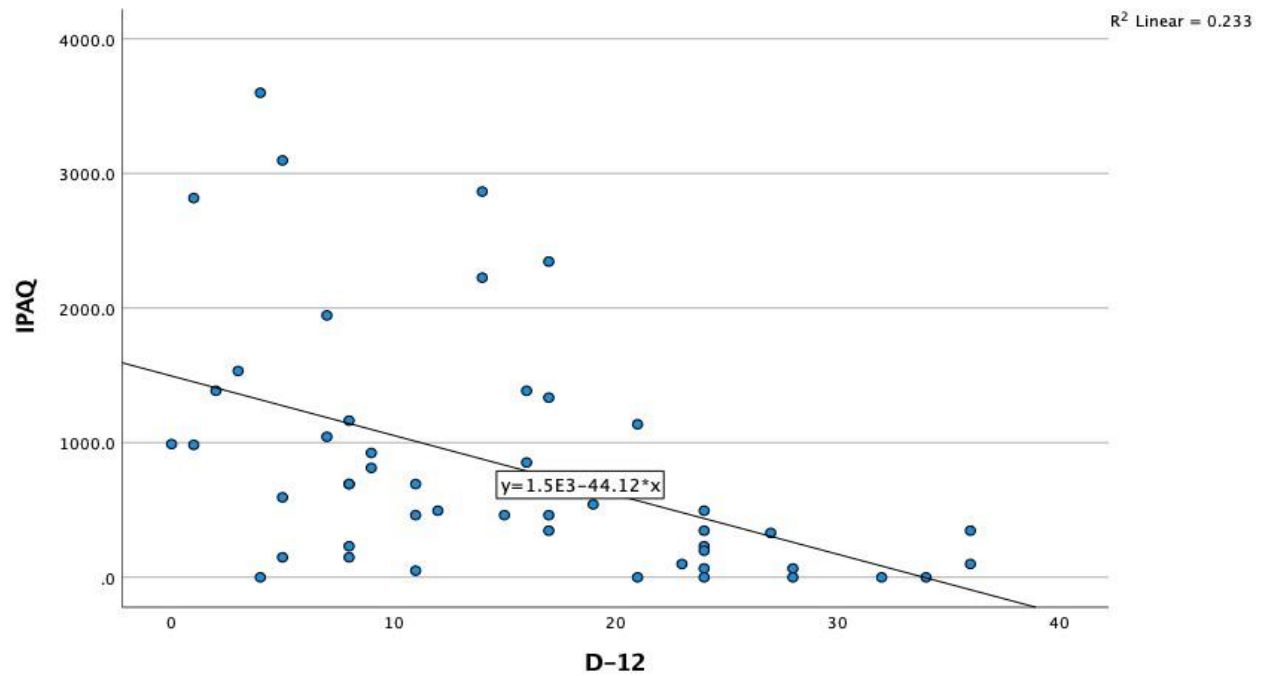


Figure 5.2 Scatter plot for IPAQ-SF and D-12 correlation in COPD group

Summary of Quantitative Results

This study included 101 participants recruited from Riyadh, Saudi Arabia, comprising 50 individuals with COPD and 51 without COPD.

Statistical comparison of PA levels between the COPD and non-COPD groups resulted in $p > 0.05$, leading to the acceptance of the null hypothesis, indicating no statistically significant difference in overall PA levels using MET-min/week between study groups. People in both groups appeared to spend more time walking than undertaking moderate or vigorous activity.

Statistical comparison of HRQoL in the study groups, measured by EQ-5D-5L and EQ-VAS, resulted in $p < 0.05$, leading to the rejection of the null hypothesis. This confirms that HRQoL was significantly different in people with COPD, with a median index value of 0.766 (IQR = .441), compared to those without COPD who recorded a median of 0.926 (IQR = .181).

Furthermore, there were no significant correlations between overall PA (measured using IPAQ-SF) and HRQoL (measured using EQ-5D-5L and EQ-VAS) in either group ($p > 0.05$), leading to the acceptance of the null hypothesis indicating no relationship between PA and HRQoL. However, a moderate negative correlation was found between IPAQ-SF and the D-12 questionnaire, leading to the rejection of the null hypothesis and suggesting that higher PA levels were associated with lower dyspnoea levels. Finally, 10 participants from the COPD group and 8 participants from the non-COPD group expressed a willingness to take part in the next phase of the research.

5.2. Discussion

Physical Activity

This is the first study to evaluate PA and HRQoL in people with COPD and without COPD in Saudi Arabia. Although this study did not find a significant difference in median PA between people with COPD and people without COPD, the proportion of people undertaking moderate and vigorous activities was lower among those with COPD than those without COPD. Nevertheless, both groups demonstrated low levels of PA according to the IPAQ classification.

Although the current study did not find a statistically significant difference in the overall median PA between people with and without COPD, the finding that a lower proportion of people with COPD engaged in moderate and vigorous intensity activities is in accordance with the previous literature. A scoping review by Xiang et al. (2022) highlighted that, while people with COPD may engage in PA, they tend to do so at lower intensity, with notable reductions in moderate and vigorous activities compared to age-matched healthy controls. This pattern was attributed to factors such as fear of breathlessness, reduced exercise capacity, and comorbidities. These insights reinforce the current study's findings and underscore the importance of examining not only the quantity but also the quality and intensity of PA when comparing COPD and non-COPD populations.

A comparison of the current study's findings with those of international studies identified notable differences. The IPAQ-SF categorical analysis indicated that 54% of participants with COPD were categorised as low active; this is higher than those reported in prior international studies. For instance, a cross-sectional study of Latin American countries using IPAQ-SF found that nearly 40% of patients with COPD in Latin America presented low levels of PA (Mendoza et al. 2021).

In contrast, a review of studies from 20 developed and developing economies using the IPAQ-SF to assess PA levels among individuals aged 18–65 years revealed low activity levels in several populations, including Belgium (43%), Japan (34.3%), and Taiwan (42.3%) (Bauman et al. 2009). Similarly, the current study found that approximately 45% of the people in the non-COPD group were classified as low active. Additionally, the review reported low activity levels in 40% of the Saudi population.

In the current study, the median of MET-minutes/week for the COPD group was 519 and for participants without COPD was 735, which was lower than the baseline median of 1,193 reported in a recent study examining the validity of IPAQ-SF in the COPD population in Portugal (Flora et al. 2023b). The variations in PA levels between the different populations of this study in Saudi Arabia and Portugal may be influenced by cultural differences, lifestyle choices, environmental and individual health conditions, all of which may contribute to the differences observed in PA levels across different studies (Jaeschke et al. 2017).

In accordance with the previous literature, the current study revealed that walking was the most reported PA among the study participants. Specifically, most of the study sample, including 86% of people with COPD and 94% of the non-COPD group, reported engaging in walking for a duration of at least 10 minutes on five or more days per week. However, only 24% and 54.9% of COPD and non-COPD participants, respectively, reported moderate-intensity physical activities, while 18% of COPD participants and 43% of the non-COPD participants reported engaging in vigorous activities. This aligns with a study of men with COPD from Saudi Arabia who spent less time engaged in walking-based activities than healthy controls (22% versus 37% of waking hours; $p < 0.001$) (Alyami et al. 2018).

These findings are consistent with the previous studies of Al-Hazzaa (2007) and Al Zahib and Baarimah (2020), where 45% and 50% of adult participants, respectively, reported walking for five or more days per week. Additionally, the results are consistent with the findings of Awadalla et al. (2014) involving university students in Saudi Arabia, which

reported that 49% of college students reported walking for more than 60 minutes per week. In a recent population-based study conducted by Alqahtani et al. (2021), it was observed that walking was the most frequently practiced PA among individuals, accounting for 56% of the total activities performed.

There was no significant difference in IPAQ-SF scores between males and females in the current study. This finding aligns with previous research, such as Al-Hazzaa's (2018) systematic review of PA in Saudi Arabia, which reported that physical inactivity ranged from 26% to 85% among males and from 43% to 91% among females, with no statistically significant difference between the two groups. This suggests that both genders face similar barriers to PA participation in the Saudi context.

HRQoL

The current study investigated differences in HRQoL between people with COPD and those without COPD using the EQ-5D-5L and EQ-VAS tools. The EQ-5D-5L utility index value median for the COPD group was 0.766 (IQR=0.441), which was significantly lower than the comparator group's median of 0.926 (IQR=0.181), indicating a perceived poorer QoL for the COPD group. Additionally, the EQ-VAS scores for the COPD group were significantly lower, with a median of 67 (IQR = 39.75), compared to the comparator group which had a median of 82 (IQR = 20) ($p < 0.001$). This indicates poorer self-reported HRQoL among people with COPD. These findings are consistent with those reported by Kokturk et al. (2018). Similarly, previous studies in Saudi Arabia reported a mean EQ-VAS score of 70.3 (± 14.8) for people with COPD, while a study in Egypt reported a mean EQ-VAS score of 76.9 (± 16.7) for the general population (Al Shabasy et al. 2022). However, it should be noted that these studies used the EQ-5D-3L. Both versions (EQ-5D-5L and EQ-5D-3L) include a VAS for self-rated health assessment but the EQ-5D-5L's expanded levels allow for a more nuanced evaluation of health status. Consequently, the EQ-5D-5L may yield different scores due to its improved sensitivity, potentially affecting the interpretation of health outcomes compared to the EQ-5D-3L. Conversely, a study conducted in the UK by Nolan et al. (2016) reported a lower baseline

mean EQ-5D-5L utility index of 0.68 (± 0.24) and EQ-VAS of 61.0 (± 20.6) for people with COPD compared to the current study, suggesting lower QoL for people with COPD in the UK compared to this study. COPD is known to have a negative impact on HRQoL. This could be due to differences in disease severity, access to healthcare, or other socioeconomic factors between the two populations.

Dyspnoea

The current study analysed the median (IQR) score of the COPD group, which was found to be 14.5 (15.75). This score was comparatively lower than the mean score reported in a previous study conducted in Saudi Arabia which sought to evaluate the validity and reliability of the D-12 scale among people with COPD. In the aforementioned study, Alyami et al. (2015) reported a higher mean score of 22.4 (SD=3.6). Similarly, a more recent study conducted with COPD males in Saudi Arabia demonstrated a mean score of 19.1 (SD = 3.5), whereas the current study's mean score for males was 14.9 (SD = 9.98). These findings suggest that the participants in the current study experienced less breathlessness than those in the prior studies. The data collection method utilised was an online survey, potentially affecting participant demographics and self-reporting tendencies. Online survey methods may have attracted individuals with varying perceptions of breathlessness or those who might under-report symptoms in the absence of direct clinical assessment. Therefore, the differences observed in terms of breathlessness levels should be considered within the context of the study's methodology.

Furthermore, in a recent study conducted in Europe and France, the aim was to estimate the minimal important difference (MID) for D-12 in COPD patients undergoing a PR programme. The study found that the baseline mean score for people with COPD was 23.9 (± 8.9) (Beaumont et al. 2021). The lower levels of dyspnoea reported in the current study compared to Beaumont et al.'s (2021) study could be attributed to cultural differences in symptom expression and communication, as well as potential variations in disease severity between the populations (Hayen et al. 2013; Mohammad et al. 2017).

Beaumont's participants had severe or very severe COPD, whereas disease severity was not assessed in the current study, thereby making direct comparisons challenging.

Relationships Between Variables

The absence of a significant correlation between the EQ-5D-5L variables and the D-12 questionnaire ($r = -0.176$) in the COPD group was unexpected because dyspnoea is a key symptom affecting QoL in COPD, as reported by Nolan et al. (2016) who found moderate-to-strong correlations between the EQ-5D-5L utility index and EQ-VAS with disease-specific questionnaires in COPD patients such as the CAT, SGRQ, and self-report chronic respiratory questionnaire (CRQ (Pearson's $r = 0.47-0.72$). While the current study did not specifically examine the D-12, it suggests that the EQ-5D-5L generally correlates well with COPD-specific measures. Research has shown that the EQ-5D-5L utility index decreases (indicating worsening health status) with indices of worsening disease severity in COPD. Because dyspnoea is a key indicator of COPD severity, one would expect there to be correlation between the EQ-5D-5L and D-12 scores. The discrepancy between the current study's results and previous research could be due to several factors. First, the previous studies found correlations using the disease-specific multi-dimensional HRQoL measures, whereas the current study used the D-12 questionnaire, which specifically assesses dyspnoea perception. Given that EQ-5D-5L is a generic HRQoL measure, it may align better with multi-domain tools like CAT, SGRQ, or CRQ rather than a symptom-specific measure like D-12. In addition, there is a difference in the gender distribution of the current study where the COPD group was 80% male, which could affect the findings. This gender-based difference in symptom perception and HRQoL reporting may explain why Nolan et al. (2016) found stronger correlations between dyspnoea and EQ-5D-5L measures, whereas the current study did not.

Summary

Contrary to expectations, the current study did not find a significant difference between groups. Approximately half of the COPD and comparator groups demonstrated low levels of PA, which led to the need for further investigation and a qualitative component to explore what other factors affect PA participation. It is possible that social, environmental, and contextual factors may also play a role in determining PA levels and that low levels of PA in Saudi Arabia may be a consequence of cultural factors that extend beyond the COPD population.

5.2.1. Strengths and Limitations of the Quantitative Phase

The quantitative phase of the current study demonstrated several methodological strengths. A substantial sample was targeted ($n=128$) and data were successfully collected from 101 participants, yielding a relatively diverse sample and enabling a broad comparison between individuals with and without COPD. Standardised and validated instruments, such as the IPAQ-SF, were employed to ensure consistency and enhance the reliability of the findings. A rigorous data-cleaning process was undertaken to improve data quality by excluding incomplete or implausible responses, thereby strengthening the integrity of the final dataset.

Despite these strengths, several limitations should be acknowledged. First, the achieved sample size fell short of the target, which may have reduced the statistical power of the study—particularly in light of the high variability observed in the IPAQ data, as reflected by a large IQR. This may have limited the study's ability to detect significant between-group differences or associations. However, it is important to note that a retrospective power analysis was not conducted, as the PA data violated the assumption of normality (Shapiro–Wilk $p < 0.05$) and a non-parametric Mann–Whitney U test was used instead of the originally planned t-test. Furthermore, post hoc power calculations are widely regarded as statistically inappropriate and non-informative, as they offer no additional insight beyond effect sizes and p-values. As recommended by Heckman et al. (2022), confidence intervals and effect sizes provide a more valid and interpretable approach for evaluating study results once data collection is complete.

It is important to note that the sample size was powered specifically to detect between-group differences in PA levels. The correlational analyses conducted in the study were exploratory in nature and were not powered a priori. As such, the findings from these analyses should be interpreted with caution. Future research should consider powering specifically for correlational testing to allow more robust inferences regarding the relationships between variables such as PA, self-efficacy, dyspnoea, and HRQoL.

Additionally, disparities in age and gender distribution between the COPD and comparator groups may have introduced confounding variables, thereby affecting internal validity and limiting the generalisability of the findings. The use of a convenience sample recruited through online surveys further constrains generalisability because the participants were self-selecting. This may have introduced selection bias, with individuals who were more health-conscious, physically active, or digitally literate being more likely to participate than the broader population.

Moreover, the COPD group was recruited from specialist respiratory clinics within two tertiary hospitals, suggesting that the sample may disproportionately represent individuals with more advanced or managed disease. As such, the sample may not adequately reflect the wider COPD population in Saudi Arabia, particularly those with undiagnosed or less severe disease managed in primary care or not receiving care at all.

Similarly, the control group was recruited from the Public Pension Agency and matched for age but this cohort may not be representative of the broader non-COPD population in terms of socio-economic status, occupational exposure, or comorbidity profiles. These contextual factors should be carefully considered when interpreting the results and assessing their applicability to the wider population.

Finally, another limitation pertains to the absence of statistical adjustments and robustness checks. No weighting or propensity score methods were used to adjust for sample non-representativeness, which may affect the generalisability of the quantitative findings. Additionally, sensitivity analyses were not performed to test the robustness of the results due to the limited sample size and exploratory focus. These methodological constraints highlight the need for future research employing larger, representative samples and incorporating sensitivity testing to validate findings.

6. Qualitative Method (Phase 2)

6.1. Introduction

This section describes the qualitative phase which comprised of semi-structured interviews. The objective of these interviews was to explore the experiences of individuals who had participated in Phase 1 and were diagnosed with COPD in order to understand the barriers to and facilitators of PA. People without COPD were also interviewed after the initial quantitative analysis to expand upon the findings presented in Chapter 5. Additionally, interviews were conducted with HCPs to explore their role in facilitating PA among people with COPD in Saudi Arabia.

This phase sought to determine the overall experiences and beliefs towards PA, as well as the barriers to and facilitators of PA in Saudi Arabia. The use of SCT (Bandura 1986) as the underpinning theory will be explained. Conducting this phase allowed the researcher to better understand the changing behaviour of people with COPD and identify relevant factors that could be used to guide evaluation processes (Phillips et al. 2015).

6.1.1.Aim of this Phase

The aim was to explore the barriers and facilitators affecting PA engagement among people with and without COPD and the role of health professionals in promoting PA for people with COPD in Saudi Arabia.

The primary objective of this phase were:

- To explore the barriers and facilitators influencing PA engagement among people with COPD.
- To explore PA behaviours in Saudi Arabia by interviewing people without COPD to more fully explore the PA behaviours and contributory factors.
- To explore perspectives of HCPs on promoting PA for people with COPD.

6.1.2.Design and Approach

Qualitative research employs different methodologies and the selection of a suitable method depends on the topic, research question, and theoretical framework (Creswell and Poth 2018). For example, if the research intends to investigate individuals' actual experiences, phenomenology is a suitable approach for gathering data and conducting interviews or focus groups are useful methods for data collection (Creswell and Poth 2017). This qualitative phase was reported in accordance with the Consolidated Criteria for Reporting Qualitative Research (COREQ) 32-item checklist (**see Appendix 11.1.6**).

Qualitative research methods include individual interviews, focus groups, document analysis, and observation (Creswell and Poth 2017). Interviews are a widely used method for acquiring a comprehensive understanding of the participants' encounters (Brinkmann and Kvale 2015). Individuals can express their beliefs and opinions freely during personal interviews without fear of judgement or influence from others, unlike in focus groups. When contemplating time and resources, Silverman (2016) established that their availability is a critical factor in the decision-making process. Other methods, such as focus groups, may face challenges such as coordinating schedules among participants or the need to consider cultural sensitivities about gender segregation in specific situations. Approaches such as observation or document analysis may offer useful insights by employing methodological triangulation (Patton 2015). However, ethical concerns regarding confidentiality may pose challenges in certain environments, such as public-sector hospitals.

As a doctoral student with limited time, it was necessary to choose an approach that is both efficient and effective. Therefore, interviews were determined to be the most appropriate approach, considering these criteria. Although one-to-one interviews may take more time, they provide a more complete understanding of each participant's thoughts and opinions. This is because the participants are not influenced by others during the interview process (Brinkmann and Kvale 2015). As a result, individual interviews provide a unique opportunity to gain a deeper understanding of the

experiences of both people with and without COPD and the perspectives of HCPs. This aligns with the aims of this thesis.

Qualitative interviews offer three distinct approaches: structured, unstructured, and semi-structured, as outlined by Edwards and Holland (2013). Structured interviews involve predetermined questions, adhering to a sequential order. The choice between unstructured and semi-structured interviews depends on various factors aligned to the research objectives or topic at hand (Edwards and Holland 2013).

The choice of interview format depends on key considerations, including the research objectives. Structured interviews yield more structured data which is easily comparable across participants (Gill et al. 2008). Conversely, exploratory studies aiming for profound insights into experiences may find unstructured or semi-structured formats to be more beneficial to collect richer, less structured data (Brinkmann and Kvale 2015). Another critical factor is the nature of the researched topic. An unstructured approach is fitting for sensitive subjects requiring free participant expression (Elmir et al. 2011), whereas straightforward information-gathering tasks may demand a more structured format (Bernard 2005).

Careful consideration of participant characteristics is paramount. Those anticipated to contribute effectively may benefit from a less rigid structure, whereas participants in need of prompts may find challenging questions instrumental in initiating meaningful dialogue (King and Horrocks 2010). Additionally, researchers must factor in their own skills, personal bias, and experience of carrying out interviews. Conducting and analysing data from less-structured interviews demands experienced interviewers who are proficient in guiding conversations towards research objectives, while accurately interpreting participants' responses (Brinkmann and Kvale 2015).

Litchman (2017) suggests that the selection of research methodologies mainly depends on the population being studied, the type of data to be gathered, and the topic matter. Expanding on Litchman's observation, the people being studied, particularly their levels

of PA, had already been reported in the prior chapters, encompassing both people with and without COPD in Saudi Arabia. Concerning the nature of the data, this section elucidates and provides the rationale for questions that offer a comprehensive understanding of their low levels of PA, incorporating influences such as symptoms and the availability of PR. Regarding the subject matter briefly highlighted earlier, PA for people with COPD represents an extensive emergent topic requiring a nuanced understanding, not only of medical outcomes but also of their lifestyle (Llamas-Saez et al. 2023). Hence, the adoption of a semi-structured interview is deemed appropriate to gain comprehensive insights into these multifaceted matters.

Bryman (2016) argues that semi-structured interviews offer researchers greater flexibility during data collection, allowing them to follow a set of predetermined questions whilst also exploring emerging themes in greater depth. The use of pre-established questions contributes to transparency and facilitates reproducibility for researchers investigating similar topics. In the current study, SCT was used to inform and guide the development of the interview schedule. Specifically, SCT constructs—such as self-efficacy, outcome expectations, and social support—were used as a framework for generating interview questions, ensuring that the inquiry was theoretically grounded and aligned with the study's aim to explore the barriers to and facilitators of PA.

Moreover, the use of probing and follow-up questions enhances the openness of inquiries and provides novel insights not previously discovered. Therefore, the flexibility offered by a semi-structured interview suggested that this approach was the most suitable for the research design, objectives, and theoretical stance. Despite the potential drawbacks highlighted by some researchers, such as the introduction of bias through probing, reflexivity is employed to maintain neutrality, enhance data quality, and identify any biases or preconceptions while gathering data (Berger 2015).

This research approach is mixed methods, utilising two datasets to provide multiple perspectives while reinforcing credibility and trustworthiness (Creswell and Plano Clark 2007). In order to efficiently achieve the study goals and address the research questions,

semi-structured interviews were utilised. These interviews offer a flexible way of collecting data with the use of interview schedules. The participants were encouraged to provide further clarification through probing and follow-up questions. While this approach offers flexibility, structured interviews could be challenging because they may resemble survey data, lacking in-depth insight into participants' experiences. Conversely, unstructured interviews, although providing a profound understanding, pose threats to consistency and replicability. Additionally, participants in Saudi Arabia may have limited experience of such methods, making conducting interviews without a schedule challenging. Hence, thoughtful considerations have been made to select the most appropriate approach for data collection, ensuring deeper engagement with participants and acknowledging the cultural context.

Despite being time-consuming and incurring costs (Adams 2015), semi-structured interviews were selected because they allow researchers to address gaps after quantitative method analysis and completion. Emphasising the suitability of semi structured interviews, Adams recommended their use to enhance data richness and depth. Gill et al. (2008) highlights the flexibility of this method, allowing researchers to incorporate appropriate follow-up questions that enhance the understanding of complex data.

Various interview methods are documented in the research, such as telephone, face-to-face, and online methods like Zoom. The online approach was selected primarily because of the COVID-19 restrictions, which made it difficult to conduct in-person interviews. Notwithstanding these limitations, there are compelling justifications for looking at online services like Zoom because they are more beneficial than traditional interview approaches. According to Novick (2008), telephone interviews have the potential to provide data of comparable depth to face-to-face conversations, while also giving the advantage of flexibility. However, Sturges and Hanrahan (2004) emphasise the distinction between both modes, specifically in terms of catching the emotional intensity of participants. This difference is primarily related to the lack of visual signals in telephone interviews compared to face-to-face sessions. These findings highlight that

although telephone interviews might yield comparable levels of data richness, they may fail to capture visual cues and impede the development of the connection between the researcher and participants, which are essential components for conducting effective interviews.

As a researcher conducting studies in both Saudi Arabia and the UK, the online aspect was invaluable, especially when needing to gather data while on the move. This contrasts with face-to-face interviews which require both parties to be in the same physical location. Coordinating appointments, securing venues, and managing logistical aspects during interview sessions are all essential considerations (Irvine et al. 2020).

Although online methods offer numerous advantages, it is essential to recognise their associated drawbacks. One notable challenge is sampling bias (Portney 2015). When recruiting participants for online studies, researchers may inadvertently attract individuals who already have access to the internet and are familiar with using technology, potentially limiting the generalisability of the findings across diverse populations. However, in the context of the current research, data collection coincided with the COVID-19 pandemic, during which regulations prohibited travel and in-person gatherings. Therefore, opting for online interviews demonstrated resilience and adaptability. However, technical difficulties or problems with internet access sometimes interfere with online interviews, especially in places with unstable internet coverage (Archibald et al. 2019). To improve the quality of their interviews, the participants were advised to ensure they had dependable internet connections and a calm, comfortable setting. Although there are drawbacks to using online interviews, the advantages greatly exceed these drawbacks.

6.1.3. Methods

In this part of the study, the qualitative aspect of this study recruited people with COPD and people without COPD who had already participated in Phase 1. They were asked at the end of the survey if they would like to participate in the interviews. The participants (10 from the COPD group and 8 from the non-COPD group who had expressed an

interest in participating in further research at the end of the quantitative phase) were contacted via email or text. Attached to the invitation were an information sheet, consent forms, and time schedules. To ensure confidentiality and privacy, a secure Zoom link was then sent with password protection. This link was restricted to only the researcher and participant. If applicable, scheduled time slots and Zoom links were provided. A reminder was sent before each day, allowing the participants to adjust their schedules if necessary and ensure timely attendance.

The HCPs were approached by a gatekeeper (AA), who sent an invitation to HCPs working in King Saud University Medical City and King Fahad Medical City, particularly those involved in PR or caring for patients with respiratory conditions. The invitation included a brief overview of the study, its purpose, and what participation would involve. Those who were interested were asked to contact the primary researcher (RA) directly if they wished to receive further information or arrange an interview.

When the researcher received an email of interest from potential participants, they were sent an information sheet by email about the study and given at least 24 hours to consider whether they would like to participate. They were given the opportunity to ask questions by contacting the researcher via email.

Participants who agreed to participate were then asked to complete a consent form by email and send it back to the researcher. The form explained that participation in the study was entirely voluntary and that participants could withdraw at any time without needing to provide a reason. For those in the COPD group, it was also clarified that participation or withdrawal would not affect the standard of care they received either during or after the study. The results were available upon request and, importantly, all information would be handled confidentially and securely.

Recruiting participants for the qualitative phase proved to be an arduous task, despite a good response from patients involved in the quantitative phase. Notably, among Saudi populations, surveys are the most commonly employed research method (Jahan et al.

2017). This could explain the Saudi population's lack of familiarity with interviews and other qualitative approaches. As such, assistance was provided to help those with and without COPD and HCPs comprehend the benefits of interviewing for researchers, particularly in terms of capturing issues that quantitative studies may not address (Creswell and Poth 2018).

6.1.4. Sample Size

In qualitative research, sample sizes are small due to the depth and complexity of data obtained, as well as the challenges that occur when managing large samples. Ritchie et al. (2014) identified additional sample size factors, such as the inclusion of different participant categories/groups in one study to produce a larger overall sample. The objective of the current study was to explore the perspectives of people with COPD and those without COPD and HCPs, in order to answer the research questions.

Data saturation is a key consideration in qualitative research because it helps to determine when sufficient data has been collected to support robust and credible findings. According to Saunders et al. (2018), saturation not only guides sample size decisions but also signals when continued data collection is unlikely to yield new insights. Fusch and Ness (2015) define data saturation as the point at which no new data, themes, or coding emerge from additional participants. Similarly, Guest et al. (2006) argue that saturation occurs when the data collected are sufficient to develop meaningful themes, and further data collection offers diminishing returns. Although some researchers, such as Adler and Adler (2011), suggest using sample sizes ranging from 12 to 60, Baker and Edwards (2012) propose that as few as 12 participants may be sufficient, depending on the nature of the research.

Saunders et al. (2018) identify four types of saturation: theoretical, thematic, inductive, and data saturation.

- Data saturation refers to the point at which no new data are collected.

- Thematic saturation involves the development of rich, well-defined themes, where additional data do not yield new thematic insights.
- Theoretical saturation is typically associated with grounded theory and occurs when further data collection no longer contributes to building or refining the theoretical framework.
- Inductive saturation refers to the point at which new inductive codes cease to emerge during analysis.

Although saturation remains widely accepted, Morse (2015) cautions that determining when it is achieved can be subjective and context-dependent, which may affect consistency and replicability across studies.

In the current study, due to the time constraints inherent in doctoral research, it was not feasible to systematically apply all four saturation approaches. However, in accordance with the approach recommended by Saunders et al. (2018), data collection continued until no additional participants volunteered, the collection window was extended, and similar patterns of responses repeatedly emerged. This approach sought to enhance the likelihood of achieving thematic saturation and to support the trustworthiness of the qualitative findings.

6.1.5.Participants

Table 6.1 Participants Inclusion and Exclusion criteria

	People with COPD	People without COPD	HCPs
Inclusion criteria	• Aged 40 years or older. • People with a current diagnosis of COPD at any stage. • Able to give informed consent and willing to participate.	• Free from any respiratory diseases. • Aged 40 years or older. • Able to give informed consent and willing to participate.	• Physiotherapists, respiratory therapists, and physicians who have worked >1year with people with COPD in King Saud University Medical City or King Fahad Medical City.
Exclusion criteria	• LTOT. • Pregnancy. • Cognitive impairment. • Diseases affecting mobility (e.g., Parkinson's disease, cerebrovascular accident, or anatomical abnormality).	• Pregnancy. • Diseases affecting mobility (e.g. Parkinson's disease, cerebrovascular accident, or anatomical abnormality).	• <1 year experience of working with people with COPD in Saudi Arabia.

6.1.6.Interview Guide

The interview questions were developed by the researcher in consultation with the supervisory team and were guided by the constructs of SCT to ensure a theoretically grounded approach. SCT, developed by Bandura (1986), is widely used to understand and explain the complex mechanisms underlying behaviour change. It provides a

comprehensive framework for exploring personal, social, and environmental influences on behaviour, particularly relevant to PA engagement in chronic disease populations such as those with COPD.

The interview guide was structured to explore five key SCT constructs: self-efficacy, outcome expectations, behavioural capability, socio-structural factors, and motivation and goal setting. These constructs informed both the content and phrasing of the interview questions. Additional questions were added to ensure alignment with the broader aims of the study. Questions were initially designed for people with COPD and subsequently adapted for HCPs and individuals without COPD. The guides were semi-structured, allowing for consistent thematic coverage while offering flexibility to explore emerging topics. Follow-up prompts (e.g., “What do you mean by that?” or “Can you tell me more?”) were used as needed to elicit deeper responses (Turner 2010; Brinkmann and Kvale 2015). The full interview schedules are provided in **Appendix 11.1.23**.

Each interview question was mapped to the relevant SCT construct, as follows:

- **Self-efficacy:** Questions in this section explored the participants’ confidence in engaging in PA despite health limitations. For example: “What limits you from doing PA?” This aligns with SCT’s emphasis on belief in one’s capabilities to act.
- **Outcome expectations:** These questions investigated the participants’ beliefs about the potential benefits or consequences of PA. For instance: “What are the benefits of PA for you?” This helps to assess perceived value or reward associated with PA, which influences engagement.
- **Behavioural capability:** Questions here examined the participants’ knowledge and understanding of how to incorporate PA into their daily lives. For example: “What is your knowledge of PA?” This construct considers whether a person has the skills and information needed to act.
- **Socio-structural factors:** These questions sought to identify the environmental or social facilitators of and barriers to PA. For example: “Are there any challenges in your

environment or social life that make it hard to be active?” These map to SCT’s consideration of external influences on behaviour.

- **Motivation and goal setting:** The questions in this section explored the participants’ PA goals and their motivation for setting or pursuing them. For example: “What might encourage you to engage in PA?” Goal setting is a critical aspect of SCT’s self-regulation component.

Incorporating these constructs into the interview guide ensured that the data collected would be theoretically informed, allowing for an in-depth exploration of the behavioural, cognitive, and environmental influences on PA engagement. This alignment between theory and data collection enhances the transparency and reproducibility of the research.

6.1.7. Pilot Study

The current research was carried out in the Saudi capital Riyadh, which is situated in the central region of the country. The reason for selecting Riyadh as the research context was its large population of more than 7 million people and its status as the business centre of Saudi Arabia. Most of the ministries and healthcare facilities are also located in Riyadh.

The initial set of interview questions was reviewed and discussed with the supervisors. In May 2022, a pilot interview was conducted with a person with COPD from Riyadh to examine the quality of questions and ensure clarity for the participants. The questions were clear to him but the quotations were reordered to achieve a better flow. Subsequently, interviews were conducted with several individuals suffering from COPD.

The interview schedules for both HCPs and people without COPD were piloted with one physiotherapist and one participant who did not have COPD, respectively. No changes were made to the questions after the pilot interviews but the order of the questions was modified to improve the flow.

6.1.8. Data Collection

Interviews with COPD participants commenced in May 2022 by contacting participants who had completed the quantitative phase and who agreed to participate in the qualitative phase. A consent form was sent to the participants via email. After the consent form with their agreement was returned, the interviews took place via Zoom at a date and time of the participants' choosing. During the interview, verbal consent was obtained from the participants. All of the interviews were audio recorded and the participants were told that they could stop or pause the call at any time. However, all of the participants completed the interview without experiencing any distress.

The interviews with the HCPs started on 23rd May 2022 at a time and date of the participants' choosing. The data were audio-recorded in Zoom, checked, and transcribed into Arabic by RA. When all of the interviews had been transcribed, the researcher (RA) translated them into English and these were reviewed by AA. Drawing on their cultural background and linguistic expertise, the researcher ensured precise translations, capturing the inherent cultural nuances in the participants' responses.

Following Squires' (2009) recommendations, it is imperative to accurately document the steps taken during translation, discussing both the advantages and disadvantages. Transparency enables future researchers to evaluate the approach applied in the current study and offers a blueprint for replication in their studies. Microsoft Word was utilised for transcription, diligently verifying the accuracy of each translation. When faced with uncertainties regarding specific phrases or expressions, guidance from bilingual peers at the University was sought.

Squires (2009) emphasises the importance of discussing the pros and cons of one's approach to assist researchers contemplating similar methods. Self-translation affords several benefits, including ethical considerations such as upholding participant confidentiality, active involvement in ensuring an accurate representation of cross-

cultural experiences, and cost-effectiveness. Nonetheless, it is not without potential drawbacks, notably the time-consuming nature of double-checking every translated word and phrase. Despite these challenges, given the unique circumstances of the current study, encompassing budgetary constraints and the necessity for a close connection with the data, self-translation emerged as the most suitable choice.

In the current study, initially, ten people with COPD were invited to the interview phase. However, on initial analysis of the interviews, it was apparent that people with COPD did not take part in PA due to factors other than their COPD, such as their age and other personal and environmental factors. It was, therefore, decided to interview similarly aged people who did not have COPD to determine factors that were specific to the COPD diagnosis. In addition, most of the COPD participants were male, and the interview was short, with a duration of less than 15 minutes, so it was decided to increase the number of interviews to have more female opinions. Amendments were submitted to the ethics committee to request an increase in data collection with the aim of recruiting at least 15 COPD participants, 15 HCPs, and 15 people without COPD. As a result, the data collection period was extended to recruit additional participants. People without COPD who participated in Phase 1, were invited to take part in an interview, with invitations sent through the gatekeeper (AA) to facilitate their continued involvement. Similarly, HCPs were contacted by the gatekeeper (AA), with an invite to contact the researcher if they wanted to take part in an interview.

During the quantitative phase of the survey, demographic data were collected for individuals with and without COPD, including their gender, age, and history of COPD. As part of the interview, participants were also asked about their occupations. In addition, demographic data for HCP participants, including their gender and speciality, were collected during the interview.

6.1.9.Data Analysis

Initial Process of Thematic Analysis

The qualitative data collected for the current study encompassed participants' perceptions regarding the barriers to, facilitators of, and motivations for PA in the context of COPD. The analysis process followed Braun and Clarke's (2006) guidance on thematic analysis and involved a series of iterative steps to identify meaningful themes and sub-themes. The process was informed by meticulous attention to detail, rigorous coding, and cross-checking of data to ensure the accuracy and richness of the identified themes.

Familiarisation with the Data

The initial phase involved in-depth engagement with the collected data. All of the interviews were transcribed verbatim by the researcher and the transcripts were subsequently translated from Arabic to English by the researcher, who is bilingual.

The translated transcripts were further reviewed and refined through collaboration with a bilingual expert (AA). This immersion allowed for a comprehensive understanding of participants' narratives and their unique experiences.

Initial Coding and Coding Review

Following the transcription and translation process, the researcher performed initial coding for each interview transcript. One transcript from each participant group was selected for primary coding. These initial codes were then reviewed and refined through discussions with supervisors, ensuring the accuracy and depth of the codes' representations of participants' perspectives.

The initial codes were reviewed and discussed with the project supervisors. To assess inter-coder agreement, the supervisors independently coded several interviews. A list of all codes was discussed among the researchers to achieve agreement. In cases of disagreement, the primary researcher decided upon the most appropriate codes and interview extracts that best reflected the transcript's meaning.

The coding process encompassed both inductive and deductive approaches, guided by the theoretical lens of SCT. Inductive coding involved an open exploration of the data, allowing patterns and themes to emerge naturally from the participants' narratives (Clarke and Braun 2021). This approach ensured that the analysis remained grounded in the participants' lived experiences without being constrained by predefined categories. In contrast, deductive coding was structured around key SCT constructs such as self-efficacy, social support, motivation, and outcome expectations. Data segments were systematically mapped to these theoretical categories, enabling the identification of expected patterns while remaining open to new, unexpected insights. The integration of both inductive and deductive coding followed an iterative process, whereby themes emerging inductively were cross-checked with SCT components to ensure alignment with theoretical frameworks. This approach validated SCT-related factors while also revealing context-specific influences that extended beyond the predefined theoretical constructs. A list of all codes can be found in **Appendix 11.1.24**.

Theme and Sub-Theme Exploration

Building upon the codes, the researcher systematically explored emerging themes. Codes with similar meanings were grouped together, initiating the formation of potential themes. This exploration process sought to capture recurring patterns, concepts, and participants' shared experiences related to COPD and PA.

Review and Further Collaboration

As part of the ongoing process, the initial themes and sub-themes were reviewed by project supervisors for accuracy and alignment with the data. Feedback and collaboration with the supervisors ensured the credibility and richness of the identified themes.

Modification and Refinement

As the analysis progressed, codes were iteratively refined, adjusted, and expanded to reflect deeper insights emerging from the data. This dynamic and flexible coding process ensured that the themes developed were grounded in the participants' narratives and remained sensitive to their lived experiences. While initial coding was conducted inductively, without imposing a pre-determined framework, the subsequent organisation and interpretation of themes were guided deductively by the constructs of SCT (Bandura 1986).

In this phase, emerging themes relating to the barriers to, facilitators of, and motivations for PA were critically examined and mapped against the SCT domains of personal, environmental, and socio-cultural factors. This approach allowed for both data-driven exploration and theory-informed interpretation, aligning with the study's aim of understanding the factors influencing PA engagement among individuals with COPD.

This analytical process combined manual data analysis (**see Appendix 11.1.31**), NVivo software utilisation (**see Appendix 11.1.32**), meticulous translation, cross-checking, peer review, and ongoing code refinement to uphold the credibility, trustworthiness, and authenticity of the thematic findings (Nowell et al. 2017).

7. Qualitative Findings and Discussion

7.1. Overview

This chapter presents findings from the semi-structured interviews. The aim was to explore the barriers and facilitators affecting PA engagement among people with and without COPD, and the role of health professionals in promoting PA for people with COPD in Saudi Arabia.

The objectives were to:

- Explore the barriers and facilitators influencing PA engagement among people with COPD.
- Explore PA behaviours in Saudi Arabia by interviewing people without COPD to more fully explore the PA behaviours and contributory factors.
- Explore the perspectives of HCPs regarding promoting PA for people with COPD.

In presenting the themes, direct quotations from the interviewees are used to reflect the participants' voices. To protect their identities and maintain confidentiality, the names of the participants were replaced by pseudonyms. The demographic details of each participant interviewed can be found in **Table 6.1**.

7.1.1. Participants

Semi-structured interviews were conducted with 19 participants (13 male, 6 female), which was considerably below the initial target of 45 participants (n=15 per group). The final sample included 8 individuals with COPD (**see Table 6.1**), 5 without COPD (**see Table 6.2**), and 6 HCPs (2 respiratory therapists, 3 physiotherapists, and 1 physician) (**see Table 6.3**).

The participants were primarily recruited from Riyadh, although some people with COPD were originally from smaller cities and towns across Saudi Arabia (e.g., Ramah, Al-Jouf,

Al-Kharj) and had sought treatment in Riyadh. Despite this regional diversity, the majority of the participants were based in Riyadh, the capital of Saudi Arabia.

Table 7.1 Demographic data of people with COPD

Pseudonym	Age (years)	Gender	History of COPD (years)	Occupation
Sami	66-70	Male	5	Retired / Office Worker
Khaled	46-50	Male	2	Retired / Military Personnel
Mosai	66-70	Male	10	Retired / Military Personnel
Nasser	61-65	Male	2	Retired / Military Personnel
Mohammed	56-60	Male	5	Retired / Office Worker
Sara	61-65	Female	15	Retired / teacher
Ahmed	46-50	Male	1	Retired / teacher
Omar	51-55	Male	5	Retired / Military Personnel

Table 7.2 Demographic data of people without COPD

Pseudonym	Age (years)	Gender	Occupation
Amal	56-60	Female	Retired / Teacher
Osiah	66-70	Male	Retired / Military Personnel
Sattam	41-45	Male	Employed / Office Worker
Saleh	46-50	Male	Employed / Office Worker
Sultan	56-60	Male	Retired / Office Worker

Table 7.3 Description of HCPs

Pseudonym	Gender	Specialty
Yara	Female	Physiotherapist
Mona	Female	Physiotherapist
Waleed	Male	Respiratory Therapist
Reem	Female	Respiratory Therapist
Salman	Male	Physician
Norah	Female	Physiotherapist

7.1.2.Introduction to Key Themes

During this phase, the primary aim was to examine the outcomes of the interviews conducted with people with COPD and HCPs who work with those who have COPD. The objective was to explore ways to encourage PA among people with COPD. However, it was discovered during the initial analysis of the quantitative phase that there was a lack of difference in PA levels among people with and without COPD. These factors could be either personal or environmental but addressing them is crucial, not only those who have COPD but also for the wider community. As a result, people without COPD were included in the study to gain a better understanding of the Saudi population over the age of 40 years and to identify the barriers and enablers to promote and enhance PA.

The thematic analysis identified key themes, sub-themes, and examples of codes for each group, as shown in **Tables 7.1, 7.2, and 7.3**. Coding is a technique used to categorise or label data based on its meaning or significance, allowing for the

identification of patterns and similarities across datasets **(see Tables 7.1-7.3)**. Subthemes emerge by grouping codes with similar meanings or concepts, which are then organised into broader overarching themes that reflect patterns within the dataset. These themes are typically presented in tabular form to enhance clarity and comprehension **(see Table 7.4)**.

Table 7.4 Sub-themes for people with COPD

Sub-themes	Categories	Codes
Barriers to PA	COPD symptoms	Weakness; breathlessness; pain
	External barriers	Timing for appointment; retirement effect
		Access to PR; no desire; lack of staff
Facilitators of PA	Benefits of PA	Social support
		Losing weight, doctor's advice; travel; work motivation
		Need for supervised rehab; time management
	Knowledge expectations and	Expectation of benefits
Motivation for PA	External motivation	Participating in social activities; travelling
		Work motivation; availability of suitable places
	Internal motivation	Personal health goals; self-efficacy
		Positive role models; beliefs about PA benefits
Coping with COPD	Psychological impact of COPD	Psychological and social effects of COPD
		Psychological barriers; lack of awareness
	Coping strategies	Seeking solutions; stop smoking
		Desire for improvement
Environmental factors	Weather preference	Weather considerations for PA
	Availability of facilities	Lack of facilities; accessibility; and cost
	Social and cultural norms	Family and community responsibilities
		Influence of social norms on PA behaviour
		Dress code; cultural factors
	Role of family and friends	Social support from family and friends

Table 7.5 Sub-themes for people without COPD

Sub-themes	Categories	Codes
Knowledge and expectations	Knowledge of PA and benefits of PA	Positive effects of PA
Facilitators of PA	Internal motivation	Health benefits and weight maintenance
		Personal accomplishment; self-efficacy
		Positive role models and inspiration
Barriers to PA	Social support	Lack of awareness
		Lack of social support
	Access and availability	Lack of suitable places and facilities
		Cost; accessibility
	Environmental factors	Weather; crowded city
	Social and cultural norms	Family and community responsibilities
		Shopping as a kind of activity
		Culture does not emerge with PA
		Influence of social norms on PA behaviour
Transition and life changes	Social change	Women walking

Table 7.6 Sub-themes for HCPs

Sub-themes	Categories	Codes
Role of HCPs in PA	Definition and importance of PA	Understanding and importance of PA
		Benefits of PA for COPD and interventions
	AHP interventions and strategies	Role of RT and HCPs in PR and monitoring
		Personalised exercise plans and dependence on therapists
Barriers to PA	Insufficient knowledge and expertise	Lack of exercise prescription knowledge
		Limited availability of PR centres and guidelines
		Lack of well-trained staff; authority to refer patients
	Psychological barriers	Psychological factors affecting patients' PA
		Lack of awareness and education
	Social barriers	Need for services; lack of confidence
		Social barriers (e.g., family and community)
Motivations for PA	Social support	Support from family, friends, and groups
	Need for psychological support	Psychological support; patient motivation
	Collaboration and communication	Individualised exercise programmes; workshops; and suitable places
		Support for doctors in promoting PA
	Transition and life changes	Private PR centre will be open
		Vision 2030

Table 7.7 Final themes and subthemes emerging from the qualitative data

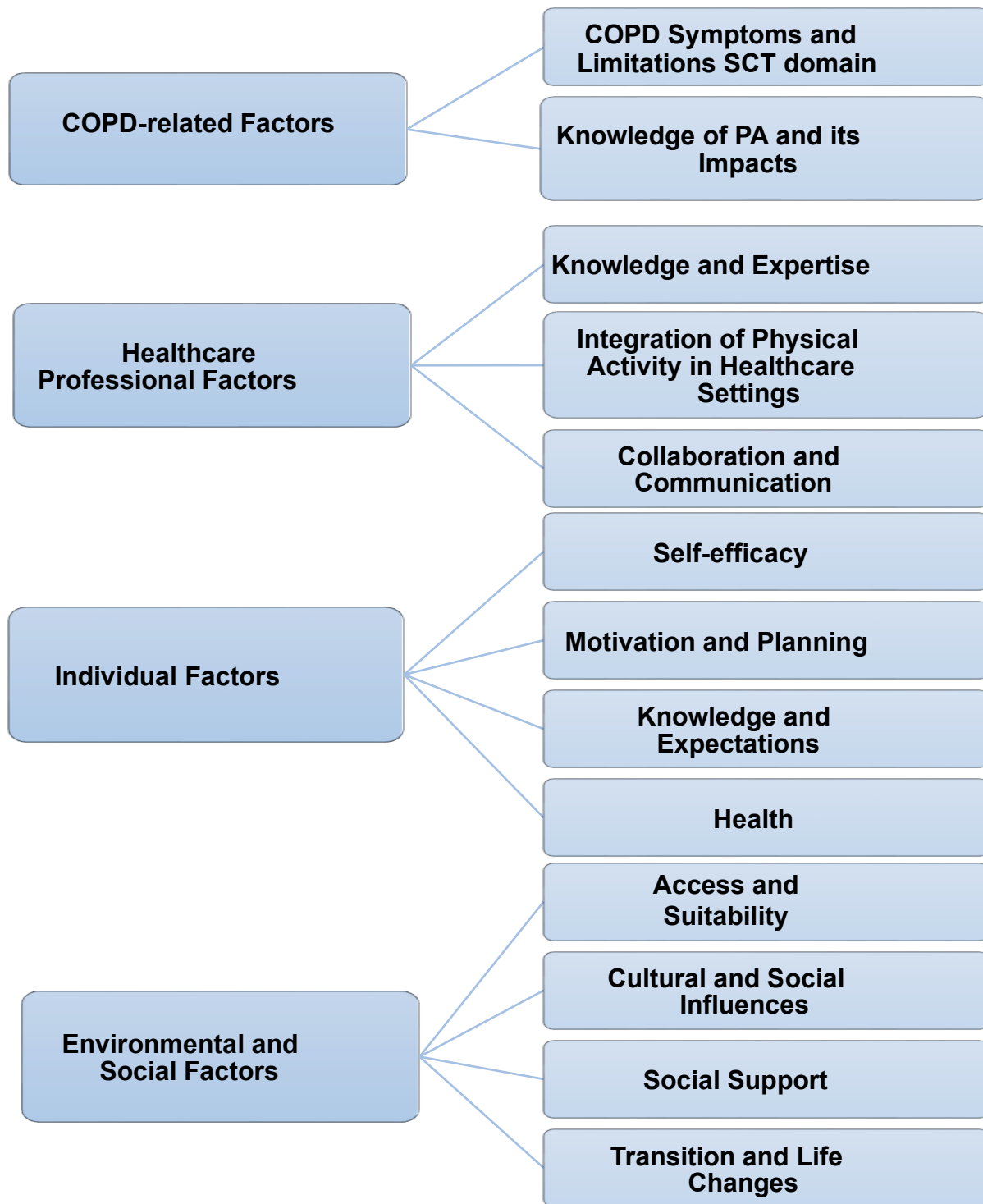
Theme	Sub-themes	Example codes	Data sources
Theme 1: COPD-specific factors	COPD symptoms and limitations	Physical symptoms (pain, tiredness, breathlessness)	COPD participants
		Reason for low PA in COPD; vicious cycle	HCP participants
	Knowledge of PA and its impact	Fear of their condition deteriorating	COPD participants
Theme 2: Healthcare professional factors	Knowledge and expertise	Lack of awareness among doctors and HCPs about PA	HCP participants
		Misunderstandings about PA and exercise terminology	HCP participants
	Integration of PA in healthcare settings	Lack of guidelines for primary care; limited availability of PR centres	HCP participants
	Collaboration and communication	Variations in therapists' approaches; programme's dependence on therapist's experience	HCP participants
		Lack of interest in PR and PA	HCP participants
		Need for training and education among HCPs	HCP participants
Theme 3: Individual factors	Self-efficacy	Not continuing PA due to a lack of confidence; personal accomplishment; positive role models	COPD participants/ non-COPD participants
		Stigmatisation and isolation due to social norms	Non-COPD participants
	Motivation and planning	Self-regulation with achievable goals; personal motivations for PA, importance of sleep and lifestyle changes	non-COPD participants

		Benefits of PA (health improvement, disease prevention)	non-COPD participants
	Knowledge and expectations	Understanding of PA; expectations about its benefits	COPD participants/ non-COPD participants
	Health	Physical limitations and medical conditions affecting PA	COPD participants/ non-COPD participants
Theme 4: Environmental and social factors	Cultural and social influences	Cultural norms and dress code; influence of societal changes on PA	COPD participants
		Shopping as a kind of activity	Non-COPD participants
		Recognising being a minority	Non-COPD participants
	Social support	Retirement affect PA; limited social support and loneliness	COPD participants/ non-COPD participants
		Role of the family in supporting PA.	HCPs participants/ COPD participants/ non-COPD participants
		No support group in Saudi Arabia	HCPs participants
	Access and suitability	Financial constraints; lack of transportation; weather as a barrier	COPD participants/ non-COPD participants
		Lack of suitable places for PA	COPD participants/ non-COPD participants
	Transition and life changes	Impact of societal changes and Vision 2030	HCPs participants/ non-COPD participants

Final themes and sub-themes are presented in the **Figure 6.5**. The initial two themes primarily centred on COPD, encompassing elements related to COPD symptoms, the available services, and the role of HCPs in facilitating improved PA.

To illustrate the role of HCPs in supporting PA, the second theme concentrated on the perspectives of HCPs, aiming to comprehend their views and identify barriers that must be overcome to enable them to effectively promote PA among people with COPD.

The third and fourth themes encapsulated the perceptions of all of the participants from the three groups, aiming to understand the individual, environmental, and social factors encountered by people residing in Saudi Arabia. This comprehensive exploration provides a holistic understanding of the challenges faced by the population, including those living with and without COPD, contributing to a more complete picture.



7.1.3. Figure 6.5 Final themes and sub-themes for all participants

Theme 1: COPD-related Factors

This theme specifically includes factors related to COPD and how the condition itself affects individuals' choices and abilities to engage in PA. The two subthemes are COPD symptoms and limitations and knowledge of PA and its impacts (see **Figure 6.5**).

Sub-theme 1: COPD Symptoms and Limitations

The interviews highlighted how COPD symptoms significantly affect the PA levels of people with COPD. The participants shared their experiences of pain, fatigue, and breathlessness, which hinder their ability to engage in regular PA. Additionally, feelings of embarrassment related to breathlessness and prolonged recovery times further discouraged participation in PA, contributing an emotional barrier alongside the physical challenges.

One of the participants, expressed:

“Hmm... maybe if only I walk more, I feel leg pain “

(Sami, a person with COPD)

The discomfort experienced during physical movement was also echoed in the following sentiment:

“The stairs make me tired.... I feel I am tired.... I feel pain...The stairs tire me a lot, I have the second floor at home, and I can't go up.”

(Mossa, a person with COPD)

Fatigue emerged as a prevalent symptom affecting the participants' PA levels.

“But the problem is fatigue, I don't have a problem other than fatigue.”

(Nasser, a person with COPD)

Highlighting how tiredness hinders his ability to engage in physical activities. One of the participants disclosed:

“I can’t walk fast and when I go up the stairs, I get tired. The second floor I have no problem but when I go up to the stairs after the second floor, I get tired”

(Ahmed, a person with COPD)

Meanwhile, Mossa emphasised:

Mossa: “The stairs tire me a lot, I have the second floor at home, and I can’t go up.

Interviewer: “You mean the most important thing is the stairs. Why are you not able to climb the stairs?”

Mossa: “I feel that I am panting. My breathing will stop.”

(Mossa, a person with COPD)

In addition, breathlessness was a major limitation cited by the participants. Omar, described experiencing sudden difficulties, particularly when using stairs:

“I don’t have a problem but suddenly sometimes, especially on the stairs, when I reach the second floor, the breath is forced to come out of me... my chest closed... I can’t take a proper breath”

(Omar, a person with COPD)

Similarly, Nasser shared how his breathlessness had become more pronounced over time,

Interviewer: “How do you feel tired? Explain to me.”

Nasser: “It’s like a shortness of breath but it’s new. I used to feel shortness of breath in the past.... But now any effort I do, I feel tired.”

(Nasser, a person with COPD)

Furthermore, both Omar and Nasser expressed feelings of embarrassment, frustration, and diminished confidence related to breathlessness and the extended recovery time required after physical activity. These emotional responses illustrate how the symptoms of COPD extend beyond physical limitations, impacting their psychological well-being. Omar described how needing several minutes to recover after walking—even when he

felt otherwise socially unaffected—often left him feeling self-conscious. Similarly, Nasser shared that his inability to walk long distances made him feel upset and hesitant to join others, despite being physically able to continue walking after resting. Such experiences highlight the interplay between physical symptoms and emotional distress in the daily lives of people with COPD.

“It didn’t affect my social life, maybe psychologically, but not socially. I breathe comfortably but I need to take 3 to 8 minutes just to rest and go back, which sometimes causes me embarrassment.”

(Omar, a person with COPD)

“I tried to walk, but to a short distance I couldn’t increase the distance, which made me upset and unconfident to walk with other people.

Interviewer: Do you need to rest?

Nasser: I can rest for 10 minutes and then complete half the distance, I mean, I don’t have a problem, but it’s hard, I can’t”

(Nasser, a person with COPD)

Sub-theme 2: Knowledge of PA and its Impacts

Despite acknowledging that walking can be a form of PA, individuals diagnosed with COPD expressed concerns and misconceptions regarding engaging in such activities, including walking. These apprehensions are predominantly centred around the fear of their condition deteriorating or encountering adverse health outcomes. For example, one of the participants articulated his concerns:

“My idea was that I avoid this effort [PA], so I do not tire my chest”

(Khaled, a person with COPD)

Mossa shared similar concerns, stating,

“There is a benefit but as I tell you, when I do PA, I am more afraid of it. It will tire me and affect me; it will give me the opposite.”

(Mossa, a person with COPD)

Fear of experiencing symptoms such as shortness of breath or fatigue acted as a limitation for some people with COPD, preventing them from engaging in walking or other physical activities. Addressing these concerns is imperative and it is necessary to collaborate with healthcare providers to identify safe and effective ways to engage in physical activities and maintain an active lifestyle.

In addition, it is possible that the lack of participation in PA by people with COPD is due to the fact that many of them reported that they had never been referred to PR by their HCPs or they had not received sufficient information to understand the safest ways to participate in PA. In response to being asked if he was aware of PR, Sami replied:

“I swear to God, they (physicians) told me to walk but no one ever talked about this topic.”

(Sami, a person with COPD)

The participants collectively highlighted the vicious cycle created by COPD symptoms, leading to reduced PA levels. One of HCPs identified this cycle as a key factor hindering people with COPD from engaging in regular activities. He stated:

“One of the topics we discussed is the vicious cycle... This is the reason why COPD patients cannot go about their daily lives or increase PA... On the other hand, when you reduce PA, you will have to decondition and aggravate COPD symptoms. There must be education about the patient’s daily life.”

(Waleed, a respiratory therapist)

The vicious cycle refers to the interplay between reduced PA and worsening COPD symptoms, leading to further physical limitations.

Theme 2: HCP Factors

This theme explores the challenges faced by HCPs when promoting or supporting PA among those with COPD, as well as the facilitators that can help them to overcome

these challenges. Subthemes include knowledge and expertise, integration of PA in healthcare settings, and collaboration and communication.

Sub-theme 1: Knowledge and Expertise

PR has become an essential component in helping people with COPD to engage in PA and improve their health and overall well-being. Most of the HCP participants (physiotherapists and respiratory therapists) were aware of the importance of PA and PR for people with COPD. Yara emphasised the importance of PR in helping people with COPD to manage their symptoms, improve their lung function, and increase their PA levels. She also stressed that PR programmes should be accessible to all of those who need them, regardless of their location or financial situation:

“Also, the physiotherapist believes that PR is important if it is available in every hospital...”

(Yara, physiotherapist)

Notably, the interviews provided insight into the lack of awareness among other HCPs, including medical doctors, regarding the importance of PA in the rehabilitation of people with COPD. The same HCP expressed her concerns, stating:

“Of course, the doctors ... they do not refer a lot. I mean, there is still no awareness of rehabilitating COPD patients; there is no great awareness.”

(Yara, physiotherapist)

This lack of awareness may hinder people with COPD from accessing appropriate rehabilitation clinics and services.

A respiratory therapist pointed out the impact of inadequate education on doctors' understanding of the significance of rehabilitation. He stated:

“As a pulmonologist or cardiologist... This deprives the patient of access to rehabilitation clinics and this is not because of the doctor's bad intentions. He does not know the importance of rehabilitation; he knows the importance of the surgery and the medicines he gives.”

(Waleed, a respiratory therapist)

Waleed further highlighted the gap in doctors' education regarding the importance of rehabilitation, contributing to the existing knowledge gap.

“The second thing is the weakness of education that doctors have concerning the importance of rehabilitation and this is one of the problems. It is necessary to move from the clinic, whether the heart clinic or the lung clinic is very important, or any other clinic, but it is important to make an estimate and test.”

(Waleed, a respiratory therapist)

Moreover, the interviews highlighted that even within the same field, there is a lack of differentiation between PA and exercise. One HCP, shared her observations, stating:

“I think, even in the same field, people still do not differentiate between the two terms.”

(Mona, a physiotherapist)

This lack of differentiation may lead to confusion in prescribing appropriate interventions and hinder the integration of PA and exercise into COPD management plans. This might be the case because when interviewing the HCPs, it was found that most of them discussed PR and exercise more than PA, despite the fact that the interviews made repeated reference to PA in general. This could indicate that their perspectives depend to their role in the hospital and they focus more on PR.

Sub-theme 2: Integration of PA in Healthcare Settings

The interviews revealed several challenges related to the integration of PA in healthcare settings, particularly in the context of COPD management. One prominent challenge identified was the lack of guidelines for primary care, as highlighted by Waleed, a respiratory therapist:

“The second thing is another part, which is the expansion of primary care... in primary clinics and dispensaries. We know that it's a majority of patients who come to primary care categorised as chronic disease into these clinics and the guidelines in hospitals or heart clinics and lung clinics have it as part of their rehabilitation and part of their treatment

plans. We see a lot in hospitals just because the doctor gives him medicines and lets him go home, the lack of these guidelines.”

This lack of clear guidelines may hinder the incorporation of PA into the standard care provided in primary care settings, potentially limiting patients' access to appropriate rehabilitation and management plans.

Furthermore, the interviews revealed that access to rehabilitation services can be challenging for people with COPD. A physiotherapist shared her experience, emphasising the lack of PR education and availability within her hospital:

“No, unfortunately not, because in the hospital I was in, I did not even have rehab as education. Rehab is available only to patients in the ICU. We did not reach this stage but I saw a person with COPD and advised him to do rehab. The service was not so easy.”

(Norah, a physiotherapist)

This highlights the need for improved PR education and service accessibility. However, it is important to distinguish PR awareness and referral challenges from PA promotion because they represent distinct aspects of COPD management.

To improve the integration of PA in healthcare settings, a thoracic physician recommended the development of structured PR programmes led by specialised physiotherapists. This approach could help to ensure that people with COPD receive the necessary support and guidance to engage in appropriate PA interventions.

“The presence of a well-structured programme for PR with dedicated physiotherapists.”

(Salman, a physician)

Sub-theme 3: Collaboration and Communication

The interviews identified several challenges related to collaboration and communication in the context of PR for people with COPD. One major issue identified was the variation

and differences among therapists, as expressed by a respiratory therapist. He raised concerns about the potential harm caused to patients when each therapist applies their own approach based on personal experience, which can result in inconsistent practices, inefficiencies, and unnecessary resource expenditure:

“This will harm the patient because if each one works in his own way and with his experience, this will waste resources and waste time. The goal is not clearly engaged; definitely, it will cause problems between colleagues and patients as well.”

(Waleed, a respiratory therapist)

Another challenge observed in the interviews was the reliance of PR programmes on the therapist’s individual experience. Waleed further explained:

“This is when you go to a clinic alone and encounter ten therapists... Each one begins treatment within the treatment plan that he has based on his previous experience, based on what he sees as appropriate, and this will cause problems in outcomes and goals.”

(Waleed, a respiratory therapist)

Such variations in treatment approaches may lead to inconsistent outcomes and hinder the achievement of clear rehabilitation goals for patients. Moreover, a lack of interest in the field of PR among HCPs was highlighted by Reem:

“Among the things, there are no guidelines and there is no centre, and it is normal that no one develops himself because there is no interest in this field.”

(Reem, a respiratory therapist)

This lack of interest may lead to a lack of improvements in PR practices and hinder the development of effective interventions for people with COPD.

The interviews also revealed a gap in research awareness concerning PA and its importance in COPD management. Mona, pointed out:

“We don’t have a lot of research in that field.”

(Mona, a physiotherapist)

The limited research in this area may hinder the understanding and implementation of evidence-based PA interventions for people with COPD.

Furthermore, a lack of patient education about the appropriate levels of activity and gradual progression in PA was noted by one physiotherapist:

“They are not even educated about the disease itself; they do not know that these activities should be gradually progressed. Any simple activity they fear, they think they should not move so as not to make the situation worse.”

(Norah, a physiotherapist)

This lack of awareness may lead to unnecessary fear and worry among patients, affecting their willingness to engage in PA.

To address these challenges, Norah emphasised the importance of training, education, and knowledge regarding PR for HCPs. She suggested:

“When physicians, respiratory therapists, physiotherapists, all of them, even nurses graduate, and they have no idea of even imagining what the rehab is. They aren’t going to try to get there. I think this is affected by training, education, and knowledge.”

(Norah, physiotherapist)

Theme 3: Individual Factors

This theme represents the individual characteristics and features that influence a person’s participation in PA that are personal to them. It includes self-efficacy,

motivations and goals, knowledge and expectations, and medical history which can affect whether or not individuals choose to participate in PA.

Sub-theme 1: Self-efficacy

Self-efficacy is the individual belief in one's ability to achieve goals. In the current study, both people with COPD and without COPD showed a range of self-efficacy levels with respect to engaging in PA. Some of the participants expressed low self-efficacy in maintaining PA and lost interest. These individuals reported experiencing difficulties sustaining their engagement in PA, even when faced with various challenges such as a lack of time and motivation. Additionally, they felt less motivated and confident in their ability to engage in PA over time, resulting in less interest in the activity:

"I have a bicycle but I did not continue to do it. I lost interest."

(Khaled, person with COPD)

In addition, Amal mentioned that her family and community responsibilities make it challenging for her to find time to practice PA,

"Maybe the community. I relate to the children and the husband, so there is no time to go out and walk."

(Amal, person without COPD)

Despite facing challenges, some of the participants exhibited higher levels of self-efficacy, motivation, and confidence in engaging in PA. Osamah, demonstrated a high level of self-efficacy, stating:

"I consider myself a professional athlete. I was a handball player a long time ago and I joined the military. After retiring five years ago as a colonel from the National Guard, I increased my practice of sports. Maybe at 10 a.m. I am in the gym doing running, jogging, swimming, and hydrotherapy. I also love hiking and am a member of the Riyadh Walker Association. We walk at least 10 kilometres."

(Osamah, a person without COPD)

Osamah's experience illustrates how maintaining an active lifestyle, engaging with a supportive community, and establishing a structured PA routine can reinforce self-efficacy and long-term PA commitment.

Moreover, certain participants were prompted to engage in PA due to their self-determination. In the context of the current research, self-determination refers to the conscious decision to be physically active without being prompted by external advice or influence. Ahmed, who has COPD, discussed how an internal desire to be active might keep some individuals motivated:

"I don't think that if the person is not self-initiated, if he is not convinced of the thing he does, no one will affect him. This is my point of view."

(Ahmed, person with COPD)

A person with COPD, showed determination in purchasing devices for home use, however, finance might be a barrier:

"I will buy devices (for exercise) that I can use at home. I search for devices that are paid in instalments."

(Khaled, a person with COPD)

Another person with COPD, considered joining a health club to focus on fitness, saying:

"I thought about joining a health club. I think that helps me focus on fitness and, like, that could help me."

(Nasser, a person with COPD)

Others emphasised their natural liking for PA. Sara, expressed:

"No one told me but I am active in life. I mean, I was working, my job was movement, and my home was movement. I was a person who did sports with TV..."

(Sara, a COPD patient)

The HCPs also discussed the crucial role of self-confidence in determining their engagement in PA. One HCP identified this factor as follows:

“Because, even if we solve the problem of the environment and the problem of education, we will still have the psychological factor among those people whose self-confidence is lower.”

(Mona, Physiotherapist)

She added a further description of how a lack of self-confidence in her patients' experience led to feelings of stigmatisation and isolation:

“Especially the people in the wheelchair or those who use the nasal cannula, in particular, the COPD one who carried the oxygen cylinder and didn't have the portable one, they feel stigmatised and isolated. It's hard to walk in it and feel the environment is encouraging.”

(Mona, Physiotherapist)

Moreover, self-imposed negative beliefs about age emerged as another factor influencing self-efficacy. Notably, both Mossa and Khaled, who were diagnosed with COPD, provided honest thoughts on this matter. Mossa, who is only 41 years of age, expressed his view, stating:

“The age factor is the main cause. I am very old.”

(Mossa, a person with COPD)

Khaled, who is under 70 years of age, similarly conveyed his reservations, remarking:

“I mean, there is an effort if I am in my youth, not now. Now, my age is gone, not the age that is suitable for doing some kind of activity.”

(Khaled, a person with COPD)

These candid reflections highlight how self-imposed age-related doubts can significantly impact individuals' perceived self-efficacy in relation to PA, despite their relatively young ages. It illuminates the need to address age-related self-perceptions, even when individuals may not objectively fall within the category of being 'old.'

Sub-theme 2: Motivation and Planning

The study highlights that the participants exhibited personal motivations to remain physically active, including positive outcomes, weight loss, mood enhancement, and health concerns. It is noteworthy that many of the participants self-regulated their PA levels to achieve their goals.

The study participants demonstrated a range of motivational factors and plans which influenced their engagement in PA. The observation of positive changes in their overall health and the tangible improvements in their fitness level, such as a reduction in fatigue during long-distance walks, proved to be significant factors that encouraged people with COPD to sustain their PA regimen.

"I mean, it makes me tired but I feel the time before becoming tired, within two minutes it has become three minutes."

(Khaled, a person with COPD)

Additionally, a person without COPD called Sattam highlighted the role of PA in strengthening immunity, stating:

"The year had diseases and Corona... One of the reasons is that our immunity is strong. Sports and PA did not expose us to anything, even if we were infected, it could make us light and relieved."

(Sattam, a person without COPD)

The participants recognised the feeling of achievement after engaging in PA, with Khaled, a person with COPD, stating:

“At least the person feels that he has accomplished something.”

(Khaled, a person with COPD)

Meanwhile, Amal talked about the effect that PA has on her mood, noting:

“Yes, it definitely has health benefits. Certainly, if I walk, I feel my mood change.”

(Amal, a person without COPD)

Sattam mentioned that losing weight was his motivation and to maintain his weight, he continued with his schedule:

“Previously, my weight was 145 and now I weigh 79kg, so I got off in less than a year and a half and after that I went on this programme. Now, in order to maintain the weight I wanted, I continued on this schedule. Of course, there is a diet.”

(Sattam, a person without COPD)

Furthermore, Nasser is motivated after losing weight and now finds it easier to move around and stay active:

“My weight went down 8 kilos, I felt light, meaning I could move better than at first.”

(Nasser, a person with COPD)

During the discussion, those participants who did not have COPD shared their strategies for maintaining a routine and self-regulating their PA. Osamah mentioned his active lifestyle:

“A person is supposed to do the sporting activity that is appropriate for his age. For example, a person should go for a walk for long distances. I mean, for example, bike, I go out by bike... even if I go to an occasion, I don't refuse to attend but when I come back, I don't go home directly, I

wear sports shoes and go for an hour, two-hour walk and burn what I ate.”

(Osamah, a person without COPD)

Another person without COPD highlighted his consistent daily exercise routine, stating:

“I have constant daily exercise, about two to three hours a day. I have been on this system for almost five years.”

(Sattam, a person without COPD)

He mentioned that following religious customs, such as prayer times, encourages him to establish a routine that facilitates PA:

“I sleep for the Al-Esha prayer and get up with the Al-Fajer prayer... I mean, someone says there is no time. No. So I pray early, I get up, I walk, I move, and most of the gyms are on from early.”

(Sattam, person without COPD)

Sub-theme 3: Knowledge and Expectations

The participants had varying levels of knowledge regarding PA, with walking accounting for a significant part of their opinions. Some of the participants associated PA with vigorous activities like running, whereas others recognised moderate activities like walking or household chores as forms of PA. For people with COPD, PA was often linked to specific actions, with many mentioning walking as a key component. For example, Sami stated:

“PA is your strength, your gait, and your walking”

(Sami, a person with COPD)

This highlights the significance of walking in his understanding of PA. Similarly, Khaled, another person with COPD, associated PA with activities like running and carrying things, indicating a broader range of activities:

“For example, running or you are doing something... or carrying things, this is what comes to mind at the moment.”

(Khaled, a person with COPD)

People without COPD also recognised walking as a form of PA, while emphasising its health benefits. Amal, a person without COPD, stated:

“Sports, movement, and walking are what come to my mind.”

(Amal, a person without COPD)

Saleh was asked to provide further details regarding why walking is the most prevalent PA in the region. In response to the inquiry, he provided his insight:

“We don’t say the easiest but walking is available, according to me. I tried to ride a bike but it didn’t suit me because of the weather in Riyadh and the bike is tiring but walking is the easiest.”

(Saleh, a person without COPD)

Finally, Sara, provided a comprehensive definition of PA, stating:

“It is not a condition of exercise, even walking is PA, work at home is PA. The concept of PA means any movement that a person makes per day: walking, jogging, going to a gym.”

(Sara, a person with COPD)

Sub-theme 4: Health

The participants’ medical history played a significant role in shaping their perceptions and experiences of engaging in PA. Medical conditions, such as heart surgery, arterial problems, pulmonary embolism, and other health issues influenced their choices and ability to participate in PA.

People with COPD shared their experiences of undergoing heart surgery and dealing with arterial problems. A person with COPD, mentioned:

“I had a heart surgery operation. I have a problem in the arteries of the heart...”

(Mossa, a person with COPD)

Another person with COPD revealed his health conditions:

“Swelling in the right side of the heart and a pulmonary embolism.”

(Nasser, a person with COPD)

These medical conditions affect their physical capabilities and add to the challenges when considering engaging in PA.

For people with both COPD and other medical issues, such as joint problems, PA choices were influenced accordingly. Omar has joint problems and discussed his limitations, saying:

“The reason is that I have a problem with the bones. There is a stretch in the joint of my left shoulder. In the future, they will replace a joint in it.”

(Omar, a person with COPD)

His joint issues affected the mobility of his upper limbs, which played a role in determining his suitable activities.

Moreover, medical conditions such as diabetes and blood pressure could be a motivation for engaging in PA. Nasser, who has COPD, received advice from his doctor to engage in PA to improve his medical condition:

“I expect an improvement in physical fitness but I do not have physical fitness. Because I did not do any sports, I only started walking after what the doctor said: You must walk for half an hour a day; it helps.”

Amal, a person without COPD, mentioned her experience with blood pressure, which encouraged her to engage in PA:

“I have (high) blood pressure but they diagnosed me late, so I didn’t have it from the beginning.”

(Amal, person without COPD)

The query that arises is whether individuals who engage in PA due to underlying health issues will persist with their regimen upon recovery or discontinue when experiencing relief or improvement in their health.

Theme 3: Environmental and Social Factors

This theme focuses on the external factors that influence individuals’ opportunities and choices regarding PA. It explores the impact of the surrounding environment and the social context in which individuals live.

Sub-theme 1: Access and Suitability

The suitability of the environment refers to the conditions under which PA could take place and how these conditions may adversely influence a person’s ability to undertake it or facilitate it. Environmental barriers and/or facilitators include the climate, urban design, and other external factors such as financial constraints.

The interviews revealed several access, availability, and suitability challenges that affect engagement in PA for both people with and without COPD. The weather, particularly the intense heat in Saudi Arabia, emerged as a significant restriction to engaging in PA, particularly outdoor activities like walking. Sara expressed her concerns about the weather conditions which can exacerbate her condition:

“I am trying to force myself to walk. Respiratory patients need a lot of oxygen and I like to walk in open spaces, not closed ones, but in the summer it is impossible. The truth is, in the summer, even at night, it’s very hot.”

(Sara, a person with COPD)

The participants were unanimous in their opinions regarding the climate of Saudi Arabia. The country is known for its extreme temperatures, which can be as high as 50°C in the summer and as low as 5°C in the winter. This makes it a challenging environment to live in. Omar, emphasised the impact of the weather, stating:

“But let’s see... in our country, most of the time, the weather is hot... if it is very hot, it is not useful to do any outside activities.”

(Omar, a person with COPD)

Even people without COPD, acknowledged the challenges caused by the weather, stating:

“The weather is a bit of a problem, it might be one of the obstacles. Sometimes, I say try to get used to yourself. Indeed, the atmosphere here is tiring for you to go out and walk.”

(Sattam, person without COPD)

Saleh has a different opinion about the weather. He does not see it as a barrier because he knows he cannot change it. Instead, he adapts his personal assistant’s schedule to be in a climate that is suitable for him. Saleh believes that those who get frustrated are affected by everything:

“The one who is frustrated is affected by everything; the hot weather and the cold weather affect him, all the weather, but the most important thing is that I have the right place, but the weather, one adapts to it. For example, when the weather is hot, I don’t have to go in the afternoon. In the cold, you can take a scarf and walk; the most important thing is not to be frustrated.”

(Saleh, person without COPD)

Issues relating to the climate and the built environment have resulted in people having limited options for PA. While some participants mentioned engaging in walking and cycling, others felt that access to appropriate facilities remained a significant barrier. For those who do not want to exercise at home, joining a gym is often considered to be the only structured alternative. However, accessing gyms has become challenging for many due to various reasons, such as limited facilities for PA and high gym fees. Saleh mentioned that the lack of available facilities for PA presented a more significant barrier than the weather:

“Other than that, the general atmosphere, if there is a suitable park and a walkway in the neighbourhood. Of course, we have it but it is very few. Some neighbourhoods can be counted on the fingers in Riyadh, complete and prepared and you can say that I can walk.”

(Saleh, person without COPD)

The issue of limited resources and services in areas outside of the capital city is a recurring challenge. Khaled’s description of his city as lacking in facilities and proper urban design underscores the difficulties faced by residents in such regions,

Interviewer: “I mean, you don’t have any areas of land to walk in or a park?”

Khaled: “We have 10 kilometres of land but it’s not suitable for walking; nothing here, just a desert.”

(Khaled, person with COPD)

Adding to that, Ahmed, a COPD patient, expressed a desire for accessible fitness centres and health centres but lamented the lack of such facilities in his city (outside Riyadh), saying:

“We do not have health centres, two sports centres.”

(Ahmed, person with COPD)

However, even a person who lives in Riyadh and does not suffer from COPD emphasised the need for more suitable places for PA, stating:

“Now we lack places for sports, so we are limited to fitness clubs... but still not enough.”

(Osamah, a person without COPD)

The crowded and expansive urban environment of Saudi cities, most notably Riyadh, poses a formidable challenge to engaging in PA. The participants shared details of their struggles in this regard:

“People now, with the crowds and pressures of life, can’t walk more than 15 kilometres to find a suitable walkway. He wants a neighbourhood around him, about 5-6 kilometres, to be able to find a suitable place.”

(Saleh, a person without COPD)

While many of the participants talked about the lack of variety in facilities as a barrier, Amal offered a different perspective. She acknowledged that shopping provided an opportunity for PA, highlighting the importance of recognising various activities that contribute to PA:

“I go to a mall and walk in it. I mean, I shop and walk.”

(Amal, a person without COPD)

Some participants make an effort to enhance their PA, even if they do not have access to suitable facilities nearby. Some of them want to attend gyms to achieve this, despite the limited number of gyms and financial constraints presenting significant obstacles. This lack of access to adequate PA facilities and services is a significant barrier for many people. Khaled, who has COPD, expressed his struggles with improving his PA by either going to a gym or bringing equipment to his home:

“My financial circumstances don’t help either.”

(Khaled, a person with COPD)

The limited number of fitness facilities in the region has led to a steep increase in membership fees. This financial burden has rendered it unaffordable for several of the

participants to enrol. Osamah, currently attending a fitness centre, highlighted the scarcity of affordable options.

“The gym, there is only one company and the prices are expensive.”

(Osamah, a person without COPD)

A person with COPD and residing outside of Riyadh communicated their difficulty in attending PR sessions that are provided free of cost by the hospital they were admitted to in Riyadh. Nasser noted that the high cost of transportation has created a significant barrier to them accessing the necessary medical care. Specifically, the expense of tickets to travel has proven to be a considerable challenge regarding their ability to attend PR sessions, which are crucial to their continued healthcare management:

“They called me. They said: “We want you to come to Riyadh.” I said: “What is it?” They said: “There is a simple lung rehabilitation programme for you...” They told me about a programme for lung activation three days every week and several hours a day for three weeks. I said it is difficult to come from Al-Jouf to Riyadh because they don’t even give me free tickets.”

(Nasser, a person with COPD)

Furthermore, due to the lack of gyms exclusively for women, the fees charged by these facilities are relatively high when compared to those paid by men. This puts an undue financial burden on many women. A woman with COPD brought attention to the problem of exorbitant gym fees for women, stating:

“The gyms are available in abundance but the fees are expensive.”

(Sara, a person with COPD)

Men without COPD experience similar difficulties as their female counterparts.

However, financial issues are a more significant challenge for females, as stated by Sattam:

“The second problem is that there are people who cannot afford to register in a gym and continue. I mean, it is even more difficult for the female component because the prices are very high.”

(Sattam, a person without COPD)

During the discussions with the participants, they emphasised the significance of supportive services and appropriate locations for PA engagement. A HCP underscored the criticality of such services in preserving individual autonomy:

“Of course, everything needs an assistant here. There is nothing to help the patient’s independence. I mean, we need services here.”

(Yara, a physiotherapist)

Sub-theme 2: Cultural and Social Influences

The interviews provided valuable insights into the cultural and social influences that affect individuals’ engagement in PA. The participants highlighted how social norms and cultural attitudes play a significant role in shaping their choices regarding PA. People with COPD and those who do not have COPD both expressed the impact of cultural norms on their engagement in PA. Being surrounded by unsupportive people who comment negatively about exercising is a notable barrier, as Khaled explained:

“When we are gathering weekly or in family meetings, if someone says who wants to walk with me, only one walks with him sometimes and sometimes no one walks with him.”

(Khaled, person with COPD)

Even participants who have not been diagnosed with COPD feel a similar sense of imprisonment relating to the people surrounding them:

The person becomes frustrated with the people around him. He is active and moving and some people have frustrated him. Why do you move, you must try, you must eat? "Death is one" and "Age won't Increase," so this may be the narrow inner circle, which means that it changes his mind. Life can be difficult, too.

(Saleh, person without COPD)

This illustrates the lack of social support and encouragement for PA within certain social settings, thereby hindering the promotion of an active lifestyle.

Additionally, Osamah drew attention to the changing cultural perceptions of sport in Saudi Arabia. It was noted that in the past, people held negative views about sport. However, this attitude has since evolved and he emphasised the importance of this shift in cultural attitudes. He highlighted the increasing acceptance and appreciation of PA among the people of Saudi Arabia.

"Actually, the culture of society has changed a long time ago. Before, if they saw you wearing sports clothes and walking on the street, they said, what is wrong with him? Get crazy."

(Osamah, person without COPD)

Amal agreed with the statement, saying:

"That is, in many things, I am not used to walking. Maybe this culture (PA) does not exist in our society. I am talking about our days from the beginning. Maybe now young people walk but our generation does not walk. PA, we work at home, we move and go out to shop."

(Amal, person without COPD)

In recent times, there has been a noticeable change in the way people perceive PA. This shift in cultural attitudes has made it easier for individuals to engage in such activities without feeling vulnerable to being criticised or judged. In Saudi Arabia, cultural and religious beliefs have traditionally dictated how women dress. Although these dress codes are becoming less strict, some individuals are still conservative. Sara explains

that dress codes, particularly the abaya, have emerged as a barrier to engaging in PA, especially in summer:

“...When I go to Jordan, I have friends, we walk a lot. When you have a friend who walks with you, it is not like here when you, as a woman, walk alone in the street. It is not acceptable socially in this country. Also, the abaya is not suitable for walking in. It’s a problem that also brings you heat ...”

(Sara, a person with COPD)

The abaya is a full-length outer garment that Muslim women wear outside of their home and it is part of the dress code in Saudi Arabia. However, some women feel that wearing the abaya in the summer makes it difficult for them to engage in outdoor activities. When Sara mentioned this as a burden, it gave the impression that she was reluctant to participate in outdoor activities while wearing the abaya, even though it is a necessary dress code.

During the conversation, Sara drew a comparison between the social life in Saudi Arabia and Jordan, where her family resides. She highlighted the difficulties faced by women in Saudi Arabia when walking alone due to prevalent social norms. Sara clarified that this topic was not related to safety and was merely a part of the conversation about the weather:

“No one can walk in the heat. It is safe to walk in neighbourhoods but the heat does not make you look forward to walking”.

(Sara, a person with COPD)

Sub-theme 3: Social Support

The interviews provide insight into the crucial role of social support in influencing individuals’ engagement in PA, particularly among those with COPD. The participants discussed the impact of feeling lonely and the need for social support from family, friends, and support groups to engage in PA. Several people with COPD expressed a lack of social support, which hindered their PA efforts.

Sami, shared his experience of his need for someone to help him engage in PA, stating:

“If someone brings me to the garden, the walkway, these things are possible, I mean, but the problem is that no one has time, everyone is alone today.”

(Sami, a person with COPD)

This lack of companionship and support made it challenging for Sami to engage in PA on a regular basis. He also mentioned feeling isolated when walking alone due to the absence of a support network.

“...there are no people. Everyone is busy. I walk alone.”

(Sami, a person with COPD)

HCPs confirmed that supervised PR was seen as an effective intervention to help people with COPD continue with PA. A physiotherapist, mentioned:

“Some of them (people with COPD) ask if they come back because they feel they are not engaged because attending sessions encourages them to exercise and this is what I hear from them constantly.”

(Mona, a physiotherapist)

Sattam emphasised the importance of social support, specifically citing positive family and community support as key factors in promoting PA:

“Firstly, I believe that the credit goes to more than one side. In the family, of course, my wife and my family have great credit. Also, the walking groups that are present in Riyadh; there are approximately 11 walking groups in the neighbourhoods here and it includes the Riyadh infantry group and there is a running group...”

(Sattam, a person without COPD)

In addition, retirement has been identified as a significant life event that affects PA engagement. Sara retired three years ago and shared her experience regarding the impact of retirement on her PA engagement:

“I was more active, I was thinner. I mean, I was working and I retired. Now I’m just trying to force myself to walk and work in my house. I don’t have a job.”

(Sara, a person with COPD)

Sara experienced a change in her activity levels after retiring. She recognised that not having the same social interactions as before retirement affected her motivation to engage in PA. The loss of social connections and support from colleagues also influenced her PA behaviour.

Most of the participants emphasised the role of family support in promoting PA among those with COPD. However, one of the HCPs, espoused a different perspective on this subject, suggesting that such support can have an adverse impact on patients’ PA:

“Of course, the family is affected by it. If they give the patient confidence, he will move, not say you are a chest patient, so you must be afraid of yourself and not do any activity.”

(Yara, a physiotherapist)

The support and encouragement provided by family members play a vital role in motivating patients to engage in PA. Another HCP highlighted the importance of families treating patients as independent individuals and providing them with support to promote confidence and positive behavioural change:

“The second thing is his family. His family must help him so that he is more active and they treat him as an independent human being, that is, transmitting negative signals to the patient like “Don’t do anything,” “I’ll go with you.” This will reduce his confidence... until he doesn’t settle the things he did before. The important part is the person and the family.”

(Waleed, a respiratory therapist)

A HCP, acknowledged the absence of support groups for people with COPD in Saudi Arabia. She expressed her desire for such groups to be established, emphasising the importance of support groups for patients suffering from COPD:

“I wish we had it; we call it a support group; it is like a COPD community. I don’t think we have a support group; it is like a community Together; I’m not aware of any community we can refer the patient to.”

(Mona, a physiotherapist)

The lack of such support groups limits the opportunities for people with COPD to connect with peers and receive the necessary psychological and social support, which could aid their PA engagement.

Sub-theme 4: Transition and Life Changes

The interviews provide insight into the impact that social changes have on PA participation among both people with and without COPD in Saudi Arabia. The participants recognised that the culture of society has evolved over time, leading to a shift in attitudes towards PA. One person without COPD, remarked:

“Actually, the culture of society changed a long time ago.”

He further emphasised the growing acceptance of active lifestyles, stating:

“When I see women and the world moving, it means that the culture of walking is widespread.”

(Osamah, a person without COPD)

This change in social norms has the potential to encourage more individuals to engage in PA and adopt healthier habits. The implementation of Vision 2030, a national

development plan in Saudi Arabia, has also been instrumental in promoting health and wellness. A physiotherapist acknowledged the positive influence of Vision 2030, stating:

“These are the things that are now, whether Vision 2030 or the rule of increasing health promotion about this.”

(Mona, a physiotherapist)

The strategic goals and initiatives of Vision 2030 include measures to improve access to PA facilities and programmes, creating an enabling environment for individuals to lead active and healthier lives. Another promising development is the opening of a specialised PR centre for people with COPD, as mentioned by Norah, a health professional. She revealed plans to establish a centre dedicated to PR, stating:

“We will open PR as an independent centre for pulmonary rehab, and this will be the first specialised centre in Saudi Arabia for Pulmonary rehab.”

(Norah, a physiotherapist)

Such a centre is likely to play a crucial role in providing tailored PA programmes and support for people with COPD, enhancing their overall health and well-being.

Summary

This comprehensive analysis of four distinct themes (COPD-related factors, HCP factors, individual factors, and environmental and social factors) has provided insight into the intricate factors influencing PA engagement among people with and without COPD in Saudi Arabia and HCPs. These themes offer valuable insight into the multifaceted nature of PA behaviour and provide critical implications for HCPs and researchers. COPD symptoms, including pain, fatigue, and breathlessness, limit individuals' ability to engage in PA, emphasising the importance of PR. HCPs are central to promoting PA but challenges related to knowledge, treatment approaches, and limited

research hinder effective interventions. Individual characteristics such as self-efficacy, motivation, knowledge, and health status significantly influence engagement in PA. Environmental factors encompassing access, cultural norms, social support, and weather conditions play a significant role in PA engagement.

7.2. Qualitative Phase Discussion

Drawing Together the Key Themes

Initially, the primary objective of this phase was to explore the barriers and facilitators affecting PA engagement among people with COPD and the role of health professionals in promoting PA for those with COPD in Saudi Arabia. This was achieved by interviewing people with COPD, and HCPs working in COPD in Saudi Arabia. The original aim did not include interviews with people who did not have COPD but because the quantitative findings did not indicate any significant difference, this was amended to include people without COPD. The key focus was on explaining PA behaviours among people with COPD in Saudi Arabia but interviews with people who did not have COPD were included to explore whether the PA behaviour was related to COPD or other factors.

This discussion aims to provide a comprehensive overview of various factors to better understand the challenges and support that affect how people in Saudi Arabia, especially people with COPD, approach PA. By understanding these factors better, the current research will suggest ways to support people to become more physically active and to help HCPs working with people with COPD to promote PA in Saudi Arabia.

Theme 1: COPD-specific Factors

The current research identified the impact of COPD and its related symptoms on PA among people diagnosed with COPD, including the physical and psychological consequences of COPD. The results show that symptoms such as pain, fatigue, and breathlessness deter individuals from engaging in regular PA and embarrassment about their breathlessness leads to psychological distress. These findings support the research conducted by Wagena et al. (2005) which suggests that clinical symptoms often lead to psychological distress. The current study expands on the clinical symptoms by acknowledging the emotional distress that individuals experience, such as feelings

of embarrassment and fear due to breathlessness. Many people had concerns and misunderstandings about engaging in PA, especially walking. Some participants feared that their condition would worsen if they engaged in PA. This aligns with the findings of Kosteli et al. (2017) who reported that fear and shame prevent people with COPD from engaging in PA. The fear of negative health outcomes and experiencing symptoms such as shortness of breath or fatigue creates a psychological barrier that limits their participation in PA.

The vicious cycle whereby reduced PA worsens COPD symptoms, which then further restricts PA is well established. This cycle was highlighted by one of the HCP participants and underscores the complex interplay between the physical and psychological barriers that people with COPD face when trying to maintain an active lifestyle. The study's findings align with broader evidence which substantiates the detrimental impact of reduced PA on COPD symptoms, perpetuating a cycle that reinforces limitations on PA (Kim et al. 2019; Xiang et al. 2022).

Focusing on the context of Saudi Arabia, the current study supports the findings of Mahmood et al. (2023) and Almuzaini et al. (2023), highlighting a broader deficit in health education regarding COPD. Notably, even people with COPD themselves lacked awareness about their condition, which may affect disease management and engagement in PA. This lack of awareness among people with COPD indicates a broader deficit in health education regarding the disease. Raptis et al. (2021) used the Bristol COPD Knowledge Questionnaire (BCKQ) and identified that people with COPD lack knowledge about their condition, including the causes of the disease, the impact of therapy, and how to manage exacerbation. Raptis et al. (2021) recommended COPD-specific knowledge programmes for this patient population. This finding is consistent with the studies conducted by Scott et al. (2011) and Thakrar et al. (2014), which also underscore the need for enhanced education on self-management, rehabilitation, and disease management. By improving their knowledge, people with COPD can better manage their condition and adhere to treatment plans (Scott et al. 2011).

Overall, this theme examines the factors that affect the engagement of people with COPD in PA. It highlights that COPD symptoms can prevent people with COPD from being physically active which, in turn, exacerbates their symptoms. The findings underline the need for better education and PR to address the psychological and physical barriers that deter participation in PA. It also emphasises the significance of creating a supportive environment to encourage people with COPD to lead healthy and active lifestyles.

Theme 2: HCP Factors

The findings from the interviews highlight several key aspects regarding the knowledge and expertise of HCPs in the context of COPD and rehabilitation. HCPs often lack awareness about the crucial role of PA and exercise in the rehabilitation of people with COPD. In the current study, the HCPs expressed concerns about the insufficient knowledge of doctors regarding rehabilitation for people with COPD. This is consistent with various previous studies highlighting a similar lack of awareness among healthcare providers in Saudi Arabia (Al-Eisa et al. 2016; Alsubaiei et al. 2016; Aldhahir et al. 2022). For instance, Alsubaiei et al. (2016) found that there is concern about a lack of knowledge regarding the content and benefits of PR programmes among Saudi healthcare providers treating people with COPD. The current study highlights the impact of insufficient education on doctors' understanding of the significance of rehabilitation for those with COPD, as reported by a respiratory therapist. This finding is consistent with previous research indicating inadequate education among healthcare providers, including physicians, nurses, nutritionists, physical therapists, social workers, psychologists, and psychiatrists, regarding COPD and the importance of PR to patient outcomes (Sami et al. 2021).

Furthermore, a physiotherapist shared her observations about the lack of differentiation between PA and exercise, even within their field. This confusion regarding the distinction between PA and exercise can lead to difficulties prescribing appropriate interventions and hinder the integration of PA and exercise into COPD management plans. This aligns

with the findings of Xiang et al. (2022b) which emphasises the need for future research to focus on the effects of different types, times, and intensity of PA on people with COPD.

The interview findings identified various important aspects of integrating PA into healthcare settings, especially in the context of COPD management. The lack of guidelines for primary care was a major concern among the HCP participants, who emphasised the need for clear guidelines to integrate PA into the standard care provided in primary care settings. This issue is consistent with the findings of previous studies which have also reported a similar lack of guidelines and awareness among healthcare providers in Saudi Arabia and other countries (Lahham et al. 2020; Chan et al. 2021). For example, a qualitative interview study conducted in Australia found that although HCPs, including respiratory physicians, respiratory physical therapists, COPD nurses, and exercise physiologists, acknowledged the importance of PA for people with COPD, they rarely addressed this in consultations due to various limitations such as time constraints, treatment prioritisation, and a perceived lack of expertise (Lahham et al. 2020).

The interview findings highlight several key aspects of PR in the context of COPD. PR is a significant factor in encouraging people with COPD to engage in PA. This finding aligns with what has been reported in numerous studies regarding the effectiveness of PR in improving exercise performance, reducing dyspnoea, reducing the risk of exacerbation, and improving HRQoL in patients with COPD (Arnold et al. 2020; Blervaque et al. 2021). In Saudi Arabia, PR is increasingly recognised by healthcare providers as an effective non-pharmacological intervention for patients with COPD (Aldhahir et al. 2021).

One of the physiotherapist interviewees emphasised the need for PR to be available in every hospital. This is a significant point because previous studies have identified the lack of PR centres as a major barrier to the implementation of PR in Saudi Arabia (Aldhahir et al. 2022).

In the current study, HCPs noted that supervised PR programmes could provide significant clinical benefits for people with COPD, including improvements in exercise capacity, HRQoL, and dyspnoea. In Saudi Arabia, healthcare providers prefer hospital-based PR programmes to supervise their patients. Research also supports the observation that supervised PR encourages people with COPD to continue with PA (Aldhahir et al. 2022; Maliki et al. 2021). Similarly, international studies have also shown that supervised PR programmes are effective in improving the health outcomes of people with COPD (Blervaque et al. 2021).

According to the findings of the current study, HCPs recommend creating a supportive environment during PR sessions to motivate patients to improve and increase their knowledge about the safety of PA. This aligns with the official statement by the ATS/ERS which defines PR as a comprehensive intervention based on a thorough patient assessment, followed by patient-tailored therapies (Rochester et al. 2015). These therapies may include exercise training, education, and behaviour change (Lahham et al. 2021). However, many people face limited access to PR services, which is a major challenge in various healthcare settings. A physiotherapist shared her experience regarding the limited availability of PR services. Studies have also reported this issue, stating that it is a significant barrier to the implementation of PR in various countries (Lahham et al. 2020; Chan et al. 2021; Sami et al. 2021). For example, a study conducted in Malaysia found that limited awareness among HCPs, a lack of referral pathways, and inadequate rehabilitation services were significant barriers to the effective implementation of PR programmes (Chan et al. 2021).

To address this problem, one of the HCP participants recommended the establishment of well-structured PR programmes with dedicated physiotherapists. This aligns with the official ATS/ERS statement which describes PR as a comprehensive intervention from a detailed patient evaluation, followed by treatments personalised for the patient (Aldhahir et al. 2021).

The findings from the interviews highlight several key aspects regarding collaboration and communication in the context of PR for people with COPD. One of the key aspects highlighted is the variation and differences among therapists. The participants in the current study expressed concern about the potential unequal effects on patients when each therapist adopts their unique approach based on their personal experience. This concern aligns with the previous literature which has identified similar worries about the lack of standardisation in treatment approaches among healthcare providers (Aldhahir et al. 2021; Xiang et al. 2022b). For instance, Aldhahir et al. (2021) found that the lack of a standardised approach to PR can lead to inconsistent outcomes and hinder the achievement of clear rehabilitation goals for patients.

Some HCPs highlighted a lack of interest in the field of PR. This is consistent with the findings of previous studies in the UK and Saudi Arabia which have reported a lack of interest and awareness among HCPs about PR, which can hinder the development of effective interventions for people with COPD (Alsubaiei et al. 2016; Kosteli et al. 2017). HCPs in the current study also pointed out a gap in research awareness concerning PA and its importance in COPD management. This aligns with what has been reported by previous studies regarding the limited amount of research in this area, which can adversely affect the understanding and implementation of evidence-based PA interventions for people with COPD (Sami et al. 2021; Xiang et al. 2022b).

Lastly, the importance of training, education, and knowledge about PR for HCPs was emphasised. One of the participants stressed the need for training to enhance HCPs' education on PA and to increase their awareness about the importance of PA for COPD patients. This aligns with the official ATS/ERS statement which defines PR as a comprehensive intervention based on a thorough patient assessment, followed by patient-tailored therapies (Arnold et al. 2020; Sami et al. 2021).

Overall, the HCP factors suggested a significant gap in knowledge and education among HCPs regarding the crucial role of PA and exercise in managing and rehabilitating people with COPD in Saudi Arabia. The lack of clear guidelines, inadequate

differentiation between PA and exercise, limited access to PR services, and variation in treatment approaches underscore a systemic issue that potentially undermines the effective management of COPD.

Theme 3: Individual Factors

The findings from the interviews suggest that self-efficacy and self-confidence play a crucial role in determining individuals' engagement in PA. This is consistent with the principles of SCT which postulate that self-efficacy is a key determinant of behaviour. The interviews revealed that some participants had low self-efficacy regarding maintaining PA, whereas one had high self-efficacy and considered himself to be a professional athlete. This variation in self-efficacy levels is consistent with previous studies which found self-efficacy to be a significant determinant of PA levels in Saudi Arabia and other countries.

Several studies have explored the role that self-efficacy plays in PA for adults. Self-efficacy, or the belief in one's ability to succeed in specific situations or accomplish a task, is a significant determinant of PA levels. Al-Otaibi (2013) conducted research in Al-Ahsa, Saudi Arabia, which examined the present PA status of Saudi adults and the association between the stages of change in PA, perceived barriers, and self-efficacy. The study found that self-efficacy was one of the psychosocial factors that could help tailor strategies to increase PA levels (Al-Otaibi 2013). Meanwhile, Alrimali (2023) assessed the PA level and self-efficacy using the exercise self-efficacy scale developed by Bandura to identify the barriers to PA among adult Saudi women. The study found self-efficacy to be an essential determinant of PA and that its effect on PA levels among a sample of women in Saudi Arabia must be determined (Alrimali 2023).

In the current study, the interviews highlighted the importance of addressing psychological factors such as self-confidence and self-imposed negative beliefs to promote PA. The HCPs working in PR with people who have COPD identified that even

if the environmental and educational problems were resolved, the psychological factor among those with lower self-confidence remains a barrier to PA.

There is limited information regarding the most common self-efficacy barriers to and facilitators of PA among those with COPD in Saudi Arabia and the Middle East based on qualitative studies or the use of the theoretical concept of self-efficacy. However, various quantitative studies have been conducted in Saudi Arabia to assess the level of exercise self-efficacy among people with chronic diseases and the efficacy of PA counselling. Almutary and Tayyib (2020) found that people with chronic diseases in Saudi Arabia have low levels of exercise self-efficacy, which can hinder their engagement in PA. Meanwhile, a systematic review of PA counselling in Saudi Arabia conducted by Almarzooqi and Saller (2022) found that the investigated clinician populations had high perceptions of self-efficacy in successfully promoting PA in patients. Previously, a systematic review of qualitative studies including international studies found that self-efficacy was one of the seven sub-themes that influenced PA following PR in people with COPD (Robinson et al. 2018).

The findings from the interviews revealed that self-imposed negative beliefs about age can significantly affect individuals' perceived self-efficacy in relation to PA, despite their relatively young ages. This highlights the need to address age-related self-perceptions, even when individuals may not objectively fall within the category of being 'old.' This finding is consistent with the conclusions arrived at by previous studies that age-related self-perceptions can be a barrier to PA. This aligns with a study conducted in the UK which concluded that people with COPD often have negative self-perceptions related to age and that a lack of control can affect self-efficacy and discourage individuals from engaging in PA (Kosteli et al. 2017). This suggests that interventions should challenge negative beliefs and empower individuals to engage in PA, regardless of their age or health status.

The current study found that personal motivations such as the desire to improve health or general fitness can drive PA participation for all people, irrespective of whether or not they have COPD. This aligns with the findings of Alqahtani et al. (2021) who used a

national survey to determine the distribution of PA practice among adults aged 15 years and over across Saudi Arabia. Alqahtani et al. (2021) identified a lack of motivation or desire as a significant barrier to PA among Saudis. Interestingly, the current study also highlighted the role of religious practices in planning for PA. One of the participants set his exercise schedules around prayer times. He suggested that religious practices, such as setting aside time for prayer, can encourage PA and promote better time management. This idea is supported by previous studies which highlight the benefits of Islamic religious practices (Benjamin and Donnelly 2013; Nazish and Kalra 2018). These studies explored various ways in which prayer movements, similar to gentle exercise, can affect PA. This implies that incorporating personal motivations and religious values in Saudi Arabia could help to develop strategies and policies to promote PA.

Knowledge about the benefits of PA can also influence participation (Williamson 2016). In the current study, the participants demonstrated various levels of knowledge about what constitutes PA. For example, some people with COPD associated PA with walking, whereas others had a broader view that included running and carrying things. This variation in understanding aligns with the notion that people have different levels of knowledge and expectations about what PA entails. It is noteworthy that walking emerged as a significant activity among both people with and without COPD. This supports the findings of Alqahtani et al. (2021) that walking accounts for 56% of PA in Saudi Arabia, highlighting its universal accessibility and importance. The participants in the current study, particularly those without COPD, recognised the health benefits of walking, linking it directly to their understanding of PA. This is supported by Fredriksson et al. (2018) who conducted an online survey and noted that awareness of the health-related benefits of exercise often encourages people to be more active. This suggests that knowledge and awareness are not just motivational factors but also guide the choice of activity.

Finally, health status can significantly impact PA participation, particularly among people with COPD. The current study is in agreement with previous research that has identified health problems as barriers to PA (Hartman et al. 2013). However, a person's medical

history can also act as a facilitator for PA. For example, people with chronic conditions are often advised to engage in regular PA as part of their treatment plan because it can help to manage symptoms and improve overall health. This aligns with the current findings where participants with diabetes and blood pressure issues reported these conditions as influencing their decisions regarding PA. This suggests that interventions should consider the unique health challenges faced by people with and without COPD and provide appropriate support to promote PA.

Overall, the individual factors reveal that self-efficacy plays a crucial role in influencing PA among people living in Saudi Arabia, including those with and without COPD. Drawing from SCT, the findings are in accordance with previous research which identifies self-efficacy as a significant determinant of PA levels. The current study also finds that motivation, shaped by personal goals, religious beliefs, knowledge, and health status is another key individual factor affecting PA engagement. These insights suggest the need for targeted interventions that consider these individual factors to effectively promote PA among the Saudi population.

Theme 4: Environmental and Social Factors

Financial constraints and limited access to suitable facilities and services present significant barriers to PA engagement for both people with and without COPD. These barriers have also been identified in previous studies (Al-hazzaa 2018; Almaqhawi 2022). It is not surprising to find participants facing challenges due to the hot climate, as indicated by the current study. This is consistent with the findings of previous systematic studies which explain how the hot and dry climate in Arab countries can make outdoor physical activities difficult, especially during certain times of the year (Al-hazzaa 2018; Sharara et al. 2018). For people with COPD, various studies indicate that the climate can have a pronounced impact. People with COPD often experience difficulty breathing and extreme weather conditions can exacerbate their symptoms. High temperatures and humidity can make it harder for them to breathe, resulting in shortness of breath and increased fatigue (Alahmari et al. 2015; Aldhahir et al. 2021).

One study participant identified shopping as a form of activity that provides an opportunity for walking. One of the participants, a person who does not have COPD, mentioned that she goes to a shopping centre to walk, highlighting the importance of recognising various activities that contribute to PA. This aligns with the findings of Chaabane et al. (2021), albeit that this particular study did not specifically mention shopping as a form of activity, rather it offers valuable insight into the factors affecting PA in the Middle East and North Africa (MENA) region. People in that region face barriers such as a lack of suitable sports facilities, time, motivation, gender and cultural norms, hot climate, and harsh weather. Walking in shopping centres is preferred as a safer, airconditioned, and free option for those who want to be physically active (Chaabane et al. 2021).

The study findings indicate that social norms and cultural attitudes significantly influence people's engagement in PA. According to interview participants, these factors played a substantial role in their personal experiences of PA. Both people with and those without COPD highlighted the impact of cultural norms on their engagement in PA. The lack of social support during family gatherings was identified as a factor deterring individuals from partaking in PA. On the other hand, a person without COPD reflected on the evolving cultural attitudes towards PA, signifying a shift from a stigmatised perception to a more encouraging outlook towards physical activities in the community, especially when women feel able to walk in parks. This supports Alrimali's (2023) emphasis on social influences and lack of support as barriers for Saudi women. The gradual shift towards a more positive cultural attitude towards active lifestyles, as noted in the current study by a person without COPD, aligns with the previous discussions regarding the importance of societal norms in influencing PA behaviour.

The traditional dress code, particularly the abaya, has been identified as a significant barrier to engaging in PA, especially for women. This aligns with the findings of a study conducted by Almaqhawi (2022) among Saudi Arabian females living in the East Midlands region of the UK which used interpretive phenomenology to investigate how

women perceive the facilitators of and barriers to PA, revealing that cultural traditions, including dress codes, were barriers to PA in Saudi Arabia compared to the UK. Semi-structured interviews provided in-depth information and the idiographic approach allowed for a nuanced analysis of each participant's experience with a detailed exploration of how Saudi Arabian females perceive the facilitators of and barriers to PA. However, the study's findings may not be applicable to Saudi females who do not live in UK and the subjectivity of PA means that the results should be interpreted with caution.

Similarly, a qualitative study of female Emirati university students also identified the lack of suitable, accessible, and affordable women-only PA facilities as a barrier. The study further noted that traditional clothing heightened discomfort for specific activities such as walking, especially in the hot climate of the UAE (Burton et al. 2021).

Social support plays a significant role in influencing PA behaviours in Saudi Arabia, as it does in many other cultures. It can derive from various sources such as family, friends, and the community and it can either facilitate or inhibit PA. The current study's interviews highlighted the significance of social support for PA, particularly among those who have COPD. One interviewee with COPD mentioned that the lack of companionship and support made it difficult for him to regularly engage in PA and he also expressed that he felt isolated. On the other hand, a person without COPD mentioned that positive family and community support helped him to be more active.

In addition, one of the participants shared how a lack of support and changes after retirement demonstrate the role that social connections play in PA. This was recognised by Sharara et al. (2018), showing that a lack of support for PA is also noted among peers, friends, and teachers in studies conducted in Saudi Arabia, Jordan, and Egypt (Sharara et al. 2018). In addition, social support can also enable the uptake and maintenance of PA by providing resources and companionship. An Australian study on adults aged 60-65 years found that social support for PA was a significant factor in promoting PA over a period of nine years (Tchounwou et al. 2023).

The shift in cultural attitudes towards active lifestyles, as highlighted in the current study, was emphasised by a person without COPD who mentioned that growing acceptance of active lifestyles is a significant factor in promoting PA. This finding is consistent with previous studies which emphasised the importance of societal norms and attitudes in influencing PA behaviour. Furthermore, HCPs have noted the positive effects of Vision 2030, which suggests a hopeful shift towards better engagement in PA. The upcoming PR Centre, as mentioned by HCPs, is a promising development for supporting people with COPD in their PA endeavours. These findings align with the broader objectives of Saudi Vision 2030 which aims to promote health and wellness among the population by improving access to PA facilities and programmes (Kingdom of Saudi Arabia 2030 Vision 2016). This aligns with the global trend of integrating health promotion into national development plans, as recommended by the WHO (2023). Albululaya and Stevinson (2023) highlight the rapid changes that have been witnessed in Saudi Arabia over recent years, including the government's explicit aim to increase PA participation among residents. The study notes that the Saudi government has demonstrated strong support for sport, especially since the launch of Vision 2030.

Overall, this theme investigates the impact that environmental and social factors have on PA participation in Saudi Arabia among people with and without COPD. The study confirms the findings of previous research that personal, behavioural, and environmental factors affect PA behaviours. The study highlights the importance cultural norms, social support, and access to resources which can significantly influence observational learning and, consequently, PA behaviours.

7.2.1.Synthesis of Themes

Novelty of the Qualitative Phase

This qualitative phase provides the first in-depth exploration of PA barriers and facilitators among people with and without COPD in the Saudi context, interpreted

through SCT. It also uniquely integrates HCPs' perspectives, which are often overlooked in similar studies. By capturing these multi-stakeholder viewpoints, this phase offers a richer and more holistic synthesis of the factors shaping PA engagement in a region where such behavioural research remains limited. The emphasis on cultural and gender-specific influences—interwoven with SCT constructs—adds a novel dimension that is not commonly reported in the previous literature concerning Western or Gulf contexts.

In terms of COPD-specific factors, the physical symptoms and psychological distress associated with COPD highlight the close connection between personal and behavioural factors. The vicious cycle of reduced PA and worsening COPD symptoms shows the complex interaction between personal health status and behaviour, a core aspect of SCT.

The HCP factor theme reveals the critical role of knowledge and expertise in bridging the gap between theory and practice. The lack of awareness and expertise among HCPs reflects a broader need for enhanced education and training to make it easier for people to become involved in PA, especially those with COPD.

Central to SCT is the concept of self-efficacy, which emerges prominently in the individual factors theme, affecting individuals' confidence and willingness to engage in PA. The varying levels of self-efficacy, influenced by personal health status and knowledge, underscore the significance of enhancing self-belief and understanding towards the benefits of PA among people with or without COPD. Additionally, motivational aspects like health improvement desires and religious practices reveal how personal encouragement, aligned with SCT's emphasis on outcome expectations, shape PA engagement.

Lastly, environmental and social factors, the influence of social norms, cultural attitudes, and social support resonate with SCT's emphasis on the role of social environments in shaping behaviour. The findings suggest that developing supportive social networks and progressive cultural attitudes towards PA can significantly influence individual

engagement in PA. Environmental barriers like climate and traditional dress codes intersect with social factors, illustrating the mutual relationship between environmental and personal factors, as outlined in SCT.

The themes collectively illustrate a complex interplay of factors which, when addressed holistically, could significantly promote PA engagement in the Saudi population. These findings align closely with the version of SCT adopted in the current study which focuses on the reciprocal interactions between personal, environmental, and socio-cultural factors. In particular, the COPD and non-COPD participants' narratives strongly reflected SCT constructs such as self-efficacy, observational learning, and outcome expectations, thus reinforcing the utility of SCT as a guiding framework for understanding behaviour in this population.

However, themes emerging from the interviews with HCPs did not align as clearly with SCT. While they offered valuable insights into system-level barriers and professional perceptions, these perspectives extended beyond the individual-focused constructs of SCT. This divergence highlights the limitations of applying SCT universally across different stakeholder groups and suggests the potential value of integrating complementary frameworks—such as socio-ecological or health systems models—to fully capture the complexity of influences on PA promotion and service delivery in the Saudi context

Conclusion

The current study has explored the factors influencing PA engagement among people in Saudi Arabia, including people with and without COPD, as well as HCPs. The key findings underscore the pivotal role of self-efficacy, motivation, and knowledge in shaping individuals' attitudes and behaviours towards PA. Additionally, COPD-specific factors, HCP factors, environmental factors, and social elements all play a significant role in either facilitating or impeding engagement in PA. The insights derived emphasise the interplay between personal, behavioural, and environmental factors and highlight

the need for a holistic approach to promote PA, especially among people with COPD. The findings also point towards a critical need to enhance HCPs' knowledge and expertise in COPD management and PA promotion, which may affect the health outcomes of people with COPD. This nuanced understanding of various factors will be instrumental in devising strategies to enhance PA levels across the population. By understanding all of these factors, the study will contribute to comprehensive factors that can be recognised in Vision 2030.

7.2.2.Strengths and Limitations of the Qualitative Phase

This phase of the study provides valuable insights into the experiences of people with and without COPD in Saudi Arabia but several limitations should be considered when interpreting the findings. The qualitative interviews included only 19 participants, a relatively small sample size that may not fully capture the diverse experiences and perspectives of people in Saudi Arabia, thereby potentially limiting the representativeness of the findings. The recruitment process was conducted entirely online due to the events of the COVID-19 pandemic, which posed significant challenges in terms of reaching a wider participant pool. Additionally, ethical approval was obtained from the Public Pension Agency in Saudi Arabia, which primarily includes individuals from similar age groups. While this approach ensured an appropriate demographic for the study, it may have restricted access to a wider range of participants, particularly non-COPD individuals from other sources. Future studies could consider recruiting from multiple centres or wider community settings to enhance diversity and generalisability.

Additionally, the majority of interviewees with and without COPD were male, with only two female participants, resulting in a significant gender imbalance. This may not adequately represent the experiences of females, who could face different challenges or have unique perspectives regarding PA engagement. Cultural and societal factors in Saudi Arabia may have influenced the recruitment of female participants, particularly given the online nature of the study during the COVID-19 pandemic. Future research should aim to include a more balanced gender representation by employing targeted recruitment strategies such as collaborating with women's health organisations,

engaging with community groups, or utilising in-person recruitment methods where feasible.

Another limitation is the language translation process. The interviews were conducted in Arabic and then translated into English prior to analysis, which may have led to the loss of nuanced meanings or cultural contexts, potentially influencing the interpretation and depth of the findings. Moreover, due to the COVID-19 pandemic, the interviews were conducted online rather than in person. While this approach was necessary for safety, it may have limited the researchers' ability to fully engage with the participants and observe non-verbal cues that could provide additional insights.

Furthermore, the study was conducted in only two healthcare centres in Saudi Arabia, which may not be representative of the broader COPD patient population in the country. Including participants from multiple centres or regions could have offered a more comprehensive understanding of the experiences of COPD patients across different areas. Additionally, the data included perspectives from individuals with COPD, those without COPD, and HCPs, rather than being solely COPD-specific. While this broader approach offers valuable insights into various factors influencing PA engagement, the COPD-specific data could be drawn out more effectively across multiple themes rather than being concentrated primarily in the first theme. Future analyses or studies could consider a more distinct separation of COPD-related findings to ensure a clearer understanding of the unique challenges faced by this population.

From a theoretical perspective, the application of SCT provided a useful lens for interpreting the experiences of people with and without COPD, particularly in relation to self-efficacy, perceived barriers, and environmental influences on PA. However, the themes generated from HCPs did not align as clearly with SCT's individual-level constructs. Their insights reflected more systemic or institutional challenges that extend beyond SCT's scope. This highlights a limitation in the exclusive use of SCT and suggests that integrating other frameworks—such as the socio-ecological model—could

strengthen the analysis of multilevel influences on PA behaviour and service delivery in the Saudi context

Despite these limitations, the current study has several strengths. The qualitative nature of the study allowed for in-depth exploration of individual experiences and perspectives, providing rich, detailed data that can highlight the specific challenges and needs of COPD patients. Conducting interviews in Arabic ensured that the participants could express themselves comfortably in their native language, which is crucial for obtaining authentic responses. Additionally, the study's adaptation to online interviews during the COVID-19 pandemic ensured that the data collection process could continue safely, maintaining the momentum of the research despite global disruptions.

These limitations should be considered when interpreting the study's findings and assessing their transferability to other settings. Nevertheless, the insights generated remain valuable and suggest important directions for future research, particularly the need for studies with more diverse samples and wider geographic representation to deepen our understanding of the barriers to and facilitators of PA among individuals with COPD in Saudi Arabia.

8. General Discussion

8.1. Introduction

After presenting the results and discussion from both phases, this chapter discusses these findings, particularly from the theoretical perspective of SCT. The primary aim of this study was to determine the difference in PA levels between people with and without COPD in Saudi Arabia. In addition, the research sought to explore the barriers and facilitators affecting PA engagement among people with and without COPD and the role of HCPs in promoting PA for people with COPD in Saudi Arabia. A mixed methods approach was employed to gather both quantitative and qualitative data, aiming to explore and offer a deeper understanding of the research topic in the context of Saudi Arabia using SCT as a theoretical framework.

The quantitative phase collected self-reported data regarding PA levels among people with COPD and the relationship with HRQoL and dyspnoea in COPD. Due to the COVID-19 pandemic, an objective assessment of PA and a more comprehensive assessment of additional contributors to PA in both the quantitative and qualitative aspects was not feasible in person. The questionnaire included demographic factors which were also explored descriptively as part of individual factors influencing PA.

The qualitative phase captured perceived factors spread across various levels of influence which could not be explored in the quantitative part. This highlights the importance of triangulation (Noble and Heale 2019), where the integration of both types of data occurred during the examination of the impact of demographic factors, HRQoL, and dyspnoea levels on participants' PA.

The quantitative and qualitative results were complementary, thereby indicating a coherent relationship between the two types of data. This contributed to a deeper understanding of the research questions.

Quantitative data such as numerical measurements obtained using reliable and standardised tools like sensors or surveys provide statistical insights into the patterns,

relationships, and trends within the data. On the other hand, qualitative data derived from interviews, observations, or open-ended responses offer rich contextual information, personal experiences, and in-depth perspectives that quantitative data alone cannot capture (Noble and Heale 2019; Inoue et al. 2024). By integrating both quantitative and qualitative data, it is possible to triangulate findings, cross-validate results, and gain a more comprehensive understanding of the phenomena under study (Inoue et al. 2024).

8.1.1.Purpose of the study

The purpose of this PhD thesis was to identify approaches for improving PA levels among people with COPD in Saudi Arabia. This general discussion is organised to answer the following research questions and integrate the quantitative and qualitative results.

1. Is there a difference in PA levels between people with COPD and those who do not have COPD in Saudi Arabia?
2. What are the barriers and facilitators to PA that people with COPD and those who do not have COPD encounter?
3. What are the perspectives of health professionals in promoting PA for people with COPD in Saudi Arabia?

1. Is there a difference in PA levels between people with COPD and those who do not have COPD in Saudi Arabia?

In the current study, there were no significant differences in median PA levels between people with COPD and those without COPD. Almost half of the participants in both groups were classified as having low PA levels, a finding that is consistent with previous studies conducted in Saudi Arabia.

However, the current study makes a novel contribution by being the first to apply the IPAQ to assess PA levels specifically among people with COPD in Saudi Arabia. While the previous research, such as Al-Hazzaa's (2018) systematic review of PA in Saudi Arabia, found that physical inactivity among males was between 26% and 85% and between 43% and 91% among females in the general population, no prior study had evaluated PA levels in the Saudi COPD population using the IPAQ. Similarly, Al-Eisa and Al-Sobayel's (2012) study of PA among Saudi females using pedometer measurements also indicated high levels of inactivity. According to Alqahtani et al. (2021), a significant majority of Saudi males (72%) and an even greater proportion of females (91%) were found to engage in low levels of PA.

The qualitative phase of the current study highlights novel findings of the shared barriers faced by people with and without COPD when attempting to engage in PA. Both groups encounter barriers rooted in individual concerns, such as socio-structural factors and environmental factors, including limited access to suitable exercise facilities. The specific barriers identified are discussed in detail in the following section of this chapter.

It was found that HRQoL, as measured by EQ-5D-5L and EQVAS, was significantly poorer among people with COPD compared to those without COPD. This finding is particularly noteworthy because it represents the first known application of these validated tools to assess and compare HRQoL between COPD and non-COPD populations in Saudi Arabia. Previous research in the region has primarily focused on other chronic conditions such as diabetes and musculoskeletal disorders, with limited attention being paid to respiratory diseases like COPD (Althemery 2021).

The qualitative insights gathered in this study provide a comprehensive explanation of the observed disparities in HRQoL. Participants with COPD reported specific symptoms (e.g., pain, fatigue, and breathlessness) which significantly hinder their ability to engage in regular PA, thereby impacting their overall QoL. Beyond physical limitations, these symptoms also contribute to emotional distress, including feelings of embarrassment and fear associated with breathlessness. Such psychological barriers further compound

the challenges faced by individuals with COPD, influencing their perception of HRQoL beyond mere measures of PA (Kosteli et al. 2017).

In addition, the quantitative findings that PA among people with COPD is negatively correlated with dyspnoea levels, as measured by D-12, aligns closely with the qualitative insights obtained from interviews with COPD participants. The majority of the participants in the qualitative phase highlighted breathlessness (dyspnoea) as the primary symptom that impedes their engagement in PA. This qualitative observation aligns with the quantitative correlation, suggesting that higher levels of dyspnoea may contribute to reduced PA among people with COPD. However, because this is a correlation, causation cannot be inferred. The qualitative data revealed that COPD participants' breathlessness significantly negatively affected their ability and willingness to engage in PA. The fear of exacerbating their symptoms, coupled with the physical challenge posed by dyspnoea during PA creates a substantial barrier to maintaining an active lifestyle. This aligns with previous findings in the COPD research, such as the study by Hanania and O'Donnell (2019) which underscores the strong association between increasing dyspnoea severity and declining PA levels in COPD patients.

SCT Framework

To interpret the findings of this study, SCT was employed as the guiding framework, aligning with the purpose of identifying approaches to improve PA levels among people with COPD in Saudi Arabia. SCT was previously detailed in Chapter 1 (see Section 1.5), where its development, foundational concepts, and relevance to health behaviour change were outlined. Originating from Bandura's work on observational learning, SCT provides a robust explanation of how personal, behavioural, and environmental factors interact in a dynamic and reciprocal manner to influence behaviour—a process known as triadic reciprocal causation. Its constructs have been widely used to inform health-related research and interventions, with their utility supported by several meta-analyses (Young et al. 2011).

SCT posits that behaviour change is shaped through six key constructs: behavioural ability (knowledge and skill), outcome expectations, outcome evaluation, self-efficacy, self-regulation, and reinforcement (Glanz et al. 2008). To ensure a clear and structured interpretation of the findings, these constructs were grouped into three overarching domains consistent with SCT's theoretical underpinnings:

- **Personal factors**, which include self-efficacy, behavioural ability, and self-regulation, reflect individuals' beliefs, skills, and capacity to control their own actions.
- **Behavioural factors**, including reinforcement, outcome expectations, and outcome evaluation, influence motivation and decision-making processes related to PA.
- **Environmental factors** refer to socio-structural influences such as access to resources, social support, and prevailing cultural or community norms.

This categorisation allows the findings to remain theoretically grounded while offering a practical framework for analysing the barriers to and facilitators of PA engagement among individuals with COPD.

In the most recent conceptualisation of SCT, Bandura (2004) proposed a causal model consisting of four interrelated constructs: self-efficacy, outcome expectations, socio-structural factors, and goals (see Figure 1.3). Within this model, self-efficacy is central because it reflects the individual's confidence in their ability to execute health-promoting behaviours and influences every other element in the framework. Outcome expectations involve the perceived benefits or consequences of performing the behaviour, whereas socio-structural factors encompass the perceived facilitators or obstacles in the environment. These three constructs shape and inform an individual's goals, which may be either proximal (short-term) or distal (long-term). Goals, in turn, guide behavioural intention and performance.

As discussed in **Chapter 1**, **Figure 1.3** illustrates the relationships among these constructs, positioning self-efficacy at the core of behavioural change, with reciprocal

influences flowing between personal beliefs, perceived barriers or enablers, and anticipated outcomes. This model provides the analytical lens through which the current study's themes were examined and mapped, enabling a deeper understanding of how these constructs manifest in the lived experiences of people with COPD in the Saudi context.

The interview findings identified four broad themes that emerged during the analysis: **COPD-specific factors, HCP factors, individual factors, and environmental and social factors.** The study's findings are divided into barriers and facilitators for all participants and then viewed through the lens of SCT constructs. Additionally, the perspectives of HCPs were discussed in detail. They talked about factors related to their role and the health system in Saudi Arabia that may affect the delivery of health management to COPD patients, which are not related to the patients themselves.

2. What are the barriers to and facilitators of PA that people with COPD and those who do not have COPD encounter?

An objective of this study was to investigate the perceptions of the barriers to and facilitators of PA among people with COPD in Saudi Arabia. However, after initial analysis, the lack of difference at the quantitative PA level necessitated further investigation to understand the factors affecting PA in people with and without COPD. The findings from the interviews suggest that the barriers to PA were not solely related to the impact of COPD but were also shaped by wider environmental and social factors. Notably, the current study took a novel approach by including both people with and without COPD to explore these influences, allowing for the identification of both common and disease-specific factors affecting PA participation. This dual-perspective approach provided new insights into the universality of certain barriers, highlighting that many challenges to PA engagement extend beyond disease status, an area that has been underexplored in previous research. While all of the participants were in the same environment, there were notable demographic differences between the groups—most of the COPD participants were older and predominantly male, whereas the non-COPD

group included younger participants. These differences in age and gender may have influenced their experiences and perspectives of PA, which should be considered when interpreting the findings. However, despite these variations, some shared barriers and facilitators emerged, suggesting that environmental and societal factors play a role in shaping PA engagement beyond the direct impact of COPD.

Previous studies have extensively researched PA levels in Saudi Arabia among healthy populations (Al-Hazzaa and AlMarzooqi 2018) and some research has investigated the barriers to and facilitators of PA for women (Almaqhawi 2022; Alageel et al. 202), and the views of HCPs (Aldhahir et al. 2022a; Aldhahir et al. 2022). However, there has been limited exploration of the perceived barriers and motivators experienced by people with COPD. Most of the studies addressing the topic relied on quantitative questionnaires and found an increase in the level of physical inactivity, which may not fully capture the personal experiences of people with COPD and the barriers and facilitators they encounter. To achieve a deeper understanding of their experiences, the study employed in-depth interviews to explore the facilitators of and barriers to PA among this population.

Barriers/Limitations to PA

This section explores the key barriers identified in the interviews that influence PA among people with and without COPD, framed within SCT.

Self-efficacy

The findings of the current study clearly demonstrate the importance of the self-efficacy constructs within the SCT framework which are believed to have a direct impact on behaviour as well as indirect effects through all other constructs in the model. According to Bandura (1998), a person's belief in their ability to perform a behaviour despite facing obstacles is a clear indication of their level of self-efficacy. In the present study, some participants reported a reduction in PA during periods of increased responsibility. While this decline in activity may suggest a potential impact on motivation or prioritisation, it

does not necessarily indicate a diminished level of self-efficacy. Rather, it highlights the complex interaction between self-efficacy and external factors such as time constraints or competing demands, as posited by SCT. As Bandura notes, behaviour is influenced by multiple interrelated factors; not solely one's confidence in their ability to act but also by contextual and environmental influences.

According to the current study, the self-efficacy of people with and without COPD was influenced by work and family responsibilities. They all agreed that they had limited time or energy for PA. This is consistent with several previous studies conducted in various countries and among different populations, where a lack of time was reported to be the main barrier to engaging in PA (Amin et al. 2011; Awadalla et al. 2014; Sharara et al. 2018). This could indicate that a lack of self-efficacy is an important factor when faced with various barriers. The participants acknowledged that without internal motivation or desire, they are unlikely to increase their PA. However, when the participants were clearly aware of their personal goals, this served as a motivator to remain physically active.

HCPs had a better understanding of self-efficacy as a motivator for PA than the other participants. This is in agreement with two US studies which explored the motivators for PA and found self-efficacy to be significant (Eyler et al. 1998; Nies et al. 1999). A more recent quantitative study from Saudi Arabia also argued that high self-efficacy was a significant motivating factor for women to engage in PA (Al-Eisa and Al- Sobayel 2012). Montaña and Kasprzyk (2015) revealed that high self-efficacy fosters greater self-confidence in the ability to perform a behaviour despite facing various barriers, resulting in stronger commitment.

Additionally, people with COPD explained how their medical condition affects their PA capabilities and the challenges faced when considering engaging in PA. These findings support the research conducted by Wagena et al. (2005) which suggests that clinical symptoms, including depression, often lead to psychological distress. The current study expands on the clinical symptoms by acknowledging the emotional distress that

individuals experience, such as feelings of embarrassment and fear due to breathlessness. This aligns with Kosteli et al.'s (2017) findings that psychological barriers including embarrassment, fear, and frustration/disappointment can impede PA in COPD patients in primary care. Embarrassment often stems from breathlessness or physical limitations, leading to self-consciousness and a reluctance to be active. Fear, especially fear of breathlessness or deteriorating symptoms, can deter patients from engaging in PA. Additionally, frustration or disappointment due to perceived limitations or setbacks can reduce motivation and self-efficacy.

Socio-structural Factors

It is challenging to define socio-structural factors with a single model. Nonetheless, in previous SCT models, they have been represented by measures of socio-cultural influence, social support, or perceptions of the built environment (Young et al. 2014). The discussion below highlights this construct to provide a better understanding.

Environmental Factors

The interview findings revealed that environmental factors play a significant role in the participants' engagement with PA. Some of the key factors include the unsuitability of the environment for outdoor physical activities and the challenges of finding or accessing suitable facilities. Environmental constraints included factors such as climate and urban design, whereas difficulties in accessing facilities included limited availability and financial challenges.

The participants in Saudi Arabia found it difficult to participate in outdoor activities such as walking during hot summers. This perceived barrier mirrors the findings of several studies conducted in the US (Adachi-Mejia and Schifferdecker 2016; Nies et al. 1999), Saudi Arabia (Amin et al. 2011), and Kuwait (Serour et al. 2007), whose participants reported similar problems. The present study identified that the barrier of hot temperatures has been compounded by cultural norms and social expectations

surrounding the dress code. This has resulted in an overlap between the identified themes, which is further elaborated upon later.

Regarding the natural surroundings, specifically concerning the weather and geography of Saudi Arabia, two factors hinder PA. This is mainly due to the very hot climate which makes it unsuitable for engaging in physical activities. Conversely, the colder winter weather might serve as motivation for PA, as highlighted by the study participants. These findings align with the outcomes of Tucker and Gilliland's (2007) systematic review, which affirms that PA levels can change with the seasons. The review emphasises that the extremes of hot or cold weather act as barriers to PA across different populations.

The inadequate provision of footpaths and the lack of suitable areas for PA in urban settings is a common environmental constraint that affects both people with and without COPD. Odunitan-Wayas et al. (2020) and Omura et al. (2020) established this finding in numerous countries, including the US and South Africa. The presence of pavements in urban areas is positively correlated with improved access to PA (Brownson et al. 2001), highlighting the significance of the built environment as a common barrier worldwide. However, there are variations in safety concerns among these studies. Participants have attributed the lack of safety to not only the nonexistence of pavements but also the neighbourhoods in which they reside. There is evidence of a threat of interpersonal crime such as acts of violence between individuals which poses a risk to individuals walking on pavements at night (Rees-Punia et al. 2018; Aliyas 2019).

Interestingly, no studies conducted in Saudi Arabia or Arab countries have previously reported this aspect of safety and nor was it mentioned by the participants in the current study. The car-dependent lifestyle of Saudi Arabia may have caused a preference for dedicated walking tracks rather than walking around neighbourhoods (Sultan et al. 2021). Additionally, one participant in the current study noted the challenge of finding walkways that are far from their place of residence. One participant raised a concern about the suitability of walking alone at night for women as a social norm, regardless of safety. This concern stems from the harassment that women may experience from male

drivers. During a holiday vacation in Riyadh, the researcher (RA) experienced frequent honking and encounters with drivers slowing down when walking to a park near their home, which is an example of such harassment.

The study reveals that women face significant environmental constraints in their pursuit of PA. As elucidated in Chapter 5, the lack of facilities for women to undertake PA leads to an increase in cost. The participants noted that female-only gyms in Riyadh are fewer in number in comparison to those available to their male counterparts, thereby exacerbating the problem. This finding is consistent with previous studies conducted in Saudi Arabia which have consistently identified the lack of female gyms as a major barrier to PA for women in the country (Abdel-Salam and Abdel-Khalek 2016; Almajwal 2015; Alquaiz and Tayel 2009; Atika et al. 2013; Awadalla et al. 2014; Brownson et al. 2001; Samara et al. 2015). In addition, Saudi women living in the UK face similar barriers regarding the relative cost of gyms between Saudi Arabia and the UK (Almaqhawi 2022).

The study findings also indicate that not it was only women who reported experiencing a shortage of available gyms but also those participants residing outside of Riyadh when attempting access gym facilities in their respective areas. This observation highlights the need for the development of more extensive PA programmes and facilities, including gyms, to promote and support PA in these areas.

Socio-cultural Influence

The current study's findings revealed a clear reflection of the socio-cultural influence construct of the SCT, which pertains to an individual's perceptions of social approval or disapproval of specific behaviours within their social context. Such influence is exercised through injunctive norms which are normative beliefs about what others think one should do. The Saudi community's cultural norms influence these beliefs and gendered norms are particularly evident in expectations concerning behaviour and dress. It is pertinent to consider how cultural norms shape these beliefs and exert social influence on individuals.

Women in Saudi Arabia face challenges participating in outdoor activities due to high temperatures and traditional attire requirements. The traditional full-length outer garment worn by Muslim women called an abaya makes PA challenging in the summer (Fehaid et al. 2024). While the current study did not identify expectations about public attire as a socio-cultural barrier to participating in PA, it is important to note that these expectations could be a factor.

Islam encourages women to dress modestly but the Quran does not specify the manner, colour, or style of veiling (Anishchenkova 2020; Shirazi 2009). Women in Saudi Arabia traditionally wear a plain black abaya when going out but there is no law requiring them to do so. In 2018, Crown Prince Mohammed bin Salman clarified that women should dress modestly, in accordance with the traditions and customs of the country.

The dress code for women in Saudi Arabia has changed over time, particularly in terms of the style and colour of the abaya. It is intriguing to witness how societal norms can evolve, influencing cultural and social customs. According to Wheeler (2020), guidelines regarding appropriate attire were previously unclear but there is now a noticeable relaxation in attitudes regarding the colour and design of the abaya.

This shift may empower women to choose more comfortable and suitable clothing for their activities, especially given Saudi Arabia's climate.

When it comes to the level of conservatism in Saudi cities, it is noteworthy that Riyadh is less conservative than other cities. However, it is important to keep in mind that cultural traditions are deeply ingrained and cannot be changed quickly, which has an impact on how people behave. Women living in more conservative cities may find it hard to conform to what is socially acceptable and face harassment and alienation as a result. Although lightening the colour restrictions on abayas could be a progressive step, it is important to acknowledge that wearing an abaya may still restrict the ability to undertake outdoor activities such as walking.

Since the introduction of Vision 2030, Saudi society has undergone rapid transformations, particularly among the younger demographic, which is the primary focus of government initiatives. However, older females may still adhere to traditional values, including the belief that women should only leave their home out of necessity and that they are solely responsible for childcare. This aligns with prior research indicating that family dynamics adversely affect older females' engagement in PA (Kosma et al. 2017).

The present study's findings reveal that social norms regarding clothing are similarly influential for males. For instance, one participant recounted that individuals who saw him exercising in sportswear previously labelled him as "crazy." This social context of appearance has evidently impacted beliefs regarding the appropriateness of sport and physical activities in SA.

Social Support

Many of the participants with COPD in the current study felt that their family members, especially those close to them, did not support their efforts to be physically active. They perceived a negative attitude from these family members which discouraged them from engaging in PA. This negative attitude could be due to societal expectations about PA for older people or those with COPD. In addition, this could be a cultural norm in Saudi Arabia that older people should be looked after and not remain active.

Additionally, overly protective family members may prevent individuals from being physically active. This aligns with the findings of Kosteli et al. (2017) where participants talked about family members doing everything for them, with this constant offer of help discouraging them from being physically active. It appears that too much support, even if well-intentioned, can sometimes prevent people from being active. Conversely, not having support from friends, family, or the community can also be an obstacle to being physically active. Without encouragement from others, individuals may feel less motivated to stay active, as highlighted by Herazo-Beltrán et al. (2017). In addition, one

participant in the current study explained how a lack of support and changes after retiring demonstrate the crucial role of social connections for PA.

Outcome Expectations

The third construct of the SCT is outcome expectations which involves an individual's judgement regarding the potential outcomes or consequences that may occur as a result of performing or not performing a particular behaviour. According to SCT, individuals tend to act based on their behavioural capability, beliefs, and expectations of achieving positive and valuable outcomes, while avoiding behaviours that could lead to unfavourable outcomes.

Behavioural Capability

The identified barriers relating to limited knowledge and skills among the participants aligns with the findings from various previous studies, reinforcing the significance of addressing this issue to promote PA. Awadalla et al. (2014) and Sharara et al. (2018) consistently highlight that a lack of knowledge, guidance, and skills can act as deterrents, hindering individuals from actively participating in physical activities.

Furthermore, a noteworthy aspect contributing to this knowledge barrier is the presence of misconceptions among COPD participants. Some people with COPD harbour incorrect expectations about PA, fearing that engaging in it might exacerbate their symptoms. This indicates a significant lack of awareness about their condition, highlighting the need for targeted educational interventions. This mirrors the findings of Scott et al. (2011) and Thakrar et al. (2014), emphasising the need for improved education regarding self-management, rehabilitation, and disease understanding.

Knowledge can empower people with COPD to make informed decisions about their PA and health. Scott et al. (2011) suggest that improved awareness enables better condition management and adherence to treatment plans. Therefore, addressing misconceptions and providing accurate information about the compatibility of PA with

COPD is pivotal in fostering a positive attitude towards exercise and promoting overall well-being.

Facilitators to be Active

This section explores key facilitators identified in the interviews that influence PA among people with and without COPD, framed within SCT.

Self-efficacy

Understanding the role of self-efficacy in motivating PA is a domain where HCPs appear to possess a more nuanced comprehension compared to the other participants. This observation aligns with the findings of two US studies investigating motivators for PA which underscored the significance of self-efficacy (Eyler et al. 1998; Nies et al. 1999). A more recent study from Saudi Arabia emphasised the pivotal role of self-efficacy as a motivating factor, particularly among women engaging in PA (Al-Eisa and Al-Sobayel 2012). The concept is further elucidated by Montaño and Kasprzyk (2015) who argue that elevated self-efficacy instils greater self-confidence in one's ability to navigate through various barriers, fostering a heightened commitment to the behaviour.

Self-regulation

In addition to self-efficacy, the concepts of self-regulation and time management are integral components influencing PA engagement. It is suggested that individuals can make time for PA by incorporating it into their daily routines and aligning it with personal obligations such as prayer. This implies that time management skills can contribute to a greater sense of self-efficacy (Bargmann and Kauffeld 2023). In addition, this notion resonates with the existing literature which posits a positive correlation between self-confidence and PA. For example, a study focused on elderly individuals with diabetes found that their self-efficacy in engaging in PA was directly correlated with their ability to overcome barriers and actively participate in physical activities (Rachmah et al. 2019). The current study echoes this sentiment because the participants who expressed

confidence in their ability to engage in physical activities were more inclined to translate that assurance into action.

By integrating self-regulation techniques into exercise programmes and providing support for individuals to set goals, monitor their progress, and reinforce positive behaviours, the promotion of self-regulation can significantly enhance PA engagement

Socio-Structural Factors

A shift in cultural attitudes towards active lifestyles was highlighted by the current study—a novel and important qualitative finding. While national statistics have documented rising levels of PA, the current study provides unique insight into the changing perceptions and social norms that underpin this shift. The participants described a growing acceptance of active lifestyles as a significant factor in promoting PA, reflecting a broader transformation in how PA is viewed within Saudi society. This is supported by national data indicating an increase in PA levels among the population from 20% in 2019 to 29.7% in 2021, an increase of 9.7 percentage points (The General Authority for Statistics 2021).

This cultural change may be linked to government initiatives such as Vision 2030 which aims to transform the country's economic and social sectors (Saudi Vision 2030 2019). Vision 2030 has placed considerable emphasis on encouraging PA through new policies, infrastructure development, and awareness campaigns. As noted by Albujujaya and Stevinson (2023), Saudi Arabia is undergoing rapid change in this area. However, the current study adds depth by capturing participants' lived experiences and perceptions of this shift, offering contextually grounded evidence that government efforts are beginning to reshape social attitudes towards PA. This suggests that the impact of national policy extends beyond structural change, also influencing individual motivation and cultural norms related to health and activity.

Social Support

Social support emerged as a key determinant influencing the engagement of participants in PA. The significance of having support from family or friends resonates strongly among the study participants. This theme aligns with the findings of numerous prior studies, each identifying the role of family and social support as a crucial motivator for individuals pursuing PA (Allender et al. 2006; Nies et al. 1999; Young et al. 2001).

The previous literature identifies social support is a recurring theme. Numerous studies identified the presence of an exercise partner as a facilitator for PA, while the absence of a support partner was identified as a barrier (Allender et al. 2006; Amin et al. 2011; Nies et al. 1999; Serour et al. 2007; Young et al. 2001). The consistency of these findings across multiple studies underscores the universal impact of social support in shaping PA behaviours.

It is recognised by some HCPs that having a support group for people with COPD can significantly contribute to their overall well-being and adherence to PA regimens. This social support group is not limited to friends and family. The endorsement of support groups by HCPs aligns with the notion that social support plays a pivotal role in motivating individuals to engage in PA and effectively manage their COPD. This was also observed in the US, as one of the HCPs mentioned during the interview. Support groups are common in Western countries, including the British Lung Foundation (Asthma + Lung UK 2024), the Better Breathers Clubs in the US (American Lung Association 2024), and Lung Foundation Australia (Lung Foundation Australia 2024). However, such groups are non-existent in Arab countries.

In Saudi Arabia, the traditional family structure plays a pivotal role in providing social support. The collectivist culture emphasises familial responsibility for caregiving, often leading to family members serving as primary caregivers for individuals with chronic conditions such as COPD. This familial support can positively influence patients' engagement in self-care and PA. However, it may also lead to an increased caregiver

burden due to the lack of formal support systems (Aloudiny et al. 2024). Previous studies have shown that perceived family social support is associated with better self-care behaviours among elderly COPD patients (Shirvani et al. 2020). Nonetheless, the absence of structured support groups may limit opportunities for patients to share their experiences and coping strategies beyond their immediate family circle.

Therefore, while family support is integral in the Saudi context, formal support groups could provide additional benefits, offering platforms for shared experiences, education, and encouragement, ultimately enhancing PA adherence and overall well-being among people with COPD.

Outcome Expectancy

The outcome expectations construct was demonstrated through the findings of a study which explored the facilitators of PA (Zhang et al. 2024). The attitudes of participants towards improving their body weight, mental state, and physical health were influenced by their beliefs about the outcomes of being physically active. This, in turn, affected their intention to engage in PA. As noted in Chapter 6, observing changes in body weight, mood, or feelings of achievement was a key motivator for the participants to continue their activity.

In the current study, it was discovered that both physical and psychological changes play a role in motivating participants to engage in PA. Previous studies have also found that weight control and feeling good after exercising were motivators (Allender et al. 2006; Alyafei and Albaker 2020; Atika et al. 2013; Dishman et al. 1985; Ferrand et al. 2008; Nies et al. 1999; Young et al. 2001).

According to Montaña and Kasprzyk (2015) people who were dedicated to their PA felt better emotionally after engaging in it, which was reflected in their improved mood. They also believed that PA would be beneficial for their health. Therefore, the study suggests that the more strongly an individual believes that performing a particular behaviour will

result in positive outcomes, the more likely they are to have a favourable attitude towards performing that behaviour (Montaño and Kasprzyk 2015).

Secondly, the participants' attitudes towards PA were influenced by their health concerns. Although few participants explicitly cited a particular health concern as a motivator for PA, many were prompted to engage in PA on the advice of a physician or after discovering that their blood sugar or blood pressure levels were unhealthy. Previous studies have noted that health scares can motivate individuals to become more physically active (Abdel-Salam and Abdel-Khalek 2016; Allender et al. 2006; Atika et al. 2013; Dishman et al. 1985; Ferrand et al. 2008; Young et al. 2001). This suggests that the participants believed that PA could help overcome specific health issues such as COPD.

Observational Learning

In the qualitative study, a person without COPD shared a positive experience they had with a walking group during an interview. They explained how being part of a community motivated them to maintain a daily walking routine. This aligns with the findings of Ebrahimi et al. (2020) that peer support can significantly improve the HRQoL of participants. This participant's experience is in accordance with the SCT, which suggests that observing and adopting others' attitudes can lead to the development of new behavioural patterns (Bandura 1991).

In the context of a walking group, a participant's motivation is closely linked to the experiences of others in the group. Conner and Norman (2005) describe this as vicarious learning. When a participant observes other members of the group actively engaging in daily walks, it provides a concrete example of successful behaviour. This, in turn, helps to boost self-efficacy and serves as a powerful mechanism to increase motivation, encouraging individuals to adopt and maintain desired behaviours.

The participant's account is in accordance with McAlister et al.'s (2008) concept, which suggests that individuals are more likely to copy behaviours when they perceive others

to be similar to themselves. Bandura (1998) supports this idea by stating that if people observe individuals with similar characteristics succeeding in a specific activity, it instils a belief in their own capabilities to achieve similar success. In the case of the walking group, the shared goal of maintaining an active lifestyle among like-minded individuals fosters a sense of similarity, reinforcing the participant's belief in their ability to succeed in adhering to the daily walking routine.

In summary, the key findings from the interviews involving people with and without COPD related to the SCT constructs and the actions recommended to overcome them are presented in **Table 7.1**. Prior to commencing these interviews, it was anticipated that the main topic of discussion would be their thoughts about PA and the cultural factors associated with PA. This expectation was grounded in the existing literature which highlights the multifaceted barriers and facilitators affecting PA participation among COPD patients (Thorpe et al. 2014), particularly within specific cultural contexts. However, during the interviews, the most commonly mentioned barriers related to environmental factors, difficulty accessing facilities, and certain cultural norms such as gender-specific expectations regarding PA, in addition to different individual factors.

When participants spoke about cultural influences, they referred to them in a general sense rather than specifically about themselves. Most of the participants acknowledged the existence of cultural barriers but did not mention their own exposure to them. Conversely, when it came to personal or environmental factors, they spoke from personal experience.

A novel finding of the current study is the overlap between the concepts of environmental constraints and social influence in both groups (those with and without COPD). This is highlighted in the discussion that follows.

The findings of this study broadly reflect key barriers and facilitators identified in studies conducted in Western contexts, such as breathlessness-related fear, embarrassment, low self-efficacy, environmental constraints, and limited social support (e.g. Kosteli et al.

2017; Wagena et al. 2005; Allender et al. 2006). However, several contextual distinctions emerged. For instance, while environmental barriers such as climate and urban design are commonly reported globally, in Saudi Arabia these are compounded by cultural dress norms, gender-specific restrictions, and a lack of female-only facilities, which are less prominent in Western countries. Moreover, social norms rooted in conservative cultural values, including expectations about women's mobility and dress, added a culturally specific dimension to the experience of barriers. While Western studies have also identified the influence of social support, the centrality of the extended family and collectivist expectations in the Saudi context shaped the nature of support differently — in some cases being overprotective rather than enabling. Additionally, support groups common in Western COPD care models (e.g. British Lung Foundation, Better Breathers Clubs) were notably absent in Saudi Arabia, which limits peer-based facilitators that are otherwise well-documented in Western settings. Thus, while many barriers and facilitators reflect universal themes seen in COPD literature globally, their expression and intensity are shaped by local socio-cultural and environmental contexts, underlining the need for culturally tailored interventions in the Saudi setting.

3. Perspectives of Health Professionals in Promoting PA Among Those with COPD in Saudi Arabia

This section is divided into two parts which help to understand the barriers to PA and the strategies to promote PA for people with COPD. The first part discusses the barriers that healthcare providers face when treating people with COPD and how these barriers affect patients' PA. The second part offers recommendations for healthcare providers to improve the quality of PA management for people with COPD, using the SCT as a framework lens.

HCPs' Barriers to PA

HCPs face significant challenges affecting their ability to provide optimal care for their patients. These limitations have a direct impact on people with COPD, thereby impeding their ability to improve their PA. This section explores the barriers to and facilitators of PA that HCPs face when managing their patients. The interviews conducted as part of this study identified a reported lack of awareness among HCPs, particularly doctors (as other HCPs mentioned), regarding the crucial role of PA in the rehabilitation of people with COPD. A key contributing factor appears to be inadequate education and training regarding the role of rehabilitation in managing chronic respiratory conditions, which has led to limited referrals to structured interventions and insufficient encouragement of PA among patients.

Furthermore, HCPs highlighted a lack of interest in PR among their peers. This disinterest is coupled with a notable absence of patient education regarding appropriate levels of activity and the gradual progression of their PA to relieve their symptoms. This dual deficiency in professional and patient knowledge highlights a systemic issue that needs to be addressed in the healthcare community in Saudi Arabia.

The consequences of this inadequate knowledge are far-reaching. It may result in the under provision, referral, and underutilisation of PR. This, in turn, denies people with COPD the opportunity to receive holistic care, encompassing vital elements such as exercise training, education, and support for behavioural change, all of which play a pivotal role in enhancing both physical and psychological well-being (Hill et al. 2013).

PR is internationally recognised as the gold standard for improving PA levels and self-management in individuals with COPD. It offers a structured, evidence-based programme that combines exercise training, education, and psychosocial support to enhance both physical and psychological outcomes (Spruit et al. 2013). However, access to PR remains limited in many parts of Saudi Arabia, leading to missed opportunities to build patients' capacity and confidence in engaging in PA (Johnston et al. 2013). Where PR is not readily available, alternative strategies—such as home-based or community-delivered interventions—should be implemented to support behaviour change. These alternatives have been shown to be effective and align with the principles of SCT, particularly by enhancing self-efficacy, reinforcing outcome expectations, and promoting observational learning (Neves 2016; Bandura 2004).

Failure to inform people with COPD about the benefits of PA and to refer them to appropriate programmes can have detrimental effects on their self-efficacy in managing their condition. Limited awareness about the existence and importance of PR may foster a belief among patients that they have fewer options for managing their condition, potentially diminishing their self-efficacy in engaging in PA and adhering to treatment regimens (Thakrar et al. 2014). Addressing these gaps in knowledge and awareness is critical to ensure comprehensive care for people with COPD.

In the context of COPD management and PA, the findings from the interviews with HCPs provide insight into the variation and differences among HCPs in managing people with COPD, as well as the perceived limited research in the field of PA and COPD, which can affect outcome expectations and, consequently, self-efficacy. The variation among therapists in managing COPD patients can lead to inconsistent information and

recommendations provided to patients regarding PA and self-management (Hillebregt et al. 2017). In addition, the limited research concerning the promotion of PA and COPD in Saudi Arabia may result in a lack of comprehensive information being available to both HCPs and patients about strategies to enhance PA in COPD management (Van Zelst et al. 2020).

Inconsistency in the provision of information concerning the potential outcomes of engaging in PA can affect patients' expectations about managing their condition. This can lead to uncertainty and varying beliefs among patients and HCPs regarding the ability of PA to improve COPD symptoms and overall health. The scarcity of evidence regarding the effectiveness of PA in managing COPD symptoms in Saudi Arabia may contribute to uncertain or suboptimal outcome expectations among both HCPs and patients.

By influencing outcome expectations, these factors can subsequently impact self-efficacy because individuals' beliefs about the anticipated outcomes of their actions are a key determinant of their confidence in engaging in those actions. Therefore, addressing the variation among therapists and the need for further research into PA and COPD in Saudi Arabia is essential to enhance outcome expectations and ultimately improve self-efficacy in COPD management.

The previous literature has reported a lack of awareness regarding the importance of PA, a lack of education, and a lack of specific guidance regarding PA for COPD patients in Saudi Arabia (Aldhahir et al. 2022). This can have an impact on the expectations of the HCPs involved in COPD management, leading to uncertainty about the potential outcomes of recommended actions, including the efficacy of specific treatments and interventions. This lack of clarity may also be one of the reasons for the low adherence to guidelines and inability to educate individuals about the disease or PA (Perez et al. 2011).

Additionally, the HCPs revealed that the main barriers affecting the referral process for patients with COPD included a lack of available PR centres, in addition to a lack of trained HCPs to manage COPD patients and a lack of authority to refer patients.

In SCT, observational learning occurs by observing others and modelling their behaviour. The limited availability of PR centres reduces the opportunities for patients to observe and learn from peers engaging in PR and PA activities (Barradell et al. 2022). Patients may have fewer opportunities to witness the positive outcomes of PA and PR, which are essential to shape their beliefs and attitudes towards these activities.

In summary, there are several challenges associated with promoting PA to manage COPD. These include a lack of awareness and education about the importance and guidelines of PA, differences among HCPs, insufficient research, and the limited availability of PR. Addressing these issues is crucial to provide comprehensive care to patients with COPD. Improved observational learning can positively impact outcome expectations and enhance self-efficacy in COPD patients.

HCPs' Recommendations to Facilitate Increased PA

Although the themes identified by the HCPs did not directly align with the core constructs of SCT, their insight offered valuable contextual understanding which complements and reinforces SCT-informed strategies. The HCPs in the current study provided several practical recommendations that, while rooted in professional experience and health system awareness, support improvements in self-efficacy, outcome expectations, and observational learning for people with COPD.

A key recommendation was the development of clear, context-specific guidance for PA tailored to the Saudi healthcare system. Such guidance would support both HCPs and patients in making informed decisions regarding PA and COPD management, thereby aligning with the SCT concept of outcome expectations (Barradell et al. 2022).

Moreover, HCPs have emphasised the need for well-structured PR programmes with dedicated physiotherapists. This recommendation aligns with the SCT concept of observational learning because it provides patients with opportunities to observe and model behaviour, fostering positive expectations and self-efficacy regarding PA and PR (Barradell et al. 2022). In addition, the establishment of additional PR places has been recommended to improve access to essential rehabilitation services. This expansion could address the lack of available PR centres, thereby enhancing patients' opportunities for observational learning and improving their outcome expectations related to PA and COPD management (Watson et al. 2020).

Furthermore, HCPs have stressed the importance of training, education, and knowledge in PR for HCPs. This recommendation aims to enhance HCPs' understanding of PR and its benefits, addressing barriers related to limited knowledge and awareness. By improving HCPs' knowledge, this strategy could positively impact patients' outcome expectations and self-efficacy regarding PA and PR (Aldhahir et al. 2022).

Finally, based on the interviews, the HCPs recommend that the creation of social support groups for COPD patients could provide a supportive environment for patients to engage in PA. This recommendation aligns with the socio-structural domain of SCT because it addresses the social and environmental factors that influence behaviour, such as social support and community engagement (Watson et al. 2020).

In summary, while the themes arising from the HCP interviews do not fit neatly within the SCT framework, they offer critical insights into system-level and contextual factors that influence the successful implementation of PA interventions. Incorporating these perspectives into clinical and public health strategies may enhance SCT-based interventions by addressing structural and organisational barriers, thereby promoting greater PA engagement among those with COPD in Saudi Arabia.

8.1.2. What Does the Story Tell?

The integration of the findings from both phases (quantitative and qualitative) provides insight into the complex relationship between PA levels, COPD status, and the underlying determinants influencing engagement in Saudi Arabia. Despite the lack of statistically significant differences in PA levels between people with and without COPD in the quantitative phase, the qualitative phase elucidated common barriers experienced by both groups. Specifically, barriers related to self-efficacy, environmental factors, and socio-cultural norms were identified as being prevalent across the board. These findings suggest that addressing these diverse barriers could benefit not only those with COPD but also the wider population, aligning with the study's goal of identifying approaches to improve PA levels.

Furthermore, the lower HRQoL reported by people with COPD in the quantitative phase is further illuminated by the qualitative findings which revealed key COPD-specific challenges. These include the need for structured support groups and greater public and professional awareness about the disease and its impact on PA participation. These insights underscore the importance of developing tailored interventions that go beyond clinical management. While access to PR remains a priority, alternative and complementary strategies are also crucial, particularly in the Saudi context where PR services may be limited. Such strategies may include community-based walking groups (Oliveira et al. 2018), culturally adapted home-based exercise programmes (Leung et al. 2022), digital platforms for remote coaching (García-Aymerich et al. 2018; Tabak et al. 2022), and the integration of PA counselling into routine primary care (Mantoani et al. 2016). These options align with SCT (Bandura 2004) by reinforcing self-efficacy, promoting observational learning, and shaping positive outcome expectations. They represent a novel contribution of this study by offering contextually relevant, evidence-based strategies for promoting PA and improving the HRQoL of people with COPD in Saudi Arabia.

Moreover, the negative correlation between dyspnoea measurements and PA levels among people with COPD, as observed in the quantitative phase, aligns with the participants' accounts of breathlessness and respiratory difficulties during PA in the qualitative phase interviews. This link between dyspnoea and PA barriers further emphasises the impact of COPD-related factors on engagement in PA. Interventions aimed at mitigating dyspnoea symptoms and addressing COPD-specific challenges may help alleviate barriers to PA participation among people with COPD, thereby promoting improved health outcomes and HRQoL.

Integrating HCPs' perspectives into the study is essential to better understand the challenges faced by people with COPD and HCPs. This broader framework can help to identify opportunities for improvement in PA management within this population. The interviews with HCPs highlight the systemic barriers that hinder the promotion of PA for people with COPD. One significant barrier identified was the lack of awareness and education among HCPs regarding the importance of PA in COPD rehabilitation. This deficiency in knowledge translates into limited referrals for PA programmes and a lack of encouragement for patients to engage in PA, thereby hindering their ability to improve their PA levels and overall well-being.

Moreover, HCPs' (particularly physicians') disinterest in PR further exacerbates the issue, leading to a lack of patient education regarding appropriate PA levels and progression. This highlights the need for comprehensive education and training programmes for healthcare providers to ensure that they are equipped with the knowledge and skills necessary to effectively promote PA among those with COPD.

Additionally, the limited availability of PR centres and trained HCPs further restricts access to essential resources for COPD management. This scarcity not only limits patients' ability to engage in observational learning but also undermines their confidence in the effectiveness of PA for managing their condition.

Incorporating the SCT lens provides understanding about how these barriers influence individuals' outcome expectations and self-efficacy in managing COPD. The lack of awareness, education, and resources contributes to uncertainty among both patients and healthcare providers regarding the potential outcomes of PA, thereby undermining their confidence in engaging in PA-related activities.

In conclusion, the integration of findings from the quantitative and qualitative phases offers comprehensive insight into the factors influencing PA levels among individuals with and without COPD in Saudi Arabia. By identifying these common barriers and addressing COPD-specific challenges, as well as acknowledging the impact of respiratory symptoms on PA engagement, interventions can be tailored to effectively promote PA and enhance overall well-being across both populations. To effectively address these challenges, a multifaceted approach is necessary. This includes the perspectives of HCPs which include providing education and training for healthcare providers, improving access to PR services, and creating a supportive environment that encourages people with COPD to engage in PA. By enhancing observational learning opportunities and promoting positive outcome expectations, people with COPD can be empowered to take an active role in managing their condition and improve their HRQoL through PA, directly supporting the aim of this study.

8.1.3.Strengths and Limitations

To the author's knowledge, this is the first study to explore the views of people with and without COPD as well as HCPs regarding current PA and the barriers and facilitators that exist in Saudi Arabia. The study is strengthened by the integration of both quantitative and qualitative data. By using qualitative interviews, the study was able to delve deeper into the barriers and facilitators experienced by people with and without COPD. Additionally, by engaging a diverse group of participants from different roles and geographical areas, the study was able to gain a comprehensive understanding of the field. The perspectives of HCPs also added insight into the landscape of practice in Saudi Arabia.

Consequently, the interviews brought to light barriers and facilitators that had not previously been addressed in studies relying solely on survey data. Additionally, the qualitative analysis revealed an intertwining of environmental and cultural influences, a nuanced aspect unlikely to surface from surveys using closed-ended questions.

Acknowledging the researcher's identity as a Saudi woman, it is possible that her cultural background may have led to the unintentional overlooking of certain elements that were not personally apparent. Also, it is important to recognise the possibility of unintentionally steering discussions in a specific direction during interviews and group meetings, potentially neglecting certain socio-cultural aspects. This acknowledgement raises concerns that the researcher's subjective perspective could influence both the research design and findings, constituting a potential limitation. However, the researcher's Saudi background helped her to better connect with the participants in the qualitative research. By using her background to connect with the participants, a better understanding of the research topic was achieved (DiCicco-Bloom and Crabtree 2006; Hawamdeh and Raigangar 2014).

To mitigate potential biases, various strategies were implemented, including utilising interview guides for both the participants and key informants, engaging in continual reflexivity throughout the research process (Ritchie 2001), and maintaining open communication with supervisors. These measures were intended to minimise the researcher's influence on the data collection and analysis processes. The study's robustness was further reinforced by its diverse participant pool, including individuals with and without COPD and HCPs. Additionally, the incorporation of validated questionnaires (IPAQ-SF, EQ-5D-5L, D-12), a substantial survey sample size in the first phase (n=101), and an extended second phase (six months) contributed to a more comprehensive and profound understanding of the research context.

Nevertheless, it is crucial to acknowledge certain constraints. The study's limited sample size hinders the global representativeness of the findings, diminishing their generalisability. Meanwhile, the use of convenience sampling in the quantitative phase

may be scrutinised because the participants were self-selected, potentially yielding different responses from individuals in other hospitals or those not affiliated with the retirement community. However, this limitation could be deemed acceptable. While acknowledging potential biases, this approach allowed for a focused exploration of relevant phenomena and facilitated data collection within a purposive and accessible participant pool.

Moreover, the quantitative phase relied on self-reported recall questionnaires to assess PA, which introduces the potential for recall bias or social desirability bias, potentially leading to an overestimation of actual activity levels (Corder and Van Sluijs 2010). In addition, differences in age and sex distributions between groups may have influenced the observed variations in PA levels and other health-related outcomes. Originally, the use of objective measures such as accelerometers was planned to improve the accuracy of PA assessment. However, the onset of the COVID-19 pandemic and associated restrictions concerning in-person contact and equipment sharing necessitated a shift to self-reported measures. This adaptation, while pragmatic, may have limited the precision of activity measurement.

During the qualitative phase, the study faced constraints in terms of participant availability, attributed to the critical timing of the COVID-19 pandemic which necessitated the use of online interviews. From the initial 101 participants in Phase 1, of those who volunteered to be interviewed, only eight had COPD and five did not, with an additional six HCPs being recruited separately from the Quantitative Phase. Consequently, only 19 participants were available for the Qualitative Phase interviews. While qualitative sampling typically recommends a minimum of 14 participants, especially in a heterogeneous group (Holloway and Galvin 2016), the limited number in the current study warrants cautious interpretation of the findings.

It is important to emphasise that the study's findings cannot be applied to the entire COPD population in Saudi Arabia given the restricted sample size involving only two hospitals in Riyadh. However, it is pertinent to note that the study's objective was not to

generate universally applicable results but rather to obtain a more in-depth understanding of the perceptions and experiences of PA among people with COPD, involving both those without COPD and HCPs.

8.1.4. Future Implications and Recommendations

The future implications that emerge from the findings of this thesis align closely with the objectives outlined in Vision 2030, a comprehensive roadmap for the country's development and transformation across various sectors, including healthcare and QoL initiatives (Kingdom of Saudi Arabia 2030 Vision 2016). By emphasising the importance of PA for all populations, including those with COPD, the current research contributes to Vision 2030's goal of promoting a healthier and more active society. Increased awareness of PA's benefits aligns with the Vision's objectives to enhance public health and well-being, ultimately leading to a healthier and more productive population.

Clinical and Practice-Based Recommendations

Culturally tailored PA counselling (SCT-based): Culturally tailored PA coaching programmes based on SCT should be implemented to enhance patients' self-efficacy and engagement in exercise. Interventions based on SCT principles have been shown to significantly improve COPD patients' daily activity levels and self-efficacy (Aliakbari et al. 2020). Tailoring advice to fit cultural norms and patient beliefs (e.g., respecting gender roles or using familiar activities) can further improve acceptance and behavioural outcomes in the Saudi population.

Routine PA assessment and promotion in primary care: PA assessment and encouragement should become a standard element of COPD management in primary care. Primary care physicians play a crucial role in monitoring activity and motivating patients to stay active (Román-Rodríguez and Kocks 2021). Early in the disease course, counselling patients about exercise and addressing exercise-related breathlessness can prevent the downward spiral of deconditioning. This holistic approach combining

optimal medical therapy with PA guidance and PR leads to better short- and long-term outcomes (Román-Rodríguez and Kocks 2021).

Structured, multidisciplinary PR: Structured PR services staffed by multidisciplinary teams (physiotherapists, respiratory therapists, nutritionists, psychologists, etc.) should be established. Effective PR programmes should include supervised exercise training, patient education, self-management coaching, nutritional support, and psychosocial care (Aldhahir et al. 2021). Numerous trials and meta-analyses confirm that PR in COPD improves exercise tolerance, reduces dyspnoea and exacerbations, and enhances HRQoL (Aldhahir et al. 2021). Delivering these benefits consistently requires well-trained teams and standardised protocols across facilities.

Expand PR access beyond tertiary centres: The HCPs in this study emphasised the limited availability and structure of PR programmes in Saudi Arabia, particularly outside of major hospitals. This aligns with existing calls in the literature to expand PR access and integrate it into community settings. The availability of PR should be increased by extending services to regional and community healthcare centres (not only major hospitals). Currently, the lack of PR centres presents a major barrier in Saudi Arabia (Aldhahir et al. 2022).

Experts have called for wider implementation of PR services nationally, noting that limited capacity means that many eligible COPD patients are unable to benefit (Aldhahir et al. 2021). Expanding PR infrastructure with adequate staffing and resources at the community level will improve access for patients in diverse regions.

Leverage social support (group or peer-based programmes): Social support interventions such as group-based PR classes, peer support groups, or family-inclusive programmes should be used to reinforce positive behavioural change. Social support is a key facilitator for sustaining PA after rehabilitation (Robinson et al. 2018). COPD patients who receive encouragement from peers and healthcare providers report feeling more motivated and “cared for,” which aligns with the SCT principles and helps to

sustain long-term exercise habits (Robinson et al. 2018). Group exercise and peer-led initiatives can thus boost confidence, reduce isolation, and improve adherence to PA regimens.

Policy and System-Level Implications

Embed PA promotion in chronic care pathways: PA promotion should be integrated into chronic disease management guidelines and care pathways. For COPD, this entails making exercise counselling and referral to programmes (e.g., PR or community exercise classes) a routine part of management, alongside pharmacotherapy. Global guidelines already recommend regular PA for all COPD patients due to its significant benefits for their symptoms and prognosis (Robinson et al. 2018). Health authorities (e.g., the Ministry of Health) should ensure that national COPD management protocols require patients' PA levels to be documented and include interventions to increase activity, in accordance with the WHO's call to incorporate PA into non-communicable disease care plans (WHO 2020).

National PA campaigns and toolkits for COPD: Thematic analysis in the current study revealed widespread misconceptions among patients, particularly regarding the safety of exercise for those experiencing breathlessness. This highlights the importance of culturally tailored education campaigns and provider training to address misinformation. Nationwide campaigns and educational toolkits should be developed to raise awareness about the importance of PA for COPD prevention and control. Public health campaigns can help shift social norms around exercise and aging. For example, the WHO's *Global Action Plan on Physical Activity 2018–2030* highlights the need for clear, consistent messaging regarding the benefits of being active, as well as culturally appropriate community events to make PA more “normal” in everyday life. A coordinated campaign in Saudi Arabia could help to dispel myths (e.g., that patients with lung disease should avoid exercise) and provide practical guidance, with printed and digital toolkits for healthcare providers to counsel patients regarding safe PA.

Research Implications

Objective measurement of PA: Future research concerning COPD should utilise objective PA measurement tools (accelerometers, pedometers, wearable activity trackers) to gather accurate data regarding patient activity levels. Many studies still rely on self-reported questionnaires, despite evidence that objective monitoring provides more reliable and comparable data (Xiang et al. 2022). A recent scoping review noted heterogeneity in how PA is measured in COPD research and emphasised the need to identify the best instruments for clinical practice (Xiang et al. 2022). Incorporating objective PA metrics will improve the quality of research findings and help to track the impact of interventions.

Effectiveness and scalability of home-based or community PR: There is a need for studies evaluating home-based and community-based PR models, especially in regions where access to hospital-based programmes is limited. Existing evidence suggests that home-based PR can be as effective as centre-based programmes in terms of improving functional exercise capacity and QoL (Uzzaman et al. 2022). This indicates that decentralised models (including tele-rehabilitation or community exercise groups) could feasibly expand PR reach. Research should explore long-term outcomes of home/community PR, strategies to remotely maintain patient engagement, and cost-effectiveness to guide the large-scale adoption of these models in Saudi Arabia and similar healthcare settings.

SCT-based and socio-ecological interventions: Further research is warranted on interventions grounded in SCT and socio-ecological models tailored for COPD populations. Behavioural change strategies such as goal setting, motivational interviewing, and self-efficacy enhancement have shown promise in terms of increasing PA among COPD patients (Xiang et al. 2022). For instance, an empowerment programme based on SCT in a Middle Eastern context significantly boosted patients' daily activity and confidence (Aliakbari et al. 2020). Building on such findings, researchers should design and test culturally appropriate, theory-driven interventions

that involve not only the individual patient but also family, community, and healthcare-system factors (a socio-ecological approach). This will help to determine the best ways to achieve sustained lifestyle change in COPD across different environments.

Public Health and Education

Public campaigns to normalise PA in older adults with chronic disease: Public health campaigns that portray PA as a normal and safe part of life for older adults and those with chronic diseases should be launched. These campaigns should emphasise that even with COPD or other chronic conditions, regular movement is beneficial and usually safe when done appropriately. WHO guidelines underscore that PA is considered safe for people living with chronic conditions and that the benefits generally outweigh the risks (WHO 2020). By showcasing stories of seniors and COPD patients engaging in exercise, such campaigns can combat ageist and illness-related stereotypes, thereby making it more acceptable and expected for these groups to be active. Over time, this will help to create a culture in which staying active into older age or with a chronic illness becomes the norm.

Culturally adapted education to address misconceptions: Education that is tailored to the cultural context should be provided to correct common misconceptions about exercise and teach safe PA practices. In many Middle Eastern communities, barriers to exercise include gender norms, the climate, and beliefs about health; for example, some women may face restrictions on exercising in public and extreme heat can discourage outdoor activities (Chaabane et al. 2021). Educational materials and counselling should acknowledge these factors and offer solutions (e.g., home-based exercises during hot weather, women-only fitness classes) that respect local norms. Importantly, educators should directly address fears that exercise could adversely affect an individual's breathing by explaining the health benefits and safety precautions, reinforced by global recommendations that even patients with chronic lung disease can exercise safely with proper guidance (WHO 2020). Culturally sensitive, language-appropriate programmes will likely be more effective in changing attitudes and empowering patients to be active.

Patient and provider education concerning PR: Efforts should be made to increase awareness among both patients and healthcare providers about the benefits of PR and the available services. A lack of knowledge about PR is frequently reported, so there is a possibility that patients and families may not understand what PR is or how it can help them (Sami et al. 2021). In addition, some providers fail to refer eligible patients due to limited familiarity or authority (Aldhahir et al. 2022). Educational initiatives should target healthcare providers through continued medical education and the inclusion of PR in COPD guidelines to ensure they have sufficient knowledge about PR and its benefits and can effectively educate and motivate patients (Aldhahir et al. 2021). Simultaneously, patient-facing education (brochures, workshops, media) should be used to demystify PR, highlighting that it includes tailored exercises, breathing techniques, and support that can significantly improve their daily function. By reducing stigma (e.g., the notion that rehab is only for very severe cases) and increasing understanding, such education can boost referral rates and patient enrolment on PR programmes, ultimately improving health outcomes for COPD sufferers.

9. Final Conclusion

Conclusion

The current research undertook a comprehensive exploration of PA in Saudi Arabia, focusing on differences in PA levels between people with and without COPD, as well as the barriers and facilitators affecting PA engagement in both groups. Additionally, it examined the role of HCPs in promoting PA for people with COPD.

This study adopted a novel approach by using a mixed-methods design (combining quantitative surveys and qualitative interviews) to explore PA engagement among people with COPD in Saudi Arabia. To the best of the author's knowledge, it is the first study to integrate a mixed methods approach to investigate PA behaviours, barriers, facilitators, and HCP perspectives within this population and context.

The quantitative phase answered the first objective, revealing that there was no statistically significant difference in self-reported PA levels between people with and without COPD. This finding diverged from expectations and existing literature, indicating the need to examine whether other contextual or environmental factors contribute to the inactivity levels of people with COPD in Saudi Arabia.

The second objective was addressed through qualitative interviews, which provided in-depth insights into the barriers and facilitators influencing PA engagement. The study identified several common barriers across both groups, including time constraints, environmental challenges (e.g., climate, lack of facilities), and cultural norms. However, participants with COPD uniquely reported disease-specific barriers, such as breathlessness-induced embarrassment, psychological distress, and fear of exacerbation. Facilitators such as self-efficacy, goal-setting, observational learning, and social support were evident across both groups, but their impact was often mitigated by systemic and cultural barriers.

The third objective—exploring the role of HCPs—was addressed through interviews with healthcare professionals working in COPD care. These interviews revealed systemic challenges within the healthcare infrastructure, including limited PR services, insufficient PA counselling, lack of structured education programmes, and organisational constraints that hinder PA promotion. HCPs acknowledged these gaps and emphasised the need for greater collaboration between healthcare services and community initiatives to foster a PA-supportive environment.

Importantly, the integration of theoretical frameworks, particularly the SCT, served as a guiding framework, the research provided a structured lens to interpret the interplay between individual beliefs (self-efficacy, outcome expectations), social influences (social support, observational learning), and environmental factors in shaping PA behaviours.

The identification of shared barriers across both COPD and non-COPD groups suggests that while some challenges are disease-specific, many are systemic and cultural, necessitating broader public health interventions that extend beyond clinical settings. Conversely, the disease-specific barriers underscore the need for COPD-targeted strategies, such as PR access, tailored education, and psychological support.

The inclusion of healthcare professionals' perspectives was essential in understanding the healthcare system's limitations in PA promotion and identifying avenues for systemic improvement. These insights highlight the need for collaborative efforts between healthcare providers, policymakers, and community stakeholders to create an enabling environment for PA promotion and COPD management.

Moreover, the inclusion of insights from HCPs offered invaluable perspectives on systemic barriers within the healthcare system itself, including limited awareness, lack of guidance, inadequate education, and logistical challenges in accessing PR services. These findings underscore the importance of collaborative efforts between healthcare

providers, policymakers, and community stakeholders in fostering an enabling environment for PA promotion and COPD management.

In light of these findings, several implications emerge for clinical practice, policy development, and future research endeavours. First and foremost, there is a pressing need for enhanced education and awareness initiatives targeting both people with COPD and healthcare providers, with a particular focus on the benefits of PA and the availability of rehabilitative services. Additionally, efforts to address environmental barriers, such as infrastructure improvements and community-based PA initiatives, hold promise for fostering a supportive ecosystem for PA engagement among COPD patients.

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11. Appendices

11.1.1. CASP Qualitative studies Summary Table

Author, date	Q1. Clear aims?	Q2. Qualitative methodology appropriate?	Q3. Research design appropriate?	Q4. Recruitment strategy appropriate	Q5. Data collection addressed issue?	Q6. Researcher-participant relationship considered?	Q7. Ethical issues considered?	Q8. Data analysis rigorous?	Q9. Clear findings?	Q10. Value of the research?
Sami et al. 2021	Yes	Yes	Yes	Yes	Yes	The study did not detail reflexivity or how the researchers may have influenced the data collection process. However, interviews were guided by an interview guide approved by qualitative research experts	Yes	Yes	Yes	The research contributes significantly to understanding the multi-dimensional barriers to PR for COPD patients. It offers insights that can inform health policy and improve PR services, especially in low-resource settings like Iran
Hartman et al. (2013)	Yes	Yes	Yes	Yes	Yes	While the study describes the data collection process, it does not provide detailed reflexivity on the role of the researcher in	Yes	Yes	Yes	The research identifies modifiable factors such as self-efficacy and insight into health benefits, providing actionable strategies to enhance physical activity among COPD patients

						shaping the interviews				
Thorpe et al. (2014)	Yes	Yes	Yes	Yes	Yes	The study mentions that interviews were conducted by a single investigator, but it does not provide extensive detail about reflexivity or how the researcher's influence may have been managed	Yes	Yes	Yes	The research highlights crucial barriers and enablers to physical activity in COPD patients, which can inform targeted interventions in pulmonary rehabilitation and post-hospital care
Kosteli et al. (2017)	Yes	Yes	Yes	Yes	Yes	While the study discusses the focus group setup and researcher roles, it does not go into detail about reflexivity or how researchers' presence may have influenced participants	Yes	Yes	Yes	The study contributes to understanding the internal and external factors influencing PA in COPD patients in primary care, offering insights for targeted interventions based on individual needs

Almaqhawi (2022)	Yes	Yes	Yes	Yes	Yes	Partially	Yes	Yes	Yes	The research highlights the unique challenges faced by Saudi Arabian women living abroad and offers insights that can inform targeted interventions to increase physical activity in this population
Almaqhawi (2022)	Yes	Yes	Yes	Yes	Yes	Partially While the study acknowledges the researcher's background, it provides limited discussion on how this relationship may have influenced data collection and interpretation	Yes	Yes	Yes	The research provides insights into cultural and environmental factors affecting physical activity among Saudi Arabian females in the UK, which can inform targeted interventions
Perera et al. 2022	Yes	Yes	Yes	Yes	Yes	Partially While the study acknowledges the researcher's background, it provides limited discussion on how this relationship may have	Yes	Yes	Yes	The research provides insights into cultural and environmental factors affecting physical activity among adults in urban Sri Lankan settings, which can inform targeted interventions

						influenced data collection and interpretation.				

11.1.2. CASP Systematic Reviews Summary Table

Author, date	Q1. Clear focus?	Q2. Right type of papers?	Q3. All relevant studies included?	Q4. Quality of included studies assessed?	Q5. Reasonable to combine results?	Q6. Overall results presented?	Q7. Precision of results?	Q8. Applicability to local population?	Q9. All important outcomes considered?	Q10. Policy/practice implications?
Robinson et al. (2018)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Tian · 2022	Yes	Yes	Yes	Yes	Yes	Yes	Moderate precision	Yes	Yes	Yes
Xiang · 2022	Yes	Yes	Yes	Partially	Yes	Yes	Moderate precision	Yes	Yes	Yes
Al-Hazaa (2018)	Yes	Yes	Yes	Partially	Yes	Yes	Moderate precision	Yes	Yes	Yes
Christofolletti et al. 2022	Yes	Yes	Yes	Partially	Yes	Yes	Partially	Yes	Yes	Yes
Mbabazi et al. 2023	Yes	Yes	Partially	Partially	Yes	Yes	Partially	Yes	Yes	Yes
Peng et al. 2023	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

11.1.3. CASP Checklist Table for Cohort Studies

Study	Q1. Clear focus?	Q2. Cohort recruited acceptably?	Q3. Exposure measured accurately?	Q4. Outcome measured accurately?	Q5. Confounding factors considered?	Q6. Follow- up complete and long enough?	Q7. Results presented clearly?	Q8. Precision of results?	Q9. Believable conclusions?	Q10. Applicability to local context?
Yang et al. (2024)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Koreny et al. (2021)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Demeyer et al. (2019)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Waschki et al. (2015)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Aiello et al. (2024)	Yes	Yes	Partially	Yes	Yes	N/A	Yes	Yes	Yes	Yes

11.1.4. CASP cross-sectional studies Reviews Summary Table

Author, date	Q1. Clear focus?	Q2. Study design appropri ate?	Q3. Sample size justified?	Q4. Sampling method appropriate ?	Q5. Accepta ble recruitm ent?	Q6. Data collectio n appropri ate?	Q7. Variable relationshi ps considered ?	Q8. Confounder s considered?	Q9. Results clear?	Q10. Local applicab ility?
Al-nozha et al. (2007)	Yes	Yes	Partially	Yes	Yes	Yes	Yes	Partially	Yes	Yes
Al-Eisa and Al-Sobayel (2012)	Yes	Yes	Partially	Yes	Yes	Yes	Yes	Partially	Yes	Yes
Al-Zalabani et al. (2015)	Yes	Yes	Partially	Yes	Yes	Yes	Yes	Partially	Yes	Yes
El Bcheraoui et al. (2016)	Yes	Yes	Partially	Yes	Yes	Yes	Yes	Partially	Yes	Yes

Althumiri et al. (2020)	Yes	Yes	Partially	Yes	Yes	Yes	Yes	Partially	Yes	Yes
Alqahtani et al. (2021)	Yes	Yes	Partially	Yes	Yes	Yes	Yes	Partially	Yes	Yes
Alyami et al. (2018)	Yes	Yes	Partially	Yes	Yes	Yes	Yes	Partially	Yes	Yes
Pitta et al. (2005)	Yes	Yes	Partially	Yes	Yes	Yes	Yes	Partially	Yes	Yes
Watz et al. (2009)	Yes	Yes	Partially	Yes	Yes	Yes	Yes	Partially	Yes	Yes

Donaire-Gonzalez et al. (2013)	Yes	Yes	Partially	Yes	Yes	Yes	Yes	Partially	Yes	Yes
Patel et al. 2024	Yes	Yes	Partially	Yes	Yes	Yes	Yes	Partially	Yes	Yes
Alotaibi (2013)	Yes	Yes	Partially	Yes	Yes	Yes	Yes	Partially	Yes	Yes
Alrimali (2023)	Yes	Yes	Partially	Yes	Yes	Yes	Yes	Partially	Yes	Yes
Alahmed Id and Lobelo (2019)	Yes	Yes	Partially	Yes	Yes	Yes	Yes	Partially	Yes	Yes

Alsubaiei et al. (2016)	Yes	Yes	Partially	Yes	Yes	Yes	Yes	Partially	Yes	Yes
Al-Ghamdi et al. (2018)	Yes	Yes	Partially	Yes	Yes	Yes	Yes	Partially	Yes	Yes
Aldhahir et al. (2022)	Yes	Yes	Partially	Yes	Yes	Yes	Yes	Partially	Yes	Yes
Sritharan et al. (2021)	Yes	Yes	Partially	Yes	Yes	Yes	Yes	Partially	Yes	Yes
Xia · 2023	Yes	Yes	Partially	Yes	Yes	Yes	Yes	Partially	Yes	Yes

11.1.1. Checklist for Reporting Of Survey Studies (CROSS)

Section/topic	Item	Item description	Reported on page #
Title and abstract			
Title and abstract	1a	State the word “survey” along with a commonly used term in title or abstract to introduce the study’s design.	XIV-XVI
	1b	Provide an informative summary in the abstract, covering background, objectives, methods, findings/results, interpretation/discussion, and conclusions.	I-II
Introduction			
Background	2	Provide a background about the rationale of study, what has been previously done, and why this survey is needed.	19-152
Purpose/aim	3	Identify specific purposes, aims, goals, or objectives of the study.	151-152
Methods			
Study design	4	Specify the study design in the methods section with a commonly used term (e.g., cross-sectional or longitudinal).	157,185
	5a	Describe the questionnaire (e.g., number of sections, number of questions, number and names of instruments used).	192
Data collection methods	5b	Describe all questionnaire instruments that were used in the survey to measure particular concepts. Report target population, reported validity and reliability information, scoring/classification procedure, and reference links (if any).	192-200
	5c	Provide information on pretesting of the questionnaire, if performed (in the article or in an online supplement). Report the method of pretesting, number of times questionnaire was pre-tested, number and demographics of participants used for pretesting, and the level of similarity of demographics between pre-testing participants and sample population.	191-192
Sample characteristics	5d	Questionnaire if possible, should be fully provided (in the article, or as appendices or as an online supplement).	437-463
	6a	Describe the study population (i.e., background, locations, eligibility criteria for participant inclusion in survey, exclusion criteria).	189-191
	6b	Describe the sampling techniques used (e.g., single stage or multistage sampling, simple random sampling, stratified sampling, cluster sampling, convenience sampling). Specify the locations of sample participants whenever clustered sampling was applied.	189
	6c	Provide information on sample size, along with details of sample size calculation.	187

Survey administration	6d	Describe how representative the sample is of the study population (or targetNA population if possible), particularly for population-based surveys. Provide information on modes of questionnaire administration, including the type190-191	
	7a	and number of contacts, the location where the survey was conducted (e.g., outpatient room or by use of online tools, such as SurveyMonkey).	
	7b	Provide information of survey's time frame, such as periods of recruitment,200 exposure, and follow-up days. Provide information on the entry process: 210 →For non-web-based surveys, provide approaches to minimize human error in data entry. →For web-based surveys, provide approaches to prevent "multiple participation" of participants.	
Study preparation	8	Describe any preparation process before conducting the survey (e.g.,200 interviewers' training process, advertising the survey). Provide information on ethical approval for the survey if obtained, including171	
Ethical considerations	9a	informed consent, institutional review board [IRB] approval, Helsinki declaration, and good clinical practice [GCP] declaration (as appropriate).	
	9b	Provide information about survey anonymity and confidentiality and describe172 what mechanisms were used to protect unauthorized access.	
Statistical analysis	10a	Describe statistical methods and analytical approach. Report the statistical 200 software that was used for data analysis.	
	10b	Report any modification of variables used in the analysis, along with reference (if 208-210 available).	
	10c	Report details about how missing data was handled. Include rate of missing201 items, missing data mechanism (i.e., missing completely at random [MCAR], missing at random [MAR] or missing not at random [MNAR]) and methods used to deal with missing data (e.g., multiple imputation).	
	10d	State how non-response error was addressed.	201
	10e	For longitudinal surveys, state how loss to follow-up was addressed.	(Not applicable)
	10f	Indicate whether any methods such as weighting of items or propensity scores have been used to adjust for non-representativeness of the sample.	(Not addressed)
	10g	Describe any sensitivity analysis conducted.	(Not addressed)

d)

Results

Respondent characteristics	11a	Report numbers of individuals at each stage of the study. Consider using a flow diagram, if possible.	204
	11b	Provide reasons for non-participation at each stage, if possible.	204
	11c	Report response rate, present the definition of response rate or the formula used to calculate response rate.	212
	11d	Provide information to define how unique visitors are determined. Report number of unique visitors along with relevant proportions (e.g., view proportion, participation proportion, completion proportion).	209
Descriptive results	12	Provide characteristics of study participants, as well as information on potential confounders and assessed outcomes.	206-215
	13a	Give unadjusted estimates and, if applicable, confounder-adjusted estimates along with 95% confidence intervals and p-values.	204-215
Main findings	13b	For multivariable analysis, provide information on the model building process, model fit statistics, and model assumptions (as appropriate).	216-218
	13c	Provide details about any sensitivity analysis performed. If there are considerable amount of missing data, report sensitivity analyses comparing the results of complete cases with that of the imputed dataset (if possible).	(Not addresse d)

Discussion

Limitations	14	Discuss the limitations of the study, considering sources of potential biases and imprecisions, such as non-representativeness of sample, study design, important uncontrolled confounders.	222
Interpretations	15	Give a cautious overall interpretation of results, based on potential biases and imprecisions and suggest areas for future research.	222
Generalizability	16	Discuss the external validity of the results.	222

Other sections

Role of funding source	17	State whether any funding organization has had any roles in the survey's design, implementation, and analysis.	161-162
Conflict of interest	18	Declare any potential conflict of interest.	161-162
Acknowledgements	19	Provide names of organizations/persons that are acknowledged along with their contribution to the research.	XII

11.1.2. Consolidated criteria for reporting qualitative studies (COREQ): 32-item checklist

No.	Item	Description	Section #
Domain 1: Research team and reflexivity			
Personal characteristics			
1.	Interviewer/facilitator	Which author/s conducted the interview or focus group?	235
2.	Credentials	What were the researcher's credentials? E.g. PhD, MD	225
3.	Occupation	What was their occupation at the time of the study?	155
4.	Gender	Was the researcher male or female?	155
5.	Experience and training	What experience or training did the researcher have?	155-156
Relationship with participants			
6.	Relationship established	Was a relationship established prior to study commencement?	246
7.	Participant knowledge of the interviewer	What did the participants know about the researcher? E.g. Personal goals, reasons for doing the research	229-230
8.	Interviewer characteristics	What characteristics were reported about the interviewer/facilitator? E.g. Bias, assumptions, reasons and interests in the research topic	187 and 242
Domain 2: Study design			
Theoretical framework			
9.	Methodological orientation and theory	What methodological orientation was stated to underpin the study? E.g. grounded theory, discourse analysis, ethnography, phenomenology, content analysis	225-229
Participant selection			
10.	Sampling	How were participants selected? E.g. purposive, convenience, consecutive, snowball	229-230
11.	Method of approach	How were participants approached? E.g. face-to-face, telephone, mail, email	229-230
12.	Sample size	How many participants were in the study?	229
13.	Non-participation	How many people refused to participate or dropped out? What were the reasons for this?	246
Setting			

14.	Setting of data collection	Where was the data collected? E.g. home, clinic, Workplace	233
15.	Presence of non-participants	Was anyone else present besides the participants and researchers?	179
16.	Description of sample	What are the important characteristics of the sample? E.g. demographic data, date	232-233
Data collection			
17.	Interview guide	Were questions, prompts, guides provided by the authors? Was it pilot tested?	233-234
18.	Repeat interviews	Were repeat interviews carried out? If yes, how many?	246
19.	Audio/visual recording	Did the research use audio or visual recording to collect the data?	234
20.	Field notes	Were field notes made during and/or after the interview or focus group?	179
21.	Duration	What was the duration of the interviews or focus group?	236
22.	Data saturation	Was data saturation discussed?	231-232
23.	Transcripts returned	Were transcripts returned to participants for comment and/or correction?	177
Domain 3: analysis and findings			
Data analysis			
24.	Number of data coders	How many data coders coded the data?	237-238
25.	Description of the coding tree	Did authors provide a description of the coding tree?	238
26.	Derivation of themes	Were themes identified in advance or derived from the data?	238-239
27.	Software	What software, if applicable, was used to manage the data?	239
28.	Participant checking	Did participants provide feedback on the findings?	176
Reporting			
29.	Quotations presented	Were participant quotations presented to illustrate the themes / findings? Was each quotation identified? E.g. Participant number	250
30.	Data and findings consistent	Was there consistency between the data presented and the findings?	248-304
31.	Clarity of major themes	Were major themes clearly presented in the findings?	249
32.	Clarity of minor themes	Is there a description of diverse cases or discussion of minor themes?	244-248

11.1.3. Appendix Ethical Approval from Cardiff



School of
Healthcare Sciences
Ysgol y Gwyddorau
Gofal Iechyd

Interim Head of School and Dean / Pennaeth yr Ysgol Dros Dro a Deon Professor David Whitaker

12 May 2021

Rawan Al Ruwaili
Cardiff University
School of Healthcare Sciences

Dear Rawan

Research project title: An Investigation of Physical Activity in chronic obstructive pulmonary disease (COPD) to promote of Physical Activity (PA) in Saudi

SREC reference: REC788

The School Of Healthcare Sciences Research Ethics Committee reviewed the above application at the meeting held on 11 May 2021.

Ethical Opinion

The Committee gave:

a favourable ethical opinion of the above application on the basis described in the application form, protocol and supporting documentation.

Additional approvals

This letter provides an ethical opinion only. You must not start your research project until all appropriate approvals are in place.

Amendments

Any substantial amendments to documents previously reviewed by the Committee must be submitted to the Committee via HCAREethics@cardiff.ac.uk for consideration and cannot be implemented until the Committee has confirmed it is satisfied with the proposed amendments. You are permitted to implement non-substantial amendments to the documents previously reviewed by the Committee but you must provide a copy of any updated documents to the Committee via HCAREethics@cardiff.ac.uk for its records.

Monitoring requirements

The Committee must be informed of any unexpected ethical issues or unexpected adverse events that arise during the research project.



Registered Charity No. 1136855
Elusen Gofrestredig Rhif. 1136855

11.1.4. Ethical Approval from King Saud University

Kingdom of Saudi Arabia
King Saud University (034)
P.O. Box 7805 Riyadh 11472
Tel: +966 11 467 00 11
Fax: +966 11 467 19 92
<http://medicalcity.ksu.edu.sa>

المملكة العربية السعودية
جامعة الملك سعود (٣٤)
ص.ب. الرياض ٧٨٠٥
هاتف: +٩٦٦ ١١ ٤٦٧ ٠٠ ١١
فاكس: +٩٦٦ ١١ ٤٦٧ ١٩٩٢



المدينة الطبية الجامعية
Institutional Review Board

11.07.2021 (01.12.1442)
Ref. No. 21/0550/IRB

To: Rawan Ahmed Alruwaili
PhD Student
Cardiff University School of Healthcare Sciences
Eastgate House 35-43 Newport Road – Cardiff, UK
Email: A [REDACTED]
Principal Investigator

Cc: Dr. Ali Albarrati, Dr. Nichola Gale, Dr. Una Jones
Co-investigators

Subject: IRB Approval of Research Project No. E-21-6118
Study Title: "An Investigation of Physical Activity in Chronic Obstructive Pulmonary Disease (COPD) To Promote Physical Activity (PA) In Saudi"

Type of Review: Expedite
Date of Approval: 08 July 2021
Date of Expiry: 08 July 2022

Dear Rawan Ahmed Alruwaili,

I am pleased to inform you that your above-mentioned research project submitted to the IRB was reviewed and approved on 08 July 2021 (28 Dhul'qadah 1442). You are now granted permission to conduct this study as approved by the IRB. Please note that this approval is for the research ethics perspective only. You still need to get approval from the department head or unit of KSU/KSUMC to collect data.

As principal investigator, you are required to abide by the rules and regulations of the Kingdom of Saudi Arabia and the research policies and procedures of the KSU IRB. If you make any changes to the protocol during the period of this approval, you must submit a revised protocol for IRB approval prior to implementing the changes. This **approval is only for one (1) year** and shall remain valid until the expiry date noted above assuming timely and acceptable responses from the IRB's periodic requests for surveillance and monitoring information. To renew approval, please submit your request at least 30 days before the expiry date. Failure to receive approval for continuation before the expiration date will result in **automatic suspension of the approval** of this protocol on the expiration date. Personal identifying data should only be collected when necessary for research. Secondary disclosure of personal identifiable data is not allowed. Data should be stored securely so that a few authorized users are permitted access to the database.

We wish you success in your research and request you to keep the IRB informed about the progress of the study on a regular basis by submitting a *Study Progress Report* every 6 months and a *Final Report* when the study has been completed. Please quote the project number and project title above in any further correspondence related to this study.

Thank you!

Sincerely yours,


Prof. Abdulrahman AlSultan
Chairman, IRB for Health Sciences Colleges Research on Human Subjects
King Saud University – College of Medicine
P. O. Box 7805 Riyadh 11472 KSA
Email: aalsultan1@ksu.edu.sa



/rubie

11.1.5. Ethical Approval from King Fahad Medical City



IRB Registration Number with KACST, KSA: H-01-R-012
 IRB Registration Number with OHRP/NIH, USA: IRB00010471
 Approval Number Federal Wide Assurance NIH, USA: FWA00018774

April 13, 2022

IRB Log Number: 21-283E

Department: External - King Saud University - Rehabilitation Health Sciences

Category of Approval: EXPEDITED

Dear Ms. Rawan Alruwaili, Dr. Ali Albarrati, Dr. Nichola Gale and Dr. Una Jones,

I am pleased to inform you that submission dated June 30, 2021 for the study titled '**An Investigation of Physical Activity in chronic obstructive pulmonary disease (COPD) to promote Physical Activity (PA) in Saudi**' was reviewed and was approved according to Good Clinical Practice guidelines.

Please be informed that in conducting this study, you as the Principal Investigator are required to abide by the rules and regulations of the Government of Saudi Arabia, the KFMC/IRB policies and procedures, and the ICH Good Clinical Practice guidelines. Further, you are required to submit a Progress report every 6 months starting from the date of approval. Approvals are for 1 year and are renewable on submission of satisfactory 6-monthly reports. The approval of this proposal will automatically be **suspended on April 13, 2023** pending the acceptance of the end-of-year Progress Report. You also need to notify the IRB as soon as possible in the case of:

9. Any amendments to the project.
10. Termination of the study.
11. Any serious unexpected adverse events (within two working days).
12. Any event or new information that may affect the benefit/risk ratio of the proposal.

Please observe the following:

13. Personal identifying data should only be collected when necessary for research.
14. The data collected should only be used for this proposal.
15. Data should be stored securely so that a few authorized users are permitted access to the database.
16. Secondary disclosure of personal identifiable data is not allowed.
17. Full disclosure to the patient and assurance of confidentiality and voluntary consent should be done. The participant shall write his/name and date and then sign. A copy of the Consent Form should be kept in the Research Subject's Medical Record and the consent process should be documented in the medical record.
18. Copy of the pharmacy clearance (IDS) must be in the medical record.



Saudi Arabia - Riyadh
 King Fahad Medical City
 Faculty of Medicine
 Phone: 0112889999



11.1.6. Ethical Approval from Cardiff After Amendments 2022



School of
Healthcare Sciences
Ysgol y Gwyddorau
Gofal Iechyd

Head of School and Dean / Pennaeth yr Ysgol Dros Dro a Deon Professor David Whitaker

4 August 2022

Rawan Alruwaili
Cardiff University
School of Healthcare Sciences

Dear Rawan

Research project title: An Investigation of Physical Activity in chronic obstructive pulmonary disease (COPD) to promote Physical Activity (PA) in Saudi Arabia

SREC reference: REC788

The School Of Healthcare Sciences Research Ethics Committee reviewed the above application via its proportionate review process.

Ethical Opinion

The Committee gave:

a favourable ethical opinion of the above application on the basis described in the application form, protocol and supporting documentation, **subject to the conditions** specified below.

Conditions of the favourable opinion

The favourable opinion is subject to the following conditions being met prior to the start of the research project.

On the participant information sheet, Director of Research Governance needs to be added after my name in the 'what if there is a problem section'.

I am happy in principle from an ethics perspective. The only query would be the need to conduct 45 interviews (3 groups of 15) which seems like a huge number. It isn't clear what time frame would be required for data processing etc. The time frame for data collection to be completed by is Dec 2022

Whilst the Committee does not propose to conduct a further review of your application/revised research project documents following implementation of the conditions above, you should notify the Committee once all conditions have been met and provide copies of any revised documentation with updated version numbers and highlighted where the changes have been made before the research commences.



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2015



Registered Charity No. 1136855
Elusen Gofrestredig Rhif. 1136855

11.1.7. CONSENT FORM for (phase1)



CONSENT FORM for (phase1)

Participant ID no:
*Do not include box for
anonymised samples*

Title of research project: An Investigation of Physical Activity in COPD to promote of Physical Activity in Saudi Arabia

SREC reference and committee: [REDACTED]

Name of Chief/Principal Investigator: Rawan Alruwaili

**Please
initial box**

I confirm that I have read the information sheet dated [Feb\2021] version [VERSION 2] for the above research project.	
I confirm that I have understood the information sheet dated [Feb\2021] version [VERSION 2] for the above research project and that I have had the opportunity to ask questions and that these have been answered satisfactorily.	
I understand that my participation is voluntary and I am free to withdraw at any time without giving a reason and without any adverse consequences (e.g. to medical care or legal rights, if relevant).	
I understand that data collected during the research project may be looked at by individuals from Cardiff University or from regulatory authorities, where it is relevant to my taking part in the research project. I give permission for these individuals to have access to my data.	
I consent to the processing of my personal information [name, address, email address and date of birth] for the purposes explained to me. I understand that such information will be held in accordance with all applicable data protection legislation and in strict confidence, unless disclosure is required by law or professional obligation.	
I understand who will have access to personal information provided, how the data will be stored and what will happen to the data at the end of the research project.	
I understand that anonymised excerpts and/or verbatim quotes from my [questioner] may be used as part of the research publication.	
I understand how the findings and results of the research project will be written up and published.	
I agree to take part in this research project.	

Name of participant (print)

Date

Signature

[Version 2]

[Feb\2021]

Participant ID no:
*Do not include box for
anonymised samples*

Name of person taking consent
(print)

Date

Signature

Role of person taking consent
(print)

THANK YOU FOR PARTICIPATING IN OUR RESEARCH
YOU WILL BE GIVEN A COPY OF THIS CONSENT FORM TO KEEP

[Version 2]

[Feb\2021]

11.1.8. CONSENT FORM for (phase2)



Appendix 4

Participant ID no:
Do not include box for
anonymised samples

CONSENT FORM for (phase2)

Title of research project: An Investigation of Physical Activity in COPD to promote of Physical Activity in Saudi Arabia.

SREC reference and committee: [REDACTED]

Name of Chief/Principal Investigator: Rawan Alruwaili



**Please
initial box**

I confirm that I have read the information sheet dated [May\2021] version [VERSION 2] for the above research project.	
I confirm that I have understood the information sheet dated [May\2021] version [VERSION 2] for the above research project and that I have had the opportunity to ask questions and that these have been answered satisfactorily.	
I understand that my participation is voluntary and I am free to withdraw at any time without giving a reason and without any adverse consequences (e.g. to medical care or legal rights, if relevant).	
I understand that data collected during the research project may be looked at by individuals from Cardiff University or from regulatory authorities, where it is relevant to my taking part in the research project. I give permission for these individuals to have access to my data.	
I consent to the processing of my personal information [name, address, email address and date of birth] for the purposes explained to me. I understand that such information will be held in accordance with all applicable data protection legislation and in strict confidence, unless disclosure is required by law or professional obligation.	
I understand who will have access to personal information provided, how the data will be stored and what will happen to the data at the end of the research project.	
I consent to being audio recorded/ video recorded taken for the purposes of the research project and I understand how it will be used in the research.	
I understand that anonymised excerpts and/or verbatim quotes from my [INTERVIEW] may be used as part of the research publication.	
I understand how the findings and results of the research project will be written up and published.	
I agree to take part in this research project.	

[Version 2]

[Feb\2021]

[Type here]

Appendix 4

Participant ID no:
*Do not include box for
anonymised samples*

Name of participant (print)

Date

Signature

Name of person taking consent
(print)

Date

Signature

Role of person taking consent
(print)

THANK YOU FOR PARTICIPATING IN OUR RESEARCH
YOU WILL BE GIVEN A COPY OF THIS CONSENT FORM TO KEEP

[Version 2]

[Feb\2021]

11.1.9. PARTICIPANT INFORMATION SHEET (phase 1-COPD)



PARTICIPANT INFORMATION SHEET (phase 1-without COPD)

An Investigation of Physical Activity in chronic obstructive pulmonary disease (COPD) to promote Physical Activity (PA) in Saudi

You are being invited to take part in a research project. Before you decide whether or not to take part, it is important for you to understand why the research is being undertaken and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish.

Thank you for reading this.

What is the purpose of this research project?

The aim of this study is to measure physical activity in COPD and without respiratory conditions to develop a guidance for people with COPD and to promote physical activity in their life.

Why have I been invited to take part?

You have been invited because we want to ask you about your levels of physical activity compared to patients who have COPD.

Do I have to take part?

No, your participation in this research project is entirely voluntary, and it is up to you to decide whether or not to take part. If you decide to participate, we will discuss the research project with you [and ask you to sign a consent form]. If you decide not to take part, you do not have to explain your reasons, and it will not affect your legal rights. I confirm that your decision to take part or not to take part will not affect the care that you receive.

You are free to withdraw your consent to participate in the research project at any time without giving a reason, even after signing the consent form.

What will taking part involve?

Your involvement will be voluntary. The overall period of involvement will be around 50 minutes; you will have two different questionnaires to complete online, which measure physical activity and quality of life. And you will be asked to provide consent.

Will I be paid for taking part?

No

What are the possible benefits of taking part?

There will be no direct advantages or benefits to you from taking part, but your contribution will help us to develop guidance for physical activity for people with COPD in Saudi Arabia.

What are the possible risks of taking part?

This study has no major risk other than taking some of your time. It might be distressing for you to answer questions about your PA. If that happens, you can contact the researcher after completing the questionnaire if you want to discuss anything, and you can stop answering questions anytime you feel uncomfortable.

Will my taking part in this research project be kept confidential?

Absolutely, all information that is collected during the study will be kept strictly confidential in a locked facility and saved on the pilot Research Data Storage Service (RDSS) in the Research Portal at Cardiff University. The researcher is working alongside three other supervisors. Therefore, your data might be available to them in line with GDPR/data protection CU policies.

What will happen to my Personal Data?

Information such as your name, address, email address or date of birth, Place of work, and profession will be collected and anonymised.

The participant's data is crucial; therefore, the data collected from the study and the participant's personal information after being coded will be saved and destroyed at the end of the study. In

addition, the anonymised data will be preserved for five years by recording an identification number of years.

Cardiff University is the Data Controller and is committed to respecting and protecting your personal data in accordance with your expectations and Data Protection legislation. Further information about Data Protection, including:

- Your rights
- The legal basis under which Cardiff University processes your personal data for research
- Cardiff University's Data Protection Policy
- How to contact the Cardiff University Data Protection Officer
- How to contact the Information Commissioner's Office

maybe found at <https://www.cardiff.ac.uk/public-information/policies-and-procedures/data-protection>

[It should not be assumed that potential participants have access to the Internet; therefore, printed copies of the above-mentioned documentation and privacy notices should be readily available.]

Immediately, the research team will anonymise all the personal data it has been collected from or about you in connection with this research project, with the exception of your consent form. Your consent form will be retained for five years and may be accessed by members of the research team and, where necessary, by members of the University's governance and audit teams or by regulatory authorities. Anonymised information will be kept for a minimum of 5 years but may be published in support of the research project and/or retained indefinitely where it is likely to have continuing value for research purposes.

The data collected from the study and the participant's personal information will be saved anonymously and the personal information will be destroyed at the end of the study. In addition, the study data will be preserved for five years by recording identification number.

What happens to the data at the end of the research project?

The researcher will analyse the results as part of a PhD thesis. The results of this study might be published in professional journals or presented at conferences.

What will happen to the results of the research project?

It is our intention to publish the results of this research project in academic journals and present findings at conferences. Participants will not be identified in any report, publication or presentation. The results will be available upon request.

What if there is a problem?

If you wish to complain, or have grounds for concerns about any aspect of the manner in which you have been approached or treated during the course of this research, please contact:

Rawan Alruwaili

Email: [REDACTED]

If your complaint is not managed to your satisfaction, please contact Dr Kate Button

kate.button@cardiff.ac.uk
[REDACTED]

If you are harmed by taking part in this research project, there are no special compensation arrangements. If you are harmed due to someone's negligence, you may have grounds for legal action, but you may have to pay for it.

Who is organising and funding this research project?

The research is organised by [Rawan Alruwaili and three supervisors, Dr Nichola Gale and Dr Una Jones at the School of Healthcare Sciences, Cardiff University and Dr Ali Albarrati at King Saud University]. The research is currently funded by the Saudi Government.

Who has reviewed this research project?

This research project has been reviewed and given a favourable opinion by the Healthcare Science School Research Ethics Committee, Cardiff University/King Saud University Ethics Committee.

Further information and contact details:

Should you have any questions relating to this research project, you may contact us during normal working hours:

Rawan Alruwaili

Email: [REDACTED]

Thank you for considering to take part in this research project. If you decide to participate, you will be given a copy of the Participant Information Sheet and a signed consent form to keep for your records.

11.1.10. PARTICIPANT INFORMATION SHEET (phase 1-without COPD)



PARTICIPANT INFORMATION SHEET (phase 1-without COPD)

An Investigation of Physical Activity in chronic obstructive pulmonary disease (COPD) to promote Physical Activity (PA) in Saudi

You are being invited to take part in a research project. Before you decide whether or not to take part, it is important for you to understand why the research is being undertaken and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish.

Thank you for reading this.

What is the purpose of this research project?

The aim of this study is to measure physical activity in COPD and without respiratory conditions to develop a guidance for people with COPD and to promote physical activity in their life.

Why have I been invited to take part?

You have been invited because we want to ask you about your levels of physical activity compared to patients who have COPD.

Do I have to take part?

No, your participation in this research project is entirely voluntary, and it is up to you to decide whether or not to take part. If you decide to participate, we will discuss the research project with you [and ask you to sign a consent form]. If you decide not to take part, you do not have to explain your reasons, and it will not affect your legal rights. I confirm that your decision to take part or not to take part will not affect the care that you receive.

You are free to withdraw your consent to participate in the research project at any time without giving a reason, even after signing the consent form.

What will taking part involve?

Your involvement will be voluntary. The overall period of involvement will be around 50 minutes; you will have two different questionnaires to complete online, which measure physical activity and quality of life. And you will be asked to provide consent.

Will I be paid for taking part?

No

What are the possible benefits of taking part?

There will be no direct advantages or benefits to you from taking part, but your contribution will help us to develop guidance for physical activity for people with COPD in Saudi Arabia.

What are the possible risks of taking part?

This study has no major risk other than taking some of your time. It might be distressing for you to answer questions about your PA. If that happens, you can contact the researcher after completing the questionnaire if you want to discuss anything, and you can stop answering questions anytime you feel uncomfortable.

Will my taking part in this research project be kept confidential?

Absolutely, all information that is collected during the study will be kept strictly confidential in a locked facility and saved on the pilot Research Data Storage Service (RDSS) in the Research Portal at Cardiff University. The researcher is working alongside three other supervisors. Therefore, your data might be available to them in line with GDPR/data protection CU policies.

What will happen to my Personal Data?

Information such as your name, address, email address or date of birth, Place of work, and profession will be collected and anonymised.

The participant's data is crucial; therefore, the data collected from the study and the participant's personal information after being coded will be saved and destroyed at the end of the study. In

addition, the anonymised data will be preserved for five years by recording an identification number of years.

Cardiff University is the Data Controller and is committed to respecting and protecting your personal data in accordance with your expectations and Data Protection legislation. Further information about Data Protection, including:

- Your rights
- The legal basis under which Cardiff University processes your personal data for research
- Cardiff University's Data Protection Policy
- How to contact the Cardiff University Data Protection Officer
- How to contact the Information Commissioner's Office

maybe found at <https://www.cardiff.ac.uk/public-information/policies-and-procedures/data-protection>

[It should not be assumed that potential participants have access to the Internet; therefore, printed copies of the above-mentioned documentation and privacy notices should be readily available.]

Immediately, the research team will anonymise all the personal data it has been collected from or about you in connection with this research project, with the exception of your consent form. Your consent form will be retained for five years and may be accessed by members of the research team and, where necessary, by members of the University's governance and audit teams or by regulatory authorities. Anonymised information will be kept for a minimum of 5 years but may be published in support of the research project and/or retained indefinitely where it is likely to have continuing value for research purposes.

The data collected from the study and the participant's personal information will be saved anonymously and the personal information will be destroyed at the end of the study. In addition, the study data will be preserved for five years by recording identification number.

What happens to the data at the end of the research project?

The researcher will analyse the results as part of a PhD thesis. The results of this study might be published in professional journals or presented at conferences.

What will happen to the results of the research project?

It is our intention to publish the results of this research project in academic journals and present findings at conferences. Participants will not be identified in any report, publication or presentation. The results will be available upon request.

What if there is a problem?

If you wish to complain, or have grounds for concerns about any aspect of the manner in which you have been approached or treated during the course of this research, please contact:

Rawan Alruwaili

Email: A [REDACTED]

If your complaint is not managed to your satisfaction, please contact Dr Kate Button

[REDACTED]

If you are harmed by taking part in this research project, there are no special compensation arrangements. If you are harmed due to someone's negligence, you may have grounds for legal action, but you may have to pay for it.

Who is organising and funding this research project?

The research is organised by [Rawan Alruwaili and three supervisors, Dr Nichola Gale and Dr Una Jones at the School of Healthcare Sciences, Cardiff University and Dr Ali Albarrati at King Saud University]. The research is currently funded by the Saudi Government.

Who has reviewed this research project?

This research project has been reviewed and given a favourable opinion by the Healthcare Science School Research Ethics Committee, Cardiff University/King Saud University Ethics Committee.

Further information and contact details:

Should you have any questions relating to this research project, you may contact us during normal working hours:

Rawan Alruwaili

Email: [REDACTED]

Thank you for considering to take part in this research project. If you decide to participate, you will be given a copy of the Participant Information Sheet and a signed consent form to keep for your records.

11.1.11. Appendix PARTICIPANT INFORMATION SHEET (qualitative Phase-COPD)



PARTICIPANT INFORMATION SHEET (qualitative Phase -COPD)

An Investigation of Physical Activity in chronic obstructive pulmonary disease (COPD) to promote Physical Activity (PA) in Saudi

You are being invited to take part in a research project. Before you decide whether or not to take part, it is important for you to understand why the research is being undertaken and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish.

Thank you for reading this.

What is the purpose of this research project?

The aim of this study is to ask your views on physical activity to help develop guidance for patients with COPD to promote physical activity in their life. There is evidence that patients with COPD are less active than healthy individuals. There is no current guidance to promote physical activity in people with COPD in Saudi.

Why have I been invited to take part?

You have been invited to help us develop guidance; we require your views because you have a respiratory disorder (COPD) which includes all or some of:

- Breathlessness – this may only happen when exercising at first, and you may sometimes wake up at night feeling breathless.
- A persistent chesty cough with phlegm that does not go away.
- Frequent chest infections.
- Persistent wheezing.

Do I have to take part?

No, your participation in this research project is entirely voluntary, and it is up to you to decide whether or not to take part. If you decide to take part, we will discuss the research project with you and ask you to sign a consent form. If you decide not to take part, you do not have to explain your reasons, and it will not affect your legal rights. I confirm that your decision to take part or not to take part will not affect the care that you receive.

You are free to withdraw your consent to participate in the research project at any time without giving a reason, even after signing the consent form.

What will taking part involve?

Your involvement will be voluntary. The overall period of involvement will be around 60 minutes; you will be invited to an online Zoom for an interview, which will be about your challenges and opportunities to participate in physical activity. The interview video will be recorded, and you will be asked to provide consent.

Will I be paid for taking part?

No

What are the possible benefits of taking part?

There will be no direct advantages or benefits to you from taking part, but your contribution will help us to develop guidance for physical activity for people with COPD in Saudi Arabia.

What are the possible risks of taking part?

This study has no major risk other than taking some of your time. It might be distressing for you to talk about your challenges and opportunities to do physical activity. If that happens the interview can be paused. In addition, I could direct you to a support group such as the Saudi Thoracic Society.

Will my taking part in this research project be kept confidential?

Absolutely, all information that is collected during the study will be kept strictly confidential in a locked facility and saved on the pilot Research Data Storage Service (RDSS) in the Research Portal at Cardiff University. The researcher is working alongside with three other supervisors. Therefore, your data might be available to them in line with GDPR/data protection CU policies.

What will happen to my Personal Data?

Information such as your name, address, email address or date of birth, Place of work, and profession be collected and anonymised.

The participant's data is crucial, therefore, the data collected from the study and the participant's personal information after being coded will be saved and destroyed at the end of the study. In addition, the participants' interview data will be preserved for five years by recording an identification number.

Cardiff University is the Data Controller and is committed to respecting and protecting your personal data in accordance with your expectations and Data Protection legislation. Further information about Data Protection, including:

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[It should not be assumed that potential participants have access to the internet, therefore, printed copies of the above-mentioned documentation and privacy notices should be readily available.]

Immediately, the research team will anonymise all the personal data it has collected from, or about, you in connection with this research project, with the exception of your consent form. Your consent

form will be retained for 5 years and may be accessed by members of the research team and, where necessary, by members of the University's governance and audit teams or by regulatory authorities. Anonymised information will be kept for a minimum of 5 years but may be published in support of the research project and/or retained indefinitely, where it is likely to have continuing value for research purposes.

The data collected from the study and the participant's personal information will be saved anonymously and the personal information will be destroyed at the end of the study. In addition, the study data will be preserved for five years by recording an identification number.

What happens to the data at the end of the research project?

The researcher will analyse the results as part of a PhD dissertation. The results of this study might be published in professional journals or presented at conferences. However, you will never be identified in any report or publication by using the false name.

What will happen to the results of the research project?

It is our intention to publish the results of this research project in academic journals and present findings at conferences. Participants will not be identified in any report, publication or presentation. After completion of the study, you will return to your usual care, and the results will be available upon request.

What if there is a problem?

If you wish to complain or have grounds for concern about any aspect of the manner in which you have been approached or treated during the course of this research, please contact:

Rawan Alruwaili

Email: 

If your complaint is not managed to your satisfaction, please contact Dr Kate Button



If you are harmed by taking part in this research project, there are no special compensation arrangements. If you are harmed due to someone's negligence, you may have grounds for legal action, but you may have to pay for it.

Who is organising and funding this research project?

The research is organised by [Rawan Alruwaili and three supervisors, Dr Nichola Gale and Dr Una Jones at the School of Healthcare Sciences, Cardiff University and Dr Ali Albarrati at King Saud University]. The research is currently funded by Prince Sattam bin Abdulaziz University.

Who has reviewed this research project?

This research project has been reviewed and given a favourable opinion by the Healthcare Science School Research Ethics Committee, Cardiff University/King Saud University Ethics Committee.

Further information and contact details:

Should you have any questions relating to this research project, you may contact us during normal working hours:

Rawan Alruwaili

Email: 

Thank you for considering to take part in this research project. If you decide to participate, you will be given a copy of the Participant Information Sheet and a signed consent form to keep for your records.

11.1.12. Appendix PARTICIPANT INFORMATION SHEET (Qualitative Phase – HCPs)



PARTICIPANT INFORMATION SHEET (Qualitative Phase - HCPs)

An Investigation of Physical Activity in chronic obstructive pulmonary disease (COPD) to promote Physical Activity (PA) in Saudi

You are being invited to take part in a research project. Before you decide whether or not to take part, it is important for you to understand why the research is being undertaken and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish.

Thank you for reading this.

What is the purpose of this research project?

The aim of this study is to ask your views on physical activity to help to develop guidance for patients with COPD to promote physical activity in their life. There is evidence that patients with COPD are less active than healthy individuals. There is no current guidance to promote physical activity in people with COPD in Saudi. Patients and professional views are needed to develop guidance to promote physical activity.

Why have I been invited to take part?

You have been invited because you have been working with people with respiratory disorders (COPD) in pulmonary rehabilitation for at least one year.

Do I have to take part?

No, your participation in this research project is entirely voluntary and it is up to you to decide whether or not to take part. If you decide to take part, we will discuss the research project with you and ask you to sign a consent form. If you decide not to take part, you do not have to explain your reasons and it will not affect your legal rights. I confirm that your decision to take part or not to

take part will not affect your employment. You are free to withdraw your consent to participate in the research project at any time, without giving a reason, even after signing the consent form.

What will taking part involve?

Your involvement will be voluntary. The overall period of involvement will be around 60 minutes, you will be invited to online Zoom for interview which will be about what kind of activities are suitable for people with COPD in undertaking physical activity and opportunities and challenges to promoting physical activity. The interview video will be recorded, and you will be asked to provide consent.

Will I be paid for taking part?

No.

What are the possible benefits of taking part?

There will be no direct advantages or benefits to you from taking part, but your contribution will help us to develop guidance for physical activity for people with COPD in Saudi Arabia.

What are the possible risks of taking part?

This study has no major risk other than taking some of your time. However, it might be distressing for you to talk about your role in the clinic with people with COPD. If that happens, the interview can be paused. In addition, I could direct you to a support group such as the Saudi Thoracic Society.

Will my taking part in this research project be kept confidential?

All information that is collected during the study will be kept strictly confidential in a locked facility and saved on the pilot Research Data Storage Service (RDSS) in the Research Portal at Cardiff University. The researcher is working alongside with three other supervisors. Therefore, your data might be available to them in line with GDPR/data protection CU policies.

What will happen to my Personal Data?

Information such as your name, address, email address or date of birth, Place of work, and profession will be collected and anonymised.

The participant's interview data is crucial; therefore, the data collected from the study and the participant's personal information after being coded will be saved and destroyed at the end of the study. In addition, the participant's data will be preserved for five years by recording an identification number.

Cardiff University is the Data Controller and is committed to respecting and protecting your personal data in accordance with your expectations and Data Protection legislation. Further information about Data Protection, including:

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maybe found at <https://www.cardiff.ac.uk/public-information/policies-and-procedures/data-protection>

[It should not be assumed that potential participants have access to the Internet; therefore, printed copies of the above-mentioned documentation and privacy notices should be readily available.]

Immediately, the research team will anonymise all the personal data it has collected from or about you in connection with this research project, with the exception of your consent form. Your consent form will be retained for 5 years. It may be accessed by members of the research team and, where necessary, by members of the University's governance and audit teams or by regulatory authorities. Anonymised information will be kept for a minimum of 5 years but may be published in support of the research project and/or retained indefinitely where it is likely to have continuing value for research purposes.

The data collected from the study and the participants' personal information will be saved anonymously, and the personal information will be destroyed at the end of the study. In addition, the study data will be preserved for five years by recording identification numbers.

What happens to the data at the end of the research project?

The researcher will analyse the results as part of a PhD dissertation. The results of this study might be published in professional journals or presented at conferences. However, you will never be identified in any report or publication by using the false name.

What will happen to the results of the research project?

It is our intention to publish the results of this research project in academic journals and present findings at conferences. Participants will not be identified in any report, publication or presentation. The results will be available upon request.

What if there is a problem?

If you wish to complain or have grounds for concern about any aspect of the manner in which you have been approached or treated during the course of this research, please contact:

Rawan Alruwaili

Email: [REDACTED]k

If your complaint is not managed to your satisfaction, please contact Dr Kate Button

[REDACTED]

If you are harmed by taking part in this research project, there are no special compensation arrangements. If you are harmed due to someone's negligence, you may have grounds for legal action, but you may have to pay for it.

Who is organising and funding this research project?

The research is organised by [Rawan Alruwaili and three supervisors, Dr Nichola Gale and Dr Una Jones at the School of Healthcare Sciences, Cardiff University and Dr Ali Albarrati at King Saud University]. The research is currently funded by Prince Sattam bin Abdulaziz University.

Who has reviewed this research project?

This research project has been reviewed and given a favourable opinion by the Healthcare Science School Research Ethics Committee, Cardiff University/King Saud University Ethics Committee.

Further information and contact details:

Should you have any questions relating to this research project, you may contact us during normal working hours:

Rawan Alruwaili

Email: [REDACTED] k

Thank you for considering to take part in this research project. If you decide to participate, you will be given a copy of the Participant Information Sheet and a signed consent form to keep for your records.

11.1.13. English Short Form International Physical Activity Questionnaire (IPAQ-SF)

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the **last 7 days**. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the **vigorous** activities that you did in the **last 7 days**. **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think *only* about those physical activities that you did for at least 10 minutes at a time.

1. During the **last 7 days**, **on** how many days did you do **vigorous** physical activities like heavy lifting, digging, aerobics, or fast bicycling?

_____ **days per week**

No vigorous physical activities *Skip to question 3*

2. How much time did you usually spend doing **vigorous** physical activities on one of those days?

_____ **hours per day**

_____ **minutes per day**

Don't know/Not sure

Think about all the **moderate** activities that you did in the **last 7 days**. **Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think *only* about those physical activities that you did for at least 10 minutes at a time.

3. During the **last 7 days**, **on** how many days did you do **moderate** physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.

_____ **days per week**

No moderate physical activities *Skip to question 5*

4. How much time did you usually spend doing **moderate** physical activities on one of those days?

_____ **hours per day**

_____ **minutes per day**

Don't know/Not sure

Think about the time you spent **walking** in the **last 7 days**. This includes at work and **at** home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure.

5. During the **last 7 days**, **on** how many days did you **walk** for at least 10 minutes at a time?

_____ **days per week**

No walking *Skip to question 7*

6. How much time did you usually spend **walking** on one of those days?

_____ **hours per day**

_____ **minutes per day**

Don't know/Not sure

The last question is about the time you spent **sitting** on weekdays during the **last 7 days**. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

7. During the **last 7 days**, how much time did you spend **sitting** on a **weekday**?

_____ **hours per day**

_____ **minutes per day**

Don't know/Not sure

This is the end of the questionnaire, thank you for participating.

11.1.14. Arabic Short Form International Physical Activity Questionnaire (SF-IPAQ)

الصيغة المختصرة لاستبانة النشاط البدني الدولية، للاستخدام بواسطة العينة الشخصية

نحن مهتمون بمعرفة أنواع الأنشطة البدنية التي يقوم بها الأفراد كجزء من حياتهم اليومية. الأسئلة التالية تركز حول الوقت الذي قضيته في ممارسة أنشطة بدنية خلال الأيام السبعة الماضية. فضلاً أجب عن كل سؤال من الأسئلة التالية حتى وإن كنت تعتبر نفسك غير نشيط بدنياً. فكر في الأنشطة البدنية التي تمارسها خلال عملك، وجزء من أعمالك المنزلية، وأثناء تنقلك من مكان لآخر، وتلك التي تقوم بها في وقت فراغك بغرض الترويح أو التمرين أو الرياضة.

الآن فكر في جميع الأنشطة البدنية التي تتطلب جهداً بدنياً مرتفع الشدة والتي قمت بممارستها خلال الأيام السبعة الماضية. الأنشطة البدنية مرتفعة الشدة هي تلك الأنشطة التي تجعل تنفسك أعلى بكثير من المعتاد، مثل رفع أشياء ثقيلة، أو حرق الأرض، أو ركوب الدراجة بسرعة عالية، أو الجري، أو ممارسة كرة القدم، أو كرة السلة، أو السباحة، أو نط الحبل. فكر فقط في الأنشطة البدنية مرتفعة الشدة التي قمت بممارستها لمدة ١٠ دقائق على الأقل في كل مرة.

١ - خلال الأيام السبعة الماضية، كم يوماً مارست فيه نشاطاً بدنياً مرتفع الشدة؟

_____ يوم في الأسبوع

☐ لا أقوم بأي نشاط بدني مرتفع الشدة. ← انتقل مباشرة إلى السؤال رقم ٣

٢ - في المعتاد، كم من الوقت قضيته في ممارسة نشاط بدني مرتفع الشدة في أحد تلك الأيام؟

_____ ساعة في اليوم

_____ دقيقة في اليوم

☐ لا أدري/ أو غير متأكد.

الآن فكر في جميع الأنشطة البدنية التي تتطلب جهداً بدنياً معتدلاً الشدة والتي قمت بممارستها خلال الأيام السبعة الماضية. الأنشطة البدنية معتدلة الشدة هي تلك الأنشطة التي تجعل تنفسك أعلى من المعتاد إلى حد ما، ويمكن أن تتضمن رفع أشياء خفيفة، أو ركوب الدراجة بسرعة عادية، أو ممارسة كرة الطائرة، أو ممارسة تنس الطاولة، أو كنس المنزل، أو غسل الملابس يدوياً، أو غسل السيارة. لا تحسب المشي ضمن هذه الأنشطة. مرة أخرى، فكر فقط في الأنشطة البدنية معتدلة الشدة التي قمت بممارستها لمدة ١٠ دقائق على الأقل في كل مرة.

٣- خلال الأيام السبعة الماضية، كم يوماً مارست فيه نشاطاً بدنياً معتدلاً الشدة؟

_____ يوم في الأسبوع

☐ لا أقوم بأي نشاط بدني معتدل الشدة.  انتقل مباشرة إلى السؤال رقم ٥

٤- في المعتاد، كم من الوقت قضيته في ممارسة نشاط بدني معتدل الشدة في أحد تلك الأيام؟

_____ ساعة في اليوم

_____ دقيقة في اليوم

☐ لا أدري/ أو غير متأكد.

الآن فكر في الوقت الذي قضيته في المشي خلال الأيام السبع الماضية، ويتضمن ذلك المشي إلى العمل، والمشي أثناء العمل، وفي البيت، وخلال انتقالك من مكان لآخر، أو أي نوع من أنواع المشي بغرض الترويح أو الرياضة.

٥- خلال الأيام السبعة الماضية، كم يوماً مارست فيه المشي لمدة ١٠ دقائق على الأقل في كل مرة؟

_____ يوم في الأسبوع

☐ لا أقوم بممارسة المشي إطلاقاً.  انتقل مباشرة إلى السؤال رقم ٧

٦- في المعتاد، كم من الوقت قضيته في ممارسة المشي في أحد تلك الأيام؟

_____ ساعة في اليوم

_____ دقيقة في اليوم

☐ لا أدري/ أو غير متأكد.

الصيغة المختصرة لاستبيان النشاط البدني الدولية، للاستخدام عن طريق التهيئة الشخصية - منقحة يوليو ٢٠١٤

الآن فكر في الوقت الذي قضيته جالساً خلال الأيام السبعة الماضية. أحسب وقت الجلوس في العمل، وفي المنزل، وفي الدراسة، وفي الترفيه. من الممكن أن يتضمن ذلك وقت الجلوس على المكتب، وأثناء العمل على الكمبيوتر، وأثناء زيارتك لصديق، وأثناء القراءة، والجلوس أو الاستلقاء لمشاهدة التلفزيون.

٧- خلال الأيام السبعة الماضية، كم من الوقت قضيته جالساً في أحد هذه الأيام من غير أيام الإجازة الأسبوعية؟

_____ ساعة في اليوم

_____ دقيقة في اليوم

☐ لا أدري/ أو غير متأكد.

(نهاية الاستبانة، شكراً لمشاركتكم)

11.1.15. Appendix English EuroQol-5 Dimensions-5 Levels

EQ-5D-5L Self-Complete:

Under each heading, please tick the ONE box that best describes your health TODAY.

MOBILITY

- I have no problems ~~in~~ walking about ☐
- I have slight problems in walking about ☐
- I have moderate problems in walking about ☐
- I have severe problems in walking about ☐
- I am unable to walk about ☐

SELF-CARE

- I have no problems washing or dressing myself ☐
- I have slight problems washing or dressing myself ☐
- I have moderate problems washing or dressing myself ☐
- I have severe problems washing or dressing myself ☐
- I am unable to wash or dress myself ☐

USUAL ACTIVITIES (*e.g. work, study, housework, family or leisure activities*)

- I have no problems doing my usual activities ☐
- I have slight problems doing my usual activities ☐
- I have moderate problems doing my usual activities ☐
- I have severe problems doing my usual activities ☐
- I am unable to do my usual activities ☐

PAIN / DISCOMFORT

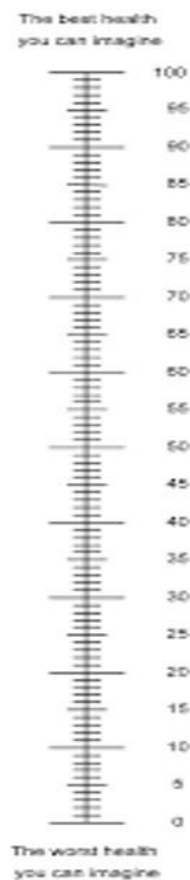
- I have no pain or discomfort ☐
- I have slight pain or discomfort ☐
- I have moderate pain or discomfort ☐
- I have severe pain or discomfort ☐
- I have extreme pain or discomfort ☐

ANXIETY / DEPRESSION

- I am not anxious or depressed ☐
- I am slightly anxious or depressed ☐
- I am moderately anxious or depressed ☐
- I am severely anxious or depressed ☐
- I am extremely anxious or depressed ☐

The EQ VAS:

- We would like to know how good or bad your health is TODAY.
 - This scale is numbered from 0 to 100.
 - 100 means the best health you can imagine.
- 0 means the worst health you can imagine.
- Mark an X on the scale to indicate how your health is TODAY.
 - Now, please write the number you marked on the scale in the box below.



Your Health Today =

11.1.16. Arabic EuroQol-5 Dimensions-5 Levels

استبيان صحّي

النسخة العربية للمملكة العربية السعودية

(Arabic version for Kingdom of Saudi Arabia)

تحت كل من البنود أدناه، يُرجى وضع علامة في صندوق واحد فقط يصف بأفضل صورة حالتك الصحية اليوم

القدرة على الحركة

- ليس لدي أي مشاكل أثناء المشي ☐
- أعاني من مشاكل طفيفة عند المشي ☐
- أعاني من مشاكل متوسطة عند المشي ☐
- أعاني من مشاكل حادة عند المشي ☐
- ليس لدي القدرة على المشي ☐

العناية الشخصية

- ليس لدي أي مشاكل عند الاستحمام أو ارتداء ملابس بنفسي ☐
- أعاني من مشاكل طفيفة عند الاستحمام أو ارتداء الملابس بنفسي ☐
- أعاني من مشاكل متوسطة عند الاستحمام أو ارتداء الملابس بنفسي ☐
- أعاني من مشاكل حادة عند الاستحمام أو ارتداء الملابس بنفسي ☐
- ليس لدي القدرة على الاستحمام أو ارتداء الملابس بنفسي ☐

الأنشطة المعتادة (مثل العمل، الدراسة، الأعمال المنزلية، الأنشطة الأسرية أو الترفيهية)

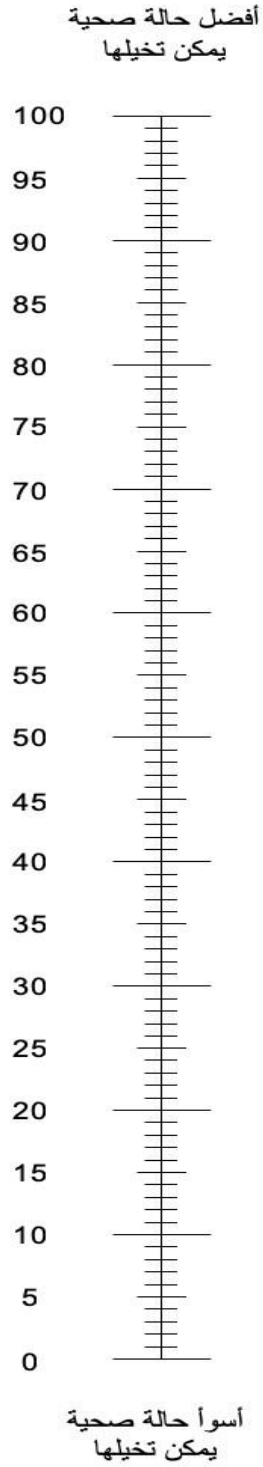
- ليس لدي أي مشاكل في ممارسة نشاطاتي المعتادة ☐
- أعاني من مشاكل طفيفة في ممارسة نشاطاتي المعتادة ☐
- أعاني من مشاكل متوسطة في ممارسة نشاطاتي المعتادة ☐
- أعاني من مشاكل حادة في ممارسة نشاطاتي المعتادة ☐
- ليس لدي القدرة على ممارسة نشاطاتي المعتادة ☐

الألم / الإحساس بعدم الراحة

- لا أشعر بأي ألم أو بعدم الراحة ☐
- أشعر بدرجة طفيفة من الألم أو عدم الراحة ☐
- أشعر بدرجة متوسطة من الألم أو عدم الراحة ☐
- أشعر بدرجة شديدة من الألم أو عدم الراحة ☐
- أشعر بدرجة شديدة جداً من الألم أو عدم الراحة ☐

القلق / الاكتئاب

- لا أعاني أي قلق أو اكتئاب ☐
- أعاني درجة طفيفة من القلق أو الاكتئاب ☐
- أعاني درجة متوسطة من القلق أو الاكتئاب ☐
- أعاني درجة شديدة من القلق أو الاكتئاب ☐
- أعاني درجة شديدة جداً من القلق أو الاكتئاب ☐



- نود أن نعرف مدى سوء حالتك الصحية أو سلامتها اليوم.
- هذا المقياس مدرج من الرقم 0 حتى 100.
- بحيث يشير الرقم 100 إلى أفضل حالة صحية يمكن تخيلها والرقم صفر إلى أسوأ حالة صحية يمكن تخيلها.
- ضع (x) على المقياس للإشارة إلى حالتك الصحية اليوم.
- الآن، قم رجاء بكتابة الرقم الذي أشرت إليه على المقياس في المربع أدناه.

= حالتك الصحية اليوم

11.1.17. English Dyspnea-12 Questionnaire

Dyspnea-12 Questionnaire:

Instructions: This questionnaire is designed to help us learn more about how your breathing is troubling you. Please read each item and then place an X in the box that best matches your breathing *these days*. If you do not experience an item, mark X in the "none" box. Please respond to all items.



Item	None	Mild	Moderate	Severe
1. My breath does not go in all the way				
2. My breathing requires more work				
3. I feel short of breath				
4. I have difficulty catching my breath				
5. I cannot get enough air				
6. My breathing is uncomfortable				
7. My breathing is exhausting				
8. My breathing makes me feel depressed				
9. My breathing makes me feel miserable				
10. My breathing is distressing				
11. My breathing makes me agitated				
12. My breathing is irritating				



11.1.18. Arabic Dyspnea-12 Questionnaire

ضيق التنفس- ١٢

صمم هذا الاستبيان بهدف مساعدتنا على التعرف على مدى الإزعاج الذي يسببه لك ضيق التنفس

الرجاء قراءة كل فقرة و وضع علامة في المربع الذي يتناسب مع أفضل خيار فيما يتعلق بحالة تنفسك هذه الايام. إذا لم تكن تعاني من إحدى الحالات المذكورة أدناه ضع علامة في المربع (لايوجد). يرجى الاجابة على جميع الفقرات.

التاريخ: .../.../...

رقم الشخص:

الفقرة	لا يوجد	خفيف	متوسط	شديد
١ - لا استطيع اخذ النفس بصورة كاملة				
٢ - تنفسي يتطلب مجهودا اكثر				
٣ - أشعر بضيق في التنفس				
٤ - اجد صعوبة في التقاط انفاسي				
٥ - لا استطيع اخذ هواء كافي				
٦ - تنفسي غير مريح				
٧ - تنفسي مرهق				
٨ - تنفسي يجعلني اشعر بالإكتئاب				
٩ - تنفسي يجعلني اشعر بالتعب				
١٠ - تنفسي يضايقني				
١١ - تنفسي يجعلني اشعر بالانفعال				
١٢ - تنفسي مزعج				

11.1.19. Interview Schedule for all Groups

SCT Construct	COPD:	Without COPD:	HCPs:
Self-efficacy (Confidence in ability to engage in PA despite limitations)	- How does the disease affect you and your daily life/quality of life (limitations)? - What type of activity do you do? And how much? - What limits you from doing physical activity? What could stop you from being physically active?	What are the difficulties you experience being physical active?	- What challenges do you see in promoting PA for COPD patients? - What would make it easier for healthcare professionals to prescribe PA?
Outcome expectations (Beliefs about the benefits of PA)	- What are the benefits of physical activity for you as a COPD patient? - What kind of challenges do you face? - What do you achieve from physical activity?	- What are the benefits of physical activity for you? - What do you achieve from physical activity?	Could you tell me your thoughts about the role of physical activity for patients with COPD?
Behavioural capability (Knowledge about PA and how to engage in it)	What is your knowledge about PA?	- What do you know about PA? - Why do you choose that type of PA?	- What is your understanding of what clinical guidelines say about physical activity for COPD? - Who do you think should prescribe physical activity?

			for patients with COPD?
Socio-structural factors (Environmental or social influences on PA engagement)	• Are there any challenges in your environment or social life that make it hard to be active? • What support do you need to be more physically active? • What factors influence your ability to do PA? • How do family and friends influence your PA? or prevent?	• Are there any challenges in your environment or social life that make it hard to be active? • Are there things which help you keep you physically active? (e.g., perceived importance, enjoyment, social factors) • How do family and friends influence your PA? or prevent?	• Do you inform the patient about the importance of physical activity?
Motivation and goal setting (Factors influencing PA participation and adherence)	• Which factors influenced you to be physically active? • What is needed for you to start doing physical activity? • What might encourage you for physical activity?	• What helps you stay physically active? • Why do you choose to be physically active (or not)?	• What strategies do you use to encourage COPD patients to engage in PA?
Additional Study-Specific Questions	• How has your physical activity changed since you were diagnosed and why?	• How would you describe your level of physical activity now and in the past?	• What do you do if you suspect a patient has COPD or the patient has been diagnosed with COPD?

11.1.20. Copy of Google form survey including consent, demographic data, IPAQ-SF, D-12 (English)

5/12/24, 4:53 PM

An Investigation of Physical Activity in COPD to promote of Physical Activity in Saudi

An Investigation of Physical Activity in COPD to promote of Physical Activity in Saudi

The aim of this study is to measure level of physical activity in people with COPD and people without respiratory conditions. We will use this information to then develop guidance for people with COPD to promote physical activity in their life.

You have been invited because you have respiratory condition (COPD) or emphysema or chronic bronchitis, or you do not have any respiratory condition. We want to ask you how much activity you do and your general health which may include.

Name of Chief/Principal Investigator: Rawan Alruwaili

* Indicates required question

CONSENT FORM

SREC reference and committee: [REC788]



Question *

Please tick the box to confirm your participation

I confirm that I have read the information sheet dat...

☐

I confirm that I have understood the information sh...

☐

I understand that my participation is voluntary and I...

☐

I understand that data collected during the researc...

☐

I consent to the processing of my personal informa...

☐

I understand who will have access to personal infor...

☐

I understand how the findings and results of the res...

☐

I agree to take part in this research project.

☐

5/12/24, 4:53 PM

An Investigation of Physical Activity in COPD to promote of Physical Activity in Saudi

Personal Information

2. Age (years) *

3. Gender *

Mark only one oval.☐ male☐ female

4. Weight (Kg) *

5. Hight (cm) *

https://docs.google.com/forms/d/1-BQvGdxhg6r_GWCurR8r9cob6yTh1F5fRKNLddU0iFM/edit

6/15

5/12/24, 4:53 PM

An Investigation of Physical Activity in COPD to promote of Physical Activity in Saudi

6. Have you been diagnosed with one of these disease? (you can choose multi-answers) *

Check all that apply.☐ heart problem☐ anxiety or depression☐ cancer☐ arthritis (not osteoarthritis)☐ weight loss malnutrition☐ joint problem (include osteoarthritis that affect your mobility)☐ Sleep disturbance☐ circulatory disease (blood pressure)☐ none

7. Do you have any other disease may effect your mobility? *

Mark only one oval.☐ Yes☐ NO Skip to section 5 (INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE Section)

5/12/24, 4:53 PM

An Investigation of Physical Activity in COPD to promote of Physical Activity in Saudi

8. If yes please specific? *

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE Section

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the last 7 days. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Vigorous Physical Activity

Think about all the vigorous activities that you did in the last 7 days. Vigorous physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

5/12/24, 4:53 PM

An Investigation of Physical Activity in COPD to promote of Physical Activity in Saudi

9. During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling? *

Mark only one oval.

- ☐ every day
- ☐ 6 days
- ☐ 5 days
- ☐ 4 days
- ☐ 3 days
- ☐ 2 days
- ☐ 1 day
- ☐ No vigorous physical activities *Skip to question 11*

Vigorous Physical Activity

10. How much time did you usually spend doing vigorous physical activities on one of those days? How many minutes per day? *

Moderate Physical Activity

Think about all the moderate activities that you did in the last 7 days. Moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

5/12/24, 4:53 PM

An Investigation of Physical Activity in COPD to promote of Physical Activity in Saudi

11. During the last 7 days, on how many days did you do moderate physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking. *

Mark only one oval.

- ☐ every day
- ☐ 6 days
- ☐ 5 days
- ☐ 4 days
- ☐ 3 days
- ☐ 2 days
- ☐ 1 day
- ☐ No moderate physical activities *Skip to question 13*

Moderate Physical Activity

12. How much time did you usually spend doing moderate physical activities on one of those days? How many minutes per day? *

Walking

Think about the time you spent walking in the last 7 days. This includes at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure.

5/12/24, 4:53 PM

An Investigation of Physical Activity in COPD to promote of Physical Activity in Saudi

13. During the last 7 days, on how many days did you walk for at least 10 minutes at a time? *

Mark only one oval.

- ☐ every day
☐ 6 days
☐ 5 days
☐ 4 days
☐ 3 days
☐ 2 days
☐ 1 day
☐ No walking *Skip to question 15*

Walking

14. How much time did you usually spend walking on one of those days? How many minutes per day? *

Sitting

The last question is about the time you spent sitting on weekdays during the last 7 days. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

5/12/24, 4:53 PM

An Investigation of Physical Activity in COPD to promote of Physical Activity in Saudi

15. During the last 7 days, how much time did you spend sitting on a week day? How many minutes per day? *

Health Information

16. Have you been diagnosed with COPD *

Mark only one oval.

☐ Yes

☐ No

Health Information

17. How long since you have been diagnosed with Chronic obstructive pulmonary disease?(years) *

Dyspnea-12 Questionnaire

Instructions: This questionnaire is designed to help us learn more about how your breathing is troubling you. Please read each item and then place an X in the box that best matches your breathing these days. If you do not experience an item, mark X in the "none" box. Please respond to all items.

https://docs.google.com/forms/d/1-BQvGdxhg6r_GWCurR8r9coh6yTh1F5fRKNLddU0lFM/edit

12/15

18. *

Check all that apply.

	None	Mild	Moderate	Severe
1. My breath does not go in all the way	☐	☐	☐	☐
2. My breathing requires more work	☐	☐	☐	☐
3. I feel short of breath	☐	☐	☐	☐
4. I have difficulty catching my breath	☐	☐	☐	☐
5. I cannot get enough air	☐	☐	☐	☐
6. My breathing is uncomfortable	☐	☐	☐	☐
7. My breathing is exhausting	☐	☐	☐	☐
8. My breathing makes me feel depressed	☐	☐	☐	☐
9. My breathing makes me feel miserable	☐	☐	☐	☐
10. My breathing is distressing	☐	☐	☐	☐
11. My breathing makes me agitated	☐	☐	☐	☐
12. My breathing is irritating	☐	☐	☐	☐

This study consists of two phases. If you wish to continue participating in the second phase, o
limit your participation to the first phase only

5/12/24, 4:53 PM

An Investigation of Physical Activity in COPD to promote of Physical Activity in Saudi

19. Do you like to participate on interview phase? *

Mark only one oval.

- ☐ Yes
- ☐ No

Untitled Section

20. Your contact number or E-mail *

This content is neither created nor endorsed by Google.

Google Forms

11.1.21. Copy of REDCap survey including EQ-5D-5L (English)

Page 1

Uk English Eq5d5l Redcap Selfcomplete

Please complete the survey below.

Thank you!

Please select the ONE box that best describes your health TODAY.

1) MOBILITY

☐ I have no problems in walking about
☐ I have slight problems in walking about
☐ I have moderate problems in walking about
☐ I have severe problems in walking about
☐ I am unable to walk about

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Please select the ONE box that best describes your health TODAY.

2) SELF-CARE

☐ I have no problems washing or dressing myself
☐ I have slight problems washing or dressing myself
☐ I have moderate problems washing or dressing myself
☐ I have severe problems washing or dressing myself
☐ I am unable to wash or dress myself

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Please select the ONE box that best describes your health TODAY.

3) USUAL ACTIVITIES (e.g. work, study, housework, family or leisure activities)

☐ I have no problems doing my usual activities
☐ I have slight problems doing my usual activities
☐ I have moderate problems doing my usual activities
☐ I have severe problems doing my usual activities
☐ I am unable to do my usual activities

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Please select the ONE box that best describes your health TODAY.

4) PAIN / DISCOMFORT

☐ I have no pain or discomfort
☐ I have slight pain or discomfort
☐ I have moderate pain or discomfort
☐ I have severe pain or discomfort
☐ I have extreme pain or discomfort

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Please select the ONE box that best describes your health TODAY.

2024-05-12 15:14

projectredcap.org



5) ANXIETY / DEPRESSION

- ☐ I am not anxious or depressed
- ☐ I am slightly anxious or depressed
- ☐ I am moderately anxious or depressed
- ☐ I am severely anxious or depressed
- ☐ I am extremely anxious or depressed

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6) We would like to know how good or bad your health is TODAY.

You will see a scale numbered from 0 to 100.

100 means the best health you can imagine.

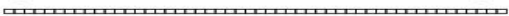
0 means the worst health you can imagine.

Please indicate on the scale how your health is TODAY.

0 - The worst
health you can
imagine

100 - The best
health you can
imagine

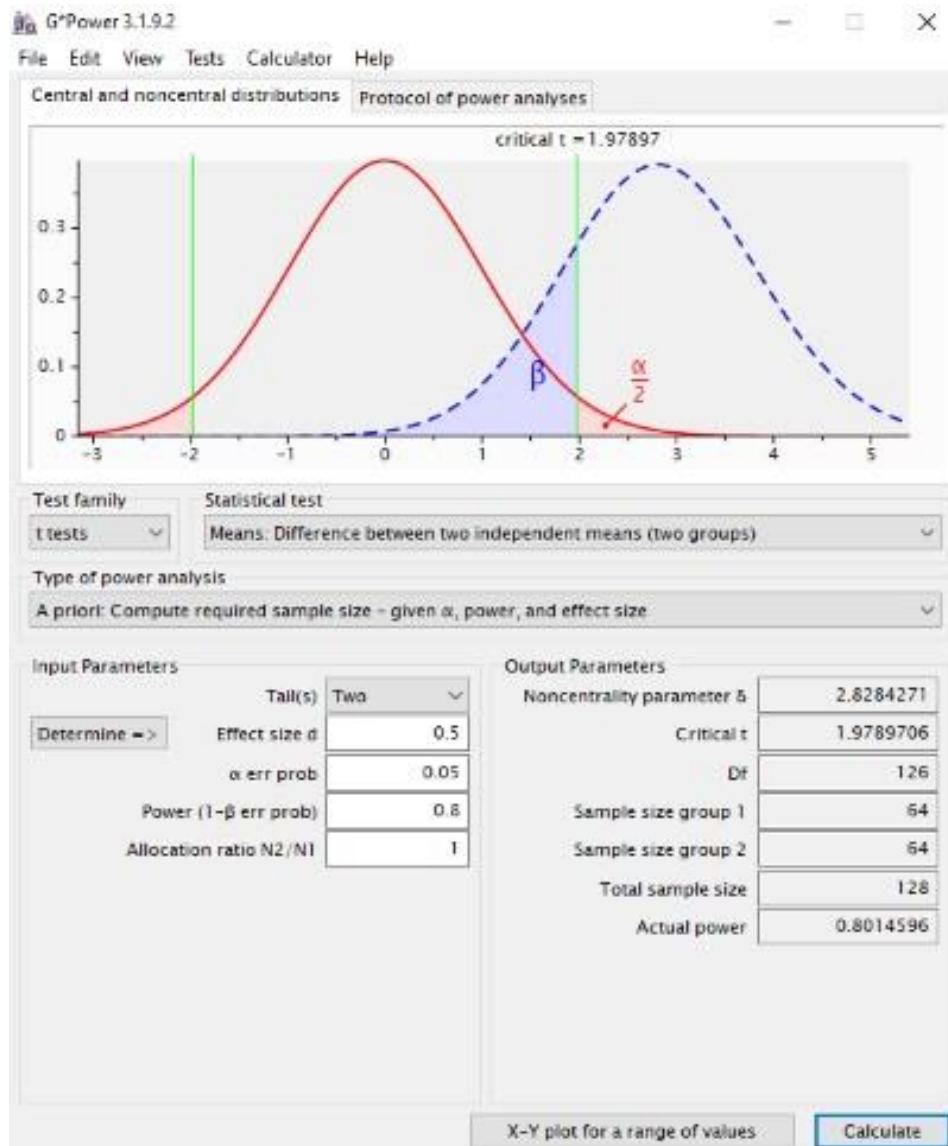
50



(Place a mark on the scale above)

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11.1.22. sample size calculation using G-power for Quantitative phase



11.1.23. Appendix Normality test for Quantitative data

Tests of Normality

		Shapiro-Wilk		
	group	Statistic	df	Sig.
age	COPD	50	.979	.491
	Comparators	51	.893	<.001
Gender	COPD	50	.490	<.001
	Comparators	51	.633	<.001
BMI	COPD	50	.967	.181
	Comparators	51	.967	.160
IPAQ	COPD	50	.823	<.001
	Comparators	51	.816	<.001
EQ-5D-5l	COPD	50	.842	<.001
	Comparators	51	.810	<.001
VAS	COPD	50	.936	.009
	Comparators	51	.920	.002

Tests of Normality

		Shapiro-Wilk		
	Statistic	df	Sig.	
D-12	.955	50	.055	

11.1.24. Comparing IPAQ-SF and EQ-5D-5L and EQ-VAS between COPD group and non-COPD group

Test Statistics^a

	IPAQ	EQ-5D-5L	VAS
Mann-Whitney U	1036.000	813.500	700.000
Asymp. Sig. (2-tailed)	.104	.002	<.001

a. Grouping Variable: V2

11.1.25. Appendix Example of codes from COPD transcripts

1 Interviewee: Hello

2 **Interviewer: Hello, is the time right now?**

3 Interviewee: Yes, may God bless you.

4 Interviewer: I wanted to tell you first that call will be recorded.

5 Interviewee: Ok, okay, no problem, but tell me more about who you are.

6 Interviewer: I am studying for a PhD. The research is related to chronic obstructive

7 pulmonary disease, and I need information from Saudi Arabia, meaning the patients are

8 from Saudi Arabia.

9 Interviewee: Excellent, excellent, okay, let's start.

10 _____

11 **Interviewer: First of all, I want to ask you. back to your questionnaire, you have**

12 **had chronic obstruction for 5 years, is that right?**

13 Interviewee: Yes

14 **Interviewer: How did it start with you? The disease, how did you find out that you**

15 **have it?**

16 Interviewee: Excellent. First of all, I was working outside the Kingdom. I had chest pain

17 on the left side. It was not normal. I went to the hospital there. They said there was

18 nothing, I mean, a day later, they did an x-ray, and they also said that you may have

19 fluid in the lung and we must withdraw it. I said as long as this, no, I am going to Saudi

20 Arabia, I went to Saudi Arabia and made an appointment at the Security Forces

21 Hospital, and of course, I went after that, and I did the tests and analyses and they said

22 you have a lung problem, it is expansion or blockage, and I forgot what they said that

23 day. Of course, they gave me treatment and medicine, as well as when I was coming

Commented [PR1]: Diagnosing COPD

24 from there, I was tired and coughing and with any coughing movement, even if I started
25 coughing, I mean, any movement I did was coughing very severely.

26 Interviewer: all right, were you a smoker?

27 Interviewee: I was a smoker, and this is one of the effects of smoke.

28 Interviewer: Since when have you been a smoker?

29 Interviewee: About 20 years old

30 Interviewer: Are you still a smoker or have you stopped?

31 Interviewee: No, I stood for 8 years and then rested a lot.

32 Interviewer: My study is related to chronic obstructive pulmonary disease and its
33 relationship to physical activity. In your opinion what is the definition of physical
34 activity?

35 Interviewee: Sports, walking, or doing an activity that makes you tired, makes me tired I
36 mean really tired.

37 Interviewer: OK, if I ask you, what are the activities that you usually do? On your
38 normal day?

39 Interviewee: Now or those days?

40 Interviewer: yes, now.

41 Interviewee: Now it is not a lot, I am just walking not a lot. Otherwise, we have, as we
42 say, a popular band for Al-Ardah, and so on. I mean, you know, we go to festivals and
43 celebrations, and we have a lot of movement, performances, and so on. The situation
44 is normal. At first, when I did something like this, I used to get tired, now it's kind of
45 lightly tired, but it's not like the first.

46 Interviewer: Ok, if you walk, how long can you walk continuously?

Commented [PR1]: knowledge of PA

Commented [PR3]: Kind of activity

Commented [PR4]: Improving PA

47 Interviewee: Maybe a quarter of an hour.

48 Interviewer: What makes you stop?

49 Interviewee: First or now?

50 Interviewer: I am talking about now, and you have been suffering from being
51 diagnosed with COPD for 5 years.

52 Interviewee: I get tired.

53 Interviewer: Can you explain more, please? How do you feel tired?

54 Interviewee: My breathing stops. The inhale and exhale a little hard. Just to be clear, the
55 situation is fine now. At first, I was tired, but then it became better.

Commented [PR5]: Symptoms

56 Interviewer: I mean, approximately how long did you mean when you first
57 discovered the disease?

58 Interviewee: At first and then until I stopped smoking, when I stopped smoking, my
59 condition came back very well.

Commented [PR6]: Stop smoking relief symptoms

60 Interviewer: Oh good, I want you to make it clear to me, you said you are making
61 a festival show, do you mean in a certain period your physical activity increases
62 and some periods decrease?

63 Interviewee: Right, yes.

Commented [PR7]: Motivation:
Participate with dancing band (traditional band)

64 Interviewer: Why is your activity increased during occasions?

65 Interviewee: Yes, like this, when there are events and festivals, my situation becomes
66 good.

67 Interviewer: With the activities that you do, do you feel that you have the ability to
68 do a physical activity?

69 Interviewee: Yes, I have the ability, much better than in the beginning.

70 Interviewer: when you found out that you had COPD, did any of the doctors and I
71 don't know if you had physical therapy, did anyone advise you to do physical
72 activity?

73 Interviewee: I went to the hospital, and they told me that I must go for a long period of
74 physical therapy and walk, and they gave me sports movements, that is, breathing and
75 so on, and it helped me a lot.

Commented [PR8]: Access the Pulmonary rehab

76 Interviewer: OK, do you know how long it was and how many sessions did you
77 take?

78 Interviewee: About two months

79 Interviewer: How many days in a week?

80 Interviewee: Three days a week.

81 Interviewer: OK, did you participate in this program they call pulmonary
82 rehabilitation?

83 Interviewee: Oh, exactly.

84 Interviewer: When you participated in pulmonary rehabilitation, I want to ask you,
85 what are the benefits are you gained?

86 Interviewee: The first thing will be physical fatigue I got rid of the muffled. What I used to
87 have with any slight effort, but when I practised breathing with them, sports and walking
88 with them, frankly, it was excellent

Commented [PR9]: Benefits of PR

89 Interviewer: did your symptoms relieved?

90 Interviewee: Yes, a lot

91 Interviewer: OK, when did you finish your pulmonary rehabilitation?

92 Interviewee: I mean, about two years ago, before Covid.

93 Interviewer: And did you continue with the things you were doing?

94 Interviewee: No, I did not continue when I felt well, I did some exercise.

Commented [PR10]: After PR : stop exercise

95 Interviewer: I mean, you played sports, you're still trying to increase your
96 physical activity, after you left rehabilitation.

97 Interviewee: Yes, not regular sometimes.

98 Interviewer: so I asked you about your physical activity before you got COPD and
99 your physical activity now, do you feel any difference?

100 Interviewee: Yes, certainly not like the first, it was very good, I don't feel anything, but
101 now it's fine after I quit smoking and so, but I'm not the same as the first.

Commented [PR11]: effect of copd

102 Interviewer: has COPD affected your social life and quality of life?

103 Interviewee: No, thank God, not at all.

Commented [PR12]: QoL

104 Interviewer: good, what do you feel if they were available to you, you would be
105 more active than now?

106 Interviewee: Sports is the cure for everything, whether in a hospital or outside it,
107 however, a person could treat himself by himself, even if the doctor gives him one or
108 two exercises, after discharge if he does not have the desire to continue, he won't do
109 anything.

Commented [PR13]: Motivation: desire

110 Interviewer: From your point of view, what are the things that, if they were
111 available to you, would make you continue with physical activity? Especially in
112 Saudi Arabia

113 Interviewee: Nothing specific

114 Interviewer: you mean nothing other than desire?

115 Interviewee: Like I said, the desire is, the person to help himself by himself. There is
 116 nothing in my mind that is not available

Commented [PR14]: motivation

117 Interviewer: And you don't see any difficulties that exist for patients that might
 118 hinder physical activity?

119 Interviewee: Nothing

120 Interviewer: You mean what prevents only desire? Ok, do you see that family and
 121 friends can affect physical activity, I mean, can they make a person active or vice
 122 versa?

123 Interviewee: The house is a necessary thing; sure, they have an effect.

Commented [PR15]: Role of family to motivate him

124 Interviewer: Are you now an employee? nor retired.

125 Interviewee: retired

126 Interviewer: You settle your things yourself, and no one helps you if you bring
 127 things.

128 Interviewee: No, I have no one.

129 Interviewer: Do you have any difficulty with it?

130 Interviewee: No, never I don't need to, because my health is good

Commented [PR16]: Health

131 Interviewer: OK now, when was the last appointment with the doctor?

132 Interviewee: From two or three years ago.

133 Interviewer: Are there any coming appointments?

134 Interviewee: No

135 Interviewer: Have you used any medicines?

136 Interviewee: No, no, I don't have any medications. Keep taking them. I use 2 sprays to
 137 breathe, and with sports and walking, I no longer have fatigue or cough, but I did not go
 138 to the hospital, and I did not see how the lung is now

139 Interviewer: Alhamdulillah, now the situation is stable?

140 Interviewee: Yes, thank God, I didn't even take the medicines.

141 Interviewer: God bless you and thank you for your time.

Age	Weight	Hight	Diagnosed (years)
57	84	176	5

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11.1.26. Schedule of initial mapping of coding (manually)

11.1.27. COPD theme

Themes	Sub-themes	Codes
Barriers to PA	COPD Symptoms	Weakness, breathlessness
		Access to PR, no desire, shortness of staff
		Timing for appointment, retirement effect
Facilitators of PA	Benefits of PA	Expectation of benefits, social support
		Losing weight, doctor advice, travel, work motivation
		Need for supervised rehab, time management
	Knowledge and Expectations	??
Motivation for PA	External Motivation	Participating in social activities, traveling
		Work motivation, availability of suitable places
	Internal Motivation	Personal health goals, self-efficacy
		Positive role models, beliefs about PA benefits
Coping with COPD	Psychological Impact of COPD	Psychological and social effects of COPD
		Psychological barriers, lack of awareness
	Coping Strategies	Seeking solutions, smoking cessation
		Desire for improvement
Environmental Factors	Weather Preference	Weather considerations for PA
	Availability of Facilities	Lack of facilities, accessibility, and cost
	Social and Cultural Norms	Family and community responsibilities
		Influence of social norms on PA behaviour
		dress code, and culture factor
	Role of Family and Friends	Social support from family and friends

Non- COPD themes

Themes	Sub-themes	Codes	
Knowledge and expectations	Knowledge of PA Benefits of PA	Positive effects of PA	
Facilitators of PA		Personal health goals, intrinsic drive	
		Health benefits and weight maintenance	
		Internal Motivation	Environmental factors, social interaction
			Personal accomplishment, self-efficacy
			Positive role models and inspiration
Barriers to PA	Social support	Lack of awareness	
		Lack of social support	
	Access and Availability	Lack of suitable places and facilities	
		Weather, crowded city	
		Cost and accessibility	
	Social and Cultural Norms	Family and community responsibilities	
		shopping as a kind of activity	
		culture does not emerge with PA.	
		Influence of social norms on PA behaviour	

Transition and life changes	Social change	Women walking

11.1.28. AHPs Participants

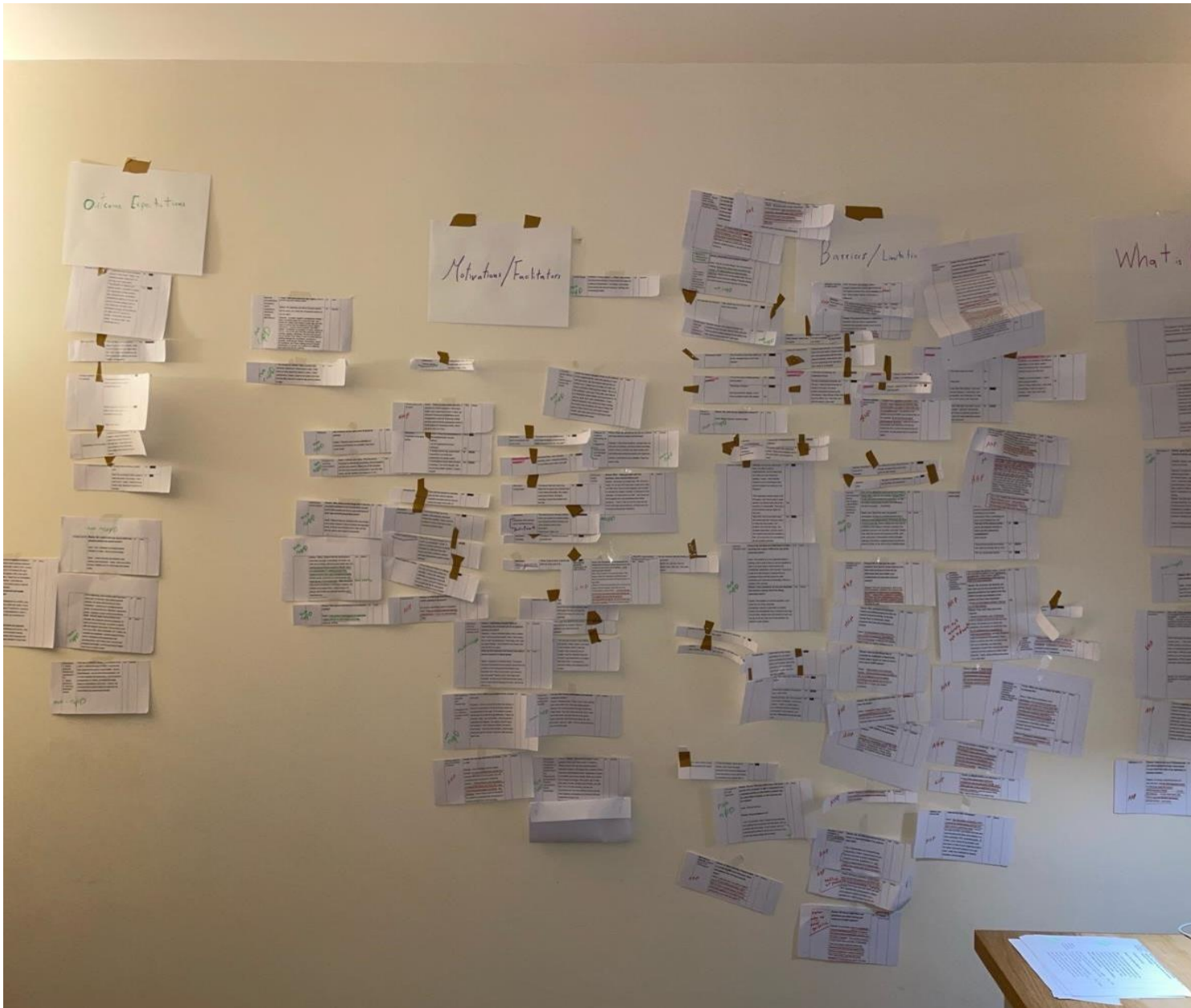
Themes	Sub-themes	Codes
Role of AHPs in PA	Definition and Importance of PA	Understanding and importance of PA
		Benefits of PA for COPD and interventions
	AHP Interventions and Strategies	Role of RT and AHPs in PR and monitoring
		Personalised exercise plans and dependence on therapists
Barriers to PA	Insufficient Knowledge and Expertise	Lack of exercise prescription knowledge
		Limited availability of PR centres and guidelines
		Lack of well-trained staff and authority to refer patients
	Psychological Barriers	Psychological factors affecting patients' PA
		Lack of awareness and education
	Social Barriers	Need for services, lack of confidence
		Social barriers (e.g., family and community)
Motivations for PA	Social Support	Support from family, friends, and groups
	Need for Psychological Support	Psychological support and patient motivation
	Collaboration and communication	Individualized exercise programmes, workshops, and suitable places
		Support for doctors in promoting PA
	Transition and life changes	Privet PR centre will be open
		Vision 2030

Final themes and sub-themes for all groups:

Theme	Sub-Themes	Codes
Theme 1: Individual Factors	Self-Efficacy	Not continuing PA due to lack of confidence, Personal accomplishment, Positive role models
		Stigmatization and isolation due to social norms
	Motivation and Goals	Self-regulation with achievable goals, Personal motivations for PA, Importance of sleep and lifestyle changes
		Benefits of PA (health improvement, disease prevention)
	Knowledge and Expectations	Understanding of PA, Expectations about its benefits
	Medical History	Physical limitations and medical conditions affecting PA
Theme 2: Environmental and Social Factors	Cultural and Social Influences	Cultural norms and dress code, Influence of societal changes on PA
		shopping as a kind of activity
		Recognises he is a minority consider,
	Social support	retirement affect her PA, Limited social support and loneliness
		Role of the family to support pt.
		no support group in Saudi Arabia
	Access and Availability	Financial constraints, Lack of transportation, Weather as a barrier
		Lack of suitable places for PA
	Transition and Life Changes	Impact of societal changes and Vision 2030
Theme 3: COPD-specific Factors	COPD Symptoms and Limitations	Physical symptoms (pain, tiredness, breathlessness)
		Reason of low PA in COPD; vicious cycle
	Pulmonary Rehabilitation	Importance of PR for COPD patients, Supervision, and motivation in PR
Theme 4: Healthcare Professional Factors	Knowledge and Expertise	Lack of awareness among doctors and healthcare professionals about PA
		Misunderstanding of PA and exercise terminology
	Integration of PA in Healthcare Settings	Lack of guidelines for primary care, Limited availability of PR centres

	Collaboration and Communication	Variations in therapists' approaches, Programme dependence on therapist's experience
		Lack of interest in PR and PA
		Need for training and education among healthcare professionals

11.1.29. List of all codes on walls to create categories and Themes



11.1.30. Themes and Sub-themes using NVivo

Themes and sub-themes using NVivo:

