

**The prevalence, socio-economic determinants, and related health
outcomes of energy drink consumption among young people in
Wales and Saudi Arabia: A mixed-method study**

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Summary

The consumption of energy drinks (EDs) by young people has become a public health concern: United Kingdom (UK) and Saudi Arabia are in the top 10 countries by per capita ED consumption. This study investigated the prevalence of ED consumption and the health and behavioural outcomes among young people by ED consumption in two culturally diverse areas: Wales and Riyadh.

A mixed-method design involving cross-sectional studies of young people was used: the Welsh Health Behaviour of School Children (N = 112,045) survey and a cross-sectional survey conducted in Riyadh (N = 2,000). A qualitative study explored the attitudes and perceptions of young people residing in Saudi Arabia.

ED consumption was prevalent in Riyadh; 52.5 % reported regular consumption compared to 40% in Wales. In both Wales and Saudi Arabia, ED consumption was positively associated with eating an unhealthy diet (Wales: OR 1.06, 95% CI 1.05 to 1.07; Saudi Arabia: OR 1.69, 95% CI 1.53 to 1.86), nicotine use (Wales: OR 4.66, 95% CI 4.35 to 5.00; Saudi Arabia: OR 5.91, 95% CI 3.47 to 10.07) and negatively associated with eating breakfast (Wales: OR 0.87, 95% CI 0.86 to 0.88; Saudi Arabia: OR 0.89, 95% CI 0.83 to 0.95) and feeling low, irritability and nervousness (Wales: OR 0.96, 95% CI 0.93 to 0.99; Saudi Arabia: OR 0.97, 95% CI 0.93 to 0.99).

Qualitative data indicated that most of the young people in Riyadh had little knowledge about ED active ingredients and associated health outcomes. Results indicated that the availability, affordability and marketing of EDs, along with peer pressure, play a fundamental role in the decision to consume EDs.

Since most of the participants reported regular consumption of EDs and acknowledged feeling some adverse health outcomes, there is a public health need to reduce the consumption of EDs.

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Glossary

ADHD	Attention deficit hyperactivity disorder
AORs	adjusted odds ratio
BAI	Beck anxiety inventory
BDI	Beck depression inventory
BF	Body Fat
BMI	Body mass index
BP	Blood pressure
CASP	Critical appraisal skills programme
CBCL	Child behavioural checklist
CDI	Children depressive inventory
CNS	Central nervous system
DBP	Diastolic blood pressure
DECIPHer	The Centre for the Development and Evaluation of Complex Interventions for Public Health Improvement
ED	Energy Drink
EF	Exploratory Factor Analysis
FAS	Family affluence score
FDA	The Food and Drug Administration
FFQ	Food frequency questionnaire
Fl. Oz.	Fluid Ounce
GARS	The Global Assessment of Recent Stress
HBSC	Health Behaviour in School-aged Children
HDL	High-density Lipoprotein

HOMA-IR	Homeostasis model assessment–insulin resistance index
HR	Heart rate
IR	Insulin resistance
KG	Kilogram
L	Litre
MetS	Metabolic syndrome
MG	Milligram
mmHg	Millimetres of Mercury
NBI	Nutrition-behaviour inventory
ND	Not Disclosed
OR	Odds Ratio
RR	The relative risk
S4SF	The sum of four skin-folds
SBP	Systolic blood pressure
SD	Standard Deviations
SES	Socio-economic status
SHRN	School health research network
SSB	Sugar-sweetened beverages
SSCB	Sugar-sweetened carbonated beverages
SUA	A Single Umbilical Artery
TBFM	Total body fat mass
TGs	Triglycerides
WHO	World health organisation
WS	Waist circumference

Chapter 1
Introduction

1.1 Energy drinks: definition and global consumption

Energy drinks (EDs) are beverages that contain caffeine, a central nervous system (CNS) stimulant, sugar, or artificial sweeteners, and herbal extracts (Seifert et al., 2011, Visram et al., 2016). The high levels of caffeine differentiate EDs from sports drinks, in which the primary ingredients are carbohydrates, which feed the muscles and replenish electrolytes and vital chemicals which are lost during prolonged, intense exercise (Ibrahim and Iftikhar, 2014, 2011). The last two decades have seen EDs become increasingly popular worldwide, predominantly among young people (Rath, 2012). The first commercial EDs, known as “Dr Enuf” entered the US market in 1949 (Alsunni, 2015). During the 1960s, EDs were marketed in Asia and Europe but did not become popular until the launch of Red Bull in Austria in 1987 and 1997 in the USA. Red Bull is a popular caffeinated ED that claims to improve physical activity and enhance mental performance (Alsunni, 2015, Reissig et al., 2009a). The EDs market has increased significantly in recent years (Reissig et al., 2009a), with more than 5.8 billion litres being consumed in 2013 across 160 countries (Alsunni, 2015).

1.2 The prevalence of EDs consumption

According to the Global EDs Report (2012), the highest per capita consumption of EDs was in USA, Vietnam, Cuba, UK, Thailand, Mexico, Australia, Germany, Poland, and Saudi Arabia (Nowak and Jasionowski, 2015). In 2012, the UK was shown to be the biggest consumers of EDs in the European Union and had the second-highest rate in the world after the United States of America (Hamilton and Wills, 2017). Consumption was said to increase from an average of 235 million to 600 million litres between 2006 and 2014 in the UK (Visram et al., 2017). Additionally, an increase in sales by 185% was reported in the UK, and this has been projected to rise more in the future (Hashem et al., 2017). Low-sugar and sugar-free EDs are being marketed, but the overall caffeine content remains the same (Visram et al., 2016). Zooming in on specific regions in the UK, there is currently a lack of studies on the effect of long-term use of EDs in adolescents. A study conducted by the Welsh government on behalf of the European Public Health Conference Parallel Programme in School-aged Children Survey involved 9,055 adolescents across 82 schools (Morgan et al., 2018). About 48% of the respondents reported on heavy use of EDs with frequent users comprising 16% of the overall users in the group. A higher incidence of EDs consumption was increasingly linked to binge drinking and alcohol consumption in addition to smoking, behavioural changes, and substance abuse (Locatelli et al., 2012, Arria and O'Brien,

2011). The motivation for the use of EDs amongst adolescents was primarily due to its taste and flavour as well as its ability to boost energy levels needed for studying (Aslam et al., 2013). Adolescents consuming these drinks reported a moderate to enhanced physical alertness. Peer pressure was another reason cited by adolescents for their increased use of Eds (Alsunni and Badar, 2011)

Research has shown that adolescents tend not to differentiate between sports drinks and EDs (Visram et al., 2017). However, more research is needed to be carried out on how these adolescents obtain these drinks.

1.3 EDs: consumption among young people, a public health issue

EDs were initially manufactured to target athletes and sports professionals. However, when ED consumption increased among the general public, these companies extended their marketing strategy to include adolescents and young adults (Azgaba et al., 2014).

In 2011, a European Food Safety Authority study revealed the prevalence of ED consumption in 16 countries of the European Union. Data from their study showed that young people between the ages of 10 to 18 years were the highest consumers (68%), compared with adults (30%), and children under 10 (18%). A study with 9,118 participants from a Canadian secondary school (Azagba and Sharaf, 2014) observed that 20% of the student cohort reported consuming EDs at least on a monthly or weekly basis. Another study conducted in the UK revealed that 30% of 21,995 participants aged 8 to 12 years; regularly consumed Eds (Terry-McElrath et al., 2014). Interestingly, high prevalence rates of ED consumption have also been observed among Saudi adolescents, where a reported 55% of 1,061 youths aged 12-19 years are consuming EDs once every week or more frequently (Musaiger and Zagzoog, 2013).

Adolescence is a crucial and influential stage in life, and any bad habits at this stage may impact healthy development and have consequences on the entire life span (Visram et al., 2015, WHO, 2017b, Musaiger and Zagzoog, 2013). Given the evidence of increasingly extensive use of EDs, it could be argued that any proof of the harmful effects of EDs on healthy development is likely to be significant, even if initially minor.

1.4 EDs: ingredients and possible side effects

Caffeine is the primary stimulating ingredient in EDs, with numerous other constituents, such as sugar, guarana, B vitamins, ginseng and taurine, which are usually added during the manufacturing process (Reissig et al., 2009a). EDs are sometimes supplemented with more caffeine by the addition of plant extracts such as guarana (Heneman and Zidenberg-Cherr, 2007, Babu et al., 2008, Reissig et al., 2009a). Guarana is a native Amazon plant whose seeds contain around four times the amount of caffeine found in coffee beans in addition to other natural chemicals believed to enhance the stimulating effects of guarana over caffeine alone (Moustakas et al., 2015). Caffeine is derived from natural sources, such as cacao bean, cola nut, roasted coffee beans, and tea, and can have a potential impact on the nervous system (Smith, 2002); with reported adverse effects on the cardiovascular system, including hypertension (Rachima-Maoz et al., 1998, Savoca et al., 2004, WHO, 2017a). A recent literature review revealed that healthy adults could consume up to 400 mg of caffeine daily without any adverse effects on the cardiovascular system, or any behaviour changes (Nawrot et al., 2003). However, the medical profession recommends that pregnant women and kids should consume caffeine in moderation, with limited daily consumption of maximum 300 mg and 2.5 mg/kg bodyweight for kids, respectively (Ibrahim and Iftikhar, 2014, Nawrot et al., 2003). Furthermore, adolescents should reduce the amount of daily caffeine intake, as caffeine exceeding 100 mg has been associated with hypertension (Savoca et al., 2004). Around 72-150 mg of caffeine can be found in one single serving of an ED (8-12 fl. oz.). However, many bottles or cans can include up to two to three servings, increasing the caffeine content to as high as 294 mg (Heneman and Zidenberg-Cherr, 2007). In comparison, one serving (8 fl. oz. = 236.59 ml) of coffee has around 134-240 mg of caffeine whereas one cup of tea contains from 48-175 mg, and caffeine levels in cola beverages have ranged from 22-46 mg of caffeine in one serving (Nawrot et al., 2003).

In addition to caffeine, sugar is the other potentially harmful ingredient contained in EDs. Sweetened beverages are considered to be a significant source of sugar among young people, providing a high calorie, low-nutrient diet (Costa et al., 2014). Moreover, excessive sugar intake could contribute to long-term health repercussions, such as weight gain and obesity, type II diabetes, tooth decay and erosion, poor nutrition, and the development of unhealthy eating behaviour (Apovian, 2004, Schulze et al., 2004). In addition to the potential adverse effects on physical health, Yu et al. (2016) studied the dose-dependent relationship between attention-deficit/hyperactivity disorder (ADHD) and sugar-sweetened beverage consumption in 946 of healthy children, aged 3-7 years.. The study revealed that the odds ratio for ADHD among children

who consumed sugar-sweetened beverages moderately (1 to 6 servings a week) and excessively (exceeding seven servings a week) was 1.36 and 3.69 odds, respectively.

In addition to caffeine and sugar, some EDs contain additional ingredients such as guarana, taurine, L-carnitine, and ginseng (Seifert et al., 2011, Visram et al., 2015), some of which are discussed in Table 1.1. Despite lack of research, Higgins et al. (2010) reported taurine and ginseng to play a fundamental role in certain body functions, such as carbohydrate metabolism; however, the combined effects of all the ingredients are not yet fully understood.

Table 1.1. Most common ingredients found in ED, benefits, scientific evidence, and safety of use.

Ingredient	Description	Benefits	Scientific evidence	Safety
Taurine	An amino acid naturally synthesised by the human body (Birdsall, 1998)	Prevents diabetes and epilepsy, and lowers blood pressure (Birdsall, 1998)	Use of taurine may prevent a heart attack by reducing blood pressure (Militante and Lombardini, 2002)	Certified by the FDA as a safe component. Insufficient data exists to suggest any adverse health effects (Clauson et al., 2008)
Guarana	A South American plant, whose seed contains four times the amount of caffeine compared to coffee (Moustakas et al., 2015)	Has the ability to stimulate the central nervous system, improve physical activity, and promote weight loss (Seifert et al., 2011) (Authority, 2000)	Effects are primarily due to caffeine content (Seifert et al., 2011); 1 gm of Guarana contains the same amount of caffeine (40 mg) that were found in a medium-strength cup of coffee (Authority, 2000)	Generally considered safe by the FDA (Clauson et al., 2008, Heneman and Zidenberg-Cherr, 2007, Seifert et al., 2011)
L-carnitine	An amino acid synthesised naturally in the human body (Rebouche, 1999)	Added to enhance fat metabolism, increase energy levels and prevent cardiovascular diseases (Heneman and Zidenberg-Cherr, 2007, Seifert et al., 2011)	No scientific proof that L-carnitine increases endurance (Brass, 2000) or weight loss (Saper et al., 2004).	No evidence to establish the safety of L-carnitine use (Heneman and Zidenberg-Cherr, 2007). However, high intake may cause sickness, stomach-ache, and diarrhoea (Seifert et al., 2011).
Ginseng	A type of herb, principally from Korea, Japan, and China (Clauson et al., 2008, Seifert et al., 2011)	Improved mental and physical performance, stress relief, and enhanced overall wellbeing (Ernst, 2002)	There is insufficient evidence suggesting the scientific benefits of ginseng use (Ernst, 2002, Heneman and Zidenberg-Cherr, 2007)	No evidence to establish the safety of ginseng use (Hashem et al., 2017). However, a high dose of ginseng could cause sleeplessness, headache, blood pressure and increase heart rate (Clauson et al., 2008, Seifert et al., 2011)

Table 1.2 lists the global top-selling EDs brands and their contents (per 240 ml). However, some EDs companies do not mention the actual amount of caffeine present in their product.

Table 1.2: Top-selling ED brands and contents

Contents per 240 serving	Red Bull	Monster	Rockstar	Full Throttle
Caffeine	80 mg	80 mg	120 mg	70.5 mg
Sugar	27 g	27 g	31 g	29 g
Taurine	1,000 mg	1,000 mg	1,000 mg	Reported as a part of 3,000-mg 'ED.'
Guarana	ND*	Reported as part of a 2,500mg 'Energy Blend'.	25 mg	Reported as a part of 3,000-mg 'ED.'
L-carnitine	ND*	ND	25 mg	Reported as a part of 3,000-mg 'ED.'
Ginseng	ND*	200 mg	25mg	Reported as a part of 3,000-mg 'ED.'

* ND = not disclosed

* Figure excludes levels of other ED stimulants, such as guarana that can enhance the effects of caffeine

* These ingredients are reported on the nutritional labels on the can. (Ishak et al., 2012)

ED manufacturers primarily rely on claims that the ingredients used to boost energy by increasing muscle strength and enhancing physical and mental performance without any side effects. However, there is not much scientific evidence to prove these claims (Nowak and Jasionowski, 2015).

1.5 EDs: adverse effects

As previously mentioned, the consumption of EDs has increased in the past two decades. It is, therefore, essential to examine the potential adverse effects of these beverages on consumer health. Recently, many studies have associated the consumption of EDs to several adverse effects on an individual's health, such as hemodynamic and psychological effects.

1.5.1 ED and hemodynamic

Numerous side effects owing to excessive consumption of ED is reported in adolescents, such as irritability, sleep impairment and insomnia, nervousness and anxiety, and in some cases, increased intoxication and even death (Seifert et al., 2011). Intoxication due to excessive ED intake is quite prevalent in adolescents due to reduced caffeine tolerance (Cappelletti et al., 2015).

Shah et al. (2016) carried out a meta-analysis to evaluate the effects of excessive EDs intake on blood pressure and heart rate in 30 Healthy volunteers between the ages of 18 and 40,, concluding that excessive ED consumption increased systolic blood pressure (SBP) and diastolic blood pressure (DBP) significantly by 4.44 mm Hg and 2.73 mm Hg, respectively, primarily due to caffeine. Similarly, Busuttill and Willoughby (2016) conducted a survey in 60 people and they reported that people who consume two or more cans of ED per day are more vulnerable to hypertension, as well as rapid heart rate, even among healthy individuals. Moreover, a recent clinical review by Ali et al. (2015) on the possible side effects of ED consumption revealed that greater than 50% of their case reports were related to heart diseases, followed by neurological problems. Grasser et al. (2014) also studied the acute effects of the popular ED, *Red Bull*, on the cardiovascular and circulatory system using beat-to-beat measurements among 25 healthy young people. He observed that the consumption of 355 ml of a sugar-sweetened ED led to an increase in cardiovascular burden by increasing blood pressure and heart rate.

Furthermore, Steinke et al. (2009) concluded that after four hours post-consumption of two cans of EDs in 15 healthy adults, the systolic blood pressure (SBP) and heart rate (HR) increased by 10 mm Hg, and from five to seven beats per minute respectively. The study by Ammar et al. (2001) also showed that 400 mg of caffeine increased SBP ($P < 0.01$) and DBP ($P < 0.05$) over three hours in ten healthy adults. However, EDs contain other stimulants such as guarana, taurine, and ginseng, which could cause hemodynamic issues (Grasser et al., 2014, Shah et al., 2016). It is a known fact that guarana contains a large amount of caffeine, and this may supplement the caffeine adverse effects. Interestingly, taurine is used to lower blood pressure in hypertensive patients, meaning that caffeine and taurine have opposite effects. It is, therefore, possible that the reason for the addition of taurine to EDs may be to decrease the blood pressure elevations caused by other components of ED (Shah et al., 2016). Also, Jovanovski et al. (2014) studied the effects of 400 mg Panax ginseng on blood pressure (BP) parameters in 23 healthy volunteers. They reported significant reductions in SBP and DBP (-4.4 ± 10.0 mm Hg and -3.6 ± 6.4 mm Hg, respectively) within three hours of consumption. Therefore, the differential effects of ED contents on hemodynamic changes

need further evaluation (Miles-Chan et al., 2015, Grasser et al., 2014, Shah et al., 2016). In summary, the above studies suggest that EDs do have adverse side effects on the hemodynamic and vascular systems, and the degree of impact depend mainly on their caffeine content (Grasser et al., 2014).

1.5.2 EDs and mental health

As caffeine is the primary ingredient in EDs, it is vital to examine the relationship between caffeine consumption and mental health. It has been implied that moderate caffeine intake negatively affected mental health, but this relationship appears not to be causal. With regards to stress levels, Hofmeister et al. (2010) conducted a study on 288 students and they reported that individuals who consume more than one could of ED per week have higher levels of stress, as compared to non-habitual consumers . More recent studies have confirmed that ED consumption does negatively impact anxiety levels (Evren and Evren, 2015, Trapp et al., 2014, Wesnes et al., 2013). Wesnes et al. (2013) reported that tension/anxiety scores of ED consumers increased, compared to placebo in in 94 healthy volunteer, one-hour post-consumption. Also, Salinero et al. (2014) concluded that anxiety, sleeplessness and hyperactivity are significantly higher in ED consumers, compared to placebo. Richards and Smith (2016) also noted a significant association between EDs and mental health, but the causation could not be determined.

1.5.3 EDs and behavioural changes

Many studies have investigated the association between ED consumption and habits such as smoking, alcohol and other substance use (Buchanan and Ickes, 2015, Arria et al., 2014, Polak et al., 2016). A survey conducted among 602 college students, observed that regular consumption of EDs saw a significant association with the use of smoking, alcohol, and marijuana use (Miller, 2008a). Similarly, Oteri et al. (2007) conducted a survey in 4,271 college students and they reported that students who drink EDs have higher frequency rates of alcohol and substance use and abuse, and behaviours changes, than non-consumers of EDs. Besides, Scalese et al. (2017) noted that EDs consumption and alcohol combined with EDs are significantly associated with habitual smoking, alcohol, and other drug use in 30,588 Italian high school students, aged 15-19years. The research by Arria et al. (2010) also observed that frequent ED consumers were likely to have a significantly higher level of alcohol and drug use, as well as a higher level of sensation-seeking, as compared those not consuming EDs in 1,060 students.. This study, along with previous literature indicates a definite correlation between sensation seeking and higher caffeine exposure, suggesting that this consistent relationship is due to the effects of caffeine (Jones and Lejuez, 2005). It has been stated that individuals with higher levels of sensation seeking tend to consume more caffeine to increase their

arousal and stimulation levels (Smith et al., 1986). However, a direct correlation between caffeine consumption and sensation seeking could not be determined (Jones and Lejuez, 2005).

1.6 *Factors relating to young people's consumption of EDs*

1.6.1 *Influence of social environment on the perception of EDs*

ED consumption among adolescents has been observed to be influenced by personal characteristics as well as those in social environments (Kremers et al., 2006). Various studies have also observed these factors to be often intermingled- for example, 383 male adolescents and those who perform less academically are more prone to be influenced by peer factors (van der Horst et al., 2007). The findings that male students were more likely to consume EDs had been recorded by various research groups- and are likely to be due to the 'masculine' marketing of these products (Visram et al., 2016). Another study that surveyed 865 students aged 13-18 years reported that 80% of students admitted consuming EDs at least once per week with the males consuming more than females (Musaiger and Zagzoog, 2013). Nevertheless, male adolescents also often tend to consume EDs during or after group physical activities- further associating a peer-pressure link for consumption (Nowak and Jasionowski, 2015). According to a study by Visram et al. (2017), (Musaiger and Zagzoog, 2013), EDs are also often marketed in a way that they result in additional savings when purchased in bulk; such offers further cause adolescents to pool in to cover costs, hence forming another link for peer-pressure factors. This study by Visram et al. (2017) also reported that male adolescents often consume EDs to appear tough; a pattern that eventually tends to be followed by other peers. According to a study by Wouters et al. (2010), peer-pressure associations do often rely on the availability of EDs.

In situations where EDs were not readily available (or were available only in high-cost brands), adolescents seem to influence each other less strongly. Familial influences on ED intake among adolescents are rather mixed-but peer influences have been observed to be more prominent. For example, in an Australian study, Jones (2011) conducted a study in 95 students and the findings reported that older adolescents (15- 17 years) were more consuming EDs at 'parties with friends' than they were during 'family gatherings' (even if ED consumption was non-restricted). Parental views regarding ED consumptions often vary significantly (based on parental education and cultural factors). Studies carried out in the UK among 37 young people had reported several parents who were ambivalent about their children consuming EDs; often also providing the children EDs for 'doing chores' or for 'replenishing' after physical activity (Visram et al., 2017).

1.6.2 The relation between perceived beliefs and ED consumption

The purchase and consumption of ED are primarily associated with their associations of perceived improvements in mental and physical performances. According to a study by Reissig et al. (2009a), these perceptions are due to the focussed marketing of EDs in terms of increasing energy and improving performance. Also, the other perceived marketed benefits (such as weight loss and improved stamina) remain unproven (Reissig et al., 2009a). In a study carried out in the United States, Cotter et al. (2013) observed adolescents cite reasons for ED consumption primarily to be to “play sports better” and to “stay awake in school”, followed by the consumption due to ED use among peers. Participants that reported perceived improvements in mental health performances cited EDs everyday use among adults to alleviate work-related tiredness. This study also reported reason such as “not to feel hungry” and “to lose weight”. Similar results were observed in an Australian study by O’Dea (2003); this study found that participants perceived various health-specific benefits from ED consumption- including improved immunity and the prevention of illnesses among 78 adolescents aged 11-18 years . The consumption of EDs has been perceived by consumers as being “necessary” to meet the demands of busy lifestyles (Costa et al., 2014). Across the studies mentioned above, very few respondents had raised awareness of the negative impacts of ED consumptions. According to Visram et al. (2016), ED consumers are often either unaware of the harmful effects or choose to ignore the possible risks. This had been observed in a 2015 Polish study as well where consumers reported using EDs for physical activity benefits and improved attention- despite nearly one-third of these respondents believing that EDs were terrible for their health (Nowak and Jasionowski, 2015).

Nevertheless, consumers from adult age groups (22- 35 years) are often more aware of the health risks surrounding EDs, showing greater scepticism on their safety profiles (Bunting et al., 2013). However, these concerns mostly surrounded the high sugar contents of EDs as opposed to their general consumptions. According to a study by Ishak et al. (2012), there is a clear need to make the consequences of ED consumption known to consumers; especially given that their primary uses revolve around the above-mentioned perceived benefits. Consumers must be made aware of adverse effects such as daytime sleepiness and reduced reaction times.

1.6.3 The influence of marketing on ED consumption

EDs are primarily marketed at adolescents and young adults with them being more often targeted at men through sexualised imagery, slogans and humour. The marketing influence

on ED consumption had been recorded by several studies reporting that participants find out about these products through sports sponsorship events, game promotions and the internet (Bunting et al., 2013). The marketing of EDs has been identified to follow a 'risk-taking' and 'hyper-masculinity' measures- to comprise a jock identity (Miller, 2008b). This pattern had been observed from the very beginning of ED production and sales, in which ED companies involve extreme-sport imagery to make their products more appealing to various individuals that perceive performance benefits to result from ED consumption (Miller, 2008b). Over recent years, ED companies have targeted their marketing to 'high octane' sports (such as motorsports) to further accelerate a perceived consumer association between these drinks and various performance benefits (Ho, 2006). In their study, Visram et al. (2017) conducted a qualitative study among 37 adolescents and they observed that rather than only targeting older adolescents, ED marketing has now also penetrated consumers in early adolescence, with the research group reporting that majority of respondents (aged 10- 14 years) displayed a strong awareness of several ED brands through advertising strategies and slogans used. This study also found several ED marketing campaigns targeted at the computer and mobile gaming applications wherein promotional codes that may be applied to these games are obtained from the ED packaging.

Interestingly, the targeted games were often restricted to older age groups- but they were familiar among early adolescent respondents. Also, recent studies have observed that alcoholic EDs are often packaged similarly to their non-alcoholic counterparts, likely targeting the 'risk-taking' youth populations (Simon, 2007). The study by Reissig et al. (2009a) also observed several EDs that seemed to follow illegal substance appearances/ names- for example, the ED named "cocaine" also had official video clips showing consumers snorting the ED. This had been observed by several other research groups as well, with several believing that ED companies had a stance that seemed to glorify the use of illegal substances (Miller, 2008b).

1.6.4 Differences in the consumption of ED in the UK and Saudi Arabia

Several studies have reported the prevalence of EDs consumption in the Western world (Malinauskas et al., 2007, Vercammen et al., 2019, Arria et al., 2011). However, there is a profound lack of knowledge on the prevalence of EDs consumption in adolescents in the Middle East, particularly in Saudi Arabia.

Musaiger and Zagzoog (2013) found that about fifty per cent of 1061 young people aged 12-19 years were not aware of the contents of EDs. More than 50% of the participants were well aware of the adverse effects EDs can have, such as elevated blood pressure, heart rate, blood sugar levels and micturition. The prevalence of EDs consumption in adolescents in the

three main cities of Saudi Arabia, Jeddah, Riyadh, and Al Khobar showed a 16% incidence rate of EDs consumption amongst the male population. Trends showed a three times weekly consumption of EDs amongst the adolescents participating in the study.

Several studies have demonstrated an increasing correlation between alcohol intake and EDs consumption (Pennay and Lubman, 2012). In the UK, for example, Johnson et al. (2017) conducted study among 2182 young people and the findings reported a significant positive correlation of ED consumption with alcohol in adolescents. Thus, Wales and Saudi Arabia were chosen for this study because of the limited literature available on the prevalence of ED consumption in adolescents in these regions. Additionally, we wanted to compare the predominance of EDs consumption amongst adolescents between these two regions due to their cultural differences. Saudi Arabia is a conservative state because of its religious practices, while Wales is much more liberal. As such, the perception of alcohol and EDs consumption in Wales and Saudi Arabia should be starkly different. In Wales, alcohol might usually be consumed during social gatherings such as parties or socialisation with friends and family, while this might not be the case in Saudi Arabia.

In addition to the above, the UK and Saudi Arabia have also taken a different form of action. For example, in the UK legislation has been passed to ban the sale of EDs by most major UK supermarkets for those under sixteen years of age (Smithers, 2018). Training of paediatricians and general practitioners on how to recognise the effects of EDs consumptions in the adolescent population is increasingly being enacted (BSDA , 2015). On the other hand, In Saudi Arabia, policies have been passed in order to ban the advertising of EDs by media outlets. Additional restrictions include the prohibition of free distribution of such drinks. The companies have been requested to have constituent labels along with health warning of adverse side effects to be printed in Arabic on the drink's labels. Special notes on the consumption of these drinks by pregnant and breastfeeding women, people with hypertension, heart diseases and diabetes were additionally included as well (Naeem, 2014).

Giving the differences between the patterns and consumption of ED, it is crucial to investigate the difference or similarity regarding ED consumption between young people living in two different part of the world.

1.7 Research Aims

This study aims to explore the prevalence of EDs consumption in young people (aged 13-20 years) in two different countries: Saudi Arabia and Wales and its association with 1) physical health, 2) mental health, and 3) behavioural changes. It also attempts to assess the factors leading to the consumption of EDs amongst young people in Riyadh, Saudi Arabia.

The objectives are to:

- Present a narrative review examining the potentially harmful effects of the main ingredients of EDs (sugar and caffeine) on health and also, to develop a better understanding of the mechanism of the main ingredients in EDs (caffeine and sugar) separately and in combination.
- Assess the prevalence rate of EDs consumption among young people in two different countries; Wales, and Saudi Arabia, with a focus on consumption patterns and associated demographic characteristics.
- Study the contributing factors that lead to the consumption of EDs amongst young people in Wales, as well as investigating any associated health outcomes (physical, mental, and behavioural changes).
- Assess young people's knowledge, awareness, and perception of EDs in Saudi Arabia and to identify reasons for consumption or non-consumption.
- Provide specific recommendations for further preventive strategies of ED consumption among young people in Wales and Saudi Arabia.

The specific research question will be presented in each chapter.

1.8 Overview of Thesis Contents

- Chapter 1 is the introductory chapter which gives general background about EDs and global consumption, as well as its potentially harmful effects, alongside the research objectives, research questions, and overview of the thesis contents.
- Chapter 2 presents the narrative review examining the effects of the main ingredients of EDs, namely sugar and caffeine, on health outcomes for children and adolescents to develop a more rigorous understanding of the mechanism of the main ingredients in EDs (caffeine and sugar) separately and in combination.
- Chapter 3 describes the methodology used for the study discussing the mixed-method approach, and ethical consideration of both quantitative and qualitative studies in this thesis are described in detailed.
- Chapter 4 presents the cross-sectional data provided by the 2017 Wales Health Behaviour in School-aged Children (HBSC) aimed to investigate the prevalence rate, socio-economic characteristics and associated health outcomes with EDs consumption amongst school-aged children in Wales.
- Chapter 5 presents a cross-sectional study aimed at investigating the prevalence rates, socio-economic characteristics, and physical, mental and behavioural outcomes associated with the consumption of EDs and the determinants contributing to the consumption of EDs amongst school-aged children, in Saudi Arabia.

- Chapter 6 presents a qualitative study and a more comprehensive investigation of the knowledge and perceptions concerning EDs in Saudi Arabia.
- Chapter 7 presents the main results of the study and the general discussion.
- Chapter 8 presents the specific recommendation strategies for both Wales and Saudi Arabia, and recommendation for future research are highlighted.

1.9 Conclusion

This chapter has clearly outlined an overview of EDs and its ingredients, providing an insight into the global prevalence of consumption rates and highlighted young people as the primary consumer. It has discussed the associated health impacts of ED consumption on young people's 1) physical and, mental health, along with reported behavioural changes.

The influence of the social environment, self-perceptions and beliefs, and marketing tools have been highlighted as motivating factors for ED consumption among young people

To begin, **(Chapter 2)** will introduce a narrative review examining the effects of the two main ingredients of EDs (Caffeine and sugar) on young people' health with a focus on physical, mental, and behavioural outcomes.

CHAPTER 2

A Narrative Review of the Harmful Effects of Energy Drinks in young people.

2.1 Introduction

As discussed previously in **(Chapter 1)**, the consumption of ED has become a significant cause for concern. The rise in EDs consumption in recent years, by children and young adults, has been attributed to the marketing techniques implemented by ED companies. The harmful effects of EDs are often discussed on mainstream media, concentrating mainly on the effects of caffeine and sugar present in high quantities (Seifert et al., 2011). By directing information on how the ingredients of EDs can help boost energy, improve physical, mental performance and muscle strength, they centre their marketing strategies on their primary consumers - children and young adults (Buchanan et al., 2017). However, there is no scientific evidence to prove the benefits of these drinks among the young (Nowak and Jasionowski, 2015).

Caffeine is the main constituent in EDs, and one serving (8-10fl.oz) of ED can contain as much as 72-150mg of caffeine or even more (Heneman and Zidenberg-Cherr, 2007). Although caffeine can increase alertness, enhance mental and physical performance and improve moods (Malinauskas et al., 2007), high concentrations of caffeine can cause intoxication (Ward et al., 2014), increase in heart rate, hypertension and increased urination (Gunja and Brown, 2012) along with anxiety, stress, and depression (Richards and Smith, 2016).

Young adults and children are more vulnerable to these side effects due to their lower body mass when compared to adults (Hering-Hanit and Gadoth, 2003). The average concentration of sugar in ED exceeds the recommended daily levels of sugar intake (25g) for young people (Association, 2019). One serving (8-10fl.oz) of ED can contain as much as 27-31mg sugar (Visram et al., 2016). High consumption of sugar has been associated with health complications such as diabetes, obesity and oral health (Visram et al., 2016, Imamura et al., 2016).

Several studies have discussed the effects of sugar and caffeine in combination, but the combined effects on children and young adults have not been addressed so far. This chapter, therefore, reviews the effects of the active ingredients; caffeine and sugar in EDs, on young people's physical, mental and behavioural health. Through extensive research of the literature, positive, negative and variable effects of the active ingredients will be reviewed.

The objective of this literature review is:

1. To investigate documented associations between consumption of EDs, by young people and children, and their physical health, mental health and behaviour.
2. To understand the associations of the two active ingredients, caffeine and sugar in EDs, independently and in combination.

2.2 Methods:

2.2.1 Literature search strategy

Strategically used keywords can help researchers build a systematic literature search to locate relevant files (Randolph, 2009). Three keywords were used to search for literature on the effects of a high-sugar diet on young adults in order to fulfil the first objective (Table 2.1).

Table 2.1: Keywords for searching the database for the effects of a high sugar diet among young people

Search term	Synonyms
Adolescents	Children, child, teenagers
Sugar	Sweetened beverage, glucose
Health effects	Impacts, consequences

Table 2.2 below shows the keywords used to search the database and journals for the second review, which is looking for the effects of caffeine on young people

Table 2.2: Keywords used to search literature, in databases, on the effects of caffeine on young people

Search term	Synonyms
Adolescents	Children, child, teenagers
Caffeine	Caffeinated beverages
Health effects	Impacts, consequences

In addition, the Boolean operators “AND” and “OR” were used to structure the search process. The Boolean operator “AND” was used to combine two or more keywords, whereas “OR” was used for either key term in order to broaden the search (Aveyard, 2010).

2.2.2 Inclusion and exclusion criteria

Inclusion and exclusion criteria are used to eliminate irrelevant data and helps focus on the main topics of the research material (Aveyard, 2014). The supervisor provided help during the inclusion and exclusion of relevant literature. The supervisor helped in identifying the relevant research literature, databases and other sources, and also provided constructive criticism in regards to each paper initially selected, which helped clear doubts in regards to papers to be included or excluded in the study.

In order to ensure the reliability of data used in this review, only published research papers in journals were used, and the chosen publications were further critically evaluated to assess their quality, in spite of the assumption that all journal publications are accurate, reliable, valid and free of bias (Boaz and Ashby, 2003). Unpublished research data may cause publication bias and increase the possibility of data and analytical methods not being correctly or entirely reported, so all unpublished research was excluded (Boaz and Ashby, 2003).

Studies older than 1997 were not included for review in this study. Research conducted on only healthy young people aged between 6-18 years were included (Ramírez-Maestre et al., 2019), whereas, all the studies on young people with health conditions such as diabetes or obesity were excluded from the analysis. Published literature on the association of high-sugar diets and caffeine were assessed based on three primary outcomes – physical health, mental health and behavioural factors. The eligibility criteria used are listed in Table 2.3, and the rationale for adopting the exclusion criteria is listed in Table 2.4.

Table 2.3: Eligibility criteria

Type of study	Primary studies published from 1997 until date, relating to the effects of a high-sugar diet among young people were used for the first review. Primary studies published from 1997 till date, relating to the effects of caffeine on young people were used for the second review.
Population	Young people, age 6-18 years
Outcomes	Physical health, mental health and behavioural factors

Table 2.4: Inclusion criteria and rationale

Inclusion criteria	Rationale
Primary studies relating to high-sugar intake among young people, age 6-18 years, was used for the first review. Primary studies relating to high-caffeine intake among young people, age 6-18 years was used for the second review.	Studies focusing on adults were excluded.
Published studies	Ensures reliability
Studies published after 1997	The first energy drink to be introduced in the USA was in 1997. Since the researcher is interested in the effects of ED on health, there were not many studies published before that year (Reissig et al., 2009b).
Publications only in the English language were included.	The researcher is fluent in English and Arabic, but there are no studies available in Arabic regarding EDs in young people.

2.2.3 Database search

Since this study is focused on the effects of EDs on young people, it is researched to explore the public viewpoint using five leading databases to search and analyse literature:

1. The Cochrane Central Register of Controlled Trials (CENTRAL) in The Cochrane Library which is a database holding a highly concentrated source of randomised control trials.
2. PubMed
3. Cumulative Index to Nursing and Allied Health Literature (CINAHL).
4. Medical literature Analysis and Retrieval System Online, or MEDLARS Online (MEDLINE).
5. PsycINFO.

2.2.4 Data Synthesis

Collected data were reviewed, synthesised into a report and conclusions were drawn. As mentioned in the previous chapter, this study focused only on quantitative studies. The two more commonly used methods for analysing quantitative data is a meta-analysis and narrative synthesis. While meta-analysis uses a statistical method that combines a group of quantitative studies based on the same research questions (Aveyard, 2010), a narrative synthesis follows a textual approach to analyse diverse literature by focusing primarily on the use of words and text (Snilstveit et al., 2012). By adopting a narrative synthesis approach for this study, research data was collected to understand if there is a potential clinical, statistical or methodological heterogeneity amongst the included studies. The quality assessment for all included paper in this review (see Appendix A)

2.3 Results

2.3.1 Search results

By implementing the corresponding restrictions during the literature search, a total of 21 studies that met the predetermined selection criteria for the first review were selected and 12 for the second review. Figures 3.1 and 3.2 represent the flow chart that was followed throughout the search process and according to which all sources were either accepted or rejected for this study.

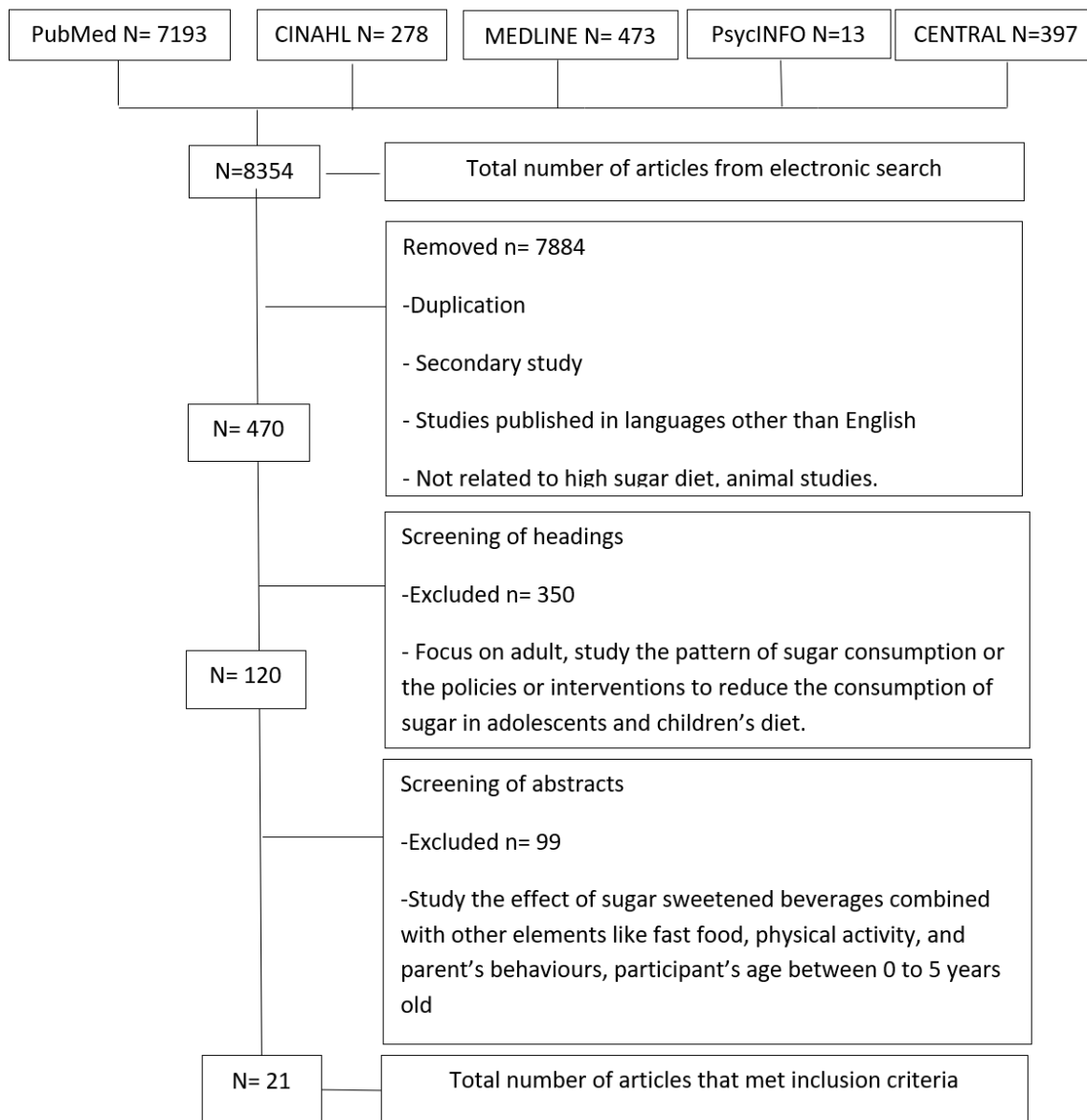


Figure 2.1: Flow chart demonstrating each step of the search process for the first review

2.3.2 Description of studies included in the first review

Figure 2.1 summarises the characteristics of the studies that have been included in the first review focusing on the effects of high-sugar intake by children and adolescents. Table 2.5 states the year of the study, population age and sample size, study design, outcome measures and principal findings.

Table 2.5 The important characteristics of the studies included in the first review.

Authors (year), country.	Population, sample	Aim of the study	Study design, methods	Outcome measures	Principal findings
Ambrosini et al. (2013) , Australian	1433 adolescents Age 14-17 years	To test the hypothesis that higher SSB intakes are associated with an increase in cardiometabolic risk factors between 14 - 17 years of age	Cross-sectional study	<p>- SSB intakes were estimated by using a food-frequency questionnaire; measurement of body mass index (BMI), waist circumference, blood pressure, fasting serum lipids, glucose, and insulin levels, and the overall cardiometabolic risk was estimated.</p> <p>- The potential link between cardiovascular disease risk factors and SSB intake was studied with adjustment for age, pubertal stage, physical fitness, socio-economic status, and major dietary patterns.</p>	<p>- Girls who consume SSB (1.3 servings/day) had increased BMI (3.8%; 95% CI: 1.8%, 5.7%), increased weight and higher obesity risk (OR: 4.8, 95% CI: 2.1, 11.4), and greater overall cardiometabolic risk (OR: 3.2; 95% CI: 1.6, 6.2) (all P-trend <0.001).</p> <p>-Girls and boys who moved into the top tertile of SSB intake showed elevated triglycerides (7.0–8.4%; P <0.03), and boys showed reductions in HDL cholesterol (23.1%;95% CI: 26.2%, 0.1%; P-trend< 0.04) independent of BMI.</p>
Berentzen et al. (2015) , German	2406 children. Age 11 years	To assess the associations between six different types of soft drinks and asthma in 11-year-old children.	Cross-sectional study	- Data analysis of 2406 children participating in the Dutch Prevention and Incidence of Asthma and Mite Allergy birth cohort. At age 11, children self-reported consumption of sugar-added drinks, diet drinks, sweetened milk drinks, 100% fruit juice, EDs and sports drinks. The definition of asthma was based on parental reports of wheezing, prescription of inhaled corticosteroids and doctor's diagnosis of asthma.	-Strong and statistically significant associations were observed for high consumption of 100% fruit juice (≥ 10 gl/wk.; OR:3.53, 95% CI:1.61–7.72); total SCB (421/5 gl/wk.; OR: 3.29, 95% CI: 1.23–8.85) and sugar-added drinks (≥ 10 gl/wk.; OR: 2.34, 95% CI: 1.10–5.000
Bigornia et al. (2015) , UK	2455 children Age 10 –13 years	To evaluate the prospective relationship between changes in sugar-sweetened beverage (SSB) intake and central adiposity in older children	A prospective cohort study with up to 3 years of follow-up.	-Dietary intakes of children were obtained by 3-day food records at ages 10 and 13 years. Waist circumference (WC), weight and height to determine BMI was measured at 10 and 13 years and total body fat mass (TBFM) was measured at 13 years.	- Increased SSB consumption from ages 10 to 13 years was associated with higher Waist circumference (standardized $\beta=0.020$, P =0.19), BMI ($\beta=0.028$, P=0.03) and total body fat mass ($\beta=0.017$, P=0.20) at 13 years.

<p>Carwile et al. (2015), USA</p>	<p>9033 girls Age 9–14 years</p>	<p>To explore the association of total and individual SSBs and age at menarche in a large,</p>	<p>A prospective cohort study with relevant follow-up questionnaires was administered annually up to 5 years.</p>	<p>-Cumulative updated SSB consumption inclusive of non-carbonated fruit drinks, sugar-sweetened soda and iced tea, was calculated using annual Youth/Adolescent Food Frequency Questionnaires from 1996 to 1998. Age at menarche was self-reported annually. The association between SSB consumption and age at menarche was assessed using Cox proportional hazards regression.</p>	<p>- Premenarcheal girls who reported consuming 1.5 servings of SSBs per day were on average, 24% more likely [95% confidence interval (CI): 13, 36%; P-trend<0.001] to attain menarche in the next month relative to girls consuming ≤two servings of SSBs weekly, adjusting for potential confounders including height, but not BMI (considered an intermediate). Correspondingly, girls consuming 1.5 SSBs daily had an estimated 2.7- month earlier menarche (95% CI: 24.1, 21.3 months) relative to those consuming ≤2 SSBs weekly.</p>
<p>Chan et al. (2014), Taiwan</p>	<p>2727 adolescents Age 12 - 16 years</p>	<p>To examine the gender-specific association of SSB intake with metabolic syndrome (MetS) among adolescents in Taiwan.</p>	<p>Cross-sectional study</p>	<p>- A questionnaire was used to collect demographic, dietary, physical and anthropometric parameters, and serum lipid profiles including HDL-C, low-density lipoprotein cholesterol (LDL-C), TGs and total cholesterol levels. and glucose levels were determined</p>	<p>- An increased SSB intake was linked to greater waist circumference in both sexes and systolic blood pressure in boys (P ≤0.043). - boys who ingested 1-500 and >500 mL of SSBs per day exhibited triglycerides levels that were 8.0 and 8.2 mg/dL higher than those of non-drinkers.</p>
<p>Coldwell et al. (2009), Washington, United States</p>	<p>143 children Age 11- 15 years</p>	<p>To evaluate perceptual, physiological and eating habit differences between children choosing solutions high in sugar compared to children preferring solutions low in sugar.</p>	<p>Cross-sectional study</p>	<p>-Sip and spit methodology were used to assess their hedonic profile, detection threshold, and perceived intensity of sucrose. -Self-Assessment of Puberty using a questionnaire based on the Pubertal Development Scale. -Serum samples were used to measure concentrations of oestradiol and progesterone in females, and total testosterone in males. - Plasma samples were analysed for leptin. -Eating Behaviours Questionnaire was used.</p>	<p>-There was no significant difference reported in the age, height, body weight, and per cent body fat between the two groups of children. - Plasma leptin levels reported were significantly higher in the high sugar preference group than in the low preference group, when using body mass index percentile and age as covariates in the analyses [F (1,129) = 5.64, p < 0.05] - High preference and low preference groups significantly differed in hedonic rating of sucrose solutions at every concentration tested [F(1, 139) = 75.0, p<0.01, Newman-Keuls, p's<0.05]</p>

<p>Hur et al. (2015), Korea</p>	<p>770 children Age 7 years</p>	<p>To identify associations between total sugar intake, sugar intake from different foods (fruit, milk, and sugar-sweetened beverages), and continuous metabolic syndrome and adiposity scores among Korean children and adolescents</p>	<p>Cohort Study with up to a four-year follow-up.</p>	<p>- Dietary intake data were collected via the three-day 24-h food records, and sugar intake was calculated for the total sugar in foods using the database from various sources.</p> <p>-Anthropometric measurements, body composition assessment, and blood analysis were performed at baseline and follow-up four years later.</p> <p>- The cMetS was calculated based on lipid profile, glucose, mean arterial blood pressure and waist circumference.</p>	<p>- The negative associations between daily fruit sugar intake and body mass index z-score and body fat per cent at baseline retained statistical significance ($\beta = .10$, $p = 0.02$, $\beta = .78$, $p < 0.01$, respectively).</p> <p>- A significant positive relationship between consumption of sugar from sugar-sweetened beverages and continuous metabolic syndrome scores at baseline ($\beta = 0.04$, $p = 0.02$), but that association was not observed at follow-up ($p = 0.83$).</p>
<p>Jensen et al. (2013), Denmark.</p>	<p>1024 children Age 6 years</p>	<p>To assess the association between sugar-sweetened drink intake at age 6 and 9 years and the subsequent 3 to 7-year changes in body mass index (BMI) and the sum of four skin-folds (S4SF).</p>	<p>A longitudinal study</p>	<p>- Information on sweetened drink intake using seven days of food record and physical activity (accelerometer) were obtained at age six years ($n = 366$) and nine years ($n = 269$). Weight, height and S4SF were measured at age 6, 9 and 13 years. Additional information on socio-economic status, maternal Body mass index and pubertal status were self-reported.</p>	<p>- No associations were observed between sweetened drink intake at age six years and change in BMI or logS4SF from age 6 to 9 years or 6 to 13 years.</p> <p>- No associations were observed between change in sweetened drink intake from age 6 to 9 years and subsequent change in BMI or logS4SF from age 9 to 13 years.</p> <p>-A weak direct association was observed between sweetened drink intake at age 9 years and change in logS4SF from age 9 to 13 years (per 100 g ~ 3.38 fl oz) (b: 0.014, 95% confidence interval [CI]: -0.001 to 0.029, $P = 0.06$</p>
<p>Jia et al. (2012), Beijing</p>	<p>322 adolescents Age 11-15 years</p>	<p>To discuss the consumption of SSBs among junior high school students and explore the relationship between SSB intake and adolescents' overweight /obesity in Beijing</p>	<p>Cross-sectional study</p>	<p>- A self-administered questionnaire and 24-hour dietary recall for three consecutive days (2 weekdays and one weekend day) were used in this study to collect nutritional information.</p>	<p>-Consumption of SSBs has a positive association with levels of overweight/obesity among male students.</p> <p>- It is indicated that when controlling for age and total energy intake, the subjects with the high level of SSBs intake were 2.59 times more likely to be obese/overweight than the ones with the low level of SSBs intake</p>

<p>Katzmarzyk et al. (2016), Australia, Brazil, Canada, China, Colombia, Finland, India, Kenya, Portugal, South Africa, UK, and the United States.</p>	<p>6162 children Age 9–11 years</p>	<p>To determine the association between regular (sugar-containing) and diet (artificially sweetened) soft drink consumption and obesity in children from 12 countries ranging in levels of economic and human development</p>	<p>A Multi-National Study Cross-sectional study</p>	<p>- Information on soft drink consumption was obtained using a food frequency questionnaire. Percentage body fat (%BF) was estimated by bio-electrical impedance analysis, body mass index (BMI), Z-scores were calculated using World Health Organization reference data, and obesity was defined as a BMI > +2 standard deviations (SD).</p>	<p>-A significant linear trend in BMI Z-scores across categories of consumption of regular soft drinks in boys (p = 0.049), but not in girls was seen.</p> <p>-No significant trends in %Body Fat or obesity were observed in either boys or girls.</p> <p>-No significant linear trend across categories of diet soft drink consumption in boys was seen, but there was a positive correlation in girls for BMI z-score (p = 0.0002) and % BF (p = 0.0001).</p>
<p>Kell et al. (2014), United States.</p>	<p>320 children Age 7–12 years</p>	<p>To explore the association between added sugars consumption in children, and CVD risk factors, specifically blood pressure (BP) and blood lipids.</p>	<p>Cross-sectional study</p>	<p>- 2 BP measurements were taken at 18:00 and two more the next day at 07:00. The systolic and diastolic Blood pressure was averaged from a total of 4 measurements each.</p> <p>- Fasting blood samples were collected, and complete lipid profile was done using a Stanbio SIRRUS analyser. LDL cholesterol was calculated using the Friedewald method.</p>	<p>-A significant positive relation was observed between added sugars and diastolic BP (P = 0.0462) but not systolic BP.</p> <p>-Added sugars were positively associated with triglycerides (P = 0.0206), but no other blood lipids</p>
<p>Kondaki et al. (2013) In ten European cities: Athens, Heraklion (Greece), Dortmund (Germany), Ghent (Belgium), Lille (France), Pécs (Hungary), Rome (Italy), Stockholm (Sweden), Vienna (Austria) and Zaragoza (Spain)</p>	<p>546 adolescents Age 12.5–17.5 years.</p>	<p>To evaluate the relationship between the consumption of certain food groups and insulin resistance, stressing on SSB, in European adolescents.</p>	<p>Cross-sectional study.</p>	<p>- Homeostasis model assessment–insulin resistance index (HOMA-IR) was calculated.</p> <p>-Several anthropometric and lifestyle characteristics were recorded. Physical activity was measured by using an accelerometer.</p> <p>-Dietary intake assessment was done using a short food frequency questionnaire, and the frequency of consumption was recorded.</p>	<p>- Mean values of HOMA-IR were also higher in adolescents consuming SSB 0.5 times per week compared with those consuming less frequently.</p> <p>-A statistically significant difference was seen between those consuming SSB 5–6 times per week and 2–4 times per week (P=0.049)</p>

<p>Laverty et al. (2015), UK</p>	<p>13,170 children Age 7–11 years</p>	<p>To study associations between sugar-sweetened and artificially sweetened beverages consumption and changes in adiposity in a nationally representative sample of UK children.</p>	<p>A longitudinal study</p>	<p>- Information on soft drink consumption was obtained using a questionnaire. -Outcome measures were Body Mass Index (BMI) and percentage body fat and Height</p>	<p>-Daily SSB consumption was associated with increase in percentage body fat, ages 7 – 11 years (+0.57 %, 95 % confidence intervals 0.30; 0.83). -Daily artificial sweetener drink consumption was linked with increased percentage body fat at age 11 (+1.18 kg/m², 0.81; 1.54) and more increases between ages 7 and 11 (+0.35 kg/m², 0.09; 0.61).</p>
<p>Lien et al. (2006), Norway.</p>	<p>5498 adolescents Age 15–16 years</p>	<p>To examine whether there was a link between high intake of sugar-sweetened soft drinks with mental distress, hyperactivity, and conduct disorder among adolescents</p>	<p>Cross-sectional study.</p>	<p>- The Hopkins Symptom Checklist and the Strengths and Difficulties Questionnaire was used to assess mental health outcomes. - Two of the subscales, Hyperactivity and Conduct disorder, were used, together with the total difficulties score</p>	<p>- There was a strong association between soft drink intake and mental health problems among adolescents. - Among both boys (OR = 2.8; 95% CI = 1.8, 4.4) and girls (OR = 4.1; 95% CI = 2.0, 8.4), adjusted odds ratios were highest for conduct problems. - Among both boys (OR = 1.4; 95% CI = 0.88, 2.17) and girls (OR = 1.50; 95% CI = 0.94, 2.39), adjusted odds ratios were highest for hyperactivity. -This association remained significant after adjustment for social, behavioural, and food-related factors.</p>
<p>Lin et al. (2013), Taiwan.</p>	<p>2727 adolescents Age 12 -16 years</p>	<p>To investigate the impact of SSB intake on serum uric acid, body mass index (BMI) and systolic blood pressure (SBP) among adolescents in Taiwan.</p>	<p>Cross-sectional study</p>	<p>-Dietary assessment was done using the semi-quantitative food frequency questionnaire that included a total of 23 food groups. -Daily dietary patterns were evaluated over the previous month. -Blood specimens were collected from participants after three weeks of data collection.</p>	<p>-Adolescents who drank 4500 ml SSB per day had a 0.24–0.41 mg/dl higher level of SUA than that of non-drinkers. - An increased SSB intake was found to be associated with an increased level of the waist and hip circumferences, body fat, BMI, SBP and SUA (P trend<0.005). The level of these outcomes increased by 3.27 cm, 3.90 cm, 3.25%, 1.70 kgm², 3.47mmHg and 0.61 ml/dl, respectively, among adolescents who consumed >750 ml per day of SSB, as compared with non-drinkers.</p>

<p>Lin et al. (2016), Taiwan.</p>	<p>1454 adolescents Age 12-16 years</p>	<p>To determine the association between SSB consumption with biomarkers of insulin resistance (IR) and investigate whether/how this relates to obesity and serum uric acid in adolescents.</p>	<p>Cross-sectional study.</p>	<p>-Dietary patterns over the previous month were recorded using the semi-quantitative food-frequency questionnaire that included a total of 23 food groups.</p> <p>-Blood specimens were prospectively collected from participants.</p> <p>-Fasting plasma glucose was measured, and serum uric acid was assessed.</p>	<p>-Adolescents who consumed a higher amount of SSBs were more likely to have elevated fasting serum insulin levels, HOMA1-IR, and HOMA2-IR levels (P trend<0.028) compared with SSB non-drinkers.</p>
<p>Martin-Calvo et al. (2014), Spain</p>	<p>348 children and adolescents Age 5.5–18.8 years</p>	<p>To assess the association between the consumption of sugar-sweetened carbonated beverages (SSCB) and obesity in children and adolescents</p>	<p>Case-control study</p>	<p>- This was a matched, case-control study design. The exposure, SSCB consumption (1 serving: 200ml), was measured with a previously validated FFQ.</p> <p>-Anthropometrical measures were taken using standardized protocols. Obesity was defined as BMI above the age- and sex-specific 97th percentile according to the Spanish reference charts.</p>	<p>- High consumption of SSCB (4 servings/week) was significantly associated with obesity (OR=3.46; 95% CI 1.24, 9.62; P=0.01). Furthermore, each additional daily serving of SSCB was associated with a 69% relative increase in the risk of obesity (OR=1.69; 95% CI 1.04, 2.73; P=0.03).</p>
<p>Nguyen et al. (2009), UK</p>	<p>4867 adolescents Age 12–18 years</p>	<p>To evaluate whether SSB consumption, a significant source of dietary fructose, is associated with higher serum uric acid levels and blood pressure in adolescents</p>	<p>Cross-sectional study.</p>	<p>- Dietary intake was measured with the 2004 Block FFQ for Children a semi-quantitative instrument that inquiries about the frequency and portion size of consumption of 72 food and beverage line items and six clarification questions on food types, over the past week.</p> <p>-Blood was collected after an overnight fast and used to measure plasma HDL cholesterol and TGs.</p>	<p>- Serum uric acid increased by 0.18 mg/dL, and systolic blood pressure z-score increased by 0.17 from the lowest to the highest category of sugar-sweetened beverage consumption (P for trend 0.01 and 0.03, respectively).</p>
<p>Park et al. (2012), USA</p>	<p>16,188 adolescents Age 14-18 years</p>	<p>To examine the association of self-reported academic grades and other correlates of sugar-sweetened soda intake among a large, nationally representative sample of high school students.</p>	<p>Cross-sectional study</p>	<p>- The main outcome measured was daily sugar-sweetened soda intake during the seven days before the survey.</p> <p>-For the behavioural variable, students were asked about dietary behaviours during the past seven days.</p>	<p>-Significantly associated with sugar-sweetened soda intake at least one time per day during the past seven days: male gender (OR=1.47), Hispanic ethnicity (vs white; OR=0.81), sleeping 8 hours on an average school night (OR=1.18), and current cigarette use (OR=2.01).</p>

					- Weight status was not significantly associated with sugar-sweetened soda intake after adjusting for other factors.
Schwartz et al. (2015), USA.	1649 adolescents Age 10-14 years	-To Describe patterns in sweetened beverage consumption by race/ethnicity and sex, documenting both the amount and types of sweetened beverages consumed. -To examine the association of sweetened beverage consumption with hyperactivity/inattention symptoms among middle school students	Cross-sectional study.	- 24 hr recall method was used by Students to self-report quantity and types of sweetened beverages consumed in the past 24 hours. -The five-item Hyperactivity/Inattention subscale of the strengths and difficulties questionnaire was used to measure hyperactivity/inattention symptoms.	- Risk of hyperactivity/inattention increased by 14% for each additional sweetened beverage consumed (adjusted for age, race/ethnicity, sex, school lunch eligibility, family structure and sugary food consumption. -Students reporting consumption of EDs were 66% more likely to be at risk for hyperactivity/inattention after adjusting for the number of drinks, other types of drinks consumed and other potential confounders
Yabao et al. (2005), Philippines.	1200 children Age 6–12 years.	To determine the prevalence of dental caries and the level of sugar consumption among 6 to 12-year-old schoolchildren	Cross-sectional study	- A questionnaire was distributed to obtain information on the dental history. Caries diagnosis was made based on the WHO recommendation. -The total food consumption with sugar was evaluated using a food frequency questionnaire (FFQ).	- No significant correlation was found between sugar intake and dental caries. - children who eat snack twice a day are 2.3 more likely to have dental caries (OR=2.3; 95% CI 1.04, 2.73; P<0.01). - The results seemed to contradict the traditional concept linking sugary foods to the formation of dental caries. -The study reported only 50% of the dental caries was caused due to the consumption of foods high in sugar

2.3.3 Different characteristics of the studies that were selected

From the 21 studies, 19 chosen studies for the review were carried out across 11 different countries: the USA, (Carwile et al., 2015, Coldwell et al., 2009, Kell et al., 2014, Park et al., 2012, Schwartz et al., 2015); the UK, (Bigornia et al., 2015, Lavery et al., 2015, Nguyen et al., 2009); Taiwan, (Chan et al., 2014, Lin et al., 2016, Lin et al., 2013); Korea, (Hur et al., 2015); Denmark, (Jensen et al., 2013); Germany, (Berentzen et al., 2015); Norway, (Lien et al., 2006); The Philippines, (Yabao et al., 2005); Australia, (Ambrosini et al., 2013); Spain, (Martin-Calvo et al., 2014) and China, (Jia et al., 2012). Furthermore, Kondaki et al. (2013) surveyed in ten European cities: Athens (Greece), Dortmund (Germany), Ghent (Belgium), Heraklion (Greece), Lille (France), Pécs (Hungary), Rome (Italy), Stockholm (Sweden), Vienna (Austria) and Zaragoza (Spain). In addition, Katzmarzyk et al. (2016) carried out a multinational study conducted in 12 countries: Australia, Brazil, Canada, China, Colombia, Finland, India, Kenya, Portugal, South Africa, the UK and the USA.

Other characteristics taken into account were age groups and study settings. The age groups of the participants ranged from 6 to 18 years since this age group is the chosen age group of this study. All the participants are of school-going age. Thus not much difference would be there in the study settings. The confounding factors when comparing results could be BMI, gender differences and pre and post-menarcheal stage in females, which may bring in differences due to hormonal changes compared to males.

2.3.4 Negative effects of a high sugar diet

Twenty-one selected studies assessed the adverse effects of a high sugar diet among children and adolescents with three different outcomes. Eighteen of the studies examined the physiological effects of a high sugar diet among children and adolescents (Ambrosini et al., 2013, Berentzen et al., 2015, Carwile et al., 2015, Chan et al., 2014, Coldwell et al., 2009, Hur et al., 2015, Jensen et al., 2013, Kell et al., 2014, Kondaki et al., 2013, Lin et al., 2016, Lin et al., 2013, Nguyen et al., 2009, Yabao et al., 2005, Bigornia et al., 2015, Jia et al., 2012, Katzmarzyk et al., 2016, Lavery et al., 2015, Martin-Calvo et al., 2014). In contrast, two studies focused on the relationship between high consumption of SSB's and mental distress, hyperactivity/inattention symptoms (Lien et al., 2006, Schwartz et al., 2015). One study examined the adverse effects of high sugar diet consumption on behavioural factors (Park et al., 2012).

2.3.4.1 Physical health

Studies have reported that high-sugar intake by children and adolescents is associated with many adverse outcomes. Coldwell et al. (2009) reported that children who prefer high-sugar solutions have significantly higher plasma leptin concentration than those who prefer low sugar solutions [$F(1,129) = 5.64, p < 0.05$]. The majority of included studies link SSBs with weight gain/obesity in children and adolescents (Ambrosini et al., 2013, Bigornia et al., 2015, Chan et al., 2014, Hur et al., 2015, Katzmarzyk et al., 2016, Lavery et al., 2015, Lin et al., 2013, Martin-Calvo et al., 2014, Jia et al., 2012). Adolescents with consumption of more than 750ml of sugar-sweetened beverage per day have an increased BMI of 1.70 kg/m² than non-drinkers (Lin et al., 2013). Also, Ambrosini et al. (2013) reported that the odds of obesity risk are 4.8 times higher in girls who consume 1.3 servings per day of SSB compared to those who do not drink. Further, Martin-Calvo et al. (2014) noted that children who consume four servings of carbonated SSBs a week have a higher odds ratio of obesity (3.46 times higher) than those who drink less than four servings.

2.3.4.2 Mental health

Two studies, one by Lien et al. (2006) and another by Schwartz et al. (2015), examined the association of the high level of SSB consumption with mental health issues such as hyperactivity, mental distress and low problem-solving ability among adolescents. Lien et al. (2006) suggest that there is a significant association between soft drink consumption and mental health problems among adolescents, even after adjustment of interfering potential confounders such as social, behavioural, and food-related factors. Moreover, Schwartz et al. (2015) reported that after adjustment for age, race, ethnicity, sex and sugary food consumption, the risk of hyperactivity or inattention increased by 14% for each additional sweetened beverage consumed. Moreover, the student who consumes EDs is 66% more likely to be at risk of hyperactivity even after adjusting for all other forms of drink consumption and the number of drinks.

2.3.4.3 Behavioural factors

In terms of behavioural factors, such as sleeping hours and cigarette use, Park et al. (2012) suggested a significant correlation between sugar-sweetened drink consumption and cigarette use. The study reported students who consumed at least one sugar-sweetened lemonade drink in a day, smoked cigarettes 2.01 times more often than students who do not.

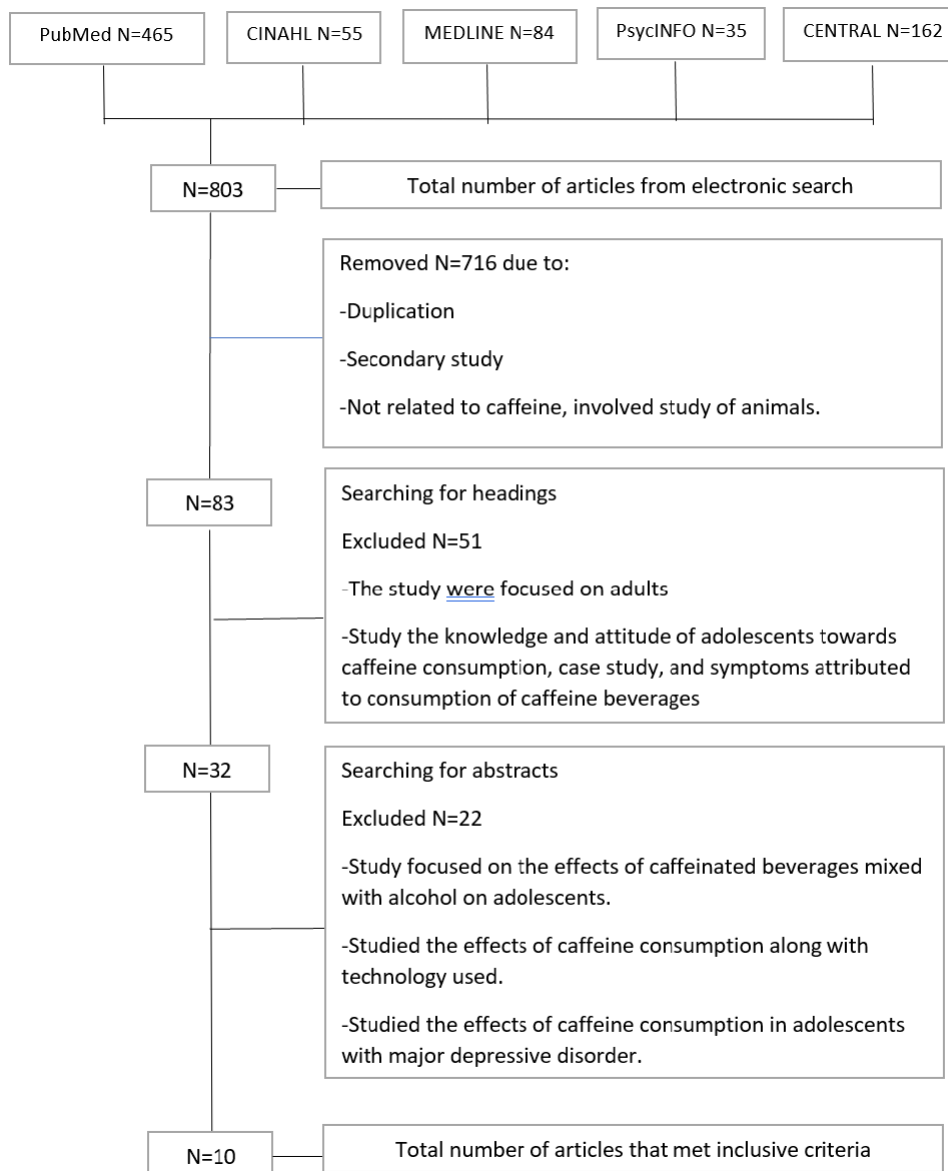


Figure 2.2: Flow chart exhibiting search process for the second review

2.3.5 Description of studies included in the second review

Table 2.6 summarizes the characteristics of the studies that have been included in the second review on the effects of high caffeine intake. It lists the year of study, population age and sample size, study design, outcome measures and principal findings.

Table 2.6: Important characteristics of studies included in the second review

Author, year, country	Population, sample	Aim of the study	Study design, methods	Outcome measures	Principal findings
Benko et al. (2011) , Brazil	51 children, Age 9-12 years	To assess the effects of caffeine consumption on children suffering from depression and those not depressed.	Case-control study	Participants were assessed for depressive symptoms through the Children Depressive Inventory (CDI). Psychopathological symptoms were assessed with the Child Behavioural Checklist (CBCL), and eating habits were assessed with the Nutrition-Behaviour Inventory (NBI). The children were compared to control children without psychopathology attending public schools in a Southern Brazilian city	<p>-It was observed that depressed children consume more caffeinated drinks than non-depressed children.</p> <p>- Children with higher the Children Depression Inventory scores (n = 34, 19.7 ± 4, mean ± SD), who met the diagnostic criteria for depression, showed higher nutrition behaviour inventory scores (52 ± 19, mean ± SD) (p < 0.001)</p> <p>-A strong association between depressive symptoms and caffeine consumption among children was found (R² = 0.530; β = 1.640; p = 0.031).</p>
Jin et al. (2016) , Korea	234 adolescents, Age 15.86±0.34 years	To evaluate the relationship between caffeine intake and depression, anxiety, stress and insomnia in Korean adolescents	Cross-sectional study	Self-report questionnaire was used. Beck Depression Inventory (BDI) was used to evaluate the degree of depression, and the Beck Anxiety Inventory (BAI) was used to evaluate the degree of anxiety. the Insomnia Severity Scale (ISI) to evaluate the degree of	<p>Q1 includes those who take caffeine ≤4.00 mg/day (58 students);</p> <p>Q2 includes those who take caffeine 4.00-9.66 mg/day (59 students);</p> <p>Q3 includes those who take caffeine 9.68-27.36 mg/day (58 students);</p> <p>Q4 includes those who take caffeine ≥27.50 mg/day (59 students).</p> <p>-The group with a higher intake of caffeine were taller in height (cm) (Q1, 164.20±7.29 cm; Q2, 164.80±7.28 cm; Q3, 165.28±6.98</p>

				<p>insomnia and the Global Assessment of Recent Stress (GARS) to evaluate stress in students was also used.</p>	<p>cm; Q4, 167.41±9.54 cm; P=0.137, P for trend=0.028).</p> <p>-The group with a higher intake of caffeine were heavier in weight (Kg) (Q1, 53.80±8.34 kg; Q2, 53.09±11.83 kg; Q3, 55.90±11.30 kg; Q4, 59.17±15.86 kg; P=0.033, P for trend=0.008).</p> <p>-Academic achievement was lower in a group with a higher intake of caffeine (P for trend=0.005). Higher caffeine intake quartile was associated with greater odds of having significant depression (Beck Anxiety Inventory (BDI) ≥10, P for trend=0.011) and insomnia (Insomnia Severity Scale (ISI) ≥8, P for trend=0.015), after adjustment for factors that can affect the psychological status.</p>
<p>Kristjansson et al. (2013), Iceland</p>	<p>11,267 children, Age 10-12 years</p>	<p>To assess the prevalence of CSSBs in children aged 10-12 years and examine the relationship between CSSBs and common physical complaints such as headaches, stomach aches, sleeping problems and low appetite</p>	<p>Cross-sectional study</p>	<p>A cross-sectional population school survey was used to assess the prevalence of cola and ED consumption and associations with headaches, stomachaches, sleeping problems and low appetite</p>	<p>A general trend of a dose-response association was observed between CSSBs and physical complaints about both types of beverages.</p> <p>- High consumption of Cola drink (1 or more servings/day) was significantly associated with headache in boy (OR=1.29; 95% CI 1.03, 1.62; P=0.01) and in girl (OR=1.13; 95% CI 0.87, 1.47; P=0.01).</p> <p>- High consumption of ED (1 or more/day) was significantly associated with headache in boy (OR=1.87; 95% CI 1.43, 2.46; P=0.01) in girl (OR=1.68; 95% CI 1.17, 2.41; P=0.01) .</p> <p>These associations were generally stronger for EDs when compared to cola drinks.</p>
<p>Kristjansson et al. (2014), Iceland</p>	<p>3,747 adolescents, Age 15-16 years</p>	<p>To investigate the relationship between caffeine use and self-reported violent behaviours and conduct</p>	<p>Cross-sectional study</p>	<p>Caffeine measure was pilot-tested in 2009 and found to adequately cover the consumption</p>	<p>-The association of caffeine with the outcomes is significantly stronger for girls than boys, for both violent behaviours and conduct disorders.</p>

		disorders and evaluate whether the association is different for boys and girls.		of caffeinated beverages among Icelandic adolescents, in a population-based health and behaviour survey. Self-reported questionnaire about violence and conduct disorder was also used.	-Effect of caffeine is still quite strong among boys (standardised beta = 0.10) and remains significantly stronger for girls (standardised betas = 0.10 + 0.05 = 0.15)
Lodato et al. (2013), Portugal	1,522 adolescents, age 13 years	To investigate the association between caffeine consumption and lower sleep duration among 13-year-old adolescents	Cross-sectional study	A self-administered questionnaire and diet were evaluated using a food frequency questionnaire	-A higher daily intake of caffeine was reported by those with lower sleep duration (≤ 8.5 hours). - Adolescents reporting caffeine intake (30mg/day) were more likely to have difficulty sleeping (OR, 1.9; 95% CI, 1.6-2.1)
Mueller et al. (2015), US	2,379 girls, age 9-10 years	To examine the hypothesis that consumption of caffeinated soft drinks in childhood is associated with a higher risk of early menarche	Cohort study with up to 10 years of follow-up	A three-day food record was used for dietary assessment. Age at menarche was self-reported annually	-After adjustment for confounders and premenarcheal percentage body fat, higher consumption of caffeinated soft drinks was associated with a higher risk of early menarche (RR for one serving/day increment: 1.47; 95% CI: 1.22, 1.79). -Consumption of artificially sweetened soft drinks was also positively associated with risk of early menarche (RR for one serving/day increment: 1.43; 95% CI: 1.08, 1.88). -Consumption of non-caffeinated soft drinks was not significantly associated with early menarche (RR for one serving/day increment: 0.88; 95% CI: 0.62, 1.25).
Orbeta et al. (2006), USA	15,686 adolescents, Age 15-16 years	To examine the association between caffeine intake in adolescents living in USA and frequency of tiredness in the morning and sleep difficulty at night.	Cross-sectional study	A self-reported questionnaire about coffee and soda intake, tiredness in the morning and difficulty sleeping was used to collect data.	-After adjusting for sociodemographic factors, students reporting a high caffeine intake, in the form of either soda or coffee, were 1.9 times (95% CI 1.6-2.1) more likely to have difficulty sleeping and 1.8 times (95% CI 1.5-2.1) more likely to be tired in the morning

					compared to students who reported lower caffeine intake.
Richards and Smith (2015), England	2,610 adolescents, Age 11-17 years	To investigate associations between caffeine (both its total consumption and that derived separately from EDs, cola, tea and coffee) and single-item measures of stress, anxiety and depression	Cross-sectional study	The study used data from the Cornish Academies Project to investigate associations between caffeine and single-item measures of stress, anxiety and depression, in a large cohort of secondary school children from the South West of England	-After adjusting for additional dietary, demographic and lifestyle covariates, positive association between total weekly caffeine intake and anxiety and depression remained significant, and the effects differed between males and females. -Consuming >1000 mg/w remained a predictor of high stress (OR=1.37, 95%,CI,1.05 to 1.80), and anxiety (OR=1.25, 95%,CI,0.96 to 1.63).
Savoca et al. (2004), Augusta	159 adolescents, Age 15-17 years	To assess the association between the consumption of caffeinated beverages and blood pressure in African American and White adolescents	Case-control study	Systolic and diastolic blood pressure readings, as well as height and weight, were measured during an initial orientation session.	-The association between systolic blood pressure and caffeine varied according to race (P=.001). African Americans consuming more than 100 mg/day of caffeine had higher systolic blood pressure readings than the groups consuming 0-50 mg/day (mean difference, 6.0 mm Hg; 95% confidence interval [CI], 2.3 to 9.7) or 50-100 mg/day (mean difference, 7.1 mm Hg; 95% CI, 3.4 to 10.7). -The diastolic blood pressure of the group consuming more than 100 mg/day was 3.7 mm Hg (95% CI, 0.41 to 7.0), higher than the group consuming 50-100 mg/day but was not statistically different to the group consuming 0-50 mg/day (mean difference, 2.4 mm Hg; 95% CI, -0.9 to 5.8). -There was no evidence that the association between diastolic blood pressure and caffeine intake varied by race (P=.80).

2.3.6 Different characteristics of the studies that were selected

Nine studies selected were carried out in eight different countries: the USA (Mueller et al., 2015, Orbeta et al., 2006, Richards and Smith, 2015) Iceland, (Kristjansson et al., 2013); Korea (Jin et al., 2016); the UK, (Richards and Smith, 2015); Portugal, (Lodato et al., 2013); Brazil, (Benko et al., 2011); and Augusta, (Savoca et al., 2004).

Other characteristics taken into account were similar to the previous objective; age groups and study settings. The age groups of the participants ranged from 9 to 18 years, which is within the chosen age group of this study. All the participants are of school-going age. Thus not much difference would be there in the study settings. The confounding factors when comparing results could be BMI, gender differences, mental illness such as depression, and pre and post-menarcheal stage in females, which may bring in differences due to hormonal changes compared to males.

2.3.7 Negative effects of caffeine consumption

The selected studies examined the adverse effects of caffeine consumption among children and adolescents from three different perspectives. Four examined the physiological effects of caffeine intake among children and adolescents: (Kristjansson et al., 2013, Mueller et al., 2015, Savoca et al., 2004). Five of the selected studies assessed the relationship between caffeine consumption and mental health issues like stress, depression and insomnia: (Benko et al., 2011, Jin et al., 2016, Lodato et al., 2013, Orbeta et al., 2006, Richards and Smith, 2015). Whilst one of the selected studies focused on the effects of caffeine ingestion and examined behavioural factors like substance use (Kristjansson et al., 2013).

2.3.7.1 Physical health

Kristjansson et al. (2013) reported a strong relationship between caffeinated sugar-sweetened beverages (CSSBs) and common physical complaints such as headaches, stomach aches and low appetite. The association was significantly stronger with ED consumption as compared to a cola drink. The study by Savoca et al. (2004) examined the association between the consumption of caffeinated beverages and blood pressure. They found that students who consume more than 100 mg/day of caffeine have a higher systolic blood pressure than those who consumed 0-50 mg/day.

2.3.7.2 Mental health

Richards and Smith (2015) and Benko et al. (2011) also found a positive correlation between caffeine consumption and depression in children.

2.3.7.3 Behavioural factors

Kristjansson et al. (2013) reported an association between adolescent caffeine use and self-reported violent behaviours and conduct disorders. This association is significantly stronger among girls than boys.

2.3 Discussion

The study design of the studies chosen varied. Some were cross-sectional, some cohorts and some were case-control study design. These are collectively referred to as observational studies. They do not contain any experimentation or intervention, and the investigated factors are not controlled, repetition of events are not generally possible, and randomisation are restricted in these studies. The results are generally consistent with real life. Cross-sectional studies are conducted in a specific time period which does not contain follow-up. "What is happening in a specific time period?" is the question that is asked. The case-control study design compares exposure between disease and healthy groups (Süt, 2014, Mann, 2012).

On the other hand, case-control studies are conducted retrospectively and enquire: "What happened in the past?" They try to explain potential causal associations between causes (exposures) and outcome (disease or clinical outcome). Case group is matched to the control group except for investigated factors (e.g. disease or clinical factors). Cohort Studies are follow-up studies and are mostly prospective. Cohort study design enquire "What will happen in the future?" Individuals are surveyed over time in cohort studies, and exposure and outcome during follow-up are assessed. Cohort studies produce the most reliable clinical evidence among observational studies because they identify clinical or health outcomes based on exposure (Mann, 2012, Süt, 2014).

Table 2.7. Strengths and limitations of the three observational studies: cross-sectional, Cohorts and case-control study design.

Cross-sectional Study design	Cohort Study Design	Case-control Study Design
<p>Strengths:</p> <p>Relatively quick and easy to conduct (no long periods of follow-up).</p> <p>Data on all variables is only collected once.</p> <p>Able to measure prevalence for all factors under investigation.</p> <p>Multiple outcomes and exposures can be studied.</p> <p>Suitable for descriptive analyses and for generating hypotheses.</p>	<p>Strengths:</p> <p>Gather data regarding the sequence of events; can assess causality.</p> <p>Examine multiple outcomes for a given exposure.</p> <p>Suitable for investigating rare exposures.</p> <p>Can calculate rates of disease in exposed and unexposed individuals over time (e.g. incidence, relative risk).</p>	<p>Strengths:</p> <p>Relatively quick to conduct</p> <p>Relatively inexpensive</p> <p>Requires comparatively few subjects</p> <p>Existing records can be used</p> <p>Multiple exposures or risk factors can be examined</p>
<p>Limitations:</p> <p>Difficult to determine whether the outcome followed exposure in time or exposure resulted from the outcome.</p> <p>Not suitable for studying rare diseases or diseases with a short duration.</p> <p>Measures prevalence rather than incident cases.</p> <p>Associations identified may be challenging to interpret.</p> <p>Susceptible to bias due to low response and misclassification due to recall bias.</p>	<p>Limitations:</p> <p>Large numbers of subjects are required to study rare exposures</p> <p>Susceptible to selection bias</p> <p>Prospective Cohort Study</p> <p>May be expensive to conduct</p> <p>May require long durations for follow-up</p> <p>Maintaining follow-up may be difficult</p> <p>Susceptible to loss to follow-up or withdrawals</p> <p>Retrospective Cohort Study</p> <p>Susceptible to recall bias or information bias</p> <p>Less control over variables</p>	<p>Limitations:</p> <p>Susceptible to recall bias or information bias.</p> <p>Difficult to validate the information</p> <p>Control of extraneous variables may be incomplete</p> <p>Selection of an appropriate comparison group may be difficult</p> <p>Rates of disease in exposed and unexposed individuals cannot be determined.</p>

Table compiled using the two references : (Song and Chung, 2010, Hennekens CH, 1987)

The three study designs all belong to the observational study category, and these studies evaluate subjects at one point in time. Proper use of observational studies permits investigation of

prevalence, incidence, associations, causes, and outcomes. Besides, they are often the only realistic choice of research methodology, mainly where a randomised controlled trial would be impractical or unethical (Mann, 2012).

2.4.1 *Physiological effects of sugar in EDs*

Sugars in EDs lead to several health complications. Sugar-sweetened beverages (SSBs) are very high in calories with few or no additional nutrients. Several studies have linked the consumption of SSBs with excess weight gain and obesity (Kit et al., 2013). Nine papers included in this study linked SSBs with weight gain and obesity in children and adolescents. Hur et al. (2015) showed a negative correlation between fruit intake and body fat percentage and reported the difference in the result to be caused by SSB consumption. While Jensen et al. (2013) obtained a weak association between SSB intake at age nine years and consequent changes in BMI till the age of 13 years; no correlations were observed at ages below nine years. In a separate study examining differences in child preference of high-sugar foods compared to low-sugar foods, Coldwell et al. (2009) found significantly higher plasma leptin levels in the group that preferred a high-sugar diet.

Interestingly, high plasma leptin levels decrease hunger; thus, theoretically, high leptin levels should lead to reduced fat and lower BMI, a finding not reported in the majority of studies reviewed here. Further studies in a larger population may be needed to deduce the leptin levels per SSB intake. Eight other studies included in the current review reported positive correlations of SSB intake with increased waist circumference, higher BMI and body fat percentages (Ambrosini et al., 2013, Bigornia et al., 2015, Chan et al., 2014, Jia et al., 2012, Katzmarzyk et al., 2016, Lavery et al., 2015, Lin et al., 2013, Martin-Calvo et al., 2014).

Kell et al. (2014) studied the role of SSB consumption and its effect on blood pressure (BP) and reported SSB consumption to have an association with only an increase in diastolic blood pressure, but not systolic blood pressure. However, in contrast, two other studies (Chan et al., 2014, Nguyen et al., 2009) obtained positive associations of SSB consumption with the systolic BP but not diastolic BP. Thus, even though hypertension is established, the exact effects of SSB on BP are unclear and require further research. Lien et al. (2006) examined the association of SSBs with mental health status among children; strong associations of SSB intake were observed with mental health statuses such as distress and hyperactivity. Similar observations were reported by Schwartz et al. (2015). Two studies (Kondaki et al., 2013, Lin et al., 2013) selected for this review assessed the effects of SSB consumption on insulin resistance index; and the consumption was associated with higher values of homeostasis model assessment- insulin resistance index (HOMA-IR). Another study

by Berentzen et al. (2015) has associated asthma with SSB consumption; the results of which have been included in the previous section, but may require further analysis to obtain the exact association.

Apart from the high sugar content, EDs also have a high erosive potential due to low pH (potential of hydrogen) (Cavalcanti et al., 2010). Enamel demineralisation is associated with such low pH levels (Shaw and Smith, 1999). However, Yabao et al. (2005) observed no significant correlation between sugar intake and dental caries. However, a few other studies have documented adverse dental effects as a result of SSBs. Bartlett et al. (1998) reported 57% of children aged 11 to 14 to have enamel erosion as a result of sugar intake. Similarly, Pinto et al. (2013) assessed the influence of EDs in exposing dentinal tubules and removing the smear layer, concluding that EDs could be an important factor in causing cervical dentine hypersensitivity. Figure 4.1 represents the combined effects of caffeine and sugar among children and adolescents.

2.4.2 Physiological effects of caffeine in EDs

Caffeine, in moderation, maybe tolerated well by healthy individuals; however, heavy consumption of it, including the use of EDs, has been associated with consequences such as stroke, seizures, and sudden death (Reissig et al., 2009a). The caffeine concentration in EDs is on average three times higher than in Cola drinks, for example; the caffeine content in soft drinks is limited by the US Food and Drug Administration (FDA), but since EDs are categorised as dietary supplements, it involves no regulations (McCarthy, 2011). Caffeine is a central nervous system stimulant in addition to being a phosphodiesterase inhibitor and an adenosine/ benzodiazepine receptor antagonist (Seifert et al., 2011). The clinical toxicity of caffeine begins at a dosage of 1g/ day while dosages below 400 mg are generally considered safe; dosages above 5g may be lethal (Cannon et al., 2001). Caffeine has a wide array of physiological effects including coronary and cerebral vasoconstriction, stimulation of the skeletal muscle, and relaxation of smooth muscles. Despite its harmful effects, in low/ moderate concentrations, caffeine intake has been associated with improved cognition, exercise endurance, mood, and reaction time (Malinauskas et al., 2007).

In a Korean study, Jin et al. (2016) evaluated the association of caffeine with depression among adolescents, of 15 years of age (N=234). The study obtained caffeine intake to allow for higher odds of depression, anxiety and stress among adolescents. Higher caffeine intake was also associated with lower academic achievement, probably as a result of increased anxiety levels and sleep deprivation. This study was also amongst the only ones that observed changes in height and weight with caffeine intake (adolescents grew taller and gained more weight with increased caffeine intake). Three other studies included in this paper obtained similar associative results of caffeine intake with

depression. Richards and Smith (2015) and Benko et al. (2011) both reported a positive association between caffeine consumption and depression in children.

Sleep dissatisfaction and deprivation is a common effect of caffeine but also accounts for ED's popularity due to enhancing 'alertness' (Malinauskas et al., 2007). In their report, Orbeta et al. (2006) associated caffeine consumption with sleeping difficulties in adolescents; participants were 1.9 times more likely to have difficulty sleeping and were 1.8 times more likely to be tired in the morning. In another study, Lodato et al. (2013) reported lowered average sleep duration (≤ 8.5 hours) as a result of caffeine consumption in 13-year-old adolescents. Caffeinated drinks have also been associated with physical complaints such as headaches, stomach aches, sleeping problems and low appetite. In their study, Kristjansson et al. (2013) observed an increase of such complaints in children aged 10- 12 years upon consumption of caffeinated drinks. The reports were higher among those who consumed EDs compared to those who consumed regular soft drinks due to their higher caffeine content. Caffeine consumption in high levels, as earlier reported, has been linked with hypertension in most cases. In their study, Savoca et al. (2004) assessed the association of caffeine consumption with blood pressure in adolescents; they observed a general increase in both systolic and diastolic blood pressure upon caffeine consumption. However, the effects on systolic blood pressure were observed to be much higher in African American children, thereby suggesting hypertension effects may vary by race.

In their study, Mueller et al. (2015) examined the association between early menarche and the consumption of caffeinated soft drinks. This study was carried out over a period of 10 years and concluded that caffeinated drink consumption was associated with a higher risk of early menarche. They also found this risk to be present with the consumption of artificially sweetened beverages. The search carried out within this current review did not find another study that associated caffeine with menarche timing. However, a study by Carwile et al. (2015) observed that premenarcheal girls who reported consumption of 1.5 servings of sweetened beverages per day were on average, 24% more likely to attain menarche in the next month relative to girls consuming \leq two servings of sweetened drinks weekly. Apart from its effects on depression and other psychiatric disorders, caffeine toxicity has been associated with dependence on other substances, including alcohol and tobacco (Reissig et al., 2009a). Caffeine has been observed to increase the reinforcing effects of nicotine; with smokers generally consuming more caffeine than non-smokers (Gasior et al., 2002). Caffeine consumption has also been linked with conduct disorders in adolescents; Kristjansson et al. (2013) observed this association of violent behaviours to be stronger in girls compared to boys. The effects of caffeine were perceived to be significantly stronger in girls than in boys.

The documented association between the two active ingredients of EDs, sugar and caffeine, and young people’s health and behaviour are summarised in Figure 2.3.

2.4.3 Limitations of the research process

The limitation of this study is the inclusion of only journal publications. Publication bias cannot be excluded, given that studies with positive results tend to be published more quickly. Another limitation is the inability to read publications in languages other than in English which might result in missing some papers that could contribute further to answering the overall research question.

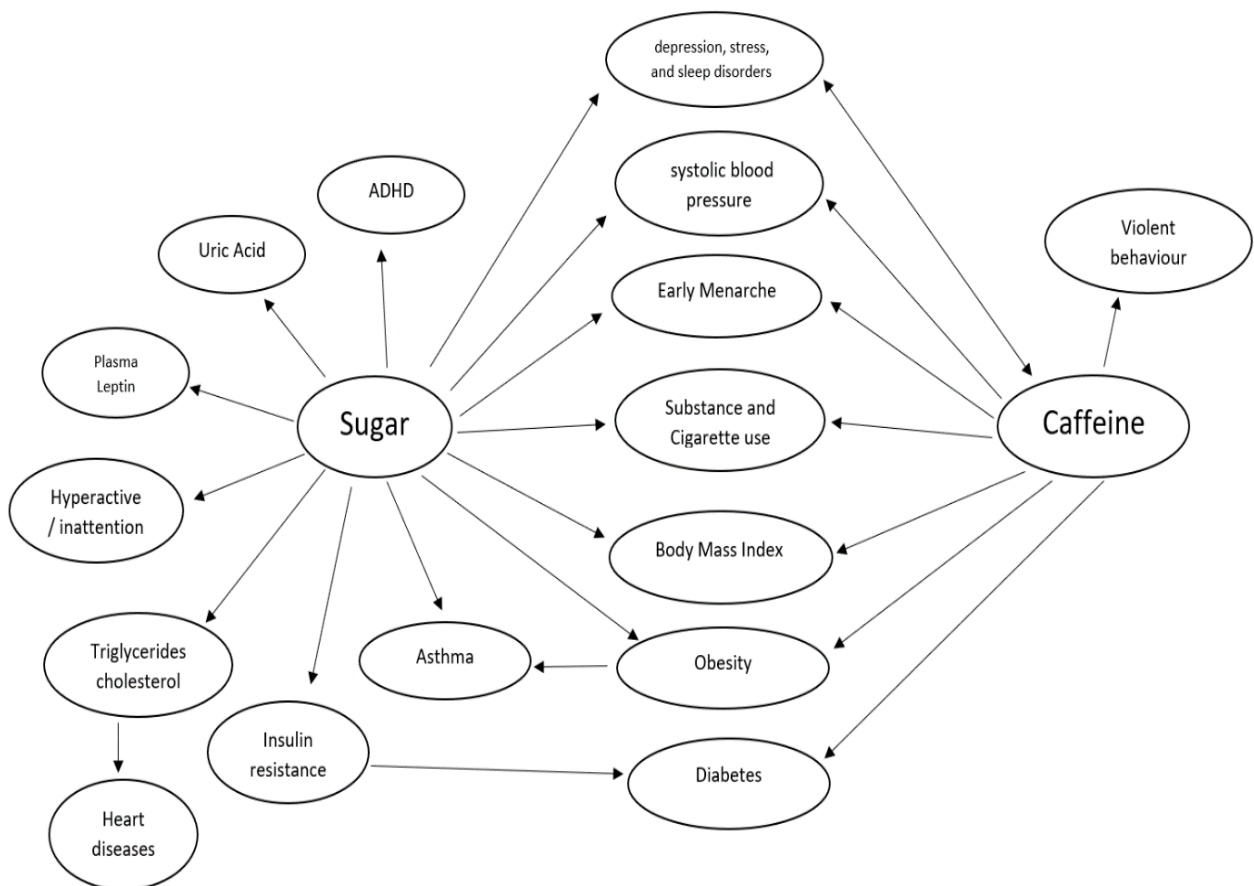


Figure 2.3. The association between the two active ingredients (sugar and caffeine) of EDs, and the adverse effect on young people’s health (Morgan et al., 2019).

2.5 Conclusion

This chapter describes the adverse effects EDs may have on the physical and mental health and behaviour of young people. The key findings outline numerous health effects associated with both caffeine and sugar. Children have a higher sensitivity to caffeine, and this may make them more

vulnerable to any adverse health effects caffeine may have (Kole and Barnhill, 2013). Since caffeine stimulates the CNS, higher caffeine intake may be associated with physical health problems, such as hypertension, cardiovascular disease and headaches. In terms of mental health and behavioural factors, ED consumption is also linked with a higher risk of sleep disorder, substance use, stress and hyperactivity. In conclusion, ED consumption may adversely affect young people's health since sugar and caffeine are both harmful in large quantities, and both these constituents are found in high concentrations in EDs. More extensive research is still required to study the quantity and frequency of consumption of EDs and its adverse effects on other health determinants as well.

In the following chapter (**Chapter 3**) an overview of the primary methodological approach used to achieve the remaining study objectives will be discussed. Chapter 3 will present a mixed-methods approach and provide a rationale for the chosen study design.

CHAPTER 3
Methodology

This chapter will provide an overview of the methodological approach that is used in this thesis to answer the research questions outlined below. The rationale for using a mixed-methods approach is provided along with a review of the strengths and weakness of qualitative and quantitative methods.

3.1 *Study Design*

The principle aim of this study was to analyse the prevalence and factors associated with ED consumption in young people in both Saudi Arabia and Wales. The study undertaken aimed to address five key research questions:

1. What are the prevalence rates and socio-economic characteristics of young people reporting ED consumption (among two distinct populations)?
2. What are the physical, mental and behavioural outcomes associated with ED consumption? How are any observed associations related to the volume of consumption?
3. Which factors motivate young people to consume EDs, and which factors prevent consumption?
4. Why, where, and when, do young people purchase EDs?
5. What are some of the key recommendations for preventative strategies targeting young people's ED consumption?

3.2 *Mixed Method Design*

This thesis uses a mixed-method design, which is distinguished by the use of both quantitative and qualitative research. Quantitative research typically involves the statistical analysis of numerical representations of phenomena. In contrast, qualitative research typically involves the analysis of narrative and textual data collected using, for example, focus groups and interviews. In this way, data from both sources is collected, analysed, and then combined to understand the problem better (Tashakkori, 2003). The quantitative method addresses questions of association, generalisability, prevalence or the scale of effects. Qualitative research examines the reasons and the ways something happens so that a theory can be developed, or an individual's experience described. Mixed method research retains the strengths of both qualitative and quantitative research (Creswell and Plano Clark, 2007). The mixed-methods approach offers a complete and comprehensive understanding of the issues that can be obtained solely by using only either the quantitative or qualitative method; this also minimises single method bias (Ivankova et al., 2006). This research design allows the use of a variety of tools to answer questions to which a single research method would be unlikely to furnish a solution (Creswell and Plano Clark, 2007).

The mixed-methods design of this thesis was explanatory and sequential (Creswell, 2014). Such a method involves two phases. The first involves collection and analysis of numeric (quantitative) data, which is given priority in addressing the research question (Creswell and Plano Clark, 2007, Ivankova et al., 2006). In the second phase, textual (qualitative) data is developed from the results of Phase 1 (Creswell, 2014). Priority is given to the quantitative data, and the findings are integrated into the study's interpretation phase. Findings from the quantitative phase are further explained and interpreted using the qualitative phase's results (Creswell, 2014, Ivankova et al., 2006). The two phases are then connected in the study's intermediate stage before finally being interpreted (Creswell and Plano Clark, 2007). The rationale for this approach is that analysing quantitative data gives an introductory understanding of the research problem, which is then refined and explained by analysing the qualitative data, which expresses participants' views in depth (Creswell, 2014, Tashakkori, 2003). The strength of this design is that the research can be carried out by a single researcher acting alone (Creswell, 2014).

The explanatory sequential mixed methods design is used in both behavioural and social sciences research (Ivankova et al., 2006). What makes possible its use for this study is the progressive nature of the approach, with one database building systematically on the other. The limited amount of time available to complete the study can be a limitation to the mixed methods approach (Creswell and Plano Clark, 2007). It can be challenging to decide which points of interest from the quantitative study should be carried into qualitative research (Creswell, 2014, Creswell and Plano Clark, 2007). This study's qualitative phase took the exploration of the quantitative findings further through an exploration of the perceptions and attitudes of the participants into the impact EDs consumption might have among vulnerable groups of young people. Figure 3.1 shows the various parts of the studies used in this thesis and in which chapter they can be found.

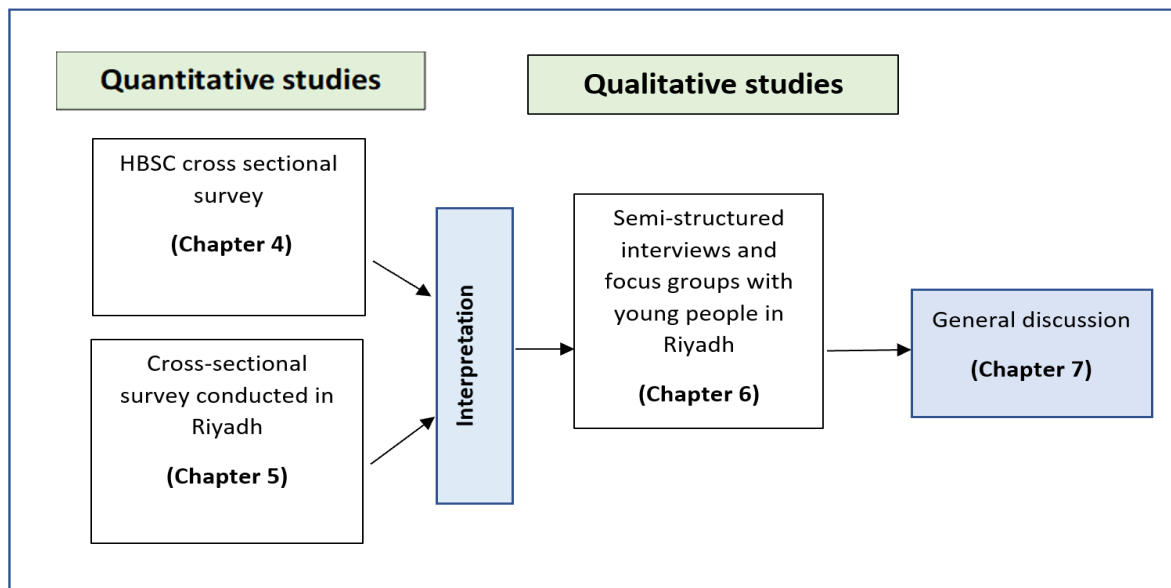


Figure 3.1 Diagram of the explanatory mixed methods design used in the present study

3.3 Quantitative Data

In order to explore research questions 1-3, a cross-sectional study design was used, this research design is based on collecting observational data from a particular population at any one time (Lindell and Whitney, 2001). A cross-sectional study design facilitates the assessment of the prevalence of conditions or behaviours. The advantage is in the ability to assess large data sets at a minimum expense. Associations between a condition or behaviour and other factors might be correlations. Although, as a cross-sectional study does not include a temporal component, there is no implication of causation, this a weakness of the method (Setia, 2016). The study objective was to examine a specific behaviour's prevalence; EDs consumption in young people living in Wales and Saudi Arabia, to identify whether correlations exist with other factors such as eating breakfast, sleeping patterns, and diet.

3.4 Qualitative Data

Although quantitative analysis makes possible the statistical testing of relationships between variables, it does not deepen understanding of a problem's intricacies and meanings. Consequently, qualitative and quantitative methods can be used together to offer additional insight into a problem (Ivankova et al., 2006). Here, qualitative data is used to address the third and fourth research questions. Two qualitative data techniques were employed; 1) one to one interview, and 2) focus groups (described in chapter 6). The author conducted this study alone, including finding participants,

collecting and transcribing data, analysing data and writing up the conclusions. A triangulation technique was used to validate the data and results. Triangulation is the application and combination of multiple methods, such as interviews and focus groups that provide a more detailed picture of the situation (Altrichter et al., 2005). The triangulation technique enables making sense of the data more rigorous - consistency, validity and completeness of data in relation to the questions raised (Creswell and Poth, 2016).

The study conforms to the guidelines and policies for ethical research conducted on children and young people (Shaw et al., 2011), and hence has received ethical approval from the Ministry of Education in Saudi Arabia and King Saud University Consequently. For individuals to participate in this research study, they needed to read and sign the particular consent form. The researcher has undergone training in qualitative data to support the qualitative aspect of the thesis. The training taken had three modules. The first module was about the comparison of qualitative methods; covering the general introductions, the strength, and the standard three methods of qualitative methods (observation, interviews, and focus group). It also discussed how each method helps to collect different type of data. The second module was about the qualitative interviewing that included recruitment, ethical guidelines in qualitative research, and also provided a valuable foundation for understanding ethical issues. The third module was about analysing the qualitative data. This module provided a general introduction about various approaches to the interpretation of qualitative data, different qualitative analysis software options, and an overview of analytical strategies.

Additionally, the research position is explained below.

3.5 Trustworthiness strategies for the qualitative study

Quality, in qualitative research comprises of systematic, self-conscious research design, data collection, interpretation, and communication (Mays and Pope, 2000). In qualitative research, credibility, transferability, dependability, and confirmability are the key criteria, first mentioned by Guba (1981) to enhance trustworthiness to ensure the rigour of qualitative research (Anney, 2014). Trustworthiness lies in the proper and thorough justification of the choice of methods and methodology. In the absence of it, personal bias and lack of transparency can result in criticism of the work. Some of the strategies used to address the four criteria at the design and implementation stage (Noble and Smith, 2015), include:

1. Acknowledging personal bias or research bias at the relevant stages – sampling, data collection and analysis, engaging with other researchers etc.
2. Fastidious record keeping or audit trail

3. Ensure that all perspectives are presented (by thoroughly looking for similarities and differences between accounts).
4. Using verbatim accounts of participants.

3.5.1 Credibility

How can one establish confidence in the “truth” of the findings of a particular inquiry for the subjects (respondents) with which and the context in which the inquiry was carried out? (Moon et al., 2016, Guba, 1981).

How can a researcher establish confidence in his/her findings? Or how do we know if the findings presented are genuine? (Anney, 2014). Credibility or ‘truth value’, according to Lincoln and Guba (1985) aims to answer the question of whether the research decisions are consistent with the researcher’s intended purpose. This applies to the entire research design beginning with the aim, context, participant selection, data collection, and the amount of data collected, all of which influence how accurately the research question/s can be answered (Graneheim and Lundman, 2004, Moon et al., 2016). Credibility lies in how the procedures and methods have been implemented or how the study will be conducted, i.e. it needs to be factored at the design stage of the research. By making logical decisions on how the study will be conducted, researcher experiences, source identifications and other biases can be addressed (Bengtsson, 2016).

Credibility establishes confidence in one’s research findings by deeming it to be true. It suggests that the said findings were derived from the participant’s original data and has been interpreted correctly from their views (Anney, 2014, Graneheim and Lundman, 2004, Lincoln and Guba, 1985). Several strategies are adopted to establish credibility, such as prolonged and varied field experience, time sampling, reflexivity (field journal), triangulation, member checking, peer examination, interview technique, establishing the authority of researcher, structural coherence (Korstjens and Moser, 2018, Anney, 2014), working with co-investigators, colleagues, expert panels and informants (Bengtsson, 2016, Graneheim and Lundman, 2004).

3.5.2 Dependability

How can one determine whether the findings of an inquiry would be consistently repeated if the inquiry were replicated with the same (or similar) subjects (respondents) in the same (or similar) context? (Guba, 1981, Moon et al., 2016).

Stability or dependability refers to the extent to which the research data can change over a period of time (Bengtsson, 2016). Dependability ensures that the study's interpretations and conclusions are derived from the evaluation of the findings of that study. By using an audit trail, one can study the various steps undertaken to arrive at the study's conclusion (Anney, 2014). According to Lincoln and Guba (1985), dependability validates the findings, interpretation and conclusions to have been derived from the primary data (from the participants). It also brings consistency and reliability (Korstjens and Moser, 2018). For this, researchers should meticulously document methods, methodology, how data was collected, etc., to enable other researchers to follow and critique the process. This will help assess whether appropriate research practices have been followed (Moon et al., 2016). According to Shenton (2004), meeting the dependability criterion can be challenging in qualitative research but researchers should nevertheless strive to enable a future investigator to repeat the study. For this, the text should clearly detail the research design and its implementation, the operational detail of data gathering and the reflective appraisal of the project (Shenton, 2004).

3.5.3 Transferability

How can one determine the degree to which the findings of a particular inquiry may have applicability in other contexts or with other subjects (respondents)? (Guba, 1981, Moon et al., 2016).

It refers to the degree to which the results can be replicated in different settings and to the number of study participants (Bengtsson, 2016). That is, to what extent can the results from the qualitative research can be transferred to other study contexts (Anney, 2014). According to Lincoln and Guba (1985), transferability or applicability lies in the accurate and thick description of the research (Korstjens and Moser, 2018). It provides external validity of the findings where findings from one study can be applied to theory, practice and future research (Lincoln and Guba, 1985). This also means that the researcher clearly details how the study may not be relevant in other contexts (Moon et al., 2016, Shenton, 2004). Showing transferability in qualitative research can also be difficult because, a qualitative project is usually small and focused making it challenging to demonstrate that the research can be applied to a broader population or other situations (Shenton, 2004).

3.5.4 Confirmability

“How do we know if the findings come solely from participants, and the investigation was not influenced by the bias, motivations or interests of the researchers?” (Anney, 2014, Guba, 1981).

Confirmability deals with the objectivity and neutrality of data (Bengtsson, 2016). Results of a qualitative research study should be confirmed and corroborated by other researchers (Anney, 2014). According to Lincoln and Guba (1985), it helps confirm, by other researchers, that the findings have indeed been derived from the data and not from the investigator's imagination thereby bringing in neutrality (Korstjens and Moser, 2018). Confirmability checks whether the results are drawn from the data (such as experiences, preferences and opinions) of the participants and not influenced by the researcher's beliefs, assumptions and other biases. This can once again be determined from a detailed methodological description (Moon et al., 2016, Shenton, 2004). To maintain objectivity, the reasons behind the choice of methods and methodology should also be acknowledged in the report. Audit trails facilitate this as they help track and trace how the study was developed (Shenton, 2004).

3.6 Researcher Positions

Regarding qualitative research, a researcher can shape the data collected using the types of questions asked and how these are interpreted, including the role of prior assumptions and experience (Sutton and Austin, 2015). In the current study, the researcher conducted the face-to-face interviews and focus groups with the study participants; therefore, the researcher's interaction with participants may be affected by their background, experiences and prior assumptions. The researcher was a Saudi female PhD student from a non-clinical background. The interview began with the researcher reminding and reassuring interviewees that their contributions would be anonymous. The range of information reported by participants was extensive, and the researcher's independence (i.e. not belonging to any official party) makes it likely that the responses accurately reflected their experiences. A personal reflective account can be located in (Appendix B)

3.7 Critical Appraisal

Recently, the importance of qualitative research in improving healthcare and services has become increasingly higher (Rolfe, 2006). Critical appraisal criteria are a vital tool to appraise the quality of qualitative research (Williams et al., 2019). Checklists from the Critical Appraisal Skills Programme (CASP) are used in appraising this qualitative study (CASP, 2019). The ten questions in the CASP qualitative study checklist make users think systematically about the major issues in a qualitative study; an example would be the existence of any relationship between researcher and participants (CASP, 2019). The critical appraisal checklist is included in the appendix (Appendix C). However, throughout the qualitative research, the researcher will be guided by the CASP checklist at each stage in the study. In addition, The Consolidated Criteria for Reporting Qualitative Studies (COREQ)

checklist was used to report all qualitative work (Appendix D). It is a 32-item checklist that helps report important aspects of the research team, study methods, context of the study, findings, analysis and interpretations. All items are grouped into three domains: (i) research team and reflexivity, (ii) study design and (iii) data analysis and reporting. The checklist promotes complete and transparent reporting among researchers and indirectly improves the rigour, reliability and comprehensiveness of the interview and focus-group studies (Tong et al., 2007).

For each study, Chapters 4, 5 and 6, gives a detailed description of the methods, including sampling, data collection, and data analysis.

Table 3.1: Trustworthiness criteria applied in this thesis

Strategies	Criteria	Application in this study
Credibility	<ul style="list-style-type: none"> • Prolonged engagement • Triangulation • Peer review • Member checking 	<ul style="list-style-type: none"> • Anonymity was applied to build trust with the young people during data collection. The researcher does not collect identifying information of individual subjects (e.g., name, address, etc.) • Semi-structured interviews and focus groups were utilized to cover all the topics and to ensure longer contact. • The research used two different methods of data collection (in-depth interviews, and focus group) to investigate the young people's views and attitudes with a deeper understanding. • The study process discussed with two supervisors with qualitative research experience. • The translation of the transcripts are checked with two different qualify translators (Arabic – to – English, and 10% of the transcripts are translated back to Arabic). To ensure the validity of the translation.
Dependability	<ul style="list-style-type: none"> • Code- recode procedure • Audit trail • Thick discretion of the methods 	<ul style="list-style-type: none"> • Meeting with the independent coder (statistician) before and after data analysis. • Well kept transcripts of the interviews and focus groups as an audit trail. • Detailed discretion of the method was highlighted
Transferability	<ul style="list-style-type: none"> • Exhaustive description 	<ul style="list-style-type: none"> • Intensive description of the study process. Providing details in a research position, sampling strategies, and data collection and analysis procedures.
Confirmability	<ul style="list-style-type: none"> • Reflexivity • Triangulation 	<ul style="list-style-type: none"> • The personal reflexivity explains how the researcher's thoughts, value, experiences may affect the research results. The personal reflexivity can be located in (Appendix B). • The research used two different methods of data collection (in-depth interviews, and focus group) that lead to investigate a young people view and attitude in a better and deeper understanding.

3.8 Ethical Considerations

The researcher assumes complete responsibility for the content and research findings of the study described in this thesis. For the HBSC data, the study uses secondary data from questionnaires and surveys for analysis. Data was collected in 2017 by the School Health Research Network (SHRN) (ethical approval (SREC/2190)). First established in 1982, the survey saw 42 countries across North America and Europe participate in 2017. Wales joined the network since 1985/86, and its participation is overseen by the Assembly Government's Knowledge and Analytical Services.

Since this study from Saudi Arabia uses primary data to address the research questions, ethical approval from the Ministry of Education in Saudi Arabia was required. This approval was obtained prior to the study implementation (Appendix E). The research was also approved by the relevant administration units of each school selected for participation. In addition, all participants were informed about the nature and objectives of the study and written consent (Appendix F) was collected along with the study questionnaire issued to the participants. For qualitative research, the participants were provided with a participant information sheet (Appendix G)

Chapter 4

**The prevalence and socio-economic determinants of ED
consumption and related health outcomes among young
people in Wales: HBSC data**

4.1 Introduction

The literature review presented in chapter 2 indicated that ED consumption could have adverse health effects on the physical, mental, and behavioural outcomes of young people, due to the high amount of caffeine and sugar. It is known that adolescence is a transitional stage in the human lifecycle, physiologically, psychologically, and socially (Alsubaie, 2017). Owing to this, developing healthy dietary habits early in life offers a protective mechanism against non-communicable disease, including obesity, diabetes and cardiovascular disease (WHO, 2015). However, EDs have become one of the attractive beverages for adolescents due to effective product marketing (Visram et al., 2017).

Since the first ED was introduced in 1987, there has been an increase in the consumption of the drinks amongst the general population, with a particularly significant increase amongst younger people (Alsunni, 2015). EDs are beverages which contain sugars and bioactive ingredients such as caffeine and taurine, which are designed to 'energise' the body. Whilst EDs have been found to improve attention and alertness in some research projects, there is also evidence to suggest that the combination of caffeine and glucose can cause problems with cognitive performance, disturb sleep and fatigue (Alsunni, 2015).

The prevalence of ED consumption is higher in young people aged (10-18 years) compared to adults and children; 68% of young people reported that they had consumed EDs compared to 30% adults and 18% of children under ten years old (Consortium, 2013). However, the consumption of EDs varies by gender, with males consuming EDs more than females (Musaiger and Zagzoog, 2013).

EDs are associated with several disadvantages which are mainly linked to the high caffeine content of such drinks (Higgins et al., 2010). Excessive EDs consumption can lead to a caffeine overdose, which can cause palpitations, sickness, convulsions, hypertension and even death in some cases (Smith, 2002). In addition, the high sugar content of EDs has also been linked with increased rates of obesity and health problems such as type-2 diabetes. However, some of the ingredients in EDs, such as taurine and B vitamins, are not well understood, and the health implications are not known (Higgins et al., 2010). Therefore the health impacts of EDs are a public health priority.

According to the Global EDs Report (2012), consumption of EDs in the UK has been classified as one of the highest alongside other countries such the United States, Australia, Germany, and Saudi Arabia. From 2006 to 2014, the average consumption of EDs increased by 155%, approximately 235 to 699 million litres ((BSDA), 2015). Recent statistics showed that the average sales of EDs in the UK are expected to increase at an annual rate of 3.5% until 2020 (LLP, 2019). According to Morgan et al. (2018), approximately half of young people in Wales reported that they

had consumed EDs, in addition, those who had reported more frequent ED consumption were more likely to report health problems.

Due to the high accessibility of EDs, young people are often drinking such drinks without realising the health implications (Visram et al., 2017). In the UK, the EDs market is still not regulated in relation to age restrictions, although the negative health impacts on young people have been acknowledged by several EDs companies (BSDA, 2015).

Among a nationally representative sample of young people living in Wales, UK. The objectives of the research presented in this chapter are:

1. To determine the prevalence of reported ED consumption among young people in Wales.
2. Assess the association between sociodemographic characteristics and ED consumption.
3. Identify factors associated with the consumption of EDs among young people.
4. Determine the cross-sectional relationship between the consumption of EDs and reported health outcomes.

4.2 Methods

The following data were collected through an online survey distributed to students attending schools throughout Wales.

4.2.1 Source of data

Data from the 2017 Health Behaviours in School-aged Children Survey (HBSC) in Wales were used in this study. The survey was completed by 112,045 students from 193 schools and different year groups (from year 7 to year 13, which is ages 11 - 18). They were recruited via the current School Health Research Network (SHRN) (SHRN, 2018). Participating schools distributed surveys among all students in years 7 to 11, to complete the survey. Due to the education system in Wales, some students go to university at age 16, so the schools were given the choice of including students from years 12 and 13 to participate in the survey (Figure 4.1).

In partnership with the Welsh Government and Public Health Wales, the SHRN network includes researchers in DECIPHer (centre for Development and Evaluation of Complex Interventions for Public Health Improvement) The network initially had 115 secondary schools registered as members of the network. By 2015, membership increased, and most secondary schools in Wales are registered SHRN members. To date (September 2019) 193 secondary school in Wales are currently registered with the network. HBSC data was used in this thesis because it is one of the most nationally representative adolescent surveys to date.

All SHRN registered schools are required to complete biennial surveys on student health and wellbeing. The data collected is based on the HBSC survey, which is included within the SHRN survey, i.e., a sample of SHRN registered schools will also complete the HBSC questionnaire. The survey includes a range of questions on health and wellbeing such as eating habits, physical activity, smoking, alcohol, injuries, drug use, school life and friends, sexual behaviour (for students in years ten and above, who are aged 14 years and above), home life, and demographics, body image, Bullying, life satisfaction, oral health, relationship: family and peers, school environment, self-rated health, socioeconomic behaviour, , obesity, weight reducing behaviour. This survey data is later analysed and returned to the school. This enables the SHRN network to create an individualised Student Health and Wellbeing Report for each school regarding their student’s health and wellbeing behaviours; this aids the schools’ health care action plans.

The HBSC survey is an international survey conducted every four years, in association with the World Health Organisation (WHO) Regional Office in Europe. The primary objective of the HBSC survey is to increase the understanding of the health behaviours of students and young adults, including their health and lifestyles within their social environment. In this thesis some of the questions were selected to answer the research questions. Data from the survey is analysed and used to inform health promotion strategies as well as health education policies at national and global levels.

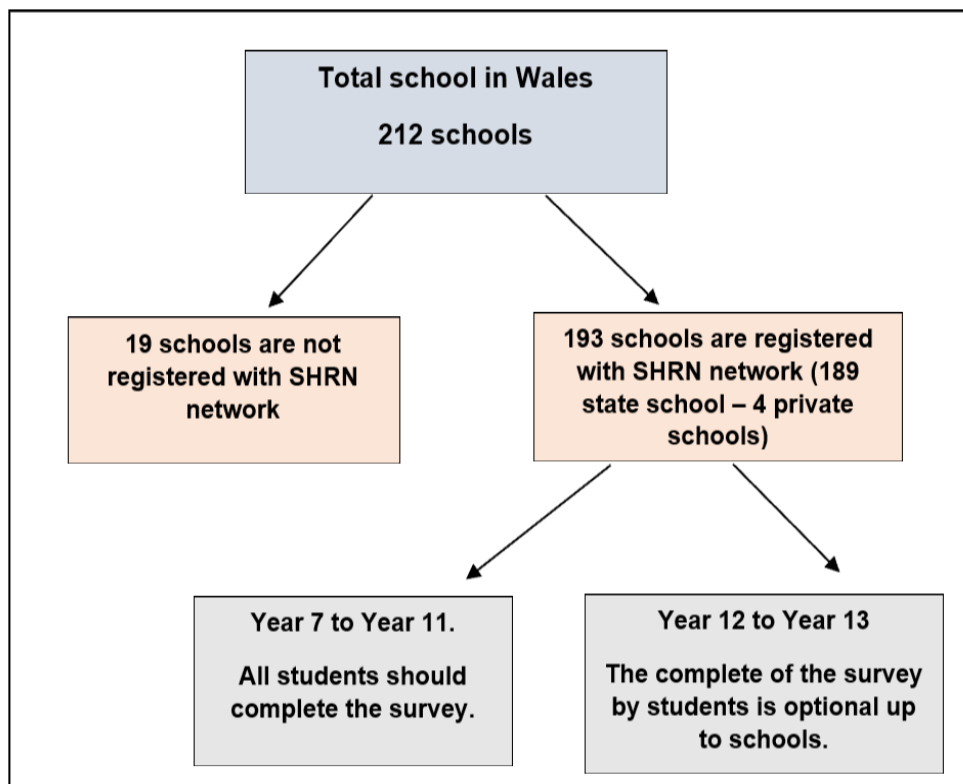


Figure 4.1: Sampling process

In Wales, there is an established data infrastructure whereby data on health behaviours and health outcomes are collected biannually on young people across Wales. Therefore this dataset provided a unique opportunity to access timely data on energy drink consumption along with a variety of wider variables which were relevant to this study. To date, studies focusing on energy drink consumption among young people in the UK are scarce, with limited findings concerning representative populations.

Similar to Saudi Arabia, Wales currently has no regulation on the sales of energy drinks to young people, this provides a comparative policy setting for that of Saudi Arabia yet the cultural differences will offer an opportunity to compare and contrast wider health behaviours among both populations.

4.2.2 Participant consent

Three types of consent were sought for this study – from schools, parents and students. For schools, consent is sought through the SHRN website, where schools are requested to participate in the survey.

Parents are sent information on the survey on two occasions (at the very least) via email, letter and/or text message, which details asking for their permission to allow their child to participate in the survey. It is essentially an opt-out consent process where the parents can contact the school if they do not wish for the child to take part in the survey.

For students (who have not been opted-out by a parent), a presentation on the survey on what it entails is given to the teachers who in turn pass it on to the students. In addition, consent was sought at the beginning of the survey. On the first page of the survey text seeking consent stated

‘I have read and understood the information about the survey’.

This is then followed by two options asking

- a) I want to take part or
- b) I do not want to take part.

If the option ‘a’ was chosen, then the student was taken to the survey page. If the option ‘b’ was chosen, then the browser leads back to the SHRN website.

4.2.3 Data collection

Students were given a choice to complete the survey electronically or in hard copy. While the electronic surveys can be self-completed by students within the classroom hours, hardcopies were completed with the assistance from a senior member of the school's management team. A dedicated staff member of the school coordinated the completion of the School Environment Questionnaire (SEQ) surveys.

4.2.3.1 Measures

As mentioned, the survey includes a range of questions on health and wellbeing topics such as eating habits, physical activities, drugs use, smoking etc. In this thesis, a variety of survey topics have been chosen to narrow the thesis' topic and focus the researcher efforts in regard to the research questions. The self-reported measures used for analyses in Chapters four (HBSC data) are listed below.

4.2.3.1.1 Demographics

1. Gender: Young people were asked to report their gender by choosing one of these response options of: 'Boy', 'Girl', 'I do not want to answer'.

2. Ethnicity: Young people were asked to report 'Which of the following responses best describes you?': 'White', 'Mixed Race', 'Asian', 'Asian British', 'Black', 'Black British', 'Chinese', 'Other' (categorised as white/white other/other).

3. School year: Young people were asked to answer this question, 'What year are you in?' with the response: 'Year 7'. 'Year 8'. 'Year 9'. 'Year 10'. 'Year 11'. 'Year 12'. 'Year 13'.

4. Family Affluence Score Socio-economic status of students was determined by a validated tool named the Family Affluence Scale (FAS) (Hartley et al., 2016, Currie et al., 2008, Boyce et al., 2008) which includes the following questions:

- 'Does your family own a car, van or truck? the responses were: 'No'. 'Yes, one', 'Yes, two or three'. 'I do not want to answer'.
- 'How many computers does your family own (including PCs, Macs, and laptops, not including game consoles and smartphones)? the responses were: 'None', 'One', 'two', 'More than two', 'I do not want to answer'.

- How many bathrooms (room with a bath/shower or both) are in your home? the responses were: 'None', 'One', 'Two', 'More than two', 'I do not want to answer'.
 - 'How many times did you and your family travel out of Wales for a holiday/vacation last year?' the responses were: 'None at all', 'Once', 'Twice', 'More than twice', 'I do not want to answer'.
- The total FAS was determined after the scores for each of the four survey items were summed (scores ranging from 0 to 7), and then divided into "high", "medium" and "low" affluence.

5. ED consumption pattern: Students were asked 'How many times a week do you usually drink EDs (such as Red Bull, Monster, and Rockstar)?' by choosing one of this response options of: 'never', 'less than once a week', 'once a week', '2-4 days a week', '5-6 days a week', 'once a day, every day' and 'every day, more than once'.

6. Smoking: Young people were asked 'How many times a week do you usually smoke? With response options of: 'every day', 'at least once a week, but not every day', 'less than once a week', 'I do not smoke'.

7. Eating breakfast: Young people were asked 'How many times during weekdays do you eat breakfast?'. With response options of: 'never', 'one day', 'two days', 'three days', 'four days', 'five days'.

8. Adverse health outcomes: Students were asked 'In the last six months: how often have you had the following: nervousness; dizziness; irritability; feeling low; and sleeping difficulties?' Each response for each health outcome (i.e. nervousness, dizziness) was: 'about every day', 'more than once a week', 'about every week', 'about every month or 'rarely or never.'

9. Dietary measures: In order to measure the diet, the young people were asked 'How many times a week do you usually eat or drink? Fruits, vegetable, sweets, soft drinks', the response options were: 'never', 'less than once a week', 'once a week', '2-4 days a week', '5-6 days a week', 'once a day, every day' and 'every day, more than once'.

4.2.4 Data analysis

Descriptive statistics were used to calculate the frequency for categorical data such as (gender, school year, ethnicity, FAS). By using factor analysis, two major dietary patterns are identified: healthy dietary pattern (fruit and vegetable), and unhealthy dietary pattern (sweet and soft drink). For health outcomes, factor analysis was chosen to analyse the health outcomes data. The HBSC is a standardized core questions, the researcher did not have the option to add their own questions. In this thesis HBSC was used to evaluate the available variables about food intake. One question

was about “how many times a week did they eat or drink fruit, vegetables, sweets, coke, milk, milk products, chips, white bread, cereal, and fish”. For dietary analysis, when quantitative data is available, factor analysis is a suitable statistical method. Factor analysis is commonly used to reduce the variables to a small set of variables for simpler interpretation. However, that is why factor analysis was used instead of using other dietary assessment methods such as the Healthy Eating Index. Exploratory factor analysis (EFA) was conducted, this identifies the numbers of factors, and it also estimates the variables that are covaried/correlated to form an overall factor (Brace et al., 2003). A one-factor model was decided on, this decision was formed using the scree plot, which retains the factors with an eigenvalue of greater than 1.0. Factor 1, which is called ‘wobbles’ is mainly defined by ‘feeling low’, ‘nervousness’, and ‘irritability’. Sleeping difficulties and dizziness were dropped from all further analysis as it is had a low loading.

Logistic regression models examined the associations between sociodemographic characteristics and frequency of ED consumption, reporting Odds Ratios (OR). Logistic regression models explored the associations between ED consumption and smoking, sleeping pattern, diet (healthy – unhealthy diet), and eating breakfast, with adjustment for age, gender and FAS. In addition, Logistic regression models were used to explore the associations between ED consumption and health outcomes defined as ‘wobbles’. All analyses were adjusted for clustering to account for the non-independence of pupils within schools. Statistical analyses were performed using STATA software (version 14.0).

4.2.5 Ethical approval

The current study uses secondary data from questionnaires and surveys for analysis. Data was collected in 2017 by the School Health Research Network (SHRN) (ethical approval (SREC/2190)).

4.3 Results

4.3.1 Population sample

The sample consisted of 112,045 students from 193 schools from Year 7 to Year 13 (aged 11 to 18). Table 4.1 provides an overview of participant characteristics. The sample consisted of 48% of male students, 49% of female students and 3% did not disclose their gender. The sample included 86% white, 5% other white, and 10% from other backgrounds. Over 90% of students were from Year groups 7 to 11 (ages 11 – 16). The majority of students (94%) did not smoke, and 3% smoked every day (Figure 4.2). Only half of the population consumed breakfast five days per week, and

over 20% never consumed breakfast (Figure 4.3). The family affluence score (FAS) was recorded for all participants; 34% of participants were considered to be low affluence, 31% medium affluence and 34% high affluence. Table 4.2 provides a summary of the main findings relating to lifestyle measures and likelihood of ED consumption.

Table 4.1 Demographic characteristic of study participants

Characteristic		N (%)
Gender	Male	53,964 (48.16)
	Female	55,820 (49.82)
School year	Year 7	22,634 (20.20)
	Year 8	22,421 (20.1)
	Year 9	22,208 (19.82)
	Year 10	19,704 (17.59)
	Year 11	17,004 (15.18)
	Year 12	4,495 (4.01)
	Year 13	3,579 (3.19)
Ethnicity	White	92,831 (85.63)
	Other White	5,065 (4.67)
	Other	10,514 (9.70)
Family affluence	Low	36,049 (34.19)
	Middle	33,181 (31.47)
	High	36,206 (34.34)

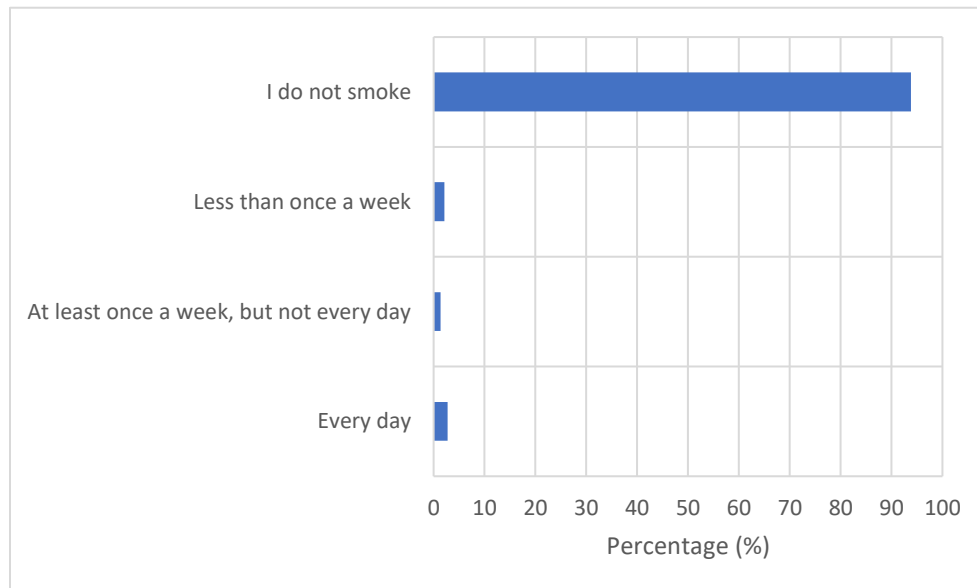


Figure 4.2 Percentage of smokers in the sample population

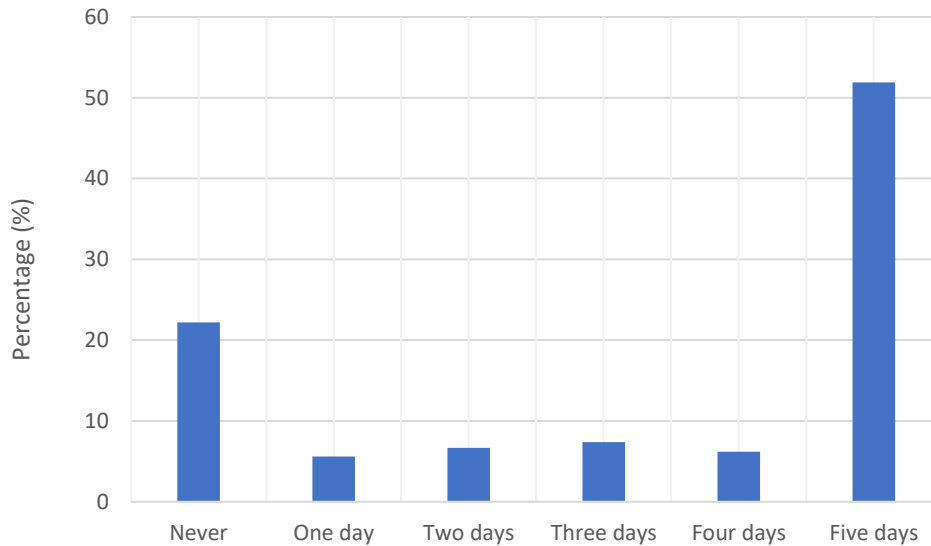


Figure 4.3 The number of days that participants consume breakfast in one week

Table 4.2. Summary of the main finding relating lifestyle measure and likeliness of ED consumption.

Measure	Odds Ratio	Confidence level (95% CI)	P. value
Males	2.05	1.97 to 2.13	< 0.001
High FAS	0.89	0.86 to 0.92	< 0.001
Unhealthy diet	1.06	1.05 to 1.07	< 0.001
Eating breakfast	0.87	0.86 to 0.88	< 0.001
Smoking	4.66	4.35 to 5.00	< 0.001
Health outcomes (feeling low, irritability, nervous)	0.96	0.93 to 0.99	< 0.05

4.3.2 ED Consumption

All participants were asked to report their EDs consumption. Figure 4.4 indicates that 60% of the sample did not consume any EDs (the prevalence rate is 538 young people per 1,000), 18% consumed EDs less than once a month (176 per 1,000), 7% once a week (71 per 1,000) and 5% consumed it 2-4 times per week (53 per 1,000). Only 2% of the population consumed EDs every day (20 per 1,000). In total, 40% of the sample population consumed EDs to some degree, and 60% of the sample not consuming EDs.

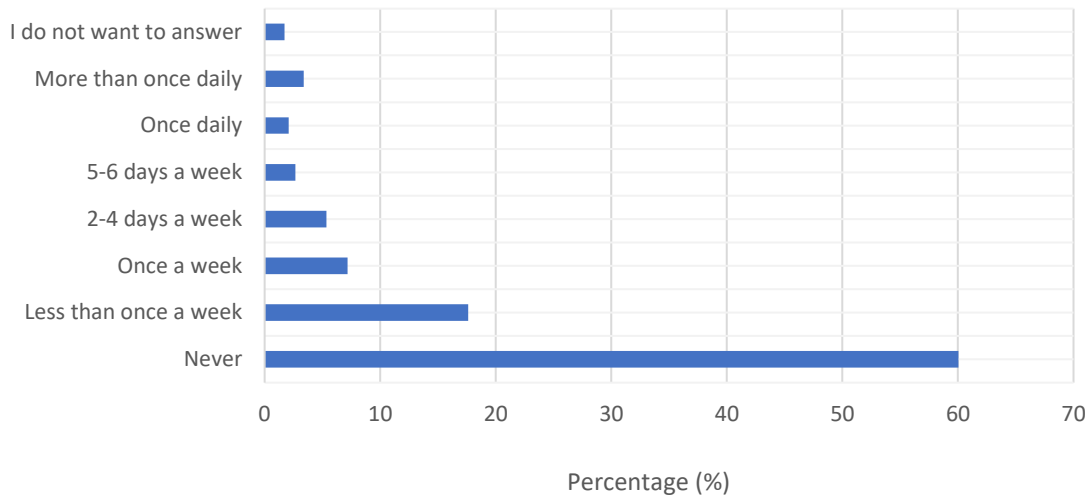


Figure 4.4. The frequency of ED consumption in the sample population

A relationship between gender and the consumption of EDs was observed; males were 2.05 times more likely to consume an ED (95% CI, 1.97 to 2.137, $p=0.28$) compared to females, meaning males were twice as likely to use EDs. ED consumption was low amongst white participants ($p<0.05$). White individuals were 0.846 times less likely to consume EDs (95% CI, 0.80 to 0.89).

A low FAS was associated with higher EDs consumption ($p<0.05$). Individuals belonging to a high FAS group were 0.89 times less likely to consume EDs compared to lower FAS groups (95% CI, 0.86 to 0.92).

Does the number of EDs consumed, associate with the physical health and eating behaviours of students?

When considering specific measures of health outcomes, factor analysis was conducted to identify which health variables are clustered, and one factor (wobbles) was found that was mainly defined by feeling low, nervous, and irritability. The findings revealed that those who consumed EDs were 0.966 times less likely to experience poor health outcomes as defined above (95% CI, 0.93 to 0.99).

A relationship was found between breakfast consumption and ED consumption, revealing that students who do not consume breakfast were more likely to consume EDs ($p<0.05$); students who ate breakfast were 0.87 times (95% CI, 0.86 to 0.88) less likely to consume ED. Students reporting an unhealthy diet were more likely to consume EDs (OR 1.07, (95% CI, 1.05 to 1.07, $p<0.05$). Students who reported drinking EDs were also more likely to report often smoking ($p<0.05$).

Specifically, those reporting smoking were found to be 4.669 times more likely to consume EDs compared to non-smokers (95% CI, 4.35 to 5.00).

4.4 Discussion

4.4.1 The prevalence of Energy Drink Consumption

The sample consisted of 112,045 students from 193 schools from various year groups. Due to the large sample size, it can be assumed that there is representation from numerous ethnicities as well as social classes. This allows the results of the study to be generalised to a broader population. Approximately 60% of the sample self-reported that they did not consume any EDs, 18% reported consuming EDs less than once a month, 7% once a week and 5% reported consumption 2-4 times per week. Only 2% of the population consumed EDs every day. In total, 38% of the sample population consumed EDs to some degree, and 62% of the sample did not consume any EDs. The literature has reported very similar numbers. For example, a study by Gallimberti et al. (2013) reported that EDs consumption tends to increase with age. They found that 17.8% of sixth graders consumed EDs, and this number increased to 56.2% amongst eighth graders. The education level of the participants varied from Year 7 to Year 13, with over 90% being from between Year 7 and 11. This study did not monitor the consumption of specific ages. However, a similar trend is likely observed considering the overall results of Gallimberti et al. (2013) who reported 9.9 % used EDs occasionally, 6.5 % monthly, 5.5 % weekly, and 1.3 % daily and these results were very similar to those reported in this study.

These statistics indicate that EDs are not yet so popular among the young population. However, smart marketing techniques used by companies which associate the drinks with danger, power and youth culture, can make them desirable to young, impressionable adolescents.

The current study revealed an association between gender and ED consumption; males were shown to be more likely to consume EDs. Males were shown to be 2.053 times more likely to consume an EDs (95% CI, 1.972 to 2.137, $p < 0.001$) compared to females. This is in agreement with other studies where males were more likely to consume EDs.

A qualitative study by (Visram et al., 2017) found that boys were more likely to drink EDs as it gave them a particular image. One young adolescent reported:

“If you have a girlfriend or something, like, boys like to drink them then, because they think... Sometimes the boys think that they look proper rock-hard when they have them in front of girls and stuff. And then when they go out, you buy like three.” (Boy, 10–11 years) (Visram et al., 2017)

This finding suggests that boys consume EDs as they think they are portraying a particular image. There was also a suggestion that peer pressure leads to EDs consumption. Students reported that they did not look 'cool' if they were drinking water, and their peers were drinking EDs. Interestingly, girls gave reasons such as boys do more sports, as well as the packaging of the drinks. One girl stated:

I think that the drinks are a little bit sexist because they have all these boyish kind of patterns, but you never see any girly ones. (Girl, 10–11 years) (Visram et al., 2017)

This highlights a perception that most EDs are marketed towards boys, and alarmingly targeted marketing is being used in order to target this group. Studies show that boys are often targeted via advertising on devices such as iPads and game consoles (Visram et al., 2017). A study by Larson et al. (2014) found that boys spent more time watching TV and playing on game consoles and the consumption of EDs led to an increase in both these activities. In addition, boys who regularly consumed EDs spent about one additional hour per week watching TV compared to boys who consumed EDs less than once per week. Furthermore, boys who regularly consumed EDs spent approximately four additional hours playing video games compared to those who consumed EDs less than once per week (Larson et al., 2014).

Whilst video game usage was not explored within the current study, this could suggest a further reason for the observed differences in consumption rates across genders. However, many of the studies are carried out on older participants who may have different habits (Alabbad et al., 2019). For example, a study recently reported that males tend to drink EDs alone, whereas females tend to mix them with other drinks (Poulos and Pasch, 2015). This shows a difference in drinking habits between ages; however, the current study has not found a relationship between school grade and the consumption of EDs ($p=0.171$). This could be due to the students still being quite young, and such trends only being observed in older individuals.

Individuals belonging to a high FAS group were 0.89 times less likely to consume EDs compared to lower FAS groups. This is in agreement with existing literature, where less affluent individuals are more likely to consume EDs due to perceived better education (Friis et al., 2014). The study found a distinct social gradient where lower social groups were more likely to consume EDs. Other studies concerning diet and social class have also found that people from lower socio-economic backgrounds usually have a more inadequate diet when compared to those of higher socio-economic status (Shahar et al., 2005).

Ethnicity has also been associated with the level of ED consumption. The current study found that reports of ED consumption were lowest amongst white participants ($p<0.05$). White individuals were

0.85 times less likely to consume EDs (95% CI, 0.800 to 0.893). Very few studies have considered the impact of ethnicity on ED consumption in the UK and as such, this an area that needs further investigation.

4.4.2 EDs Consumption and the predictors of use

There have been suggestions that ED consumption is linked to smoking. In this study, the majority of students (94%) did not smoke, and 3% smoked every day. Students who reported drinking EDs were also more likely to report smoking often ($p < 0.05$), which supports the notion that those who consume EDs also have an unhealthy lifestyle or diet. Smoking seems to be a significant contributing factor to the consumption of EDs, with smokers being 4.67 times more likely to consume EDs compared to non-smokers.

In support of this finding, a large-scale study by Treur et al. (2016) reported that smoking is positively associated with caffeine consumption. The results were similar when comparing smoking initiation, smoking persistence and smoking heaviness (Treur et al., 2016). Although the study was focused more on tea and coffee consumption, the authors also generalised to ED consumption due to the caffeine levels in the drinks. The study was further supported by Larson et al. (2014), who found that EDs consumption was linked to smoking, with smokers drinking more EDs compared to non-smokers. The number of smokers in the current study was relatively low, and therefore, it is not likely to be the main contributing factor for EDs consumption in this sample. However, it does have wider implications for the population, as studies have reported that the initiation of smoking can lead to an increase in the consumption of caffeine via EDs (Polak et al., 2016).

In the current study, only half of the sample consumed breakfast five days per week, and over 20% never consumed breakfast. A relationship between the lack of breakfast consumption and EDs consumption has been observed. Students who do not consume breakfast were more likely to consume EDs. Those students who ate breakfast were 0.85 times less likely to consume EDs. This is in agreement with the literature where individuals who skip breakfast are much more likely to have an unhealthy diet and drink EDs, perhaps in order to get a boost of energy (Smith and Richards, 2018). Larson et al. (2014) also reported similar findings; those students who skipped breakfast were found to consume more EDs. A good breakfast can provide a good energy source for the rest of the day, and therefore when it is lacking, people are more likely to snack on less healthy options which can have further consequences on health (Spence, 2017). Furthermore, the consumption of breakfast is associated with an improvement in cognitive function as well as academic achievement (Rampersaud, 2009, Chaplin and Smith, 2011). If breakfast is being replaced with an ED, it is likely

to have a significant negative impact on cognitive function as EDs have proven to reduce cognitive function (Gallimberti et al., 2013).

Furthermore, the present study also found that ED consumption was related to reports of an unhealthy diet. Students with an unhealthy diet were more likely to consume EDs, and those students who consumed EDs were 1.07 times more likely to have an unhealthy diet. In support of this, students with a healthy diet are less likely to consume EDs. A recent study by Poulos and Pasch (2015) reported that EDs were more likely to be consumed by males, and they also found these students consumed fewer fruits, vegetables, milk and breakfast. Instead, ED consumption was highly associated with soda and ready meal consumption. Due to the high sugar in EDs, consumers are likely to experience low sugar once the initial high of the ED has worn off, which can lead to individuals craving more sugar leading to a cycle of consuming high sugar foods (Nowak et al., 2018, Anderson and Horne, 2006).

4.4.3 ED Consumption and health outcomes

As discussed previously, EDs can have a negative association on both physical and behavioural outcomes (Reid et al., 2017). In the current study, health outcomes such as feeling irritability, nervous, and feeling low were evaluated. EDs have not been found to have a direct impact on the health outcomes of the student population. Those who experience poor health outcomes were 0.966 times less likely to consume EDs, as defined above. This is inconsistent with results already published in the literature where the consumption of EDs has been linked to disruption to the sleeping pattern, increased feelings of nervousness or increased anxiety (Mwape and Mulenga, 2019, Richards and Smith, 2016).

A small relationship could be owed to the population only drinking small amounts of EDs which may not be having significant effects. Furthermore, some students may not notice the difference in their sleep pattern or may attribute it to other factors such as stress and exams. The consumption of EDs has been associated with insomnia and daytime fatigue amongst adolescents (Marmorstein, 2017). This has been attributed to the increased caffeine consumption, which can impact on brain activity (Sanchez et al., 2013). The impact of EDs on sleep is very critical, as poor sleep quality can lead to students feeling tired in the day which may lead to greater EDs consumption, and perhaps more regular consumption worsening sleep quality (Sanchez et al., 2013), causing a vicious cycle of health problems.

Although studies have shown that caffeine and EDs can increase alertness, it has also been shown to have a direct impact on the growth and development of the nervous system (Wentz and

Magavi, 2009, Smith, 2002). The process of neurogenesis occurs within the hippocampal and olfactory bulb through the adolescent years until adulthood. An *in vivo* study on mice found that the administration of caffeine can have an impact on the proliferation of hippocampal neural precursors; therefore, suppressing hippocampal neurogenesis (Wentz and Magavi, 2009).

In order to suggest how the health implications of EDs can be communicated within this group, there is a need to understand that the factors that contribute to consumption, as well as understand the negative impact of ED consumption on health outcomes (Visram et al., 2017). Many young adolescents consuming these drinks may not be aware of the health implications, and therefore education may be required in order to ensure that informed choices are made.

4.5. *Strength and limitations*

The findings of this study can be generalised as a well designed sampling method was used, making the sample representative. The sampling size together with a sampling method is a strength of the study. The first limitation of this study arises from the cross-sectional approach which does not allow to establish a causal association between ED consumption and the health outcomes so that young people could consume ED as a result of their low sleep quality. The second limitation is this study used self-reported data, making the study more exposed to bias reporting. Another limitation regarding the dietary data is qualitative it did not include portion size. Finally. In this study, any container was considered as a homogenous item (one container) regardless of volume variation between containers so actual amount of ED consumed cannot be determined, but only the frequency.

4.6 *Conclusion*

The purpose of the current study was to investigate the prevalence of reported EDs consumption among young people in Wales and, to explore the predictors of ED (sociodemographic factors and smoking) use and the adverse health outcomes associated with EDs consumption. Important conclusions drawn from this work include: 1) the prevalence of ED consumption among young people in Wales is associated with socio-economic characteristics. In agreement with existing literature, the consumption of ED is most likely to be reported by adolescent males than females, and, 2) the EDs consumption is associated with a poor-quality diet and skipping breakfast. The consumption of ED was found to be significantly associated with nicotine use which demonstrates that risk behaviours seem to cluster.

In the next chapter (**Chapter 5**) the prevalence of EDs among young people in Saudi Arabia and the predictor factors and health outcomes associated with the consumption of these drinks will be investigated.

Chapter 5

**The prevalence and socio-economic determinants of ED
consumption and related health outcomes among Saudi young
people in Riyadh, KSA.**

5.1 Introduction

As discussed in the narrative review (**chapter two**), the effects of EDs on young people go beyond health-specific outcomes (Seifert et al., 2011) to include, physical, mental, and behavioural issues (AlBuhairan and Olsson, 2014).

As previously mentioned, ED companies mostly target the 18-35 years age group. A few studies conducted in Saudi Arabia reported the prevalence of EDs consumption among young people in different cities. Among these studies, a few reported a high prevalence of ED consumption from Dammam (45.6%) (Alsunni and Badar, 2011), 59.9% from Jeddah (Alrasheedi, 2016), 52.2% from Madinah (Aluqmany et al., 2013), and 60% from Hail (Epuru et al., 2015). These studies also indicated that the prevalence of ED consumption is different depending on gender, as the males are more likely to consume ED compared to females. Earlier estimates suggested that 16.3% of the male in Saudi Arabia aged 14 to 19 years consume EDs more than three times a week (Al-Hazzaa et al., 2011).

Since the marketing and consumption of ED among young people increased dramatically, this age group has received increased attention from policymakers and health consultants worldwide (WHO, 2014). The sale of EDs has been banned in some European countries such as Denmark and France, whereas laws have been introduced in many Nordic countries and Canada (Seifert et al., 2011). Other countries have implemented changes to labelling laws that include a requirement for clear health warnings; an approach adopted universally across the European Commission Union (Seifert et al., 2011). ED manufacturers have been aggressively marketing EDs in Saudi Arabia over the past two decades. According to the Global EDs Report (2012), Saudi Arabia has been classified as one of the top ten nations, where individuals consume an excessive amount of EDs.

Adolescents (12-19 years) represent 20% of the population in Saudi Arabia (AlBuhairan and Olsson, 2014). In 2012, Saudi's Council of Ministers banned the sale of EDs at all government, education and health facilities, including the abolishment of advertising and sponsorship. Moreover, the government has asked the ED companies to include a health warning and a consumption limitation of two cans a day; to be written in Arabic and English on their products (Alrasheedi, 2016). In 2017, the Saudi government imposed a tax on unhealthy products which included a 100% tax on EDs. Despite all the precautions, the drinks are still readily available and accessible to adolescents in Saudi Arabia without any age restriction, exposing young people to the EDs (Alrasheedi, 2016).

Research on the prevalence of EDs consumption among Saudi youth is still limited. Many studies have focussed on the consumption prevalence only and did not try to recognise the determinants and associated factors of ED use. Moreover, no study reports an association between EDs consumption and health outcomes among young people in Saudi Arabia. An understanding of

current consumption rates is needed to develop strategies to increase awareness and preventives measures.

The objectives of the research presented in this chapter are:

1. To determine the prevalence of ED consumption among a representative sample of Saudis aged 13-20 years in Riyadh.
2. Assess the association between sociodemographic characteristics and ED consumption.
3. Identify factors associated with the consumption of EDs among young people.
4. Determine the cross-sectional relationship between the consumption of EDs and reported health outcomes.

5.2 Method

Based on the HBSC survey described in chapter four, this cross-sectional study was designed to collect and analyse primary data relevant to ED consumption as exemplified by young people aged (13-20 years) in Riyadh, Saudi Arabia. Data was collected using an online survey, and the sampling method, data collection and data analysis are discussed in the following section.

5.2.1 Study sample

The population targeted for this study were young people of all genders, aged between 13 to 20 years of age, attending intermediate and secondary schools located in the city of Riyadh in the Kingdom of Saudi Arabia (N= 1,522 schools and N=424,434 students). This age group was chosen as it represents the young people in Saudi Arabia that consume EDs; in addition, this age group does not need adult supervision to complete the questionnaire.

The city of Riyadh was selected to recruit participants as it is the capital city of the Kingdom of Saudi Arabia with the highest population in the country. The total population of Riyadh city was almost 8 million in 2015 (GAS, 2015, Musaiger and Zagzoog, 2013). In order to determine the sampling procedure, it was necessary to assess the characteristics of the resident population in Riyadh. Table 5.1 shows the total population of Riyadh categorised by gender, age group and nationality.

Table 5.1 Population in the Riyadh region by gender, age groups and nationality in 2015

Total			Non-Saudi			Saudi			Age Groups
Total	Females	Males	Total	Females	Males	Total	Females	Males	
702,399	334,778	367,621	186,626	896,25	970,01	515,773	245,153	270,620	0-4
577,323	275,737	301,586	199,660	939,55	105,705	377663	181,782	195,881	5 - 9
620,176	301,510	318,666	173,285	813,25	919,60	446,891	220,185	226,706	10 - 14
603,782	288,034	315,748	136,931	611,67	757,64	466,851	226,867	239,984	15 - 19

Table 5.2 shows the number of intermediate and secondary schools categorized further into private and governmental schools for both genders. The sampling protocol and inclusion criteria were designed to reflect the variation of young people living in Riyadh.

Table 5.2: The total number of intermediate and secondary schools in Riyadh city in 2015

Gender	Intermediate schools				Secondary schools			
	Public	No. of students	Private	No. of students	Public	No. of students	Private	No. of students
Male	278	807,19	162	372,53	151	549,10	154	502,18
Female	258	895,77	153	165,06	205	700,73	141	291,78

Study participants were selected from the target population using simple random sampling. The selected schools included both girls and boys schools. Moreover, both public and private schools open for tuition during the daytime were eligible for inclusion in the study. Evening schools and those that only served students with special needs were excluded from the study.

Students were included in the study regardless of gender, ethnic origin or citizenship in the Kingdom of Saudi Arabia. This provision was made to address any bias stemming from variation in the gender, demographic or socio-economic conditions of the participants as evident in Figure 5.1. The inclusion criteria included all males and females from all socio-economic or demographic background, studying at intermediate/secondary level, in public/private schools in the Riyadh city

area operating during the day. Students attending evening schools or schools catering for special needs students were excluded from the sampling protocol.

The random sampling procedure was used to select 25 schools (both private and public) in Riyadh city using the list of schools. An email was sent to the headteacher of all 25 schools that were selected, describing the main aim and objectives of the study, and its approval from the ministry of education. Nine of the schools declined to participate in the study, out of which one school was from the area of high socio-economic status, and 8 of them were located in the area of middle socio-economic status. Finally, 16 schools took part in this study. Based on the number of the student population in each school, two classes from each grade were selected, so there was a total of six classes from each of the three grades in the intermediate and secondary schools (96 classes in total). The sampling was continued until a target of 1000 male; 1000 female was achieved, oversampled and sought $n = 2,000$. To adjust for gender bias; equal sampling was selected from male and female students (50% male and 50% female). Twenty-four students opted out of the study due to the lengthy questionnaire (the response rate was: 98%), which was estimated to take approximately 15 minutes to complete. The online survey was distributed equally to all the selected students. The students were informed that the information collected would be anonymous, and participation would be entirely voluntary.

The participants enrolled in this study were both male and female students between 13 to 20 years of age in secondary (13-15 years) and high schools (16-20 years) in Riyadh, Saudi Arabia (figure 5.1).

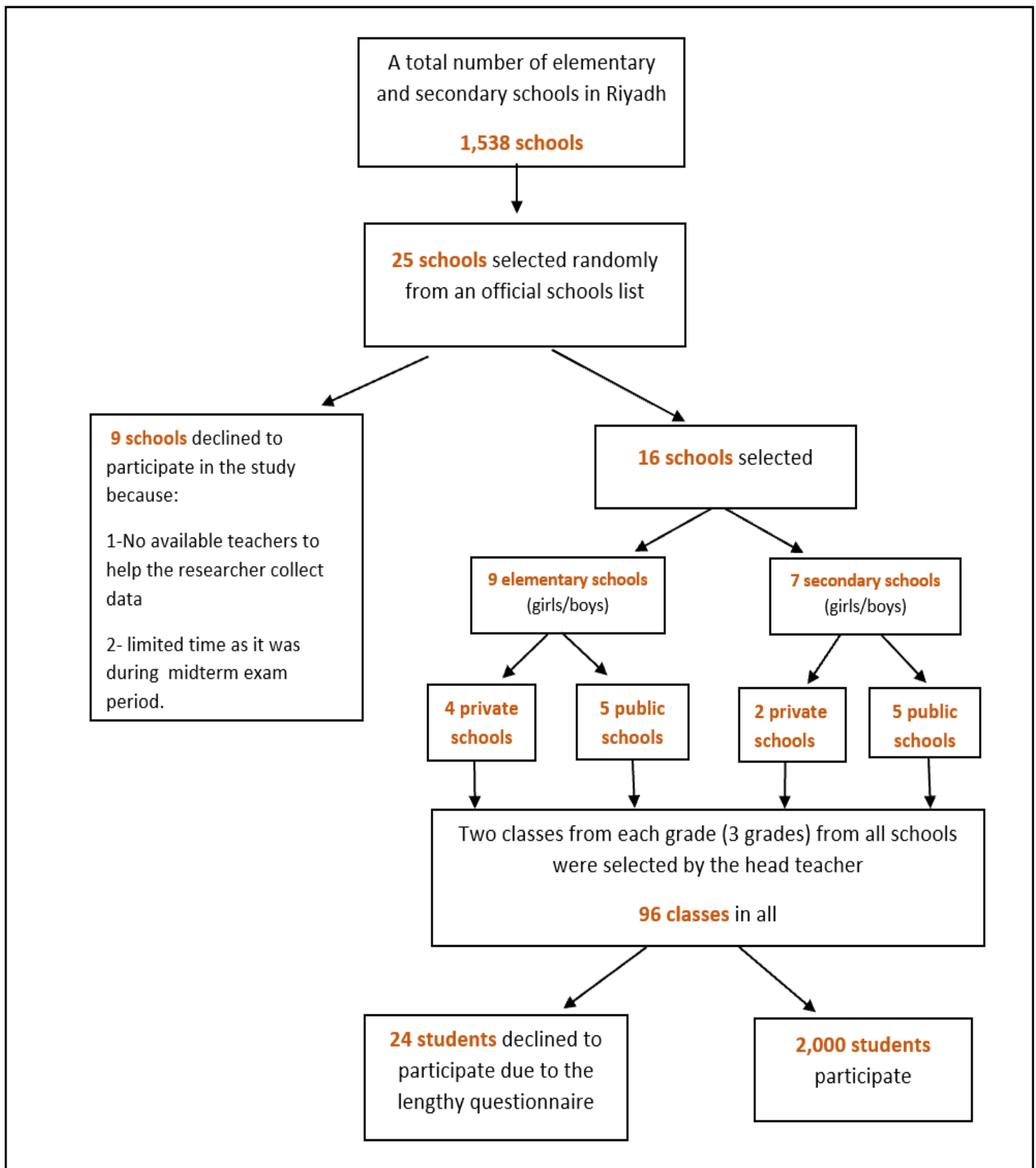


Figure 5.1: Sampling process

5.2.2 Study Tools

The questionnaire for the study was initially developed in English and subsequently translated into the Arabic language. Once the data collection using the Arabic questionnaire was completed, the data was translated from Arabic back into English. The forward -backwards-forward translation technique (Apolone and Mosconi., 1998). was applied to check the accuracy of the translation. The questionnaire was developed based on an existing model implemented by SHRN in the UK. This survey format was revised, and some questions relevant to ED consumption in Saudi Arabia were added.

The questionnaire was divided into three main parts. The first part focused on the subject's demographic information, such as gender, age, education level, and nationality. The second part included multiple-choice questions required to gather data about the consumption frequency of EDs and the reasons that led to consumption. This part also included questions on the choice of the drink brands and time of day these drinks were consumed. The third part of the questionnaire covered the physical and mental health status, as well as any behavioural outcomes of the students (Appendix H).

5.2.2.1 Measure

The self-reported measures used for analyses in Chapter five (primary data collection) are listed below.

5.2.2.1.1 Demographics

- 1. Gender:** The participants were asked to report their gender by choosing one of these response options of; 'Boy', 'Girl'.
- 2. Age:** The participants were asked for their year of birth 'Your year of birth' '1998', '1999', '2000', '2001', '2002', '2003', '2004', '2005'.
- 3. School-level:** The participants were asked 'In which level are you studying?' by choosing one of these responses 'Intermediate school', 'Secondary school'.
- 4. School type:** The participants were asked to report their school type 'Which type of school are you studying?' with two responses 'Public school', 'Private school'.
- 5. Nationality:** The participants were asked to report their nationality 'What is your nationality?'" Saudi', 'Non-Saudi'.

6. Father's education level: The participants were asked to report 'What is your father education level?', 'Illiterate', 'Primary school education', 'Intermediate and secondary school education', 'Bachelor's Degree', 'Master's degree', 'Advanced Graduate work or PhD'.

7. Mother's education level: The participants were asked to report 'What is your mother education level?', 'Illiterate', 'Primary school education', 'Intermediate and secondary school education', 'Bachelor's Degree', 'Master's degree', 'Advanced Graduate work or PhD'.

8. Family income: The participants were asked to report 'Family monthly income' the possible responses were; 'Less than 5000 SR', 'Between 5000 to 10000 SR', 'More than 10000 SR'. The measure of the socio-economic status depends on the family monthly income, which is the most potent indicator affecting living standards in Saudi Arabia (Al-Agha et al., 2015, Alfrayh, 1990).

9. The frequency of ED consumption: The participants were asked 'How many times a week do you usually drink ED (such as Red Bull, Monster, and Rockstar)?' by choosing one option of 'Less than once a week', 'Once a week', '2-4 days a week', '5-6 days a week', 'Every day'. This question coded as ED frequency.

10. The quantity of ED consumption: The participants were asked to report 'How many EDs would you usually drink in one go?' with options of 'Not more than one', 'Two', 'Three or more'. This question coded as EDs quantity.

A composite variable was created using group function in STATA from ED frequency and EDs quantity to derive 'ED intensity'. $ED\ intensity = group (ED\ quantity \times ED\ Frequency)$. In this study, Energy drink intensity is defined as the cumulative effect of the amount of ED consumed and the frequency of consumption.

11. Dietary measures: Dietary intake was measured by asking participants 'How many times a week did they eat or drink fruits, vegetable sweets, coke or other soft drinks, skimmed or semi-skimmed milk, full-fat milk, other milk products (like yoghurt, milkshakes), chips, white bread, cereals, fish'. The options to choose from were; 'Never', 'Less than once a week', 'Once a week', '2-4 days a week', '5-6 days a week', 'Once a day, Every day.' For dietary measures the research was used the same question that was in HBSC, due to that and when quantitative data is available, factor analysis is a suitable statistical method. Factor analysis is commonly used to reduce the variables to a small set of variables for simpler interpretation. However, that is why factor analysis was used instead of using other dietary assessment methods such as the Healthy Eating Index.

12. Smoking: The participants were asked 'How many times a week do you usually smoke?'. With response options of; 'Every day', 'At least once a week, but not every day', 'Less than once a week', 'I do not smoke'.

13. Eating breakfast: The participants were asked 'How many times during weekdays do you eat breakfast?' With response options of; 'Never', 'One day', 'Two days', 'Three days', 'Four days', 'Five days'.

14. Negative health outcomes: Possible side effects of ED consumption among the young people was evaluated by asking 'In the last six months: how often have you had the following; headache, stomach ache, nervousness, dizziness, irritability, low mood, insomnia, feeling dizzy, and depression?' the choices are given for each health outcome were; 'About every day', 'More than once a week', 'About every week', 'About every month or 'Rarely or never.'

15. Oral health: The participants were asked to report 'Are suffering from one of the common gum diseases such as gum infection, swollen gum, and wandering of a tooth? With response option of; 'Yes', 'NO', 'I do not know'.

16. Sleep times: The participants were asked to report their sleep time 'when do you usually go to bed if you have to go to school the next morning?'. With response options of 'No later than 9', '9:30 pm', '10pm', '10:30pm', '11pm', '11:30pm', '12pm', '12:30am', '1:00am', '1:30am or later'.

5.2.3 Pilot Study and Validation Procedure

A pilot study was carried out before the full implementation of the research study. This was performed to ensure that the study protocol was suitable for answering the research questions. The pilot study aimed to validate the study questionnaire as well as to identify issues related to the implementation of the study protocol.

The pilot study involved the distribution of the study questionnaire to a group of 15 students aged between 13 and 18. The pilot group comprised of 7 male and eight female students chosen randomly from different schools that fulfilled the inclusion criteria. The researcher was present to address any queries from the students regarding the study questionnaire. Following a period of 14 days, the questionnaire was redistributed to the same 15 students. This step was included in determining whether a difference was observed in either the survey results or difficulties in completing the survey when students completed the questionnaire twice. The survey data collected at both points reported the same results, and there was no variation observed across the data for each of the 15

participants. The 15 participants that took part in the pilot study, and the questionnaire used for the pilot study were excluded from the final analysis.

5.2.4 Data collection

The cross-sectional study was carried out in intermediate and secondary schools selected randomly in Riyadh city, and the study was conducted between February 2018 and April 2018.

A self-administered survey was used to explore the prevalence rates of ED consumption amongst adolescents in Riyadh. The study questionnaire developed and validated in Section 2.3 was distributed electronically to students in the selected schools. The survey was distributed during the official working hours of each school, while the students were in attendance. In addition to the study questionnaire questions, the online survey also contained a detailed description of the objectives of the study and a section for any feedback response. This information was included to fulfil the ethical requirements of conducting the study.

The online survey was distributed to all students of all genders, who were in attendance at the selected schools during the period in which the survey was conducted. Equal sampling was done to adjust for gender bias, (50% male and 50% female).

Participation in the survey was voluntary and, prior written consent was acquired from each participant, in accordance with the ethical requirements. The confidentiality of all study participants was maintained throughout the process. The study questionnaire did not collect the names or other personally identifiable information about the study participants.

5.2.5 Data analysis

Quantitative data were analysed using STATA software (v.14, Stata Corp LLC) (STATACORP, 2018). Descriptive statistics were used to calculate frequencies for categorical data such as gender, age group, nationality, type of school, family income and, student pocket money, etc. By using factor analysis, two major dietary patterns were identified: healthy dietary pattern and unhealthy dietary pattern (Table 5.3). However, the low-fat milk, the full-fat milk, the cornflakes, and the fish were excluded from the analysis because they have very low factor loading scores. Factor analysis was chosen to analyse the health outcomes data. Factor 1 is called 'wobbles' and is mainly defined by the health outcomes 'headache', 'stomach aches', 'irritation', 'insomnia', 'feeling dizzy' and 'depression' whereas 'depression' was dropped from all further analysis as it had a low loading (Table 5.4).

Table 5.3. Factor analysis of dietary patterns.

Variable	Factor 1	Factor 2
Fruits	0.522	-0.031
Vegetables	0.952	-0.123
Sweet	0.153	0.531
Soft drinks	-0.009	0.553
Low-fat milk	0.232	0.047
Full fat milk	0.255	0.203
Milk products	0.429	0.232
Potato chips	0.111	0.504
White bread	0.298	0.676
Cornflakes	0.145	0.260
Fish	0.233	0.036

Table 5.4. Factor analysis of adverse health outcomes

Variable	Factors
Headache	0.8502
Stomach aches	0.4906
Irritation	0.7774
Feeling low	0.3692
Insomnia	0.4542
Feeling dizzy	0.5226
Depression	0.4609

Logistic regression models examined the associations between ED consumption, and socio-economic determinants adverse effects and other factors affecting ED consumption. A P value of ≤ 0.05 was considered statistically significant. The analysis was conducted on the quantity of ED consumed by students to ascertain if this has an impact on their physical health and sleep patterns (i.e., if an increase in the quantity of ED consumed was associated with an increase in the odds of students eating breakfast, sleeping earlier, and having better oral health), at 95% confidence intervals. The first ordered logistic regression analysis was performed with factors predicting student's eating behaviours (consumption of breakfast). A second ordered logistic regression model was generated to assess whether the quantity of ED consumed also impacted student's sleeping patterns. Lastly, the third logistics regression model was generated to assess whether the quantity of ED consumed had an impact on the student's oral health.

5.2.6 Ethical approval

This study was approved by the Ethics Committee of the Ministry of Education in Saudi Arabia. The aim and objectives of the study were described to each participant, and written consent from all the participants was obtained before enrollment in the study. The questionnaire distribution and data collection were done from February 2018 to April 2018.

5.3 Results

5.3.1 Socio-demographic characteristics of the participants

A total number of 2,000 students (age 13-20 years) from intermediate and secondary schools in Riyadh participated in the study. The ratio of females and males was 1:1. The majority of the participants were Saudi nationals (84.73%), and 45.65% were from public school. Table 5.5 provides an overview of participant's demographic characteristics.

Table 5.5. Demographic characteristic of study participants

Characteristic		N (%) *
Gender	Male	1,000 (50.0)
	Female	1,000 (50.0)
Age Group (year)	20	83 (4.15)
	19	54 (2.70)
	18	99 (4.95)
	17	240 (12.00)
	16	312 (15.60)
	15	371 (18.55)
	14	473 (23.65)
	13	368 (18.4)
Nationality	Saudi	1,692 (84.73)
	Non-Saudi	305 (15.27)
Type of education	Public	913 (45.65)
	Private	1,087 (54.35)
Family monthly income	Low	312 (15.60)
	Middle	1,532 (76.60)
	High	155 (7.75)
Student pocket money (£, monthly)	≤60	1,210 (60.50)
	>60	790 (39.50)

5.3.2. EDs CONSUMPTION

From the total number of participants, 52.5% (0.52, 95% CI 0.50 to 0.55) reported regular consumption of EDs (525 young people consume ED per 1,000). Approximately 25% of the participants reported that they consumed one can of ED per week, 11.20% reported drinking two to four cans per week, and 1.60% (n=32) drank more than one can per day. The most popular ED among the students was Code Red (28%), with 39% of students reporting that they enjoyed the flavour. It was also found that 32 % of the students started to consume EDs between the age of 11-15 years, with 22% consuming ED at home (Table 5.6).

Table 5.6. Consumption of EDs among participants.

Variable	N (%) *
Consumption of EDs	
Yes	1,051 (52.55)
No	949 (47.45)
ED Consumption	
Once a week	511 (25.55)
2-4 at Week	224 (11.20)
5-6 at Week	43 (2.15)
More than once a day	32 (1.60)
Do not know	241 (12.05)
Never	949 (47.45)
Type of EDs consumed (more than one choice)	
Red Bull	271 (13.55)
Power Horse	30 (1.50)
Code Red	567 (28.35)
Bison	87 (4.35)
Other	96 (4.80)
Do not know	949 (47.45)
Reason for drinking ED (only drinkers)	
It is famous	87 (4.35)
Good taste	773 (38.65)
Given advice	48 (2.40)
It is available	29 (1.45)
Helps to wake up	57 (2.85)
Other	57 (2.85)
Do not know	949 (47.45)
At what age did you have the first ED? (only drinkers)	
Less than 5 Years	26 (1.30)
6-10 Years	170 (8.50)
11-15 Years	635 (31.75)
16 Years	164 (8.20)
Do not Know	56 (2.80)
Do not want to tell	949 (47.45)

5.3.2.1 Intensity of EDs consumed

It was found that males were 1.26 times (95% CI, 1.08 to 1.46) more likely to consume ED of higher intensity compared to females. Students who had secondary education were also 1.57 times (95% CI, 1.14 to 2.15) more likely to consume ED of higher intensity as compared to intermediate

schoolers. It was also observed that unhealthy diets seemed to lead to 1.69 times (95% CI, 1.53 to 1.86) higher consumption of ED of higher intensity. Those who used nicotine were 5.91 times (95% CI, 3.47 to 10.07) more likely to consume ED of higher intensity. However, students who ate breakfast were 0.89 times (95% CI, 0.83 to 0.95) less likely to consume ED of higher intensity (Table 5.7)

Table 5.7. The relationship between the intensity of EDs consumption with gender, education, diet and smoking.

The intensity of EDs consumption	Odds Ratio	P-value	[95% Conf. Interval]	
Male	1.26	< 0.05	1.08	1.46
Secondary school	1.57	< 0.05	1.13	2.15
Unhealthy diet	1.69	< 0.001	1.53	1.86
Nicotine	5.91	< 0.001	3.47	10.07
Eating breakfast	0.89	< 0.05	0.83	0.95

5.3.2.2 Frequency of EDs consumed

It was found that males were 1.23 times (95% CI, 1.07 to 1.41) more likely to consume ED more frequently. Participants with secondary school education were also 1.55 times (95% CI, 1.12 to 2.16) more likely to consume ED frequently; in addition to those with unhealthy diets (odds ratio = 1.67; 95% CI, 1.52 to 1.83) and those using nicotine (odds ratio= 5.67; 95% CI, 3.41 to 9.44). Students who ate breakfast were 0.88 times (95% CI, 0.83 to 0.94) less likely to consume ED more frequently (Table 5.8).

Table 5.8. The relationship between frequency of EDs consumption with gender, education, diet and smoking.

Frequency consumption of EDs	Odds Ratio	P- value	[95% Conf. Interval]	
Male	1.23	< 0.05	1.07	1.41
Secondary school	1.55	< 0.05	1.12	2.16
Unhealthy diet	1.67	< 0.001	1.52	1.83
Nicotine	5.67	< 0.001	3.41	9.44
Eating breakfast	0.88	< 0.001	0.83	0.94

5.3.2.3 Quantity of EDs consumed

It was found that males were 1.23 times (95% CI, 1.07 to 1.43) more likely to consume higher quantities of ED (two or more cans in one go) compared to females. Students with secondary education were also 1.52 times (95% CI, 1.14 to 2.01) more likely to consume higher quantities of ED. Students with unhealthy diets were 1.68 times (95% CI, 1.53 to 1.85) more likely to consume higher quantities of ED, and also those who used nicotine were 5.53 times (95% CI, 3.69 to 8.28) more likely to consume higher quantities of ED. Students who ate breakfast were 0.89 less likely to consume higher quantities of ED (95% CI, 0.83 to 0.96). In terms of socio-economic status, the young people with high family income were 1.08 more likely to consume high quantities of ED, but it is not statistically significant ($P > 0.05$) (Table 5.9).

Table 5.9: The relationship between the quantity of EDs consumption with gender, education, diet, smoking and socio-economic status.

Quantity consumption of EDs	Odds Ratio	P- value	[95% Conf. Interval]	
Male	1.23	< 0.05	1.07	1.43
Secondary school	1.52	< 0.05	1.14	2.01
Unhealthy diet	1.68	< 0.001	1.53	1.85
Nicotine	5.53	< 0.001	3.69	8.28
Eating breakfast	0.89	< 0.05	0.83	0.96
High family income	1.08	>0.05	0.81	1.46

5.3.3. Amount of EDs consumed and its association on the physical health and eating behaviours of students

It was observed that those participants who consumed higher quantities of ED were more likely to experience poor health outcomes that include headache, irritation, and dizziness. The results indicated that young people who consumed higher quantities of ED were 0.74 times (95% CI, 0.64 to 0.84) less likely to eat breakfast. Students who used nicotine were also 0.57 times (95% CI, 0.41 to 0.79) less likely to eat breakfast. However, students with healthy diets were 1.44 times (95% CI, 1.33 to 1.55) more likely to eat breakfast.

Students who consumed higher quantities of ED were 0.73 times (95% CI, 0.47 to 0.99) less likely to sleep early. Students who were Saudi nationals were also 0.65 times (95% CI, 0.22 to 1.09) more likely to sleep at later times; along with students with an unhealthy diet (odds ratio= 0.22; 95% CI, 0.09 to 0.35) and students who used nicotine (odds ratio= 0.61; 95% CI, 0.19 to 1.02). Students with healthy diets were 0.23 times (95% CI, 0.35 to 0.12) less likely to sleep at later times, along with students who ate breakfast (odds ratio= 0.26; 95% CI, 0.37 to 0.16). Thus, an increase in the quantity of ED consumed is significantly associated with an increase in the odds of students sleeping at later times (Table 5.10).

Table 5.10 Factors predicting sleep times

Explanatory variable	Estimated coefficient	Standard error
Quantity of EDs	0.73**	0.12
Male	-0.18	0.12
Secondary school	0.45	0.26
State school	-0.16	0.18
Saudi national	0.65*	0.21
Father's education	0.05	0.14
Non-occupied mother	-0.04	0.32
Retired mother	0.19	0.14
Medium family income	-0.05	0.35
High family income	0.45	0.35
High personal income	-0.13	0.10
Adult	0.05	0.06
Children	0.05	0.05
Healthy diet	-0.23*	0.06
Unhealthy diet	0.22*	0.06
Age	0.02	0.05
Nicotine	0.61*	0.19
Breakfast	-0.26**	0.05

Note: * $p < .05$, ** $p < .001$

It was found that students who consumed higher quantities of ED were 1.40 times (95% CI, 1.19 to 1.64) more likely to be in the higher categories of poor oral health, students with fathers who had degrees were also 1.32 times (95% CI, 0.99 to 1.17) more likely to be in the higher categories of poor oral health; and lastly, students who used nicotine were 2.06 times (95% CI, 1.46 to 2.92) more likely to be in the higher categories of poor oral health. Thus, an increase in the quantity of ED consumed is significantly associated with an increase in the odds of students being in the higher categories of poor oral health (Table 5.11).

Table 5.11 Factors predictive of oral health status.

Explanatory variable	Estimated coefficient	Standard error
Quantity of EDs	0.33**	0.08
Male	-0.21	0.20
Secondary school	0.12	0.22
State school	-0.13	0.09
Saudi national	-0.06	0.29
Father's education	0.27*	0.14
Non-occupied mother	-0.21	0.42
Retired mother	0.06	0.21
Medium family income	0.03	0.22
High family income	0.04	0.19
High personal income	0.01	0.14
Adult	0.04	0.04
Children	0.09	0.07
Healthy diet	-0.05	0.07
Unhealthy diet	0.04	0.07
Age	-0.01	0.05
Nicotine	0.724*	0.18
Breakfast	-0.022	0.05

Note: * $p < .05$, ** $p < .001$

5.4. Discussion

The current study identifies the prevalence, socio-economic determinants, and behavioural outcomes associated with the consumption of ED among Saudi youth.

5.4.1 The prevalence of ED Consumption

ED consumption is prevalent among young people in Riyadh city and has become a regular daily choice for many. More than 50% (525 per 1,000) reported consuming ED and an increase in consumption is predicted to rise very rapidly in Saudi Arabia because more than two-thirds of the Saudi Arabia population is under 29 years old (Murphy, 2011). This study found that among male students studying in secondary schools, those who consumed nicotine and had an unhealthy diet were more likely to report a higher frequency and quantity of ED intake. Similar results have been reported in previous studies and also mentioned in the previous chapter (Wales data) (Richards and Smith, 2016, Visram et al., 2016, Mann et al., 2016). Approximately 50% of the participants reported having consumed at least one ED. Amongst these, half of them reported consuming at least one ED per week and 11.2% consuming two to four ED per week. The main reason for ED consumption was reported to be the flavour of the drink, which was similarly reported by Musaiger and Zagzoog (2013), who studied a similar population. However, many participants in this study did not know the reason for why they consumed ED, which may suggest other factors such as social and marketing influence for ED consumption.

As highlighted in Chapter 4, higher consumption of ED in males compared to females has been reported in many studies (Azagba and Sharaf, 2014, Flotta et al., 2014). Interestingly, Aluqmany et al. (2013) investigated the motives to consume ED in female Saudi secondary school students. The study found that a large proportion of students did not recommend the consumption of ED, but a significant proportion still used them. The main reasons given for ED consumption were due to social factors, degree of satisfaction, body changes, and concentration and alertness. In contrast to this, males engage in ED consumption for reasons that include energy, experimenting, and as a replacement for soft drinks (Alsunni and Badar, 2011, Costa et al., 2014, Mann et al., 2016). Our study further confirms Al-Hazzaa's (Al-Hazzaa et al., 2011) observation, who reported that 16.3% of males and 8.5% of females consumed ED more than three days per week. In this study, we found that 14.95% of participants consumed more than 2 EDs per week, and 12.05% were not even aware of how many drinks they consumed each week. Amongst them, 1.6% reported consumption of more than one ED daily, which may further clarify some of the differences in the results. An increase in the consumption frequency during the time of examinations or assessments or the completion of projects was reported by Bawazeer and AlSobahi (2013), which may also be a relevant consideration among

the current study population. Another possible explanation for EDs to be consumed routinely among young people in Saudi Arabia is because of a high level of social acceptance of ED and hardly any awareness about the potential harm on health.

Altogether, the literature suggests that the prevalence of ED consumption may be reliant on several factors including social influences, marketing, and individual needs, yet further exploration of reasons among the Saudi population is required given the evident cultural differences among worldwide populations. The current findings, however, add to the growing literature which identifies males in secondary schools as the primary consumers of ED in Saudi Arabia. The increase in consumption may be related to the strategic marketing campaigns being concentrated explicitly on young males (Alrasheedi, 2016).

Socio-economic status can have a significant influence on the choices one makes. The participants in the study were from different socio-economic backgrounds which can influence a higher probability of ED consumption. The majority of the participants belonged to the middle (76.6%) or low income (15.6%) families, with only 7.75% belonging to high-income families, but even then, 54.35% of the students studied in private schools. The results indicate that the association between high family income and ED consumption is not statistically significant. In contrast, the role of education type and ED consumption has been well established within the literature. A study by Locatelli et al. (2012) reported that the students in private schools with higher socio-economic status in Sao Paulo engaged in ED consumption and also combined the drink with alcohol. Richards and Smith (2016) found that children from higher socio-economic sectors were similar to middle-income sectors where consumption of ED led to lower consumption of breakfast.

This current study recruited both Saudi and non-Saudi participants, but there was no difference between the two group's reporting. Such findings appear to contrast the current literature, for instance, Al-Hazzaa et al. (2011) studied the cross-cultural differences and similarity in health behaviours between Saudi adolescents living in 4 different cities in Saudi Arabia and British adolescents living in Birmingham and Coventry, the result indicated a significant difference in the consumption of ED between Saudi and British adolescents. Moreover, a study from Duncan et al. (2014) also reported similar findings with British males having a significantly higher reported ED consumption compared to Saudi males, and a lower difference compared to British females. A possible explanation for the lack of significance in the current study may be due to a small number of non-Saudi participants. In contrast, the Saudi participants represented 85% of the total study participants. Having a more significant representation from other nationalities may provide greater insight into the differences between nationalities. Another reason could be because, all the participants of this study were residing in Saudi Arabia, and were exposed to similar lifestyles

whereas the participants in Al-AI-Hazzaa et al. (2011) and Duncan et al. (2014) study resided in two different countries have entirely different culture and lifestyles.

The use of ED has commonly been found to be associated with various socio-demographic variables. Reid et al. (2015) reported significant unhealthy BMI scores, trying to lose weight, excess expenditure, and higher alcohol consumption in Canadian secondary school students. The findings from the current study are similar to those reported by Cameron et al. (2012). They found that the education of the mother only had a strong correlation with ED consumption in girls, and the father's education was found to have a strong correlation with boys. It was also observed that students whose fathers held a degree were more likely to report higher consumption of ED. Ratnayake and Ekanayake (2012) also reported males attending private schools were associated with the consumption of sugar-sweetened soft drinks while factors relating to the mother's education level and father's occupation were found to be significant predictors of consumption. This, therefore, suggests that the parent's education, especially the fathers in our case, as well as their occupation, may have a significant influence on the consumption as well as the frequency of consumption of ED in young Saudi children. In the Saudi families, the father is considered as the primary breadwinner, and his education and job status have direct influences, especially on the male children. The daughters are usually closer to their mothers; therefore, the mother's education, job status and lifestyle directly influence the daughters. A higher socio-economic status of Saudi families often leads to a more laidback and carefree lifestyle in the children.

5.4.2. EDs Consumption and the predictors of use

Breakfast is considered an essential meal of the day, and it is reported that those who do not have a healthy breakfast have more unhealthy food choices in school and later in the day (Laska et al., 2015). This study observed that young people who did not consume breakfast have a higher intake of ED on a daily and weekly basis which further led to behavioural changes. Several studies have reported the possible behavioural associations of adolescents who consume ED (Harris and Munsell, 2015). Jackson et al. (2013) reported behavioural effects such as the increased risk of "being in trouble" either in school or at home as well as various physiological effects such as caffeine toxicity (Oddy and O'Sullivan, 2009, Wolk et al., 2012, Oddy and Sullivan, 2015). Individuals who had a healthy diet were more likely to consume breakfast regularly and were less likely to have regular consumption of ED. Several studies have investigated the various lifestyle factors which can lead to a Saudi adolescent being overweight or obese with several studies suggesting this is partially due to ED consumption. For example, Al-Hazzaa et al. (2012) found ED to be amongst one of the critical factors in weight gain in both male and female Saudi students alongside factors such as an unhealthy diet and sedentary behaviours. (Alrasheedi, 2016) suggested that a primary reason for the frequent

consumption may be related to the lack of knowledge and understanding in regards to the ED contents and health implications.

This study also identified an increase in late-night sleep pattern in young people who regularly consumed ED. Interestingly, the current study observed that late-night sleep pattern was more prevalent in Saudi nationals compared to non-Saudi nationals. Many studies have found a strong association between ED consumption and sleep pattern. Calamaro et al. (2009) reported students who had consumed more ED were more likely to fall asleep during school hours and have difficulty falling asleep at night confirming our observation as young people who consumed more ED typically had later sleep times.

The consumption of ED was linked to higher consumption of nicotine products, which, when combined with ED use, typically revealed a decrease in breakfast consumption in this study. Similar reports have been reiterated within the literature, for example; Terry-McElrath et al. (2014) reported the correlation of ED consumption with 30-day alcohol, cigarette, and illicit drug use in secondary school students in the US. The association between ED consumption and smoking is a common finding within the literature, with Larson et al. (2014) reiterating the finding in both middle and high school students in the US. This suggests higher consumption of ED leads to an increase in risky behaviours in adolescents which can have many adverse health effects also.

Nicotine consumption is also known to be a useful predictor of oral hygiene status. By consuming nicotine products such as cigarettes, individuals are at an increased risk of various dental conditions including periodontal disease (Genco and Borgnakke, 2013, Lappin et al., 2013), edentulism that has been reported in India, China, Ghana, Russia, Mexico, and South Africa (Nagaraj et al., 2014, Peltzer et al., 2014), and oral cancers (Krishna Rao et al., 2013, Lin et al., 2011). It was observed in this study that young people who consumed ED frequently scored higher on the oral health measure, suggesting that ED consumption leads to poorer oral health. The effects of ED can cause deterioration of dental hygiene and lead to an increase in caries (Skinner et al., 2015). The increased presence of dental caries has been suggested to be related to pH levels within the ED. However, a study by Jawale et al. (2012) found regular soft drinks to have higher pH as compared to ED and to pose a significant challenge to the enamel. This would suggest that a combination of both excessive soft drink and ED consumption would lead to the most significant declines in oral hygiene.

5.4.3 ED Consumption and health outcomes

As mentioned earlier, ED has serious side effects on health among young people due to a high amount of caffeine and sugar. The current study revealed the association between the consumption

of ED and health outcomes such as headache, irritation, and dizziness. The finding is consistent reports in previous studies. Nowak and Jasionowski (2015), reported that polish students consuming ED experienced common side effects which included stomach-ache (about 50%), excitement, palpitation, or vomiting. Furthermore, Khan (2019) reported some severe health effects among university students who consume ED. The most common effects reported among consumers were insomnia (45%), headache (35.7%), and increased urination (30.8%).

5.4.4 The strength and limitation of this study

The findings of this study can be generalised as a well designed sampling method was used, making the sample representative. The sampling size together with a sampling method is a strength of the study. The first limitation of this study arises from the cross-sectional approach which does not allow to establish a causal association between ED consumption and the health outcomes so that young people could consume ED as a result of their low sleep quality. The second limitation is this study used self-reported data, making the study more exposed to bias reporting. Another limitation regarding the dietary data is qualitative it did not include portion size. Finally, in the Saudi market, there is no standard container size for ED, and the drinks come in 240 – 473 ML volume size. In this study, any container was considered as a homogenous item (one container) regardless of volume variation between containers.

Since little is known about the influencing factors behind ED consumption, it is essential to investigate the determinants for ED consumption in greater detail, among the Saudi population. For this reason, in the next chapter (**Chapter 6**), we continue and extend our research for the narratives of young people perception of ED consumptions to understand the effects of marketing and branding of products.

Chapter 6

Young peoples' perception of EDs and factors influencing their consumption: a qualitative study in Riyadh, Saudi Arabia.

6.1 Introduction

Chapter 5 identified the prevalence rate of EDs consumption, the contributing factors, and provided a preliminary investigation of its association with physical, mental, and behavioral health in Saudi Arabia's young people. The findings showed that the prevalence of ED consumption is relatively high among young people (13-20 years), with approximately 52.2% of young people reporting to have ever consumed EDs. In addition, the findings revealed strong correlations between unhealthy diet, smoking, sleeping late and the consumption of these beverages. However, the study indicates that it is essential to understand young peoples' perceptions, awareness, and contributing factors to their consumption.

In earlier studies, a significant association was found between EDs consumption and EDs perceptions among young people in the U.S. (Kumar et al., 2015). Findings from this study indicated that the odds of consuming EDs weekly were between 4 and 7 times and 2.5 and 4.5 times higher if the youth agreed that EDs are safe for them and that EDs are a type of sports drink, respectively.

In an Australian study, the majority of adolescents were found to be very familiar with the use of EDs and the EDs brands name but were unaware of key ingredients (Costa et al., 2014). On the other hand, Visram et al. (2017) conducted a study with students from four different schools in northern England, aged 10–11 years (n = 20) and 13–14 years (n = 17). The study reported that adolescents and children in northern England know the key ingredients and some of the potential risks associated with ED consumption. Since the study had a small number of participants, it can not be generalized to all the children living in northern England. However, it can apply to a sample with characteristics similar to the study population.

Regarding influencing factors related to EDs consumption among adolescents, Bunting et al. (2013) reported that advertising and brand loyalty play a fundamental role in influencing young people's use of EDs. For example, the youngest age group (16-21 years) are more influenced by marketing and advertising, such as packaging, colours, and slogan. Whereas, the oldest age group (29-35 years) showing high awareness level regarding the marketing strategies to promote specific products, especially that targeting young consumers. However, several studies have indicated several other risks and protective factors that could influence EDs intake among young people. These factors can be classified into the following areas: parent-adolescent relationship (Visram and Hashem, 2016), peer pressure (Bunting et al., 2013, Visram et al., 2017, Visram and Hashem, 2016), accessibility, price and advertising (Visram et al., 2017).

Qualitative research on this topic is limited; only five published studies are available and are conducted across three countries; Australia (Costa et al., 2014, Jones and Lejuez, 2005), New Zealand (Bunting et al., 2013, O'Dea, 2003) and England (Visram et al., 2017). Subsequently, to

date, no previous qualitative study has explored the perceptions surrounding EDs consumption among the Saudi population.

In the present study, a qualitative approach was utilized to explore the attitudes and perceptions of young people residing in Saudi Arabia, about EDs, and to seek their views on possible intervention strategies to prevent the consumption of ED. The study had the following research aims:

1. To assess young people's perceptions of ED availability, ingredients, accessibility and potential health impacts.
2. To explore young people's views on factors related to EDs use among young people.

In addition, the specific questions this study set out to answer are as follows:

1. What factors motivate young people to consume EDs, and what are the potential protective factors that prevent consumption?
2. What factors are related to the purchasing of EDs?
3. What strategies could be recommended for the prevention of EDs consumption targeting young people in schools and communities?

6.2 Method

This research study implements a data-driven qualitative design to fulfil the aims and objectives defined in an earlier section. As outlined in Chapter 3, two qualitative methods were employed for the acquisition of data relevant to the purposes of this study: a) one-to-one structured interviews and b) focus groups. The study population comprised young people aged 13-20 years that reside in Riyadh City, Saudi Arabia. Both methods were selected as primary qualitative tools that allow the efficient assessment of young peoples' perceptions regarding EDs but also the identification of potential factors that influence and propel their use. The study conforms to the guidelines and policies for ethical research conducted on young people (Shaw et al., 2011), and hence has received ethical approval from the Ministry of Education in Saudi Arabia and King Saud University (Appendix E). Consequently, and for individuals to participate in this research study, they needed to read and sign the consent form, providing informed consent.

6.2.1 Participants

All participants were between 13 and 20 years old. It is important to note that the educational system in Saudi Arabia does not permit boys and girls studying in the same school; therefore, only single-gender focus groups were done.

6.2.1.1 Study sample for one-to-one Interviews

For the interviews, sampling continued until the researcher reached the data saturation. Fourteen young people were recruited to participate in this study, eight young people from grade one in intermediate schools (aged 13-14 years) and six young people from grade three from secondary schools (aged 16–20 years). These educational grades were selected because grade one in intermediate school is a pivotal transition year between primary and intermediate school in Saudi Arabia. In contrast, grade three in secondary schools is the final year in school before students undergo significant exams – with unavoidably increased levels of stress – to enter Universities. Furthermore, these participants were selected in order to compare and contrast with findings of Visram et al. (2017) who explored the views on similar age groups in the UK. Hence, the respective findings will enable an investigation into whether EDs perception is similar or whether it is affected by external social elements such as culture and lifestyle.

To aid participant recruitment, at each of the four schools, the teachers who were selected by headteachers were encouraged to randomly select potential participants (comprising equal numbers of boys and girls). Moreover, teachers provided the selected students only with age-appropriate study information packs provided by the researcher (see Appendix G) to consider before deciding whether or not to take part in the interviewing process. Eventually, a student consented to participate in the proposed interviews, and all participants gave their written informed consent to take part in the study. The sampling process for the interview is shown in Figure 6.1.

6.2.1.2 Focus groups

For focus groups, the researcher randomly selected seven schools from the school's list (boys school's list and girls school's list). These schools were different from the schools that were selected for interviews; four schools accepted participations. The class were selected by headteacher depending on the available class at that time. Participants were randomly selected by the class teacher and, as previously mentioned, teachers provided the selected students only with age-appropriate study information packs to consider before their deciding whether or not to take part in the focus groups. Finally, focus groups but also the selection of conversational tone and topics to be discussed were based on guidelines and protocols available on current literature (Heary and Hennessy, 2002). The sampling process for focus groups is shown in Figure 6.2.

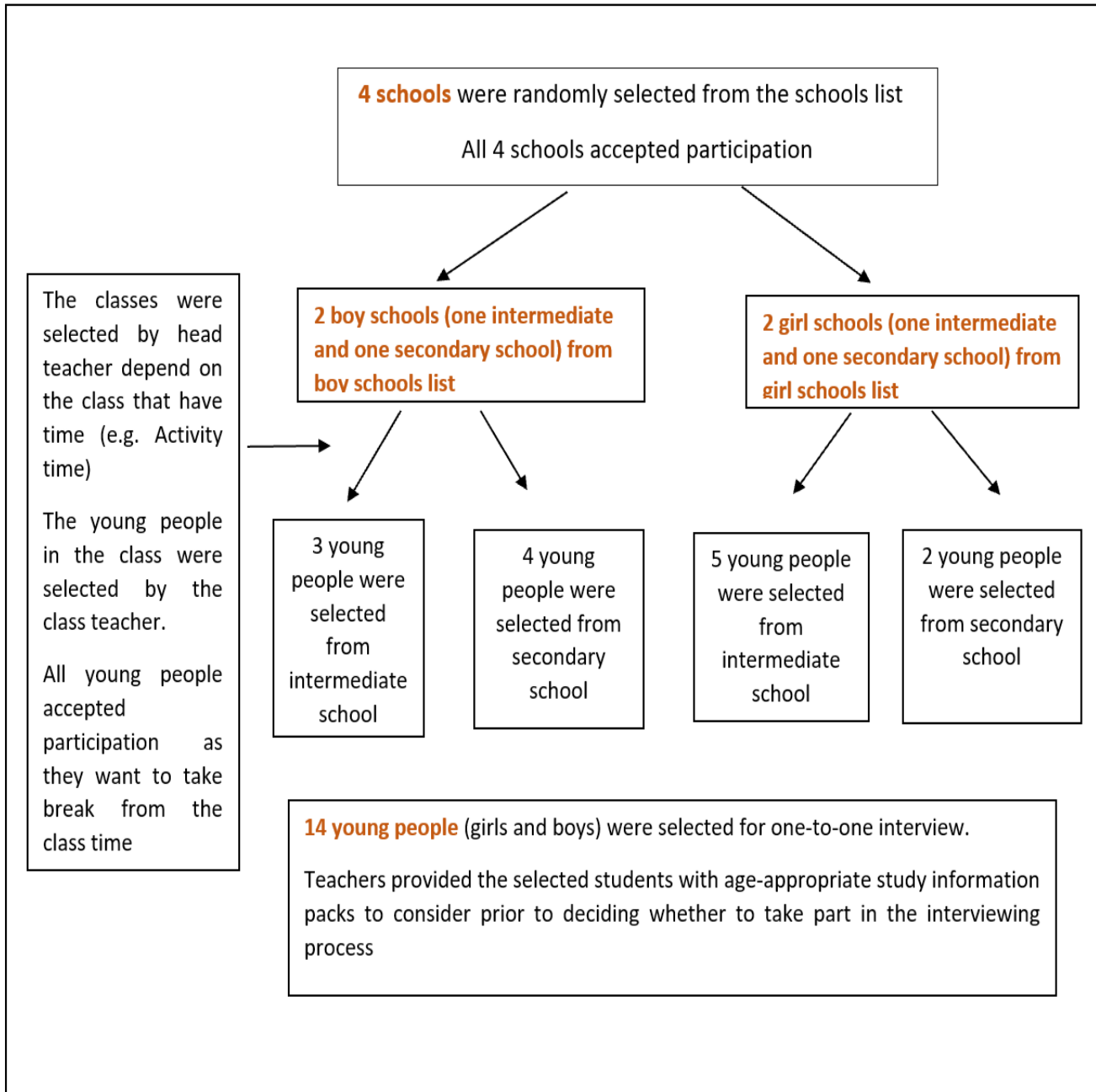


Figure 6.1. The sampling process for a one-to-one interview

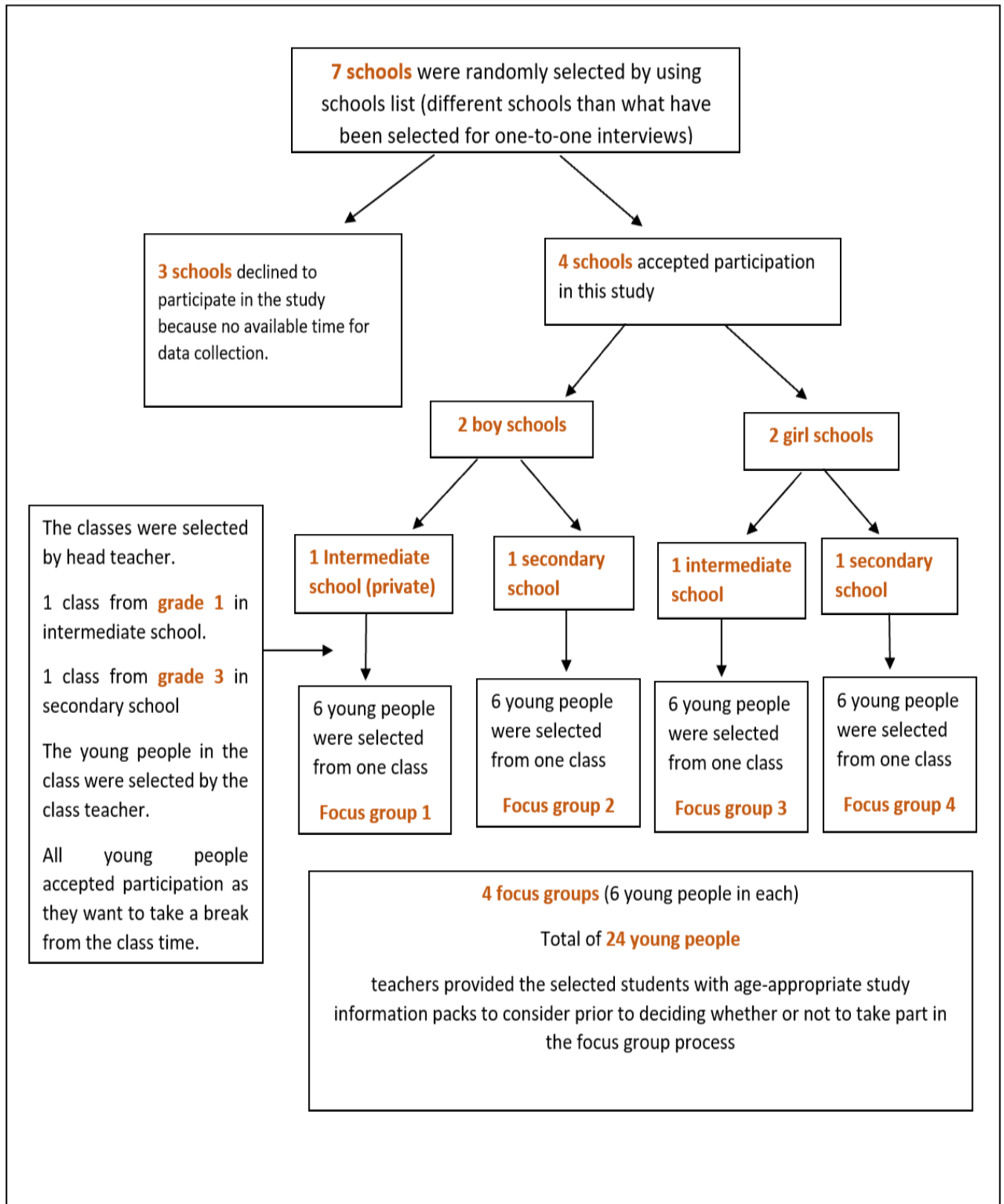


Figure 6.2. The sampling process for focus groups.

6.2.2 Data collection

6.2.2.1 Interviews

Fourteen semi-structured one-to-one interviews were conducted by the researcher using a developed topic guide (see appendix I) in order to address the research topics highlighted in Figure 6.3. The primary advantage of utilising a one-to-one interview process is that participants are not influenced by the presence or replies of others unlike group sessions, a fact which enables them to "speak in their own voice and express their own thoughts and feelings" (Berg, 2007). All interviews began with general talk regarding the consumption of EDs, and consequently, the process became more individualized to identify personal experiences and viewpoints regarding this issue. Eventually, the interview intended to identify individual understandings regarding the differences between EDs and other drinks but also the role that parents, peers and teachers can play in this process. In addition, the interview aimed to examine further the participant's views on EDs and their consumption behaviour, including reasons for abstaining. In addition, the interviews sought to gather information on how the participants felt that ED products affect consumers. The participants' awareness of the effects of EDs (and their ingredients), as well as their views on the impact of these products on health, mental, behavioural outcomes, were explored. The interview lasted between 15 and 20 minutes and was held on school premises, during school hours, without school staff present. All discussions were audio-recorded. All interviews took place during April 2018. All discussions were audio-recorded with participants' consent.

The responses gathered during these one-to-one interviews informed research questions 3 and 4.

- Differences between energy drinks, sports/isotonic drinks and soft drinks
- The main ingredients of EDs
- Effects of energy drinks on young people health
- When, where, why, EDs are consumed by young people.
- Motivate and prevent factors of energy drink consumption for their age
- Accessibility and cost of EDs

Figure 6.3 research topics explored in interviews

6.2.2.2 Focus group

Four semi-structured focus groups (6 students in each group) were conducted by the researcher using a similar topic guide (appendix J) used in interviews in addition to other areas (see Figure 6.4). The purpose of conducting a focus group in this research was to include the explicit use of group interaction to produce additional data and insights (Kitzinger, 1995). Potential risks to this approach included participants seeking to impress their peers or the researchers by either exaggerating or understating their level of EDs use (Visram et al., 2017). The format was kept flexible and informal to enhance comfort and foster openness. The focus groups began with a discussion generally about the EDs' ingredients and their thoughts about the EDs' benefits and effects to generate discussion on the participants' understandings of the differences between EDs, soft and sports drinks. The groups lasted between 20 and 30 minutes and were held on school premises, during school hours, without school staff present. All discussions were audio-recorded with participants' consent.

- Differences between EDs, sports/isotonic drinks and soft drinks
- The main ingredients of EDs
- Effects of EDs on young people health
- When, where, why, EDs are consumed by young people.
- Factors motivating and preventing ED consumption for their age.
- Accessibility and cost of EDs
- Marketing and packaging
- Regulation of energy drink within their school
- Possible interventions

Figure 6.4 Research topics explored in focus groups

6.2.3 Data collection and analysis

The data from Saudi Arabia were collected and analysed in the Arabic language. Whereas, the data collected and analysed from Wales was done in the English language. The translation and the back-translation method was used to report the data collected and analysed from Saudi Arabia. Forward-translations and back-translations method have been refined by several WHO

studies, and the guidelines provided by WHO were followed. This method is used for cross-cultural studies. The method includes four steps; 1. Forward translation; 2. Expert panel Back-translation; 3. Pre-testing and cognitive interviewing; and 4. The final version (WHO).

- 1) Forward Translation: The translator was the researcher and was familiar with the terminology of the area covered by the instrument and had the interview skills for the task. The translator was knowledgeable in the English-speaking culture, but the mother tongue was the primary language of the target culture.
- 2) Expert panel Back translation: The same approach as the first step was used; the instrument was translated back to English by an independent translator, whose mother tongue is English and who has no knowledge of the questionnaire. Help was taken from the supervisor at this step, and the translation was repeated as many times as needed until a satisfactory version was reached.
- 3) Pre-testing and cognitive interviewing: The instrument was pre-tested on the target population. Pre-test respondents were 10 in number, and the interviews were conducted by an experienced interviewer (Researcher).
- 4) The final version: The final version of the instrument in the target language should be the result of all the reiterations as a result of the previous steps.

There have been many studies conducted in regards to data collection in the native language and translation methods, leading to a conclusion that it is best to collect data in the native language (Smith et al., 2008, Van Nes et al., 2010). When both the participants and the leading researcher speak the same language, no error and language differences are present in data gathering, transcription and during the first data analyses. The first language variances may arise when the first discussions are taking place among members of a multilingual research team. This is a fragile phase, and for the initial discussion, the interpretations need to be explained in English. An excellent understanding of subtle meaning differences is needed to come to the best English wordings (Van Nes et al., 2010). The challenges faced with a translation may occur even with the support of a professional translator and also adds to the costs of a study. However, using a translator contributes to improving the validity of the research and the quality of the transference of the findings to the researchers for the publication. Furthermore, it has been suggested that the use of a translator in earlier phases of the research reduces efforts to refine translations in later phases (Van Nes et al., 2010). This study used two qualified translators to help with forward-backwards translation method to reduce any chance of error.

Audio recordings (both interview and focus group) were transcribed word for word, anonymised and analysed using a constant theme approach, so that generation of themes was

inductive and driven by the data (Braun and Clarke, 2006). Braun and Clarke (2006) describe this kind of thematic analysis as having six steps:

- 1) Become familiar with the data.
- 2) Generate initial codes.
- 3) Search for themes.
- 4) Review themes by starting with candidate themes and refining them to clearly distinguish themes from coherence, in addition to the meaning within themes; generate a thematic analysis map.
- 5) Define and give names to themes, refining them for presentation. Describe each theme's essence and what it encapsulates. Identify interests and why they are interesting by generating an analysis of the story and providing a definite name for each of the themes.
- 6) Produce a report which should be succinct, coherent, rational and exciting, without repetition and should support themes with evidence in the form of extracts from the data, ensuring that the argument relates to the question being researched. The qualitative data gathered in the interviews and focus group sessions were analysed using NVivo software (QRS International) (QSR, 2018). This software enables research data to be organised and analysed to identify common themes and trends in the data. At the start of the qualitative data analysis, the researcher read and transcribed the data, searched for meanings and patterns, and developed ideas for coding. Next, the data was organised into systematically meaningful groups across the dataset. The different codes were sorted into potential themes to create candidate themes and sub-themes. The themes were refined for presentation in the analysis. Two review levels were conducted; 1) Level one reviews at the level of the coded data extracts. 2) Level two is similar but in relation to the entire dataset. Then each of the specific names of each theme was defined and named. The last step was the final analysis and writing up the report.

To check the validity of the transcript translation, we got a second person to translate the original recording and then compared the two. Initial analysis of 14 interviews and four focus groups was undertaken by the researcher to identify emerging themes from the data; primary codes were identified and then discussed with the statistician. Themes were checked and further codes identified following subsequent analysis. Preliminary findings were discussed with the statistician, to obtain feedback on the researchers' interpretations and to generate further discussion on the implications for policy and practice.

6.3 Results

A total of 14 young people consented to participate in the interview (seven males and seven females; aged 13– 20 years) and 24 young people for focus groups (four focus groups with six participants in each group) aged 13-20 years. Results were categorized according to each research questions

6.3.1 First research question

To assess young people’s perceptions of ED availability, ingredients, accessibility and potential health impacts.

Two themes emerged 1) ED products; and 2) availability of ED. Figure 6.5; shows the two overarching themes and the related sub-themes that emerged from the two qualitative research designs.

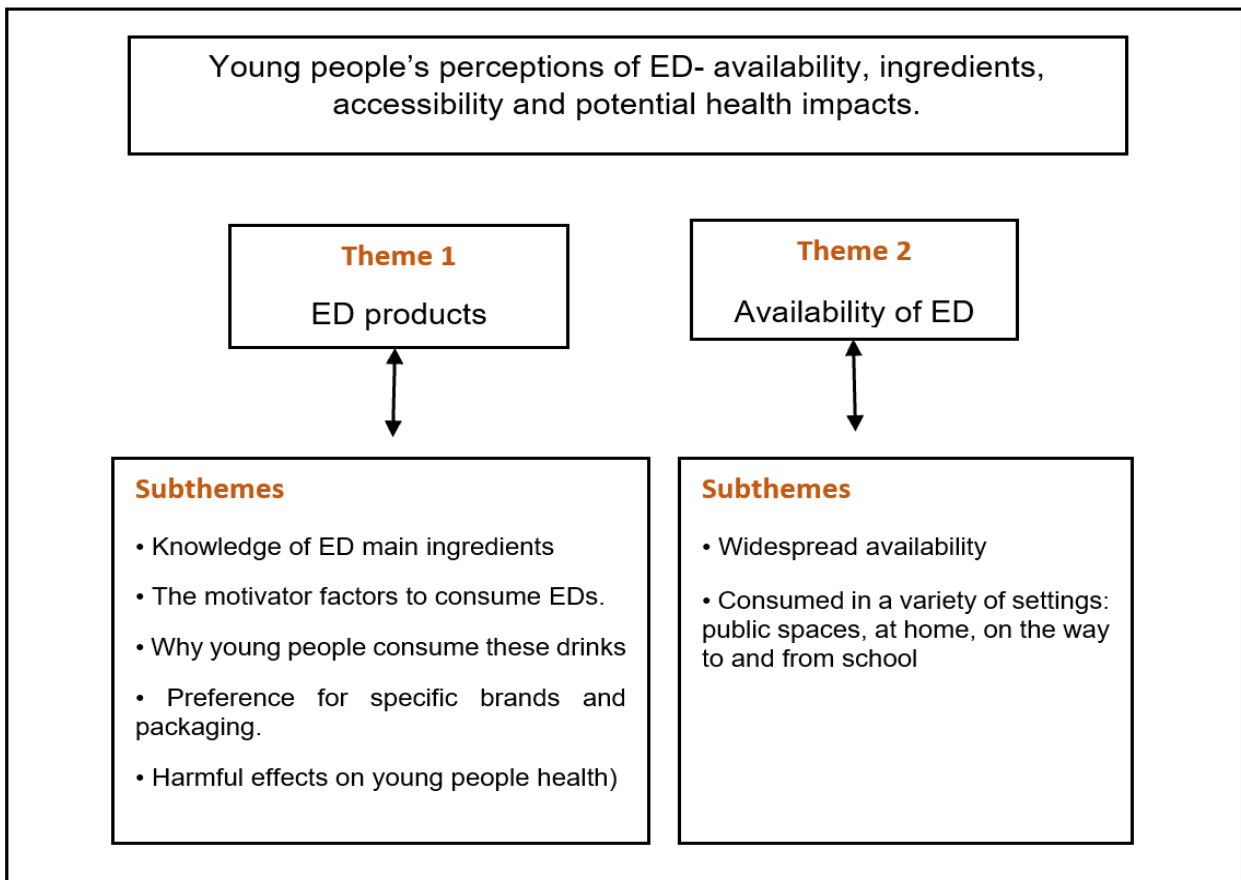


Figure 6.5 Themes and subthemes that emerged from data to address the first research question

6.3.1.1 ED product

In general, all young people – in both age groups – appeared to have good knowledge about EDs brand names available in the market. However, their answers showed little consistency when it came to pinpoint the differences between EDs and other drinks, such as soft drinks and sports drinks. One of the most profound trends noticed was that most young people knew that there is a difference between EDs and other beverages, yet they were unable to specify what this difference is.

“I think that soft drinks and EDs are no different”. (Girl, 15 years)

“I have read that the EDs are more harmful than a soft drink, but I do not know the difference in the components”. (Boy, 16 years)

On the other hand, and when it came to young peoples’ understanding regarding the content of EDs, most of them underlined that these drinks have a high sugar content (a defining characteristic of these drinks). Nevertheless, students seemed to be unaware of what exactly, is meant by high levels of caffeine or sugar. The majority of these young people agreed that they had little or no idea regarding the basic ingredients of the EDs, and it had never crossed their mind to read the nutrition value label. The only indication that they seemed to be aware of is the presence of a warning on EDs cans highlighting that these drinks are not suitable for people younger than 16 years old. Furthermore, most young people agreed that one of the most critical aspects that render these drinks as appealing and attractive to young people is the sweet and distinctive flavour. The EDs’ taste was identified as one of the main propelling factors in their decision to consume these products. Some participants replied that they preferred drinking these products when they felt tired and needed a physical or mental boost to allow them to persevere and be focused on their studies before exams (often linked to consuming EDs to stay up late).

“The primary motivation to try it the first time was to try something new then, later, I liked the taste, and I always drink it”. (Girl, 13-14 years)

“I drank it once to try it, and then I drink it daily because it tastes delicious”. (Girl, 13 years)

“I drink ED during exams so I can study and concentrate on tests”. (Boy, 17-18 years)

Conclusively, collected data underline that both age groups had a right level of knowledge about EDs’ adverse effects and the potential risks associated with their consumption.

“Head throbs as I feel palpitations and dizziness”. (Girl, 13 years)

“EDs are more harmful because they contain more gases, substances, and preservatives”. (Girl, 13 years)

“Make me feel dizzy, palpitations, and harmful to the kidney”. (Boy, 18 years)

Preference for particular brands and packaging sizes was highlighted as an important factor when trying the EDs for the first time.

“At first, the packaging attracted me; secondly, the shape of the box can be beautiful, attractive, and I first tried because of the shape of the can, and then I like its taste”. (Boy, 14 years)

“The can with drawings showing strength, made me immediately try it”. (Boy, 14 years).

6.3.1.2. Availability of ED

EDs appeared to be easily accessible to young people in Saudi Arabia, with one participant stating, *“EDs are everywhere, and I can get them very easily.”* The young people reported the consumption of EDs in a variety of places, including public spaces, e.g. streets, parks or shopping malls. Young people also highlighted that in their journey to and from school, the EDs could be purchased in grocery stores near schools, which, in turn, sell them to all ages with no restrictions.

“Very easy to get, and it is available in the grocery store near the school, after school time we buy it and take it home”. (Boy, 13 years)

“I go out after school time, and go to the grocery store near the school and buy it”. (Boy, 18 years)

“It is available in the grocery store next to the school, and anyone can buy it, and drink it after school”. (Boy, 13 years).

6.3.2 Second research question

To explore young people’s views on factors related to EDs use among adolescents.

Three themes emerged 1) the price; 2) peer pressure; and 3) parent influence. Figure 6.6 shows the three overarching themes and the related sub-themes that emerged to address the second research question.

6.3.2.1 Price

Most young people reported that the price of EDs has doubled since last year in a way to reduce ED consumption in young people (2017). Although there was some disagreement around the most appropriate price level, this policy was highly approved by most young people.

“Raising the price of ED reduces its consumption, because I buy it from my pocket money, and it is not enough to buy two packs a day”. (Boy, 13 years).

However, a significant finding of this study is that this increase in price did not seem to affect young people's consumption patterns because of the financial prosperity of the whole country.

“Prices, even after the tax, are considered affordable and easy for me to buy”. (Boy, 17 years)

Moreover, it was also found that young people do not need to buy EDs by themselves because their families provide them at home. In fact, some participants mentioned that EDs are typically available for free at a party or family gathering

“Price has nothing to do with it because I am not the one who buys it, my father buys it for me”. (Girl, 14 years)

“I do not think that the consumption of these drinks changed after raising prices, everything changed its price, it is reasonable, and sometimes it is available for free on occasions, and I drink it at any time”. (Girl, 13 years)

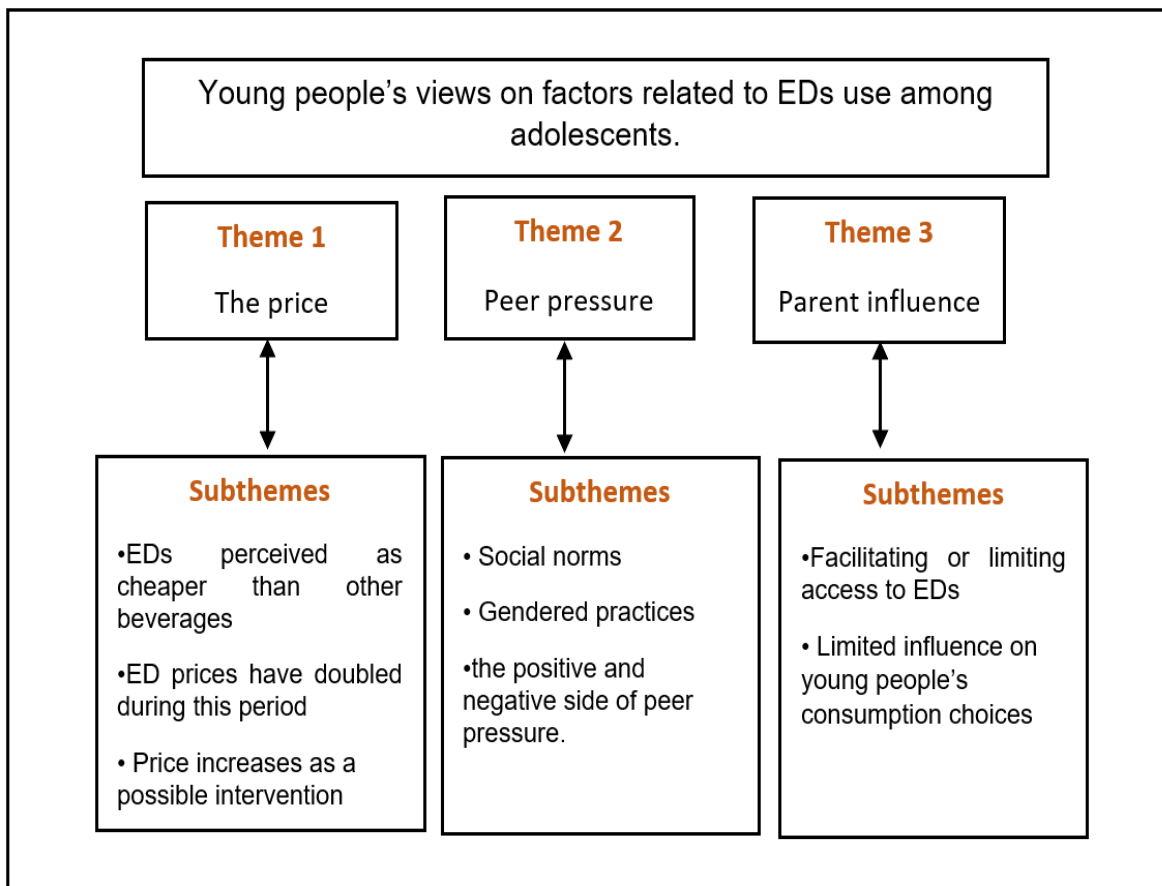


Figure 6.6 The three overarching themes and the related sub-themes that emerged to address the second research question.

6.3.2.2 Peers pressure

The general impression and feelings in both age groups were that ED consumption was widespread within their peer groups. A prominent finding is that consumption appeared to be highly gendered: male students are more likely to drink EDs and in higher quantities compared to female students. This was often associated with the fact that male students are more active compared to females, and they need to stay awake for longer in order to study, especially during weekends.

Another finding of this research study is that ED consumption in male students was linked to their trying to appear tougher or more attractive, and hence earn the approval of their peers. On the other hand, female students showed a preference for 'expensive-looking' brands in smaller cans, which allowed them to look more sophisticated and refined. In both cases, ED consumption was associated with students' trying to prove to themselves and their peers that they are not children but mature and more like adults.

"Often girls drink it to prove that they are grown up and drink adult drinks, and it even looks cool". (Boy, 13 years)

"Boys in intermediate school mimic boys in secondary school and drink it to prove that they are big". (Boy, 14 years)

This is also supported by the fact that some of their peers drink EDs to enhance their image or identity. However, there was some evidence of boys and girls choosing to consume EDs as part of the desire to 'fit in':

"I think they have a high impact because if I did not drink with them, they would consider me a coward and child". (Boy, 13 years)

"Friends have a significant effect. Some girls drink these drinks because their friend has the same drink; it is just the tradition, turning into a habit and addiction every day". (Girl, 15 years)

Young people who did not consume EDs reported positive instances of effects of their friend groups who had decided to abstain from EDs usage because of its harmful consequences, and hence they encouraged each other to avoid the consumption of such drinks.

"All of my friends do not drink it because it is harmful, so I did not even think to try it". (Girl, 14 years)

6.3.2.3 Parents influence

Parents were found to play a fundamental role in young people's decisions to consume EDs, both in terms of facilitating or/and limiting their access to these drinks and in modelling children's behaviour. Participants gave examples of family members who are consistently drinking EDs but showed ambivalence when their children attempted to do the same. At the same time, other parents stood firmly against the consumption of these products. Hence, this theme showed that parents showed distinct heterogeneity when it comes to their children's ED consumption.

"I do not drink them because it is forbidden in the house". (Girl, 14 years)

*"I drink with my parents, but they do not allow me to drink it every day because it is harmful".
(Girl, 16 years)*

"My parents have a great influence on our choices because they always prevent us from drinking them and they know the harmful effects well". (Boy, 13 years).

Furthermore, most young people reported purchasing EDs themselves, often using their 'pocket money'. Therefore, and because young people tend to consume EDs in various settings outside their home, family members were not always aware of their children's behaviour. Consequently, most young people stated that parents could not be included as primary factors in discussions regarding possible intervention options.

"Parents do not allow drinking ED at home, so they always preferred to drink them when they are out". (Girl, 14 years).

6.3.3 Third research question

The strategies that could be recommended for the prevention of EDs consumption targeting young people in schools and communities

One theme emerged 1) policy. Figure 6.7 shows the one overarching theme and the related sub-themes that emerged to address the third research question.

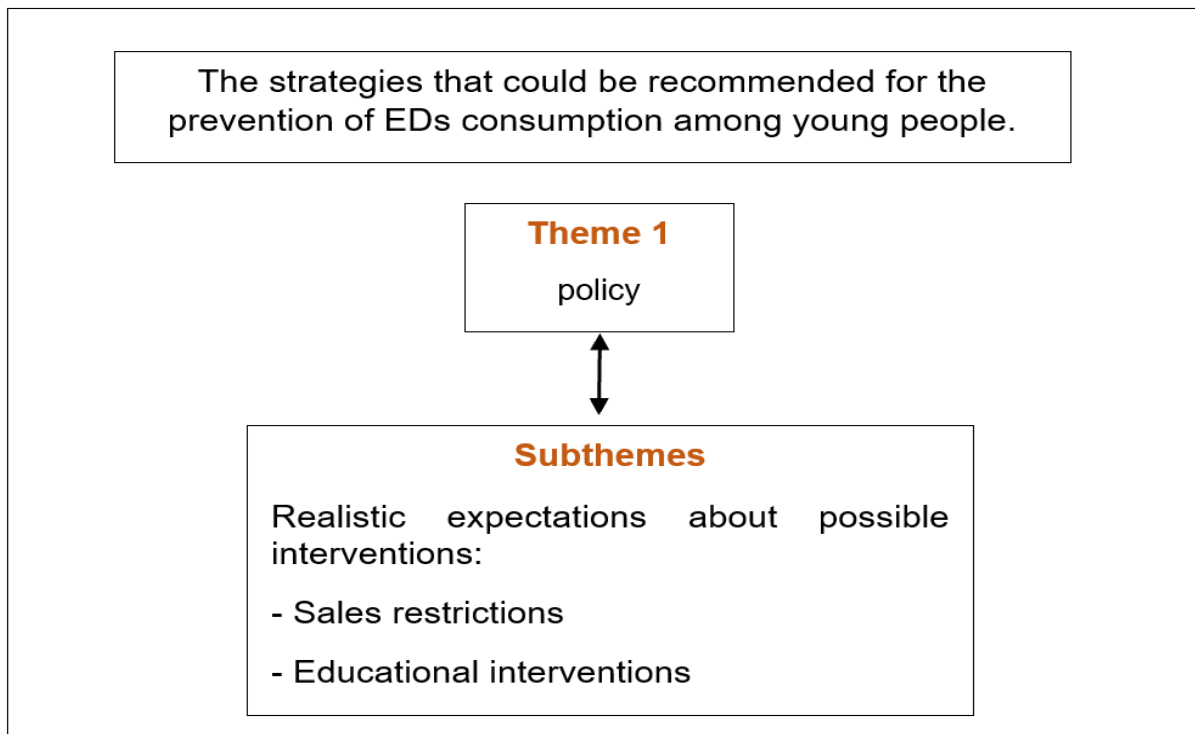


Figure 6.7 The overarching theme and the related sub-themes that emerged to address the third research question.

6.3.3.1 Policy

The general approach regarding this theme is that there should be an age restriction on EDs consumption, similar to those imposed for buying cigarettes. However, some young people stated that this type of age-related intervention to reduce ED consumption could be easily bent by merely asking older friends, siblings or parents to purchase EDs on their behalf.

“I feel that these drinks are available everywhere and are easily accessible, so I think that making a certain age for selling these drinks could be the right intervention”. (Girl, 14 years)

“Specifying a certain age will not help because I can ask someone older to buy it for me” (Girl, 13 years).

Recently, school food policies have turned their attention and focus on reducing ED consumption during school hours. Even then, young people had many examples to mention in terms of finding other ways to purchase these products outside of school, e.g. in the grocery stores around the schools. Finally, these young people highlighted the fact that a specific portion of the school staff exhibited a profound lack of knowledge regarding EDs and their consequences on students’ health.

This comes to underline that education and the respective dissemination of knowledge should not be limited to involve students but also teachers and parents:

“I expect to raise awareness of parents first, and then they will advise their children not to drink”. (Boy, 18 years).

6.4 Discussion

6.4.1 Summary of the key findings

This qualitative research study about ED was carried out as a means of examining the knowledge, attitudes, and practices of young people aged 13 to 18 years. It was anticipated that developing insight into these young peoples' beliefs, and practices would facilitate the development and implementation of health education and health promotion interventions directed toward this target population. It was conducted using two main methods of data collection: one-on-one in-depth interviews focused on individual practices and factors influencing their choices as well as a focus group that examined general perceptions about ED.

The participants acknowledged that, although EDs were prohibited in their schools, these drinks were readily available at most stores outside the school premises without any legal restrictions. They also acknowledged that there was a difference between EDs and soft drinks, but were unaware of how they differ from other available drinks. Drink packaging and friends who drink these drinks play a significant role in decisions to drink ED. This is despite a significant proportion of the participants knowing that the drinks can be harmful to them. Although, the majority of the participants approved the increase in the price of the EDs; there was some disagreement. Some also indicated that their parents do not allow them to drink any EDs at home.

6.4.2 Young people perception of EDs consumption

Over the past two decades, there has been a marked increase in the consumption of ED all over the world (Nowak and Jasionowski, 2015). They are currently being sold in more than 140 countries globally, with many beverage companies seeking to enter the market in the wake of diminishing sales of sugar-laden sodas and soft drinks (Seifert et al., 2011). Up to half of the current global ED, market is made up of children, adolescents and young adults (Seifert et al., 2011).

The sample in this study reported a relatively high intake of caffeine-containing EDs despite restrictions by their parents and guardians and the prohibition of these drinks in their schools. This is in agreement with the findings of researchers such as Visram and Hashem (2016) who reported

significant increases in the sale and consumption of EDs over the past few years. According to Visram et al. (2017), there has been a 185% increase in the purchase of EDs in the UK in the years from 2006 – 2015. Therefore, while concerns about the public health implications of excessive sugar intake mean that there has been a steady lowering of the rates of consumption of sugar-sweetened beverages (SSBs) over the past few years, this trend has not extended to EDs (Driessen et al., 2014, Cameron et al., 2012, Visram et al., 2017).

Clear rules for eating and lifestyles have been found to facilitate the development and sustenance of healthy eating behaviours among young people, patterns of behaviour that can be maintained into adulthood (MacFarlane et al., 2007). It can, therefore, be suggested that poor eating behaviours among adolescents (including the consumption of EDs) are sometimes a reflection of lenient parental rules in the homes of these children (Vieux et al., 2017). However, it must be noted that a significant proportion of young people in both the focus groups and the personal interviews admitted that their parents prohibit the consumption of EDs. In addition, guidelines restricting the sale and consumption of EDs in schools also point to clear rules for these young people. It can, therefore, be suggested that there might be a range of other factors that influence the choice of these drinks by young people.

6.4.3 Factors motivate young people to consume EDs.

The ready availability and affordability of these drinks are often described as playing a part in the choice of EDs since they could be purchased in most stores without any specified legal age or other requirements (Vieux et al., 2017, Visram and Hashem, 2016). The lack of age requirements for EDs and lower pricing in contrast to alcohol was mentioned by some participants as determining their choice of these drinks for regular consumption. This could be a factor that contributes to the highest prevalence of EDs consumption among individuals aged 10-18 years (68%) in contrast to adults (30%) and even children younger than ten years (10%) in the UK (Visram and Hashem, 2016). However, alcohol is prohibited in Saudi Arabia, and, as a result, EDs serve as a substitute social drink among young people because of their high caffeine content.

It is worth noting that some participants did indicate some degree of concern about the increasing costs of the drinks. While Visram and Hashem (2016) reported that their participants admitted to buying EDs as an affordable social drink, research has demonstrated that increasing costs of EDs often limit the extent to which this population group can imbibe these drinks regularly (Ibrahim and Iftikhar, 2014). It could, therefore, be suggested that this might be a potential means of limiting the purchases by this population group.

It is also important to note that it is thought that marketing plays another role in this pattern of EDs consumption among this target population (O'Brien et al., 2008, Vieux et al., 2017). The focus group and interviews highlighted the fact that many young people became aware of the drinks after being exposed to branding and advertising. The careful selection of names and aggressive marketing at events that are populated by adolescents and young adults are only some of the measures used by relevant companies (O'Brien et al., 2008). This means that they are exposed to these products regularly through different media platforms. This is similar to the findings of Vieux et al. (2017). They described advertising and brand awareness as another factor that contributes to increased consumption of these drinks by adolescents and young adults.

While young people were responsive to marketing and advertising efforts, this also meant that they did not develop full knowledge of the nature and effects of these drinks (MacFarlane et al., 2007, O'Brien et al., 2008, Vieux et al., 2017). In the current study, this was reflected by the fact that the majority of the respondents did not recognize that there was a difference between EDs and soft drinks. In addition, while a significant proportion of young people recognized that the drinks could potentially be harmful to them, over 75% of the participants admitted to drinking EDs regularly. This is similar to the findings of Nowak and Jasionowski (2015), who reported that adolescents drink EDs regardless of the perceived risks arising from their consumption. However, it must also be noted that Visram and Hashem (2016) reported that participants in their study were more focused on the impact that these drinks had on their performance in any area of endeavour and demonstrated little or no awareness of the risks arising from the consumption of these drinks. It could, therefore, be argued that a relative lack of knowledge would make it difficult for them to make informed decisions and choices relating to their consumption of EDs.

The possible influence of social and marketing on ED consumption is a crucial consideration, especially when focusing on adolescents who are easily influenced by social factors. Several studies have reported a significant influence of peers and friends on children and adolescent eating and activity behaviours (Salvy et al., 2012, Bruening et al., 2012) suggesting the regular consumption of ED by peers may lead to the youth following them. In addition to this, the marketing of ED may lead teens into believing that the drinks are safe for consumption, as noted by Kumar et al. (2015). They found that the frequency of consumption was associated with attitudes and knowledge of ED. Visram et al. (2016) reported branding and marketing was affecting the consumption choices among the youth which is expected as several companies target adolescents and young adults (Heckman et al., 2010, Reissig et al., 2009a). Reissig et al. (2009a) emphasised that the targeting is directed more towards males due to the wording and titles of the products and its promises of "psychoactive, performance-enhancing and stimulant drug effects".

These patterns are, therefore, of significant concern since childhood and adolescence is an important time of growth and development (Visram and Hashem, 2016). It is also necessary to note that the excessive consumption of caffeine in children is associated with some health effects, including but not limited to, sleep disturbances and increases in blood pressure (Seifert et al., 2011). Visram and Hashem (2016) also stated that individuals who regularly consume EDs as adolescents and young adults are more prone to abuse alcohol, tobacco or other psychoactive substances. The potential for medium- and long-term negative impacts of childhood and adolescent consumption of ED on overall health and wellbeing of these individuals highlights the importance of action to improve awareness and health-related decision-making in this population. It could, therefore, be suggested that there is a need to develop and implement health and other related policies that can reduce the availability of these drinks to young people.

6.4.4 Strengths and limitations of the Study

This research study was conducted in a small population in a limited geographical area of Saudi Arabia and, as such, it cannot be fully representative of the broader population of adolescents in the country (Saunders et al., 2016). Moreover, there was little effort to identify gender differences as determinants of ED consumption. Such information could potentially be of benefit in the development, implementation, and maintenance of interventions and health policies aimed at reducing young people EDs consumption in any specific population. Furthermore, it must be recognized that there is a potential for a degree of social acceptability bias (Saunders et al., 2016) that could influence the responses provided by the individuals participating in focus groups. While this was mitigated by the use of individual interviews for some participants, it must also be recognized that there is a place for fully confidential data collection in such a manner that ensures truthful answers. Finally, it must also be recognized that there is a range of social, cultural and other contextual factors that could potentially influence the nature of health and health-related behaviours among populations (Entwistle and Watt, 2013). During the recruitment of the participants, the researcher tried her best to avoid selection bias but because the education system in Saudi Arabia, at times the headteachers were encouraged to randomly select the student from the class, which may increase chances for selection bias. Selection of participants from the boys' school was difficult because the researcher is female, she could not go inside the school, and the participants were selected by the headteacher. There is a possible role for further research to identify factors that could potentially influence patterns of EDs consumption among young people in specific social and geographic locations. It is anticipated that such research will help guide the development and implementation of future programs and interventions targeting this population group.

6.5 Conclusion

The present study was designed to assess the young peoples' awareness and perceptions regarding EDs and to identify potential factors that influence (and propel) their use. This study found that the participants of this study appeared to lack knowledge about the active ingredients and sugar content of ED, and they did not know the difference between EDs and other drinks such as sport and soft drinks. The results of this study indicate that the availability and affordability of the products in Saudi Arabia as they are widely available in stores and currently no restrictions exist on their purchase by minors play a fundamental role in young people's decisions to consume EDs. In addition, Marketing and peer pressure also have a significant role in driving desire for the products among young people. The next chapter (**Chapter 7**), discusses and compares the data collected from Wales and Saudi Arabia.

Chapter 7

General Discussion

Comparison of data collected from Wales and Saudi Arabia

7.1 Introduction

The main aim of the present study was to investigate the prevalence of reported energy drink consumption and the associated socio-demographic characteristics among young people living in two culturally different parts of the world, Wales (UK) and Riyadh (Saudi Arabia). The study also aimed to investigate the possible factors that may affect young people consumption of EDs and identify any associations between ED consumption and health outcomes.

The consumption of ED is a primary public health concern due to the secondary risks of ED consumption- including poor diet quality, weight gain, and the increased risk of dental disease (Larson et al., 2014). However, this cross-sectional study, having a moderate study population (N=2,793), does have some limiting factors. For example, the study found an association between negative health behaviours; despite this, the direction of implied causality is not clear in terms of whether ED consumption is a causal factor in these health behaviours or whether these health behaviours are a causal factor for ED consumption. A cohort study may help mitigate this issue by giving a more robust analysis of ED consumption and associated health behaviours over a more extended period of time. However, the association that has been established still provides legitimate evidence as to why this ED consumption is of such concern.

Although the term 'Sports drink' is often used interchangeably with ED, a primary difference is that ED mostly contains caffeine and is therefore associated with caffeine-toxicity related health risks as well (Seifert et al., 2011). Additives such as guarana contain high quantities of caffeine and, as manufacturers are not required to list the amount of caffeine derived from these sources, it is difficult for consumers to assess how much caffeine is within the product accurately. Agencies such as the US Food and Drug Administration (FDA) view EDs as 'dietary supplements' thereby not subjecting them to food marketing or ingredient regulations (McCarthy, 2011). Soft drinks, on the other hand, are limited by these regulations. The average caffeine content in EDs is 9.6 mg in comparison to 3.5 mg average content in soft drinks (Reissig et al., 2009a). Heavy consumption of caffeine in the form of EDs has also been associated with adverse outcomes such as seizures, stroke and instant death; the significant variations of its reported benefits and adverse events may be due to it being tolerated differently as per individual (Reissig et al., 2009a). While this is compelling in establishing the health concerns around ED consumption, it should be noted that the adverse health events listed above have mainly been studied in adults.

Furthermore, the reference in Reissig et al. (2009a), refers to an individual case report; one incidence does not allow any inferences to be made, a more thorough review of available literature would need to be conducted, focussing on the target population. Both forms of beverages also

contain significant amounts of sugar, which can expose consumers to further health risks, along with other frequently used additives- such as taurine, vitamins, and herbal supplements. It is perhaps interesting to note that taurine has nervous system depressant properties and can limit the effect of caffeine on cardiovascular function (Menzie et al., 2013). While this may have some advantages, it does raise the question as to whether the physiological effects of taurine may increase ED consumption in those looking for specific effects from the product. In terms of the 'glucose rehydration' properties of EDs, the American Academy of Paediatrics (AAP) did report that small amounts of such beverages might aid athletes during physical activity in harsh environmental conditions (Schneider and Benjamin, 2011). The report also highlighted and demarcated between 'sports drinks' and 'energy drinks' for the confusion that may exist regarding both drinks. The report also mentioned that, for regular physical activity, the use of EDs as a 'sports supplement' may often do more harm than good, being unnecessary and contributing to adverse health outcomes.

In light of the documented concerns surrounding ED consumption, the following sections highlight the key findings of the present study concerning reported ED intake, influences and associated health outcomes among adolescents.

7.2 Prevalence of ED consumption

In Saudi Arabia, 52.55% of the young people (aged 13 to 20 years) reported having consumed EDs, with 26% consumed EDs approximately once a week, while 11.2% of young people consumed between 2 to 4 EDs per week. Data from the HBSC Wales, on the other hand, revealed that 38% of young people reported to have consumed EDs, with 7% consuming EDs once a week, and 5% consuming EDs between 2 to 4 per week. While the Welsh data suggested that ED consumption increases with age, Saudi Arabia data also showed that participants with secondary school education were also 1.55 times (95% CI, 1.123 to 2.157) more likely to consume ED frequently than participants between the age of 13-15 years. Future studies could seek to expand study data from later age groups in both countries as it may provide a more realistic finding into how alcohol dependence may associate with ED consumption (given that it is prohibited in the Saudi culture). Studies in the US had reported a strong association between alcohol dependence and ED usage, also suggesting the ED consumption to be a good indicator for identifying students and young adults who may engage in high-risk health behaviours (Arria et al., 2011). However, the studies included in the review by Arria et al. (2011) were mostly cross-sectional in design, limiting the opportunity to explore temporality of found associations.

In a study conducted in Saudi Arabia, Al-Hazzaa et al. (2011), observed associations between physical activity and ED consumption among late adolescents (15-19 years). The findings, however, revealed that this was only significant in males. ED consumption was also associated with higher rates of television screen time. When questioned on the reasons for ED consumption, the participants primarily responded to 'flavour', with a large proportion also 'not knowing why they consumed ED'. The flavour aspect has been reported in other studies carried out in Saudi Arabia. The study by Musaiger and Zagzoog (2013) reported nearly 58.4% of participants (12-19 year-olds; n=1061) stating the main reasons for consumption to be 'taste and flavour'. This study also reported that 43% of respondents consumed ED to 'get energy', while 51.8% only wanted to 'try them'. Unsurprisingly, young people in this study were not aware of the ingredients of ED, a finding similar to that presented in several global studies (Salinero et al., 2014, Bunting et al., 2013, Cotter et al., 2013). The findings of Musaiger and Zagzoog (2013) are perhaps not easily generalisable to other populations given the limited sample size (n=<45); however, this is partly mitigated by similar findings in the other referenced studies. In a 2011 study carried out in the UK, Sartor et al. (2011) observed taste to be a major factor for ED consumption, with EDs containing more than the average sugar content being favoured by overweight/ obese individuals.

As the prevalence of ED consumption is high among young people, it may be suggestive that there are various smart marketing techniques used by companies to associate EDs with the youth culture, promoting the 'power' and 'danger' aspects. Our present data revealed adolescents to be unsure as to why they consume EDs- revealing that marketing strategies (billboards, television, radio) have influenced them in early adolescence, which now seems to be an expanding segment of the beverage industry (Oddy and O'Sullivan, 2009). In spite of the regulation about ED marketing in Canada, the Advertisements is still targeting the young people between 12-14 years old and under (Danielle et al., 2020). Such marketing techniques, in combination with peer pressure, seem to influence ED consumption in children starting from the age of 10-11. Research groups have observed a lowered risk of adolescents becoming habitual consumers once awareness programs are implemented (Gallimberti et al., 2013).

7.3 Gender variations in ED consumers

One widely common aspect across the studies on ED consumption is usage-based on participant gender. The current study identified males in secondary schools as the primary consumers of ED in both Wales and Saudi Arabia; data from Wales highlighted that males were 2.053 times more likely to report ED consumption compared to their female counterparts. Musaiger and Zagzoog (2013) reported a significant difference in genders based on ED consumption; the study focuses on 12-19

year-olds, showed 72% of male respondents in Saudi Arabia as consuming EDs, while only 36% of female respondents confirmed the same. Arguably, consideration should be given to how this information was obtained; self-reporting may not give a truly accurate picture due to under or over-reporting and therefore reporting bias. Given the vast disparity between genders, it could perhaps suggest a difference in how EDs are viewed by males and by females, thus altering the propensity to self-report consumption.

This study also confirmed advertisements to be the primary source of information among participants; 51.6% and 33.9% in males and females, respectively. In their 2013 survey of university students in Makkah (KSA), Bawazeer and AISobahi (2013) observed a significant difference between gender groups concerning ED consumption, with 61.5% male students and 12.3% female students reporting regular consumptions. The study reported the primary reasons for both genders to be 'stress during examinations' or 'needing energy in general'. Again, the difference between the reported consumption in males and females could suggest a difference in how EDs are perceived between the two groups. ED consumption was also reported frequently by males during driving. However, this data would need re-evaluation as Saudi Arabia has since changed the laws to permit women to drive.

In a study carried out in Cardiff Metropolitan University (UK), Broughton et al. (2016) observed male respondents (aged 12-14 years) significantly more likely to drink EDs than female respondents. The study also observed that while male respondents chose to consume EDs primarily during sports and physical exercises, females drank EDs on a social basis. Another UK study by Fitt et al. (2013) also observed males have higher ED consumptions than females; surprisingly though, in terms of total caffeine intake (including coffee), a significant variation was not observed- with intakes of over 300 mg/ day of caffeine reported in 4.1% of males and 3.8% of females.

Data that represents gender-based ED consumption may be reliant on several other factors as well- including social influences and marketing. Since the time of EDs being introduced in the market, they were marketed to comprise a 'jock' identity, to identify hyper-masculinity and risk-taking measures (Miller, 2008b). Furthermore, despite ED companies not specifically claiming athletic prowess enhancements, they form a strong association with various sporting events, especially motorsports, that seem to have a high-octane reputation (Ho, 2006). Marketing literature for EDs also often employ extreme-sport imagery, perhaps to further evolve the public image of EDs around nexus of sport (Miller, 2008b). Such strategies could potentially make these products more appealing to male consumers. In their UK study,

Visram et al. (2017) explored children's (aged 10-14 years) attitudes and perceptions concerning EDs. Given that this age group seems to be the target consumers, researchers observed that most participants were actively aware of several ED brands while also being aware of various advertising strategies and slogans. Participants reported that several ED products target male population groups with their association with extreme sports and their packaging/brand names. The respondents also reported several EDs to have associations with video games (codes/tips printed onto the packaging). Both male and female respondents agreed that ED usage was more widespread in their peer groups. Despite influence, male respondents were more likely to consume the drinks (primarily for the 'extra-edge' on sport-related activities). Young people believed that their peers consumed EDs to enhance their image/ identity, while males did so to appear tougher. Nevertheless, research groups have identified that individuals aged below 21 are often more likely to be sensitive to peer influences than adults, with social situations often being a common context for ED consumption (Bunting et al., 2013). Studies in Saudi Arabia have also observed males be more likely to get ED-based information from their peers (22.1%; compared to 8.6% in females), but advertising and brand loyalty remain the strongest influences (Musaiger and Zagzoog, 2013).

7.4 Socio-demographic characteristics

With regards to the association between ED consumption and socio-economic status (SES), the current study obtained somewhat comparable findings. In Saudi Arabia, the results showed that consumption of ED was proportional to parental education; adolescents whose parent (father) held a degree were more likely to report higher consumption of ED. Furthermore, we assume that higher parental education does relate to higher SES scores; thus, Saudi young people may be more likely to consume EDs if they come from a higher SES background. In addition, data from Saudi Arabia also showed that young people who come from high-income families are more likely to consume ED, but the association was not significant. Data obtained from Wales used the family affluence scale (FAS) as a proxy for SES. The results also showed that individuals belonging to a high FAS group were more likely to report ED consumption compared to lower FAS groups. While the FAS has been through several iterations, it should be noted that there could be potential for confounding based on its use. For example, not owning a dishwasher may be less to do with affluence and more to do with preference. Similarly, not owning a car may be associated with a lack of necessity rather than affluence.

In their UK study, Richards et al. (2015) also observed that while lower SES was associated with a generally poorer dietary pattern among adolescents, those from higher SES groups consumed more EDs. Research groups often tend to combine EDs in the 'energy-dense foods' criteria, which

has been associated with lower SES, along with higher consumptions of sweetened beverages and processed foods (Voracova et al., 2016). This association may be further promoted by the fact that EDs are often eligible to be purchased under government-assistance programs for lower SES individuals; of the 'beverage budget' in this program, approximately 48-58% is allocated to sugary drinks, including EDs (Andreyeva et al., 2012). Several research groups have since presented conflicting evidence in terms of ED consumption and SES. In their paper, Arria et al. (2014) observed students from lower SES backgrounds be at higher risk of excess ED consumptions; however, the data used to determine SES was the average income for the ZIP code in which the participant lived. Such a method is likely to open to error; if a student is from a high-income household but lives in an area with a large number of average-income households, the disparity may not be represented in the mean income figures.

A study by Locatelli et al. (2012), on the other hand, observed higher ED intakes along with alcohol in students (aged 15- 17 years) from higher SES backgrounds in Brazil. This study categorised SES of students into five categories; those under the highest SES category showed ED prevalence at 45.5%, while only 17.7% of students from the lowest category reported ED consumption. This study recruited from private schools, suggesting that the majority of the participants were already from a higher SES level, as evidenced by the participant characteristics. 95.4% of the participants came from class A or class B. Participants from classes C, D, and E, representing 4.6% of the study population, were analysed together. While this grouping was likely to be necessary for statistical analyses to be effective, it may be inappropriate to group them. Similar patterns were observed in a survey carried out in the United States.

The National Health Interview Survey reported the ED consumption to be higher in families having household incomes exceeding \$100,000- in comparison to those having overall incomes lower than \$35,000 (Park et al., 2013). Another study by Reid et al. (2015) observed ED use to increase with students from higher SES backgrounds primarily due to them getting higher 'spending money' as compared to their counterparts. The additional income allowed them to obtain EDs from 'higher brands', to improve their identity or image. Furthermore, this Canadian study also linked ED use to higher alcohol intakes, unhealthy body mass index (BMI) ranges, and in those participants reporting to 'try and lose weight' (possibly due to increased stress factors). Several other studies on ED consumptions have reported no socio-economic patterning variations in ED consumption in terms of income, status, or education levels (Rios et al., 2013, Berger et al., 2011). The data obtained by Reid et al. (2015) may explain the variations observed in linking SES with ED consumption; it may not be directly associated to act as a 'direct result' of SES factors, but rather on the additional factors (such as increase pocket money to children, increased freedom/ free time, and so on). The large study

population in this study (n=23610) would suggest that these findings are robust; however, the ethnic diversity of the population is perhaps somewhat lacking and may indicate a confounding factor in the results unless this was controlled for in the analysis.

As observed in the present study data, parental education has also been suggested to play a significant role in determining adolescent ED consumption patterns. However, it may be essential to understand that the individual's education and their parents' education tend to have different pathways to ED consumption. For example, Friis et al. (2014) did observe an increase in ED consumption in individuals with a low level of education. In a Canadian survey on 36,155 individuals (aged 12- 18 years), Azagba et al. (2013) observed students with an academic average over 70%, and those feeling more connected with their academics were less likely to consume EDs. Similarly, a 2015 study carried out in the US reported that, among students aged between 10 to 14 years, ED usage was associated with lowered academic performances due to hyperactivity and inattention (Schwartz et al., 2015). It is perhaps important to note here that, while this association was considered significant in ED consumption, data for sports drink consumption gave an odds ratio and confidence interval that was not deemed significant; the confidence interval crossed the null [95% CI 0.460, 1.074]. Since the Schwartz et al. (2015) study is cross-sectional, the researchers were unable to comment on whether ED usage caused lowered academic performance and hyperactivity/inattention or whether those with lower performance/hyperactivity/inattention were more likely to consume EDs.

With regards to parental education, Cameron et al. (2012) observed that the education of the secondary carer had a strong association with ED consumption with girls; while the education of the primary carer was found to have a strong association with ED consumption in boys. However, this study did associate a lower risk of ED consumption with higher education in parents, a finding that is in contrast to our data. Rather than associating with SES, this study observed parents' being aware of the health risks associated with ED intake, with their influence on the children's food habits playing a primary role. While parental influence in food/ drink choices does decrease over the adolescent period, children regularly consume EDs if their parents are reported to consume them as well (Grimm et al., 2004).

7.5 Affordability and availability factors

Findings of the present study did support that the affordability and availability of EDs do play a significant role in its consumption patterns. In comparison to the consumption patterns in Saudi Arabia, these factors may play a more prominent role in Western markets, primarily due to the availability of 'store-branded' EDs in these countries (Alam, 2017). Visram et al. (2017) reported that in comparison to branded EDs, several convenience stores (in the UK) sold 'own-brand' EDs at

relatively lower costs and stocked them at greater volumes, often being amongst the cheapest drinks sold in the store, even more so than water, they also observed that several of these EDs were included in multi-purchase offers (resulting in the form of discount if purchased in bulk); these 'offers' were reportedly taken advantage of by students by pooling their money and sharing EDs with their peers.

Furthermore, some Western countries have vending machines in schools and community centres that stock sugar-sweetened beverages and EDs, thus increasing their availability. Surprisingly, studies have noted that the presence of vending machines in such areas was associated with a decrease in ED consumption among students (Reid et al., 2015). A possible explanation may be a shift of school policies to accommodate healthier beverages in vending machines, or in them turning off the machines during school hours (Minnesota and Missouri, 2009). In the UK, EDs may be purchased from most convenience stores without any specified legal age or other requirements restricting the choice of these drinks for regular consumption by adolescents (Vieux et al., 2017, Visram et al., 2017). In the US, organisations such as the American Beverage Association have suggested that the sales and marketing of beverages with high caffeine content to restricted for children under 12 years of age, however, this is yet to take effect (Owens et al., 2014). Surveys in the US have also reported parents agreeing (74-78%) that EDs should not be marketed or sold to children and adolescents (Pomeranz et al., 2013).

In 2010, the World Health Organization (WHO) declared the marketing of unhealthy products to children a global problem, calling on the Member States to act. Since then, several policy options have been made available to limit beverages of public health concern among the young. This may require factual disclosures, increased taxation, and regulating the sale and location of such beverages within schools, retail and foodservice establishments. For energy drinks, the government might restrict the size of non-resealable containers or institute per capita restrictions on the sale of energy drinks in large non-resealable containers. The suggestions above might be combined with an age restriction so that they would apply only to youth under a certain age similar to age restrictions on purchases of tobacco and alcohol (Pomeranz, 2012). The existing school food policies in the UK inhibit ED consumption for the majority of children and young people during school hours, mostly in primary schools. However, some pupils find ways around these rules and also school staff lack knowledge of EDs, highlighting the importance of education for school staff as well as children and young people (Visram et al., 2017). In the absence of law regarding the sale of EDs to the young people, several participants in the study by Visram et al., (2017) suggested voluntary schemes involving local retailers. They acknowledged local shops or, individual employees who voluntarily restricted sales to young people. This approach is not feasible because of the challenges of

implementation with large national retailers and the importance of ED-related income to smaller sellers (Visram et al., 2017).

The increased availability of EDs is also associated with the advertising of these products being targeted to children and adolescents as primary consumers. As previously mentioned, several ED companies engage in sponsorship of music concerts and extreme sporting events, thereby appealing to pre- and early adolescents (Miyake and Marmorstein, 2015). At the same time, marketing strategies are placed to use EDs for performance enhancements and in promoting physical activity (Owens et al., 2014). A 2015 study carried out on male Saudi Arabian students (aged 12- 18 years) observed poor knowledge on the composition of EDs despite respondents being well aware of various advertising strategies and on the knowledge of the availability of products (Epuru et al., 2015). Similar results were obtained by Musaiger and Zagzoog (2013) who reported nearly half of all Saudi Arabian student respondents (total n= 1061; aged 12-19 years) did not know that ED contained caffeine nor was aware of the actual ingredients; two-thirds of all respondents viewed EDs to be similar to soft drinks, based on advertising. This pattern was observed in several Western countries as well; Costa et al. (2014) observed a majority of Australian students to have limited knowledge of ED compositions with trouble differentiating them from other soft drinks.

These factors call for an improved advertising platform for such products that specifically disclose their contents and possible adverse effects to the target groups and their parents/carers where applicable. US parents have reported being in support of possible regulations for EDs that require them to have warning labels and caffeine disclosure labels (Pomeranz et al., 2013). In Saudi Arabia, ED advertising has been banned altogether by the Saudi Council of Ministers; this ban also prohibits the sale of EDs in government, educational and health facilities as well as its free distribution to consumers (Aljaloud, 2016). To our knowledge, no research group has studied the effects of this ban on consumption patterns, which may be useful to obtain in order to determine the role of advertising on ED consumption in young people. This may be considered as an area for future research.

As mentioned by Visram et al. (2017), the affordability of EDs in the UK may also need to be tackled to reduce consumption patterns. These viewpoints seem somewhat at odds with each other; if increasing the cost would not significantly impact the consumption trends, why is there a need to be concerned with cost increases? According to their UK study, Visram and Hashem (2016) reported that their participants admitted to buying EDs as an 'affordable' social drink. A 2014 study on ED consumption among medical students and interns in Saudi Arabia pointed out that increasing costs of EDs may significantly limit the extent to which individuals may be able to imbibe these drinks

regularly (Ibrahim et al., 2014). However, an appropriate pricing structure for EDs is the topic of some conjecture across several studies. While a drastic increase in price levels may not be feasible to establish, a moderate increase may be a potential means of limiting purchases by the children/adolescent group, especially for own-brand ED products. As noted earlier, children and adolescents often make these purchases from their 'spending money', thus increasing prices of EDs may shift their attention to other more affordable beverages, especially in terms of being a 'social drink'. Further research may be required before implementation to investigate the effects of such changes on students/adolescents from higher SES groups. Similarly, as shift workers also often rely on EDs (Walia et al., 2012), it may be necessary to evaluate affordability effects on various population groups outside of the child/adolescent demographic.

Several studies mentioned in this report (especially those carried out in Western countries) have reported ethnicity-based variations of ED purchasing and consumption patterns. For example, Arria et al. (2014) observed higher consumption rates among Hispanic individuals in the US; Park et al. (2012) observed a higher prevalence among Hispanic and black individuals in the US, also observed by Schwartz et al. (2015). While an ethnic variation is apparent in ED consumption patterns, this was not investigated in Saudi Arabia cross-sectional study. On the other hand, the Wales data observed that white young people are less likely to consume EDs than others. Very few studies have considered the impact of ethnicity on ED consumption in the UK and as such, this an area that needs further investigation.

7.6 Associations with health-related behaviors

Several studies have identified various health-related behaviours to be consistently associated with ED consumption in young people. These include higher risks of excessive alcohol consumption, tobacco use, and substance misuse (Larson et al., 2014, Locatelli et al., 2012, Visram et al., 2016, Emond et al., 2014). These studies observed that ED consumption patterns might predict the level of alcohol consumption or the number of 'drinking days' in individuals (Miyake and Marmorstein, 2015, Visram et al., 2016). Studies in adolescents aged 13- 18 have also found a higher frequency of substance misuse in respondents who consumed EDs (in comparison to those who consumed other non-caffeinated beverages) (Terry-McElrath et al., 2014).

The current study observed that in Saudi Arabia, the consumption of ED was associated with higher consumptions of tobacco products. In addition, secondary adverse health effects were also observed in the Saudi Arabia study group, as tobacco use was found to be a useful predictor of oral hygiene status. Various studies have observed the associations of tobacco use with increased risk

of various dental conditions (Genco and Borgnakke, 2013). This finding is consistent with findings of a recent study conducted in Saudi Arabia by Subaiea et al., (2019), which indicated that those who consume ED daily are more likely to report adverse health effects such as (chest pain, insomnia, headache, diuresis, chronic fatigue, muscle fatigue, and nervousness) than students who consume 1-3 time per month. As alcohol is banned in Saudi Arabia, the present study did not consider this. This association may merit further exploration.

Our data from the Wales study group also observed those who consumed EDs more likely to be tobacco smokers ($p < 0.05$), which may support the notion that those who consume EDs have an unhealthy lifestyle. The higher risk of negative health-related behaviours has also translated in UK adolescents who consume EDs being more likely to “be in trouble” at home and in school environments (Visram et al., 2017, Wolk et al., 2012). A 2018 meeting at the House of Commons (UK) heard that several high school teachers in the UK (especially London) were concerned by the problematic behaviours portrayed by students consuming EDs; these included unruly behaviour in classrooms and their inability to concentrate on academics. It is unclear how the consumption of EDs was assessed by teachers. The study by Kristjansson et al. (2013) observed the ‘conduct disorder’ aspect of EDs and other caffeinated drinks to be more prominent among females than males. This finding could be misleading. The study used the Oregon adolescent depression project conduct disorder screen (OADP-CDS), which includes questions such as “how often have you broken the rules at home”. It could be suggested that this question is subjective in nature, allowing a massive amount of individual interpretation as to what a rule may be. It also does not allow for variances in parenting practices generally, or for variances that may occur in attitudes to discipline for male and female children.

7.7 ED consumption and lifestyle factors

Other adverse lifestyle and behavioural changes have also been associated with ED consumption, with it most often linked with poor dietary habits. In their 2013 study, carried out in the UK and other EU countries, Breda et al. (2014) found that one in 20 adolescents have EDs instead of breakfast, with the highest ED consumption rates in adolescents who are overweight/obese, followed by those who are underweight. Larson et al. (2014) reported ED intake to be positively associated with weight status among participants generally, and lower breakfast consumption among female respondents, but, as previously mentioned, the cross-sectional design of the study may mean that these associations show a bi-directional relationship. However, the association between EDs and reduced breakfast consumption have been observed by several studies. Rather than a possible reduction of body weight, skipping breakfast tends to increase the overall sugar cravings in individuals. According

to a UK study, such individuals often consume EDs to get a 'boost of energy' (Smith and Richards, 2018).

The high calorific value of EDs further adds to the problem of weight gain (Kit et al., 2013). According to a 2015 study by Poulos & Pasch, the weight gain among ED consumers was also due to an associated higher consumption of ready-made meals and sodas. While caffeine itself acts as an appetite suppressant, it is the high sugar content in EDs that result in a calorific surplus while also inducing additional sugar cravings. Several studies in adolescent populations have reported ED consumption to result in higher body fat percentage and increased waist circumference (Hoare et al., 2017, Katzmarzyk et al., 2016). While the systematic review by Hoare et al. (2017) included EDs as a search term; there would appear to be no differentiation between EDs and other sugary drinks. For example, orange juice is also considered as a sugary drink for the purpose of the review.

A study by Rush et al. (2006) observed that rather than obtaining caffeine's fat oxidation effects, EDs tend to suppress fat oxidation and increase carbohydrate oxidation due to the combination of sucrose and caffeine. Lipogenesis and insulin resistance have also been reported to result due to ED consumptions (Deliens et al., 2015). Our findings from both countries were in line with these studies. In Saudi Arabia and Wales, young people who did not consume breakfast were more likely to have higher intakes of ED on a daily and weekly basis. Similarly, individuals who did follow healthier diets and lifestyles were significantly less likely to consume EDs. Thus, educating adolescents and parents on the importance of breakfast consumption may be one approach to lowering the rates of ED consumption.

Studies carried out in Saudi Arabia, and the UK have supported that EDs pose a primary risk in weight gain and obesity factors among adolescents (Al-Hazzaa et al., 2012, Briggs et al., 2013). According to Briggs et al. (2013), the consumption of EDs in the UK now represents the third-highest factor of adolescent obesity. One particular study carried out in the UK, however, observed ED consumption not to be associated with unhealthy dietary habits alone, as ED consumption with high-stress levels was predictive of "skipping breakfast" and other unhealthy dietary behaviours (Richards and Smith, 2016). ED consumption may, therefore, act as an exacerbating factor when there is already high risk of adverse health behaviours.

7.8. ED consumption and mental health

Various research groups have observed adverse mental health associations with ED consumption; greater odds of stress, anxiety and depression with high levels of caffeine consumption in

adolescents (approximate age of 15 years) were observed in a recent Korean study (Jin et al., 2016), suggesting that EDs could be included in this. Increased depression and suicidal ideation have also been associated with ED and caffeinated drink consumption (Park et al., 2016), an association that increases with the addition of frequent junk-food consumption. This increase in adverse mental health outcomes has been correlated with a higher risk of sleep disorders and substance misuse as well (Kristjansson et al., 2013). The present study did identify that adolescents in Saudi Arabia who consumed ED had on average 'later sleep times' than non-ED users; these later sleep times were more prevalent in Saudi nationals as compared to non-Saudi nationals. Data from the Wales cohort, on the other hand, observed a general category of health outcomes (including feeling irritable, nervous, difficulty in sleeping, dizziness and generally feeling low) to be directly related to the consumption of EDs. These results are in line with those from other studies.

A study by the Department of Health and Social Care (2018) in the UK observed ED consumption in adolescents (aged 12 to 18 years) to cause them to be 3.4 times more likely to report experiencing tiredness, 3.5 times more likely to report sleeping problems, and 4.5 times more likely to report experiencing headaches. According to a UK study by Brooks et al. (2011), the inability of adolescents to concentrate on academics were significantly associated with ED intakes. Interestingly, a 2016 study in the UK (in 11 to 16-year-old students) (Richards and Smith, 2016) did not observe ED consumption to be associated with mental health outcomes that had been reported by several Western studies. However, this study did observe that ED consumption correlated with stress/anxiety factors only if they were combined with infrequent breakfast conditions. Further, the study reported excess usage in students who were older males. Whilst the evidence does suggest that there is an association between ED consumption and negative mental health outcomes, the conflicting results may indicate a need to consider the direction of the relationship.

7.9. Other factors influencing ED intake

As observed in this study, ED intake among adolescents may be influenced by several factors. The taste was reported as a primary driver among Saudi Arabia young people. While young people in Western countries tend to utilise EDs as mixers to alcoholic beverages, EDs may be the primary 'social drink' among users in Saudi Arabia. In their 2013 study, carried out in Saudi Arabia, Musaiger and Zagzoog (2013) observed more than half of total respondents to have reported regular consumption of EDs primarily due to "taste and flavour"- with several respondents reporting to have initially only wanted to "try them" due to various influences. Peer influences do have a significant role to play in both Saudi Arabia and in Wales. However, they seem to have a greater influence on young male people in Saudi Arabia (with over 22.1% reporting regular ED consumption due to peer pressure (Musaiger and Zagzoog, 2013). The 'masculinity' of EDs may make them seem like an attractive

option for this group. A study in Saudi Arabia by Faris (2014) observed EDs to specifically relate to social cues in male adolescents, further promoting various risky lifestyle behaviours.

Female adolescents in Saudi Arabia were more likely to be influenced by family members to consume EDs than by peers. Various studies have reported the parental influence in adolescent ED intake; this key role may either endorse the use of EDs or prohibit them (Costa et al., 2014). In the UK study by Visram et al. (2017) observed a higher rate of ED use among adolescents when their family members consumed the same or were neutral about their consumptions. Several respondents in the UK also reported EDs to be provided by parents after sports activities for rehydration, thus further highlighting the importance of parental education regarding ED use. Adolescents also reported frequent use of EDs to “enhance sports abilities”- with energy-seeking patterns being the secondary driver in most cases. While peer pressure and family influences do play a significant role, the pricing of these products also makes them an attractive option for adolescents, more so in Western countries due to the availability of store-brand ED products. These findings have clear implications for policy and practice in both Saudi Arabia and wales.

However, some key limitation should be considered since the two surveys differs in several aspects. The first consideration is the primary purpose of the survey. This may seem pretty fundamental but it's easy to get focused on the particular domains and data elements that you are interested in and lose sight of the larger context in which the data were collected. That larger context has significant implications for a number of factors that can influence how the domains of interest are measured. HBSC is a national annual survey that covered rang of areas such as: body image, bullying, school environments, sexual behaviours, and alcohol. And for this thesis only a specific question were selected to narrow the research topic and due to limited time. However, not selected all variables for the study may have potential implications for a number of factors that can affects ED consumption among young people.

The second consideration is the primary purpose of the survey affects how the respondent's attention is focused. Attention may be more or less focused on the topics you're investigating. Moreover, it affects how in depth the domains of interest are covered. In addition, the primary purpose of the survey affects the context in which questions are asked and their placement in the survey. Are the questions of interest placed early on, at the end of the survey, or somewhere in between?

For Saudi Arabia survey the primary purpose was to assess the prevalence of ED consumption and identify the motivation factors among young people. So the majority of the question focusing in this area, and the questions have been revised to answer the research questions. however, in HBSC data ED is not the primary focus of the survey so the ED question was a part of eating behaviour

section and Questions placed late in the survey that's mean the questions are more likely to have missing data. So that may influence reporting accuracy.

Despite our efforts to locate similar questions, wording differences between the surveys in case of items focusing on energy drinks consumption, sociodemographic status, affected some of our comparisons between Wales and Saudi Arabia.

Question wording may influence what is referred to as the social desirability effect, where respondents may consciously or unconsciously answer the question based on their perception of social norms or expectations rather than based on their actual behavior.

Questions about health behaviors often include a time reference but the reference period may not be the same across surveys. In general, the longer the reference period, the more likely it is that there will be reporting inaccuracies. In addition, the less clearly defined is the time reference period, the more it is subject to varying interpretations by different respondents which also contributes to less accurate reporting. For this reason, the researcher was careful to make the question identical in term of reference period to reduce in accuracy reporting.

Chapter 8

Conclusion

8.1 Policy Implications

The implications of the findings regarding the potentially harmful effects of the caffeine, taurine and ginseng commonly found in EDs, as well as the effects of the sugar content on obesity levels, are multiple. In addition, the lack of knowledge about the long-term health impacts, particularly in relation to the increased risk of heart palpitations or similar, suggests that not only is further investigation required but that more stringent policies and regulations are put in place to prevent long term health effects in Saudi Arabia and Wales young people. Indeed, given the indications that behaviours such as skipping breakfast, or engagement in sports combined with the perceived masculinity of the packaging, are all factors in increased ED consumption, it is evident that these are areas which need to be targeted by the policy in both Saudi Arabia and Wales. Other indications connected to video gaming that came from the literature (Larson et al., 2014) whilst not identified in the current study may, along with the effect of packaging and parental influence, also need to be addressed by the policy if the trends of consumption and consequent ill health are to be reversed. Furthermore, the identification of significant correlations between smoking, and early alcohol usage, along with a high BMI suggest that the focus should also be on encouraging healthier lifestyles so that better choices are made by the target group. Overall, it would appear that an overarching policy approach needs to be in several parts, as follows:

a) Addressing marketing and packaging which is aimed at the younger target market (focusing mainly on males)

Alongside age restrictions and increased taxation on the products, there appears to be strong evidence for policies which target the packaging of EDs. The masculine, alpha male nature of much of the branding and marketing of these products was cited as a potential motivator by individuals in this work and others (Bunting et al., 2013, Reissig et al., 2009a, Trapp et al., 2014). The question then arises as to how this could be regulated and managed to change the image and potentially reduce the desire for the drinks as a means of demonstrating social belonging and achieving peer acceptance. Examination of the approaches taken by other countries who have also recognised the potential problems being created by young people's high consumption, and indeed desire for what they perceive to be popular drinks can provide routes to follow for the achievement of the aim to reduce motivation to purchase, but crucially also reduce access and appeal of the products.

In this context, evidence comes from regulations used to change other young people purchasing behaviours that could cause long term health benefits. The success of plain cigarette packaging indicated by a Cochrane report (2017), suggests that a similar approach would be useful in reducing ED consumption. EDs which are not branded with either gaming or other “tribal” designs and logos are likely to be less attractive and desirable to young people who are using the drinks as a means of demonstrating their social identity. Indeed, this “tribal belonging” view of the motivations for ED consumption, (Costa et al., 2014, Droste et al., 2017), is potentially a major driver of the growth in popularity of these products. Moreover, given the correlations between cigarette smoking and ED consumption identified in this work, taking a plain packaging approach could be highly effective in reducing the desire for a product which is no longer presented as desirable or part of an identity creation culture. In essence, therefore, making the cans more uniform and enforcing the use of unappealing fonts and colours could lead to a reduction in attracting young people to the drinks.

b) Importance of role modelling and environmental interventions in reducing excessive ED consumption

The most crucial policy intervention and practice is the development and delivery of health education programmes. This is because it was noted that many of those in the study had a vague idea of the ingredients and their potential effects and were unclear how EDs differed from other soft drinks. In terms of how to deliver the health messages, it appears that parents and GPs are key sources of information, where parents take responsibility for ensuring that young people are aware of the health implications of sugary and energy drinks, the potential for high consumption in adolescence is reduced. For example, Van Lippevelde et al. (2013) identified that where children were exposed to positive parental role models in terms of healthy eating and drinking habits, they were more likely to replicate this in early and late adolescence, irrespective of peer pressure. Indeed, those who had more information provided by parents were more likely to examine ingredients more carefully and make wiser decisions (Melbye et al., 2016). Therefore, an effective policy would be to target health centres with promotional campaigns and interventions that focus on both short and long term impacts, of high ED consumption (Chaput et al., 2018).

Alongside campaigns that focus on providing strong role models in early childhood and adolescence, it should also be recognised that in later adolescence peer influences may be stronger than those of parents or GPs (Aluqmany et al., 2013, Reid et al., 2015). This aligns with the previous indications regarding peer pressure and social acceptance that appear to be associated with consumption of EDs and noted by Costa et al. (2014) and Droste et al. (2017). In other words, to

reinforce early childhood modelling by parents, policies need to be developed that are focused on older adolescents and underline the importance of healthy eating patterns, including understanding the ingredients of EDs and their impact on short- and long-term health. Furthermore, educational organisations need to consider how to promote healthier choices and reduce access to EDs for older adolescents. For example, if schools banned the consumption and did not have them available for sale, this would reduce access and thus consumption.

c) Placing age restrictions on the purchase of the drinks.

Interestingly, despite age restrictions not being in the statute book, many stores are now refusing to sell these products to under 16's, suggesting that a high profile campaign can be effective in encouraging the view that EDs are harmful to young people (Poulter, 2018). The Association of Convenience Stores in the UK, whilst stating that there is no legal ban, recognises societal concerns about the products and suggests local bans can be implemented, (Stores, 2018). This is an approach that could be adopted in Saudi Arabia, whilst legal approaches are being discussed and debated. In addition to age restrictions, a sugar tax has been successfully implemented in several states in America, and in the UK, which has helped reduce consumption by around 20% (Falbe et al., 2016, Zhong et al., 2018, Colchero et al., 2017).

d) Increased price and reduce availability in stores

These approaches have been recommended and indeed implemented in several countries, (Breda et al., 2014, Francis et al., 2017). For example, placing a minimum age for the purchase of these products has been discussed in the UK. Although not yet fully enshrined in law, a report published in 2018 suggests that the rising levels of obesity and other health impacts associated with EDs could be reduced by placing minimum age requirements (Government, 2018).

A further measure which can be dictated by the policy is to increase the price of EDs, through what has been described globally as a "sugar tax" (Zhong et al., 2018). A sugar tax was introduced into the UK on sweetened drinks in April 2018 (Thornton, J., 2018). However, recently, in Saudi Arabia sugar tax has been implemented from 1 Dec 2019. Given the association between socio-economic status, cigarette smoking, alcohol consumption and EDs, there is a growing body of evidence that increasing the price of these products could reduce consumption with evidence coming from Australia and Mexico as well as the UK, (Briggs et al., 2013, Colchero et al., 2017). Furthermore, previous research has shown that public acceptability affects the adoption of SSB tax. Therefore, one of their study's recommendation is to reduce the gap between the core beliefs and scientific evidence (Eykelboom et al., 2019). An added benefit is that if the EDs are less accessible, this also appears to have a consequent effect on the desire to purchase alcohol and mix this with the ED, reinforcing

the value of this policy intervention. Francis et al. (2017) drew greater attention to the advisory statements on the cans supports awareness and thus more informed decisions about whether or not to purchase and drink EDs.

In conjunction with these marketing and packaging regulations, an additional policy intervention that has been effective in other countries is curtailing, where ED companies can advertise their products. Evidence from Larson et al. (2014) suggests that teenagers who play a high level of video games show a positive correlation with increased ED consumption. Product placement in these games should, therefore, be significantly reduced, particularly when the games are targeted at young people who will suffer health problems as a result of increased ED consumption.

This study can be used to summarize several key recommendations that can be made to the Saudi government, Wales and health organisations in the countries based on the outcomes of this study.

For both Wales and Saudi Arabia:

- a) Introduce a minimum age of 16 or 18 years for purchase and consumption of EDs.
- b) Review the marketing practices of ED companies and enforce regulations that ensure the ads are not directly targeting those under 16 years of age, particularly young males.
- c) Consider the introduction of 'plain packaging' to reduce the shelf appeal of the drinks
- d) Develop and implement health promotion and education programmes in schools and health centres to provide information about the potentially harmful effects of excessive ED consumption amongst young people.
- E) Increase the size of advisory information on the side of cans so that purchasers are made more aware of both the ingredients and their effects before purchasing an ED.

For Saudi Arabia:

- a) More data on student consumption of these products needs to be gathered, and it is therefore suggested that the government consider the introduction of annual health surveys (diet, physical activity, behaviours) which can be used for as a baseline for evaluating success or otherwise of interventions. In the UK, there are numerous student surveys undertaken relating to these areas (HBSC, 2019, SHRN, 2018, UK, 2019) which are then used as part of a national database for understanding student behaviours, and a similar approach could be beneficial in Saudi.

Following some of these recommendations (increased price/sugar tax) has already reduced consumption some countries such as Australia, Mexico and Chile, (Nakamura et al., 2018, Colchero et al., 2017, Zhong et al., 2018). As such, there is a proven track record of their viability, it can be used as a model for the Saudi population, but at the same time, more investigation in the area is necessary.

8.2 Behavioural change theories

The behavioural change theories are approaches that focus on changing lifestyle behaviours that have an impact on health. The behavioural change models are based on the belief that providing people with information will change their beliefs, attitudes, and behaviours. There are three major theories of behaviour change that describe the key variables of the behaviour change models. They explore the link between behaviour change and attitude (Lewis and Daltroy, 1990).

1. **Social Cognitive theory:** This model suggests that human functioning can be explained by the interaction of three factors; behaviour, personal and environmental factors and this is known as reciprocal determinism. Environmental factors represent situational influences and the environment in which behaviour is preformed while personal factors include instincts, drives, traits, and other individual motivational forces. These two factors together can intervene in the process of behaviour change (Perry et al., 1990, Bandura, 1986).
2. **Theory of Planned Behaviour:** This theory suggests that behaviour is directly dependent on one's intention about a particular behaviour. The intention is determined by an individual's attitude towards the behaviour and beliefs about what other people think the person should do or general social pressure. Behaviour is also determined by an individual's perceptions of their ability or feelings of self-efficacy to perform the behaviour. This relationship is typically dependent on the type of relationship and the nature of the situation (Armitage and Conner, 2001, Ajzen, 1991).
3. **The transtheoretical model:** This model states that change can occur in six stages. Precontemplation is the stage in which people do not intend to make a change soon (often defined as the first six months). Contemplation is the stage where people intend to change, which occurs within the next six months. People at this stage are aware of the pros and cons of changing their behaviour. Preparation characterises the stage where people have a plan of action and intend to take action in a month's time. Action is the stage in which people make the behaviour change and maintenance represents the stage where people work to prevent relapse. Finally, termination represents that stage where individuals have 100 per cent

efficacy and will keep up their behaviour, which is quite tricky and sometimes requires a lifetime in maintenance (Prochaska et al., 1998).

Regular consumption of energy drinks alone is not a major addiction, and maybe easy to overcome, unlike addiction to smoking and alcohol. Sometimes, just changing the behaviour is not the primary goal but priority to change attitude or public opinion about some issue may be more critical, which in turn may help influence change in behaviour in large numbers. Educating parents and teachers to spread awareness on the adverse effects of EDs can be one approach. Making use of the technology to spread knowledge about healthy eating and drinking behaviours can also help, where social networks like Facebook can display advertisements and pictures of adverse effects of EDs.

8.3. Future research pathways

The present study has investigated the prevalence of ED consumption. These factors can contribute to the consumption of EDs, as well as the consequences of drinking EDs among Saudi young people. The study results from Saudi Arabia were further compared to the results obtained from the study conducted in Wales.

- This work has identified a clear need to provide education to young people regarding the negative impact of EDs on health and the importance of a clear policy to reduce the current level of consumption; however, further investigation is required.
- Long term health risks and effects of ED consumption is an under-researched area due to the newness of the popularity of these products. Therefore it is recommended that longitudinal studies are undertaken to investigate the long term health effects, a view endorsed by Seifert et al. (2011) and Ishak et al. (2012).
- As part of increasing understanding of the long term effects of ED consumption, it is further recommended that investigation into the components and addictive properties of EDs (taurine, taurine and ginseng and other active ingredients) is studied. There are growing indications of the potentially harmful effects of taurine and caffeine on adolescent brains (Curran and Marczyński, 2017) which need further investigation.
- As Kozik et al. (2016) suggest, excessive consumption can lead to cardiac palpitations and other associated conditions, as well as the well-documented impact on weight and overall health noted by Bashir et al. (2016). Similar findings from the current study identified the association between ED consumption and adverse health outcomes but not the causality, and this area requires further examination in future works.

Strong correlations between diet and smoking with ED consumption is seen. Furthermore, consumption can also have a negative association on health outcomes. There is a need to understand other factors which can also have an impact on consumption and its consequences. Although it was not possible in this study, EDs have been associated with increased consumption of alcohol; therefore there is a societal need to reduce the consumption of EDs in order to protect young adolescents from future alcohol problems (Jones and Fernyhough, 2009). Furthermore, individuals can become dependent on EDs, more specifically, the caffeine within the drinks. Studies have reported people that consume high amounts of caffeine often experience withdrawal symptoms such as headaches, depression, anxiety and fatigue but there have been mixed results (Keast and Riddell, 2007, Smith, 2002). There is also a need to determine the perceptions of young people in-depth regarding ED consumption. This would help determine what initiatives could be used in order to help reduce consumption amongst young people, whether it be through education, clearer labels or restrictions on marketing.

8.4. Summary and closing remarks

In the UK, the ED market is continuing to increase in 2019, despite the new policies that have been implemented, such as bans the EDs advertising and sugar tax (Euromonitor international., 2019). However, the ED market is growing at a rate of around 7.3% in Saudi Arabia, contributing SAR 2,019.29 Million (approximately 410.95 million GBP). The primary target market of male teenagers, however, causing concern given the documented health implications and overall excessive consumption of these products. Indications are that easy availability and focused marketing are contributing to sales. In order to reverse the trend and adverse health effects, some major policy changes are required in both countries. Given the concerns and responses from other countries to the growing consumption, the recommendations in this work for both policy and future research should be considered carefully by the Saudi and the UK government. The major contribution of the current study has been to understand further the prevalence and impact of energy consumption amongst young people in Saudi Arabia and Wales and to uncover what drives consumption rates. Also of value is the recommendations made and what this means for future health intervention programmes, taking best practice approaches from other countries and recognising what has worked and what has not. EDs consumption is widespread, but this behaviour carries an associated health risk which needs to be effectively communicated to young people to avoid long term health implications. The findings and recommendations of this thesis will be shared with SA government to help inform the policy decisions.

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Appendices

Appendix A

Quality assessment for included paper in chapter 2

Appendix Table 1: National Institutes of Health Quality Assessment Tool for Observational Cohort and Cross-sectional Studies

	1. Was the research question or objective in this paper clearly stated and appropriate?	2. Was the study population clearly specified and defined?	3. Was the participation rate of eligible persons at least 50%?	4. Were all the subjects selected or recruited from the same or similar populations (including the same time period)? Were inclusion and exclusion criteria for being in the study prespecified and applied uniformly to all participants?	5. Was a sample size justification, power, description, or variance and effect estimates provided?	6. For the analyses in this paper, were the exposure(s) of interest measured prior to the outcome(s) being measured?	7. Was the timeframe sufficient so that one could reasonably expect to see an association between exposure and outcome if it existed?	8. For exposures that can vary in amount or level, did the study examine different levels of the exposure as related to the outcome (e.g., categories of exposure, or exposure measured as continuous variable)?	9. Were the exposure measures (independent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?	10. Was the exposure(s) assessed more than once over time?	11. Were the outcome measures (dependent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?	12. Were the outcome assessors blinded to the exposure status of participants?	13. Was loss to follow-up after baseline 20% or less?	14. Were key potential confounding variables measured and adjusted statistically for their impact on the relationship between exposure(s) and outcome(s)?
Coldwell et al., (2009)	+	+	+	+	-	-	-	+	+	NA	+	+	+	+
Kell et al., (2014)	+	+	+	+	NA	-	-	+	+	-	+	-	+	-
Hug et al.,(2015)	+	+	+	+	-	+	+	+	+	NA	+	NA	-	-
Jensen et al., (2013)	+	+	+	+	-	+	+	+	+	+	+	NA	-	+
Besentzen et al.,(2015)	+	+	+	+	NA	+	+	+	+	-	+	-	+	+
Chan et al., (2014)	+	+	+	+	NA	-	-	+	+	-	+	-	-	+
Lien et al., (2006)	+	+	+	+	NA	-	-	+	+	-	+	-	+	+
Kondaki et al., (2013)	+	+	+	+	+	-	-	+	+	-	+	-	+	+
Yabao et al., (2005)	+	+	+	+	NA	-	-	+	+	-	+	-	+	+
Lin et al., (2013)	+	+	+	+	+	-	-	+	+	-	+	-	+	+
Schwartz et al., (2015)	+	+	+	+	NA	-	-	+	-	-	-	-	+	+
Lin et al., (2016)	+	+	+	+	NA	-	-	+	-	-	+	-	+	+
Ambrosini et al., (2013)	+	+	+	+	+	+	+	+	-	+	+	NA	-	+
Katzenarczyk et al., (2016)	+	+	+	+	NA	-	-	+	+	-	+	NA	+	+
PARK et al., (2012)	+	+	+	+	NA	-	-	+	+	-	-	-	-	+
Lavery et al., (2015)	+	+	+	+	NA	+	+	+	+	-	+	-	+	+
Carville et al., (2015)	+	+	+	+	-	+	+	+	+	+	+	-	+	+
Nguyen et al., (2009)	+	+	+	+	+	-	-	+	+	-	+	NA	+	+
Bigornia et al., (2015)	+	+	+	+	NA	+	+	-	+	+	+	-	+	NA
Jia et al.,(2012)	+	+	+	+	NA	-	-	-	-	-	+	-	+	-
Kristiansson et al., (2013)	+	+	+	+	NA	-	-	+	-	-	-	-	+	+
Park et al.,(2016)	+	+	+	+	NA	-	-	+	-	-	-	-	+	NA
Kristiansson et al., (2013)	+	+	+	+	+	-	-	+	-	-	-	-	+	+
Richards and Smith, (2015)	+	+	+	+	+	-	-	+	+	-	+	-	+	+
Lodato et al., (2013)	+	+	+	+	NA	-	-	+	+	-	+	NA	+	+
Mueller et al., (2015)	+	+	+	+	+	+	+	+	+	-	+	+	+	+
Kobusilla et al., (2016)	+	+	+	+	NA	-	-	+	+	-	+	-	+	+
Terry-McElkath et al., (2014)	+	+	+	+	+	-	-	+	-	-	-	-	+	+
Orbeta et al., (2004)	+	+	+	+	+	-	-	+	-	-	-	-	+	+
Jin et al., (2016)	+	+	+	+	NA	-	-	+	-	-	-	-	+	+

NA= not Available, + = Yes; - = No.

Appendix Table 2: National Institutes of Health Quality Assessment Tool for Case-Control Studies

	1. Was the research question or objective in this paper clearly stated and appropriate?	2. Was the study population clearly specified and defined?	3. Did the authors include a sample size justification?	4. Were controls selected or recruited from the same or similar population that gave rise to the cases (including the same timeframe)?	5. Were the definitions, inclusion and exclusion criteria, algorithms or processes used to identify or select cases and controls valid, reliable, and implemented consistently across all study participants?	6. Were the cases clearly defined and differentiated from controls?	7. If less than 100 percent of eligible cases and/or controls were selected for the study, were the cases and/or controls randomly selected from those eligible?	8. Was there use of concurrent controls?	9. Were the investigators able to confirm that the exposure/risk occurred prior to the development of the condition or event that defined a participant as a case?	10. Were the measures of exposure/risk clearly defined, valid, reliable, and implemented consistently (including the same time period) across all study participants?	11. Were the assessors of exposure/risk blinded to the case or control status of participants?	12. Were key potential confounding variables measured and adjusted statistically in the analyses? If matching was used, did the investigators account for matching during study analysis?
Martin-Calvo et al., (2014)	+	+	NA	+	+	+	+	+	+	+	NA	+
Savoca et al., (2004)	+	+	NA	+	+	+	NA	+	+	+	NA	+

NA= not Available, + = Yes; - = No.

Appendix B

Personal reflexivity

My journey started in 2005 as a student in the College of Applied Medical Sciences. During my study, I participated in many health education programmes that involved working with school-age children as a part of my academic curriculum. I graduated in 2010, with good grades, and soon after I got offered the position of a teacher assistant at King Saud University. My interaction and exposure with students and colleagues at work, discussions with them regarding different researches being carried out at the college, opened my mind to the realities of public health work. I voluntarily took part in the public health sector and community betterment events which made me a critical thinker and gave me a lot of knowledge in regard to positive community development. It is through the exposure at work, that inspired me to work harder. I soon became a lecturer and decided to move ahead towards acquiring my PhD. I wanted to gain more knowledge to help and work for the betterment of society.

It is most valuable to acknowledge that research has both its power and limitation for social and policy changes. I realized its importance in conveying the community views and attitudes to policymakers to understand the community health needs. I realized I was not only challenged to develop my skills as a researcher but even my basic virtues as an individual. I had to find the correct frame and flow of questions and make sense of the data acquired from the participants to draw any conclusion to support my research.

While the process of coding and analysis findings demanded hard work, it showed me the value of being concise and accurate in identifying categories and data, and to be always mindful of detaching my own interpretation at the different stages of data processing. It taught me how to be discriminating in selecting core and fundamental data from those that were non-essential to give due importance to the information provided by young people. I have had some difficulties in interpreting and analysing the data since English is not my first language, and thankfully, I have been assisted by statisticians and translator with intense experiences to reduces the researcher bias and to ensure that the responses accurately reported.

Appendix C

The critical appraisal checklist

Section A: Are the results valid?

1. Was there a clear statement of the aims of the research?

Yes

Can't Tell

No

2. Is a qualitative methodology appropriate?

Yes

Can't Tell

No

Is it worth continuing?

3. Was the research design appropriate to address the aims of the research?

Yes

Can't Tell

No

4. Was the recruitment strategy appropriate to the aims of the research?

Yes

Can't Tell

No

5. Was the data collected in a way that addressed the research issue?

Yes

Can't Tell

No

6. Has the relationship between researcher and participants been adequately considered?

Yes

Can't Tell

No

Section B: What are the results?

7. Have ethical issues been taken into consideration?

Yes

Can't Tell

No

8. Was the data analysis sufficiently rigorous?

Yes

Can't Tell

No

9. Is there a clear statement of findings?

Yes

Can't Tell

No

Section C: Will the results help locally?

10. How valuable is the research

Appendix D

COREQ 32-item checklist for Virsam et al,(2017).

Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups.

No. Item	Guide questions/description	Reported on Page #
Domain 1: Research team and reflexivity		
1. Interviewer/facilitator	Which author/s conducted the interview?	4
2. Credentials	What were the researcher's credentials?	1
3. Occupation	What was their occupation at the time of the study?	1
4. Gender	Was the researcher male or female?	1
5. Experience and training	What experience or training did the researcher have?	3
6. Relationship with participants established	Was a relationship established prior to study commencement?	3
7. Participant knowledge of the interviewer	What did the participants know about the researcher?	4
8. Interviewer characteristics	What characteristics were reported about the interviewer/facilitator?	4
Domain 2: study design		
9. Methodological orientation and Theory	What methodological orientation was stated to underpin the study?	5,6
10. Sampling	How were participants selected?	3,4
11. Method of approach	How were participants approached?	3
12. Sample size	How many participants were in the study?	6
13. Non-participation	How many people refused to participate or dropped out? Reasons?	6
14. Setting of data collection	Where was the data collected?	4
15. Presence of non-participants	Was anyone else present besides the participants and researchers?	4
16. Description of sample	What are the important characteristics of the sample?	4,5,6
17. Interview guide	Were questions, prompts, guides provided by the authors?	4
18. Repeat interviews	Were repeat interviews carried out?	NO
19. Audio/visual recording	Did the research use audio or visual recording to collect the data?	4
20. Field notes	Were field notes made during and/or	4

	after the inter view?	
21. Duration	What was the duration of the interviews	4
22. Data saturation	Was data saturation discussed?	5
23. Transcripts returned	Were transcripts returned to participants for comment and/or correction?	No
Domain 3: analysis and findings		
24. Number of data coders	How many data coders coded the data?	6
25. Description of the coding tree	Did authors provide a description of the coding tree?	6
26. Derivation of themes	Were themes identified in advance or derived from the data?	6
27. Software	What software, if applicable, was used to manage the data?	5
28. Participant checking	Did participants provide feedback on the findings?	No
29. Quotations presented	Were participant quotations presented to illustrate the themes/findings? Was each quotation identified?	7-12
30. Data and findings consistent	Was there consistency between the data presented and the findings?	7-12
31. Clarity of major themes	Were major themes clearly presented in the findings?	7-12
32. Clarity of minor themes	Is there a description of diverse cases or discussion of minor themes?	7-12

Appendix E

المملكة العربية السعودية
وزارة التعليم
٢٨٠
الإدارة العامة للتعليم بمنطقة الرياض
إدارة التخطيط والتطوير

وزارة التعليم
Ministry of Education

الرقم : ٣٩٤٨٠١٣٧
التاريخ : ٢١/٤/٢٠١٩
المرفقات : ١ نسخة

تسهيل مهمة باحث

الاسم	السجل المدني
منال بنت عبدالله الحمود	١٠٤١٦٨٢٥٢٥
العام الدراسي	الجامعة
١٤٣٨/١٤٣٩ هـ	الملك سعود
الغرض من الدراسة	الدكتوراه
عنوان الدراسة : مدى انتشار إستهلاك مشروبات الطاقة وأضرارها الصحية والنفسية والسلوكية على الأطفال والمراهقين في مدينة الرياض.	
عينة الدراسة : طلاب وطالبات المرحلة المتوسطة والثانوية .	

المكرم /ة قائد/ة مدرسة.....
وفق/ها الله

السلام عليكم ورحمة الله وبركاته ، وبعد :

إشارة إلى قرار معالي وزير التعليم رقم ٣٨٧١٧٠٨٠ وتاريخ ١٢/٥/١٤٣٨هـ بشأن تفويض الصلاحيات لمديري التعليم ، وبناءً على قرار مساعدة مدير عام التعليم بمنطقة الرياض رقم ٣٨٩٢٠٧٩٣ وتاريخ ٢٣/٦/١٤٣٨هـ بشأن تفويض الصلاحية لإدارة التخطيط والتطوير لتسهيل مهمة الباحثين والباحثات ، وحيث تقدمت إلينا الباحثة (الموضحة بياناتها أعلاه) بطلب إجراء دراسته ، ونظراً لإكمال الأوراق المطلوبة ، نأمل تسهيل مهمتها .

مع ملاحظة أن الباحثة تتحمل كامل المسؤولية المتعلقة بمختلف جوانب البحث ، ولا يعني سماح الإدارة العامة للتعليم موافقتها بالضرورة على مشكلة البحث أو على الطرق والأساليب المستخدمة في دراستها ومعالجتها.

شاكرين لكم وتقبلوا تحياتي..

مدير إدارة التخطيط والتطوير
سعود بن راشد ال عبد اللطيف

مسودة لجميع مكاتب التعليم

Appendix F

Consent Form for Interviews and Focus Group

- The information of the research and the research aim and objectives has been given to me sufficiently, and I am agreeing to take part in the interview or focus group.
- I understand that the interview or focus group will be recorded and no-one will have access to recording beyond the researcher and her two supervisors.
- My participation in this research is voluntary and I have the right to withdraw at any time.
- I understand that the results of this research will be used only for academic purpose such as (PhD thesis, research papers or presentations.
- I understand that the data will be anonymised in any report or research paper so the participant's name or the school's name will not be included.

Signature of Respondent:

Date:

Name of Researcher:.....

Signature of Researcher:

Appendix G

THIS INFORMATION SHEET FOR PARTICIPANTS

We would like to invite you to take part in a research study conducted by PhD student in Cardiff University. Before you decide whether or not to take part, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and contact the researcher if you should have any questions.

What is the purpose of the study?

This study aims to explore the attitudes and perceptions of young people residing in Saudi Arabia, about EDs, and to seek their views on possible intervention strategies to prevent the consumption of ED.

What is involved?

A one-to-one interview and focus groups will be conducted to explore the young people's perceptions of energy drink availability, ingredients, accessibility, and potential health impacts. In addition, to explore young people's views on factors related to EDs use among young people. This study will be conducted with students aged 13-20 years.

RESEARCH SETTING

Where will the research take place?

All interviews and focus group will be conducted during school hours, without school staff present. All discussions were audio-recorded.

STUDY PARTICIPANTS

What if I do not wish to participate in the study?

At each data collection time point we will ask each student whether they are happy to participate

Will all student be involved in a focus group?

No. student will be randomly selected to participate; only a small sample will be needed

How long will the interviews take?

Approximately 15-20 minutes and these can be scheduled for an appropriate time, which suits the Head teacher and schoolteacher.

What if participants change their minds about taking part?

Participation is voluntary and anyone can withdraw at any time, without giving a reason. However, I would reserve the right to include any non-personal data that was given prior to leaving.

STUDY DATA

How will information be recorded?

During the interviews and focus groups, a taperecorder will be used to record from session start to end with participant consent

What will happen with the information?

The field notes and transcripts will only be accessible to myself and the research team and will be kept securely, in strict accordance with the Data Protection Act. They will not be used for any other purpose. An analysis of the information will form the basis of published findings in academic journals and future project work. You are welcome to see a copy of the findings/journal articles prior to publication.

Will taking part be confidential?

Yes. The participants and schools will not be named or identified in any way in the field notes, transcripts, or the reports of the study.

RESEARCH TEAM

Who am I?

My name is Manal Alhumud and I am a PhD student at Cardiff University. This research is a part of my PhD thesis. If you would like further information about the study, you can contact me at any time on 07900531720 or by e-mail at alhumudm@cardiff.ac.uk

Appendix H

Questionnaire

2 Energy drink use and associated health behaviours and health outcomes among young people

This is a survey will be conducted by a PhD student in Cardiff university to determine the prevalence and the pattern of use of energy drinks by adolescents in Riyadh city and the physical, mental and behavioural outcomes associated with energy drink consumption

All information disclosed in this questionnaire will be kept private and confidential

Section 1: ABOUT YOU

This questionnaire is completely anonymous, we do not collect any information that can be used to identify you.

Please answer the following questions as honestly as you can. If you do not want to answer a question then leave it blank.

Q1 – Are you a boy or a girl?

Please tick one box

Boy ₁

Girl ₂

Q2 – In what year were you born?

Please tick one box

1998	1999	2000	2001	2002	2003	2004	2005	2006
<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅	<input type="checkbox"/> ₆	<input type="checkbox"/> ₇	<input type="checkbox"/> ₈	<input type="checkbox"/> ₉

Q3 – What level are you in at school?

Please tick one box

Intermediate school ₁

Secondary school ₂

Q4 – What type of school are you studying in?

Please tick one box

Public school ₁

Private school ₂

Q5 – What is your nationality?

Please tick one box

Saudi ₁

Other ₂

Q6 – Where do you live?

Please tick one box

Al-Bat'ha ₁

Al-'Olayya & Sulaymaniyyah ₂

Nemar ₃

Iraqah ₄

Diplomatic Quarter ₅

Al-Malaz ₆

Al-Shifa ₇

Al-Urayja ₈

- Al-Shemal 9
- Al-Shemaysi 10
- Al-Ma'athar 11
- Al-Ha'ir 12
- Al-'Aziziyah 13
- Al-Naseem 14
- Al-Rawdhah 15
- Al-Selayy 16
- Al-Moroje 17
- Al-Sahafa 18
- Al-nakeel 19
- Al-falah 20
- Other 21

Q7 – 1-What is the highest level of education completed by your father?

Please tick one box

- None 1
- Primary school education 2
- Intermediate and secondary school education 3
- Bachelor's Degree 4
- Master's degree 5
- Advanced Graduate work or PhD 6
- Don't know 7

Q8 – 1-What is the highest level of education completed by your mother?

Please tick one box

- None 1
- Primary school education 2
- Intermediate and secondary school education 3
- Bachelor's Degree 4
- Master's degree 5
- Advanced Graduate work or PhD 6
- Don't know 7

Q9 – How many adults/grown ups live with you in your home (aged 18 years or more)?

Please tick all that apply

- One 1

- Two ₂
- Three ₃
- Four ₄
- More than four ₅

Q10 – How many other children (not counting you) live with you in your home (under 18 years)?

Please tick all that apply

- None ₁
- One
- Two ₂
- Three ₃
- Four ₄
- More than four ₅

Q10 – What type of accommodation do you live in?

Please tick one box

- The house is owned ₁
- The house is rented ₂
- The flat is owned ₃
- The flat is rented ₄
- Other ₅
- Do not know ₆

Q11 – When you have free time, do you mainly?

Please tick one box

- Go somewhere with friends ₁
- Go to a friend's house (or they come to my house) ₂
- Spend time with your family ₃
- Spend time by myself? ₄
- None of these ₅

Q13-How much pocket money do your parents give you monthly?

Please tick one box

- Less than 300 SAR ₁
- 300 SAR ₂
- More than 300 SAR ₃

Q13 – how many times a week do you usually eat or drink ?

Please tick one box for each line

		Never	Less than once a week	Once a week	2-4 days a week	5-6 once a week	Once a day, every day	Every days more than once
Q14	Fruits	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅	<input type="checkbox"/> ₆	<input type="checkbox"/> ₇
Q15	Vegetables	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅	<input type="checkbox"/> ₆	<input type="checkbox"/> ₇
Q16	Sweets (candy or chocolate)	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅	<input type="checkbox"/> ₆	<input type="checkbox"/> ₇
Q17	Coke or other soft drinks	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅	<input type="checkbox"/> ₆	<input type="checkbox"/> ₇
Q18	Skimmed or semi-skimmed milk	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅	<input type="checkbox"/> ₆	<input type="checkbox"/> ₇
Q19	Ordinary (full fat) milk	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅	<input type="checkbox"/> ₆	<input type="checkbox"/> ₇
Q20	Other milk products (like yoghurt, milk shakes)	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅	<input type="checkbox"/> ₆	<input type="checkbox"/> ₇
Q21	chips	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅	<input type="checkbox"/> ₆	<input type="checkbox"/> ₇
Q22	White bread	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅	<input type="checkbox"/> ₆	<input type="checkbox"/> ₇
Q23	Cereals (like cornflakes, coco pops)	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅	<input type="checkbox"/> ₆	<input type="checkbox"/> ₇
Q24	fish	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅	<input type="checkbox"/> ₆	<input type="checkbox"/> ₇

Q25 – How often do you eat breakfast during a usual school week?

Please tick one box

- Every day ₁
- Three or four times a week ₂
- One or two times a week ₃
- Less than once a week ₄
- Never ₅

Section B: ENERGY DRINK CONSUMPTION AND USE

Q26- have you ever consumed an energy drinks like (Red Bull, Bison, Red code....)?

Please tick one box

- Yes ₁
- No ₂

Q27 – How many times a week do you usually drink an energy drink like (Red Bull, Bison, Red code....)?

Please tick one box

- Never ₁
- Less than once a week ₂
- Once a week ₃
- 2-4 days a week ₄
- 5-6 days a week ₅
- Once a day, every day ₆
- More than once a day ₇
- Don't know ₈

Q28 – Did you drink an energy drink at any of these places in the last seven days?

Please tick ALL that apply

- I do not drink energy drinks** ₁
- At home** ₂
- At a friend's house** ₃
- At a party** ₄
- At a relation's home** ₅
- In a restaurant** ₆
- In a public place (e.g. park)** ₇
- In school** ₈

Q29 – At what age did you first drink your first energy drink?

Please tick one box

- 0-5 years old** ₁
- 6-10 years old** ₂
- 11-15 years old** ₃
- 16 years old or older** ₃
- Don't know** ₄

Q30 – How did you first find out about energy drinks?

Please tick one box

- Advertisement** ₁
 - At the store** ₂
 - Socially** ₃
 - Recommendation from friends** ₄
 - Don't know** ₅
 - Other (please specify)** ₆
-

Q31 – In your opinion what is the main reason for drinking energy drinks?

Please tick ALL that apply

- To play sport** ₁
- To study** ₂
- To stay awake** ₃
- For mental enhancement** ₄
- For an energy boost** ₅
- Good taste** ₆
- To quench thirst** ₇
- Other** ₇

Q32 – What type of energy drinks do you usually drink?

Please tick one box

- Red Bull ₁
- Power Horse ₂
- Red Code ₃
- Bison ₄
- Other ₅

Q33 – Why do you choose these energy drinks?

Please rank the top 3 reasons

- It is cheap ₁
- It is popular ₂
- It tastes nice ₃
- It was recommended to me ₄
- It has ingredients that are good for me ₅
- It is available ₆
- It wakes me up ₇
- Other ₈

Q34 – How many energy drinks would you usually drink in one go?

Please tick one box

- Not more than one ₁
- Two ₂
- Three or more ₃

Q35 – How often do you friends drinks energy drinks?

Please tick one box

- Never ₁
- Less than once a week ₂
- Once a week ₃
- 2-4 days a week ₄
- 5-6 days a week ₅
- Once a day, every day ₆

Q36 – On a scale of one (not very acceptable) to seven (very acceptable), how acceptable is it for someone of your age and gender to drink energy drinks?

Please tick one box

- 1 ₁
- 2 ₂
- 3 ₃
- 4 ₄
- 5 ₅
- 6 ₆
- 7 ₇

Section C: PHYSICAL, MENTAL AND BEHAVIORAL OUTCOMES

Q37 – How would you say your health is?

Please tick one box

- Excellent ₁
- Good ₂
- Fair ₃
- Poor ₄

Q38—How often do you experience the following?

please tick one box on each row

		Every day	More than once a week	About every week	About every month	Rarely or never
Q39	Headache	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
Q40	Stomach ache	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
Q41	Backache	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
Q42	Feeling low	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
Q43	Irritability	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
Q44	Feeling nervous	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
Q45	Difficulties in getting to sleep	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
Q46	Feeling dizzy	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
Q47	Depression	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅

Q48 – Gum disease is a common problem with the mouth. People with gum disease might have swollen gums, receding gums, sore or infected gums, or loose teeth. Do you think you might have gum disease?

Please tick one box

- Yes ₁
- No ₂
- Don't know ₃

Q49 – Do you have a long-term illness, disability or medical condition (like diabetes, arthritis, asthma, or allergies) that has been diagnosed by doctor and lasted more than one month?

Please tick one box

- Yes ₁
- No ₂

Q50 –when do you usually go to bed if you have to go to school the next morning?

Please tick one box

- | | | | |
|-------------------|---------------------------------------|----------|---------------------------------------|
| No later than 9pm | <input type="checkbox"/> ₁ | 11.30pm | <input type="checkbox"/> ₆ |
| 9.30pm | <input type="checkbox"/> ₂ | Midnight | <input type="checkbox"/> ₇ |
| 10pm | <input type="checkbox"/> ₃ | 12.30am | <input type="checkbox"/> ₈ |

10.30pm ₄ 1am ₉
 11pm ₅ 1.30am or later ₁₀

Q51 – have you ever participates in any of these activities?

Activities		Never	Yes	
			1 – 3 times a week	More than 3 times a week
Q52	Violent/ aggressive behaviour	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃
Q53	Serious physical fight	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃
Q54	electronic cigarette use	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃
Q55	Smoke shisha	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃

Q56 – How often do you smoke tobacco?

Please tick one box

I do not smoke ₁
 Every day ₂
 At least once a week, but not every day ₃
 Less than once a week ₄

Q57 – At what age did you smoke your first cigarette?

Please tick one box

I do not smoke ₁
 11 years of age or younger ₂
 12 years of age ₃
 13 years of age ₄
 14 years of age ₅
 15 years of age ₆
 16 years of age ₇
 17 years of age or older ₈

Q58 – Would you like to gain weight?

Please tick one box

Yes ₁
 No ₂

Q59 – Would you like to lose weight?

Please tick one box

Yes ₁
 No ₂

End
Thank you

Appendix I

One -to-one interview topic guide

How old are you and have you ever had a drink of energy?

What are the ED brands that available in the market?

Did you try reading the components of each can and it is written on the packaging from the outside?

did you know the basic ingredients of ED?

What are the damages resulting from them?

Do they have benefits?

why do you drink it?

Why do not you replace them with soft drinks?

Do you know the difference between energy drinks, soft drinks and sports drinks?

Well in terms of ingredients, what is the difference between them?

In your opinion, do girls like your age drink energy drinks?

Girls are like your age and do not drink energy drinks. What makes them not try it?

When do girls choose to drink energy drinks?

Does this mean that energy drinks are sold at school?

if your father or mother sees you and you drink energy drinks, what do they do?

From your point of view, do friends have a negative impact on young people in term of ED consumption?

Appendix J

Focus group topic guide

tells me your age, and whether she ever experienced energy drinks or not?

What is the different between ED and other drinks such as soft drink and sport drinks?

After you drink, what do you feel exactly, and do you think it cause damage to your health?

Let's talk about how you get it, or where do you buy it? Is it available in supermarkets and shops?

Who buys it for you?

What is the reaction of your family if they see you drinking energy drinks?

Did you think of reading the nutritional value table on energy drinks cans and warning messages that are written on the box?

How are this drink displayed in stores?

They can be sold to anyone? or is there a specific law?

For any ages do you think that it is suitable.

In your view what is the reason that girls in the same age drink energy drinks?

What are the times when girls drink energy drinks?

Do you think that raising their prices reduces their consumption?

Do these drinks available in school? Or can you bring it with you and drink it in school?

Let's talk about the impact of advertising on your consumption of these drinks:

What is the effect of your friends on you drinking these drinks?

In your opinion, how can we raise awareness among girls in your age?

Appendix K

Regression output for Chapter 4

Table I: Ordered logistic regression that analyse the associations between ED consumption and health outcomes, gender, grade, ethnicity, FAS, smoking, and breakfast (reporting odds ratios and 95% confidence intervals).

ED consumption	OR	St. Err	Z	P	95% CI
Wobbles	0.69	0.01	-2.03	0.04	[0.93, 0.99]
Sex	1.00	0.00	1.07	0.28	[0.99, 1.00]
Secondary school	0.98	0.01	-1.37	0.17	[0.95, 1.00]
Ethnicity	1.06	0.02	2.16	0.03	[1.00, 1.11]
FAS	0.93	0.01	-3.57	<0.001	[0.90, 0.97]
Smoking	0.49	0.01	-26.54	<0.001	[0.47, 0.52]
breakfast	0.87	0.00	-20.00	<0.001	[0.86, 0.88]

Table II: Ordered logistic regression that analyse the association between health outcomes and gender, grade, school type etc. (reporting odds ratios and 95% confidence intervals).

Wobbles	Coef.	St. Err	t	P	95% CI
ED consume	-0.02	0.01	-3.62	<0.001	[-0.03, -0.00]
Male	-0.01	0.00	-10.55	<0.001	[-0.01, -0.01]
Secondary school	-0.07	0.01	-13.30	<0.001	[-0.08, -0.06]
Ethnicity	-0.01	0.05	-0.61	0.545	[-0.04, 0.02]
FAS (High)	0.04	0.01	0.00	<0.001	[0.02, 0.06]
Smoking	0.17	0.01	0.00	<0.001	[0.15, 0.19]
Eating breakfast	0.08	0.00	0.00	<0.001	[0.08, 0.09]

Appendix L

Regression outputs for Chapter 5

Table III: Ordered logistic regression that analyse the associations between Intensity of ED consumption and gender, grade, ethnicity, school type, nationality, Father education, family income, smoking, and breakfast in Saudi Arabia young people.

ED consume (intensity)	Robust				[95% Conf. Interval]	
	Coef.	Std. Err.	z	P>z	Conf.	Interval]
Male	0.23	0.08	3.01	0.003	0.08	0.38
Secondary school	0.45	0.16	2.76	0.006	0.13	0.76
State school	-0.05	0.08	-0.65	0.518	-0.22	0.11
Saudi nationality	0.21	0.19	1.09	0.278	-0.17	0.60
Father education	0.12	0.13	0.89	0.374	-0.14	0.38
Family income - medium	0.04	0.16	0.23	0.821	-0.28	0.35
Family income high	0.00	0.17	0.02	0.982	-0.34	0.34
Healthy diet	-0.07	0.04	-1.47	0.143	-0.16	0.02
Unhealthy diet	0.52	0.05	10.47	<0.001	0.43	0.62
Age	-0.02	0.03	-0.78	0.433	-0.08	0.03
Nicotine use	1.78	0.27	6.54	<0.001	1.24	2.31
Eat breakfast	-0.12	0.03	-3.41	0.001	-0.19	-0.05

Table IV: Ordered logistic regression that analyse the associations between frequency of ED consumption and consumption and gender, grade, ethnicity, school type, nationality, Father education, family income, smoking, and breakfast in Saudi Arabia young people.

ED consume (frequency)					[95% Conf. Interval]	
	Coef.	Std. Err.	z	P>z	Conf.	Interval]
Male	0.21	0.07	2.95	0.003	0.07	0.34
Secondary school	0.44	0.16	2.65	0.008	0.11	0.77
State school	-0.04	0.08	-0.48	0.633	-0.21	0.12
Saudi nationality	0.24	0.18	1.34	0.180	-0.11	0.60
Father education	0.12	0.13	0.92	0.359	-0.14	0.38
Family income - medium	0.05	0.17	0.28	0.778	-0.29	0.38
Family income high	0.02	0.19	0.09	0.925	-0.36	0.40
Healthy diet	-0.07	0.06	-1.2	0.229	-0.19	0.04
Unhealthy diet	0.51	0.04	10.79	<0.001	0.42	0.60
Age	-0.03	0.03	-1.07	0.284	-0.09	0.02
Nicotine use	1.73	0.26	6.67	<0.001	1.22	2.24
Eat breakfast	-0.12	0.03	-4.02	<0.001	-0.18	-0.06

Table V: Ordered logistic regression that analyse the associations between the quantity of ED consumption and consumption and gender, grade, ethnicity, school type, nationality, Father education, family income, smoking, and breakfast in Saudi Arabia young people.

ED (quantity)	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
Male	0.21	0.074	2.83	0.005	0.06	0.36
Secondary school	0.42	0.14	2.87	0.004	0.13	0.70
State school	-0.03	0.10	-0.33	0.743	-0.24	0.17
Saudi nationality	0.12	0.20	0.63	0.531	-0.27	0.52
Father education	0.15	0.12	1.23	0.220	-0.09	0.38
Family income - medium	0.04	0.15	0.28	0.777	-0.26	0.35
Family income high	0.08	0.15	0.56	0.577	-0.21	0.38
Healthy diet	-0.07	0.03	-2.03	0.042	-0.14	-0.00
Unhealthy diet	0.52	0.04	10.91	<0.001	0.42	0.61
Age	-0.03	0.03	-0.99	0.32	-0.09	0.03
Nicotine use	1.71	0.20	8.31	<0.001	1.30	2.11
Eat breakfast	-0.11	0.03	-3.03	0.002	-0.19	-0.04

Table VI: Linear regression that analyses the associations between health outcomes and the quantity of ED consumption, consumption and gender, grade, ethnicity, school type, nationality, Father education, family income, smoking, and breakfast in Saudi Arabia young people.

Health outcomes	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
ED (quantity)	0.36	0.03	10.17	<0.001	0.28	0.42
Male	-0.01	0.04	-0.38	0.71	-0.11	0.08
Secondary school	0.06	0.07	0.85	0.403	-0.09	0.21
State school	-0.02	0.04	-0.52	0.606	-0.12	0.07
Saudi nationality	-0.01	0.07	-0.13	0.895	-0.15	0.14
Father education	-0.02	0.05	-0.4	0.691	-0.12	0.08
Family income - medium	-0.05	0.12	-0.45	0.659	-0.31	0.20
Family income high	-0.09	0.11	-0.83	0.416	-0.34	0.14
Healthy diet	-0.08	0.03	-2.92	0.008	-0.14	-0.02
Unhealthy diet	0.05	0.02	2.3	0.032	0.00	0.09
Age	0.03	0.02	1.23	0.235	-0.02	0.06
Nicotine use	0.39	0.07	5.52	<0.001	0.24	0.53
Eat breakfast	-0.06	0.01	-3.97	0.001	-0.09	-0.03

Table VII: Ordered logistic regression that analyse the associations between eating breakfast and the quantity of ED consumption and consumption and gender, grade, ethnicity, school type, nationality, Father education, family income, smoking, and breakfast in Saudi Arabia young people.

Eat breakfast	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
ED (quantity)	-0.31	0.07	-4.47	<0.001	-0.44	-0.17
Male	-0.01	0.13	-0.07	0.945	-0.25	0.23
Secondary school	-0.13	0.12	-1.07	0.283	-0.36	0.10
State school	0.01	0.07	0.08	0.935	-0.14	0.15

Saudi nationality	0.04	0.11	0.37	0.711	-0.18	0.26
Father education	0.10	0.13	0.76	0.449	-0.16	0.36
Family income - medium	-0.12	0.15	-0.78	0.433	-0.43	0.18
Family income high	-0.02	0.21	-0.11	0.91	-0.43	0.38
Healthy diet	0.36	0.039	9.37	<0.001	0.29	0.44
Unhealthy diet	0.04	0.037	1	0.317	-0.03	0.11
Age	-0.02	0.038	-0.59	0.554	-0.09	0.05
Nicotine use	-0.55	0.16	-3.39	0.001	-0.88	-0.23

Table VIII: linear regression that analyse the associations between sleep late and the quantity of ED consumption, consumption and gender, grade, ethnicity, school type, nationality, Father education, family income, smoking, and breakfast in Saudi Arabia young people.

Sleep late	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
ED (quantity)	0.73	0.12	5.86	<0.001	0.47	0.99
Male	-0.18	0.12	-1.5	0.15	-0.43	0.07
Secondary school	0.41	0.26	1.55	0.136	-0.14	0.96
State school	-0.16	0.18	-0.9	0.378	-0.54	0.21
Saudi nationality	0.65	0.21	3.14	0.005	0.22	1.085
Father education	0.05	0.14	0.36	0.722	-0.23	0.33
Family income - medium	-0.05	0.35	-0.13	0.898	-0.78	0.69
Family income high	0.45	0.34	1.32	0.203	-0.26	1.17
Healthy diet	-0.23	0.06	-3.92	0.001	-0.35	-0.10
Unhealthy diet	0.22	0.06	3.52	0.002	0.09	0.35
Age	0.019	0.05	0.34	0.735	-0.09	0.13
Nicotine use	0.61	0.19	3.07	0.006	0.194	1.02
Eat breakfast	-0.26	0.05	-5.38	<0.001	-0.35	-0.15

Table IX: linear regression that analyse the associations between oral health and the quantity of ED consumption, gender, grade, ethnicity, FAS, smoking, and breakfast (reporting odds ratios and 95% confidence intervals).

Oral health	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
ED (quantity)	0.33	0.08	4.11	<0.001	0.17	0.49
Male	-0.21	0.20	-1.05	0.293	-0.61	0.18
Secondary school	0.12	0.22	0.53	0.599	-0.32	0.56
State school	-0.13	0.09	-1.44	0.151	-0.31	0.048
Saudi nationality	-0.06	0.29	-0.21	0.834	-0.64	0.51
Father education	0.27	0.14	1.95	0.052	-0.01	0.55
Family income high	0.04	0.19	0.19	0.846	-0.34	0.41
Healthy diet	-0.05	0.07	-0.71	0.478	-0.18	0.08
Unhealthy diet	0.04	0.07	0.56	0.575	-0.10	0.19
Age	-0.00	0.05	-0.08	0.934	-0.09	0.09
Nicotine use	0.72	0.18	4.09	<0.001	0.38	1.07
Eat breakfast	-0.02	0.05	-0.43	0.664	-0.11	0.07

Appendix M

The published paper

Energy Drink Mechanisms of Harm in Young People and Adolescents: A Narrative Review

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Abstract: Caffeinated energy drink (ED) consumption has rapidly worldwide grown, particularly among young people. This review considers whether the health outcomes associated with young people's energy drink consumption are too narrowly defined on physiological mechanisms, and whether there is evidence to support the hypothesis that energy drink consumption incurs broader social costs. A narrative review of studies published between 1997 and 2017 focusing on the behavioural, physical and mental health outcomes associated with (EDs) consumption and the two main ingredients, sugar (including glucose, sucrose and fructose) and caffeine with explication of causal mechanism linking ingredient to outcome where relevant. The population of interest was children and adolescents aged 6 to 18 years of age. A total of 33 studies were identified. EDs consumption was found to be associated with health problems including high blood pressure, cardiovascular disease, headaches, sleep disorder, substance use, stress and hyperactivity. The causal relationship could not be determined for all outcomes. The caffeine and sugar contained in EDs can promote adverse effects on children and adolescents. There is a weak evidence that these effects could extend beyond physical health to educational attainment, mental health and substance use. Increased awareness, regulation, and further prospective studies are required.

Keywords: *energy drinks, children, adolescents, caffeine, health outcomes*

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1. Introduction

An energy drink (ED) is a non-alcoholic beverage that primarily contains caffeine and sweeteners, served in combination with brand specific-ingredients that can include herbal extracts [1,2]. There is growing interest in the health consequences of ED consumption among young people, partly due to the growth in sales of EDs to this demographic [3,4]. The well-publicised health outcomes of EDs, however, are mostly limited to the immediate physiological effects such as increased heart rate, heart rhythm irregularities, and high blood pressure. The literature concerning health outcomes for EDs' active ingredients, sugar and caffeine, is far broader and, as is argued here, suggests ED consumption may have more far

ranging effects on a young person's health and impose additional social costs than is currently being captured.

Over the past two decades, the popularity of EDs has rapidly worldwide grown, particularly among young people. By 2006 there were more than 500 brands globally [5] with reported consumption at more than 5.8 billion litres across 160 countries [6]. EDs differ from traditional sports drinks by containing more caffeine and fewer carbohydrates [7]. EDs were originally targeted at athletes but as the ED market grew manufacturers broadened their marketing efforts to include young people aged between 16 and 35 years, the result of which was a 155% increase in sales between 2006 and 2014 among this group [8,9]. In Europe, the highest ED consumption rates are now found among young people aged between 10 and 18 years [10].

Caffeine and sugar are the main active ingredients in EDs [2]. A single serving of eight to 12 fluid ounces

(fl. oz.) can contain between 72mg and 150mg of caffeine and 25g to 33g of sugar [1,2]. Many brands contain two to three servings in one beverage can, which raises the caffeine content to as high as 294 mg per can [11]. In comparison, a double espresso coffee contains around 80 milligrams of caffeine and popular carbonated sugar sweetened beverages (SSBs) can contain 10.6g of sugar per 100ml (35g of sugar per 11 fl. oz. can) [12,13,14]. Other ingredients in EDs can include guarana, kola nut, yerba mate and cocoa, which also contribute caffeine to the beverage [6-11]. Current guidelines indicate that healthy adults should not consume more than 400 mg of caffeine daily and adolescents are advised to limit their daily consumption of caffeine to 100 mg daily, less than a single serving of some EDs [15-16]. According to the World Health Organization (WHO) 2015 dietary guidelines, individuals should limit their sugar intake to less than 10% of their overall daily calorie intake, equating to 44g of sugar for children. Some 17 fl. oz. servings of ED exceed this limit, containing 55 g sugar [17].

2. Energy Drink Determinants of Health

Documented associations between the two active ingredients of EDs, sugar and caffeine, and young people's health and behaviour are summarised in Figure 1.

2.1. Sugar

SSB consumption is positively associated with weight gain and obesity in both children and adolescents [18]. The extent of SSB consumption measured at age nine years has been shown to predict increases in body mass index (BMI) across the following three years [19]. A study, compared children with a preference for high-sugar foods to peers who preferred low-sugar foods, found significantly higher levels of plasma leptin concentrations in the high-sugar preference group [20]. This finding is important as higher levels of leptin are associated with obesity while leptin resistance can lead to an inability to control hunger and therefore greater food consumption [21]. There is a strong evidence demonstrating that SSB intake is associated with increased waist circumference [22,23,24], higher BMI [25,27], higher body fat percentages [26] and obesity [28,29]. The relationship between SSB consumption and blood pressure however is less clear. While some studies have documented associations between SSB intake and increased diastolic

blood pressure only [30], others have noted positive associations only between SSB consumption and increased systolic blood pressure [22-31]. On the other hand, the literature widely documents that sleep disorders, substance use and mental health outcomes such as distress and hyperactivity, are positively associated with greater SSB consumption [32,33,34]. Previous research has shown that a positive association between SSB consumption and an increased risk of asthma in children [35]. SSB consumption is further associated with changes in the insulin resistance index and higher values of β -cell function [36,37,38]. Insulin resistance occurs when parts of the body such as muscle, fat, and liver cells do not adequately respond to the hormone insulin and as a result, the body is less able to absorb glucose from the bloodstream [37]. Consequently, insulin resistance in children and adolescents has been positively associated with a number of health conditions including cardiovascular disease, hypertension, endothelial dysfunction and diabetes [37]. Premenarcheal girls who reported consumption of one and a half servings of sweetened beverages per day were, on average, 24% more likely to exhibit menarche in the following month compared to girls consuming fewer than two servings of sweetened drinks weekly [38]. Studies examining consumption and oral health have noted tooth enamel demineralisation resulting from the low pH of SSBs, causing enamel loss [39]. Up to 57% of children aged 11 to 14 years exhibit enamel demineralisation that is attributable to their sugar consumption in the UK, for example [39]. One serving of ED (8. oz) contains similar levels of sugar content to that of popular sugar sweetened beverages such as cola [2]. It is therefore likely that the risks to health and associated health behaviours from EDs should be expanded to include; obesity, high blood pressure, sleep disorders, substance use, mental health outcomes, asthma, cardiovascular disease, early menarche and tooth erosion.



Figure 1. The effects of over doses energy drinks on young people, based on the two active ingredients sugar and caffeine

2.2. Caffeine

The consumption of caffeine has been shown to be associated with depression, anxiety, stress [40], and lower academic achievement and sleep deprivation among adolescents [41]. In addition, evidence suggests that caffeine consumption is positively associated with depression, stress, suicidal ideation and sleep dissatisfaction in young people [42]. The nature of the association between caffeine and circadian dysregulation among young people suggests EDs may cause sleeping difficulties, excessive tiredness [43] and shorter sleep durations (≤ 8.5 hours) [44], when compared to young people who do not consume caffeine. Poor sleep quality is further associated with risk taking, with studies demonstrating greater risk of alcohol use, tobacco use, and aggression among students who sleep less than eight hours a day [45,46]. Furthermore, due to the negative effects of poor sleep on mental health, sleep quality and sleep duration have been shown to be positively associated with diabetes, cardiovascular disease, obesity and depression [47]. Those who experience a sleep disorder are also at greater risk of hypertension, stroke, coronary heart disease and cardiac arrhythmias compared to those who sleep eight or more hours a night [47,48]. Caffeinated drink consumption has also been associated with reports of physical complaints such as headaches, stomach-aches, poor appetite and irritation [1,2]. An increase of such complaints has been observed in children aged 10 to 13 years with a higher prevalence in those consuming EDs compared to those consuming SSBs [49]. Excessive caffeine consumption of over 200mg per day is positively associated with hypertension [49] and high systolic and diastolic blood pressure is observed immediately following consumption [50,51].

3. Mechanisms

While evaluating the effects of sugar and caffeine on physical, mental and behavioural outcomes is vitally important, it is also necessary to consider whether there are feasible causal mechanisms underpinning a documented relationship. For example, evidence has maintained that minimum unit pricing can reduce harms of specific products [66]. The study was based on the assessment leading to the UK Chancellor's announcement of a levy placed on sugar-sweetened beverages (SSBs). The move was largely welcomed in terms of its likeness to the minimum pricing per unit strategies that had been implemented to some success with other harmful products and was largely welcomed by those in the health profession. The study maintained that interventions such as these which were structured and also population-based had the effect of sending a message that a healthy diet cannot accommodate carbonated drinks. Accordingly, the proposition of the levy was such that it could provide a positive contribution to the general health of the population. However, criticisms within the same study maintained that those drinks which were exempt of the levy still contained sugar that could cause harm to teeth and general health. Whilst the levy was considered to be a positive beginning in the improvement of the diet of the nation, some improvements were suggested with the involvement of a lower threshold of exemption and a scaled volumetric tax of sugar that is added to products.

It has been established that a diet high in sugar is associated with physical health, primarily weight gain due to excessive calorie intake [52]. EDs are high in sugar and therefore are likely to cause weight gain, their

consumption does not lead to satiety unlike similarly calorific solid foods [53]. Being overweight or obese is, in turn, an established risk for diseases that include diabetes, cardiovascular diseases, and fatty liver disease [54,55]. Furthermore, high sugar intake associated with diabetes is known to contribute to mental health problems such as depression, stress, anxiety, and sleep disorder, sleep deprivation can additionally increase the risk of stress [53] but stress can also lead to weight gain because overeating is a known coping mechanism [56]. There are uncertainty remains on the relationship between sugar intake, stress and sleep [57].

The consumption of caffeine is associated with high blood pressure, a known risk factor for tachycardia and cardiovascular disease [2]. While it is established that caffeine is generally a stimulant, how this effect manifests is shown to vary by dose, for instance, whereas 250mg of caffeine consumption has been shown to cause elation, 500mg of consumption has been shown to lead to irritability [58]. Caffeine has been associated with a number of mental health problems including stress, depression, and anxiety, along with a plethora of health behaviours that include aggression and violence, resultant causality cannot be determined. The majority of available evidence is limited to cross-sectional studies and therefore makes it difficult to speculate on the plausible mechanisms linking consumption to mental health problems. For example, mental health outcomes such as depression and anxiety may induce caffeine consumption to promote feelings of well-being and energy [59]. Furthermore, caffeine consumption is associated with sleep disorders [49] including sleep duration and quality. While tiredness may in turn promote headaches, stomach-aches, mental health, behavioural problems and poor attention, it may also encourage greater caffeine consumption to enhance feeling of well-being. It is feasible that the relationship between caffeine consumption and mental health and sleep disorders is bidirectional [56].

4. Discussion

4.1. Main Findings of the Study

This article attempts to provide a more detailed investigation regarding the casual mechanisms between the primary active ingredients of EDs (i.e. sugar and caffeine) and health behaviours and outcomes among 6-18 year olds. The findings from this study revealed that the consumption of caffeine and sugar are associated with a multitude of serious adverse effects on young people's health with common adversities shared between the two ingredients. Indeed, the combination of these two substances has also been studied by Shimizu [59], who maintains that the effect of sugar and caffeine in combination were negative on the body. It was argued that the levels of blood glucose rose and dropped shortly afterwards when the substances were combined, resulting in a rise of energy from the sugar and caffeine which would have the effect of a drop in blood sugar. This takes place over the space of a few hours, resulting in a cycle of cravings which accompany the

swings. In addition to this, the series of swings produced a large imbalance of levels of blood glucose.

4.2. What Is Already Known on this Topic?

Sugars which are contained within ED's lead to severe health complications. SSBs are very high in calorific value and sugars, with few or no additional nutrients [2]. The National Federation of State High School Associations, in 2008, cited the risks and drug interactions involved with ED, while recommending water and sports drinks for rehydration [60]. Caffeine, in moderation, may be tolerated well by healthy adults; however, heavy consumption of it, including the use of EDs, has been associated with consequences such as stroke, seizures, and sudden death in some cases [2]. The caffeine content of EDs is on average three times greater than Cola drink content, with caffeine content in soft drinks limited by the US Food and Drug Administration (FDA) However, as EDs are classified as dietary supplements, no such regulations apply [6]. The clinical toxicity of caffeine begins at dosages of 1,000 mg/day while dosages below 400 mg are generally considered safe; dosages above 5,000 mg may be lethal [61]. Caffeine has a wide array of physiological effects including coronary and cerebral vasoconstriction, stimulation of skeletal muscle, and relaxation of smooth muscles [62]. Despite its negative effects, in low/moderate concentrations (12.5 to 100 mg) caffeine intake has been associated with improved cognition, exercise endurance, mood, and reaction time [63].

The use of caffeinated drinks as well as SSBs has been associated with mental health problems in children and adolescents, including depression, anxiety, stress, and distress levels [2]. Energy drink consumption has also been linked with higher risk of sleep disorders and substance use, with one study reporting higher violence rates [48]. In addition to these negative health effects of sugar, other concerns are related to Attention deficit hyperactivity disorder (ADHD) in children. A study was carried out which aimed to test the hypothesis that sugary drinks were associated with ADHD in children [64]. The study concluded that children who consumed these beverages to a moderate degree had a 1.4 likelihood of developing the condition whilst those who consumed a high amount had a likelihood of 3.7. This was compared to those who did not consume any sugary drinks. It was also the case that similar results were produced when females were excluded from the study, which highlighted the negative correlation between the consumption of sugary drinks and the development of ADHD. Other studies have addressed the issue of sugar causing an increase in uric acid [65]. The study identified clinical studies which have reported an association between levels of serum uric acid and the development of diabetic nephropathy, hyperactive behaviours, and also an imbalance of cholesterol levels which could result in the development of heart diseases.

Given that high doses of caffeine have been linked to tachycardia, excessive consumption of EDs puts children at risk of intracardiac conduction abnormalities, arrhythmias and may also cause sudden death [2]. Apart from its acidic effects on enamel erosion and causing dentine hypersensitivity, caffeine interferes with intestinal

calcium absorption and may have negative effects on bone mineralisation in children, as maximal calcium deposition in bone occurs during adolescence [2].

This is supported in the study by Pinto et al., who evaluated the influence of EDs on the exposure of dentinal tubules and the removal of the smear layer [65]. The study concluded that EDs can be an important factor in causing cervical dentine hypersensitivity [65].

4.3. What This Study Adds

The review confirms that there is a limited evidence on the mechanisms and combined effects of sugar and caffeine on young people's health. To our knowledge, the present study is the first of its kind to investigate the associations and mechanisms of the main ingredients of EDs (sugar and caffeine) on the physical, mental, and behavioural well-being of young people. Figure 1 depicts the combined impact of overdoses caffeine and sugar on children's and adolescent's health and behavioural outcomes.

Findings indicate that caffeine use can cause violent behavioural patterns while also affecting the mental health of the consumer. Furthermore, it is associated with high blood pressure, early menarche, obesity and diabetes due to the added sugar content. Besides the mentioned health impacts of sugar, there are some additional health concerns that include ADHD, increase in the uric acid, hyperactive behaviours, and imbalanced cholesterol level leading to heart diseases. Although caffeine alone acts as an appetite suppressor, the excess sugar content contained within EDs has been associated with higher risks of obesity along with increased fat percentage and BMI levels. Dental erosion is one of the most common issues that most adults and children face upon consuming EDs, eventually resulting in the loss of hard tissue of the teeth due to the acids and sugars inherent in the energy drink [66]. Apart from a high sugar content, EDs also have a high erosive potential due to a low pH [66].

4.4. Limitations of This Study

There are several limitations. First, as most of the reviewed papers are cross-sectional in nature, it would be difficult to infer causation between consumption of sugar and caffeine and health outcomes. Second, because the initial searches were carried out between the years 1997 – 2017, it is possible that more recent studies have been missed.

5. Conclusion

This study set out to determine the adverse effects that consumption of energy drinks which may have on physical and mental health outcomes and behaviours of children and adolescents. Caffeine and sugar are the main ingredients in energy drinks with consumption of the latter creating potential serious adverse effects on young people. The discussed adverse effects of energy drink consumption may have implications for the design of public health interventions. In terms of regulation, sales of

energy drink should be prohibited in schools and university campuses and restricted for adolescents. Well-designed prospective studies and randomised controlled trials are required to consolidate the impact of energy drinks in relation to a wider range of outcomes.

Conflict of Interest Statement

The authors of this paper declare no conflict of interest.

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