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Exploring the implementation of a long COVID rehabilitation intervention: a mixed-methods process evaluation

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Abstract

Background Long COVID is recognised as a global public health concern, creating demand for rehabilitation. Despite a growing evidence base on long COVID rehabilitation interventions, knowledge of the implementation of these interventions remains limited, constraining adaptation and transfer across health care settings. In a previous study, the programme theory of a Danish community-based long COVID rehabilitation intervention was refined. However, uncertainties regarding its implementation remain. This study therefore aimed to explore the delivery and implementation of *The Long COVID Rehabilitation Intervention*.

Methods This convergent mixed-methods process evaluation focused on what was delivered (reach, fidelity, and dose) and how it was delivered (implementation processes and adaptations). Quantitative data comprised baseline patient questionnaires and routine rehabilitation patient records. Qualitative data comprised a focus group interview with health professionals and an individual interview with the rehabilitation centre manager. Quantitative data were analysed descriptively, and qualitative data were analysed using content analysis. Findings were integrated narratively.

Results In total, 336 patients were included of whom 325 patients were referred for rehabilitation and 321 initiated the programme. Most patients were female, had a long education and were employed or enrolled in education prior to their COVID-19 disease. Median rehabilitation length was 183 days (IQR 131–261), and the patients received a median of 13 sessions (IQR 8–22). Overall, key intervention activities were consistently delivered. Most rehabilitees received a combination of individual and group-based sessions, with the energy management group being the most common. Variation over time was observed in median rehabilitation length and number of sessions delivered, reflecting adaptations to the intervention over time. Adaptations and implementation were influenced by contextual conditions concerning flexible delivery within a clear structure, knowledge of long COVID, space for reflection and adaptation, and organisational recognition and legitimacy.

Conclusions This paper reports the implementation and delivery of *The Long COVID Rehabilitation Intervention* and highlights key contextual conditions that shaped these processes. These findings may inform adaptation and transfer

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of similar rehabilitation interventions to other health care settings. Future development and adaptation of long COVID rehabilitation should explicitly consider equity in access to ensure rehabilitation services reach diverse patient groups.

Trial registration ClinicalTrials.gov, NCT06544382. Registered retrospectively on 9 August 2024.

Keywords Long COVID, Rehabilitation, Implementation, Process evaluation, Mixed methods, Health services research

Background

Although most individuals with COVID-19 recover without treatment, some experience prolonged symptoms, commonly referred to as long COVID [1]. The World Health Organization defines this condition as new or persisting symptoms occurring after infection with SARS-CoV-2, causing COVID-19, typically emerging within three months after the acute illness and lasting for at least two months [2]. Long COVID is characterised by a wide range of symptoms from multiple organ systems, with fatigue, dyspnoea, muscle and joint pain, and cognitive impairment being among the most common [3–5]. Prevalence estimates vary considerably across studies, reflecting differences in study design, patient cohorts, case definitions, and follow-up timepoints. Recent systematic reviews and meta-analyses suggest pooled prevalences of 30% to 57% for at least one persistent symptom 12 weeks or more after infection, though these findings should be interpreted cautiously given the substantial heterogeneity [6–10]. Despite this variation and uncertainty in estimates, long COVID is recognised by The World Health Organization (WHO) as an ongoing public health concern [11]. Long COVID can lead to impaired functioning, reduced ability to perform daily activities, decreased quality of life, and long-term sick leave [12–14]. Such outcomes underscore the substantial need for rehabilitation, which has been highlighted as essential in the management of long COVID [1, 15]. Considerable variation in the content and delivery of long COVID rehabilitation programmes, together with patient experiences of barriers to accessing health care services [16, 17], indicates inconsistencies in both the availability and organisation of rehabilitation. In addition, limitations in the quality of existing studies mean that evidence on effective, safe, and inclusive rehabilitation efforts remains limited [18, 19]. Effectiveness studies provide valuable insights into patient outcomes following rehabilitation, e.g. symptom burden, engagement in regular daily activities, return-to-work, health care utilisation, and health-related quality of life [20, 21]; however, they rarely address the implementation of interventions. Without knowledge of how these interventions are implemented in practice, such efforts risk being ineffective or difficult to scale across health-care settings [22]. As a result, even with a rapidly growing evidence base, important uncertainties persist

regarding how and why long COVID rehabilitation interventions work in practice. In a previous study, we explored the underlying programme theory of a Danish outpatient long COVID rehabilitation programme, called *The Long COVID Rehabilitation Intervention* [23]. Combining individual and group-based sessions, it was theorised to facilitate identity transformation through patient education, peer support, and a person-centred approach, supported by an overarching mechanism of acceptance. Nevertheless, uncertainties regarding its delivery and implementation persisted. Building on our earlier programme theory refinement, this study examines what was delivered and how the intervention was implemented, to inform future adaptation and implementation into diverse health care settings. The aim of this study is therefore to explore the delivery and implementation of *The Long COVID Rehabilitation Intervention* by addressing the following research questions:

1. What components of the intervention were delivered, to what extent, and to whom?
2. How was the intervention implemented and adapted, and what contextual conditions influenced these processes?

Methods

Design

This paper reports the implementation of the intervention, with specific attention to delivery, implementation processes, and adaptation as part of a wider process evaluation study. This study employed a convergent mixed-methods process evaluation, integrating quantitative and qualitative data collected and analysed during a similar timeframe and integrated through merging of the findings [24]. The process evaluation was informed by the Medical Research Council guidance for process evaluation of complex interventions and was organised around the key functions of process evaluation: context, implementation, and mechanisms of change [22]. Drawing on the process evaluation guidance [22], the evaluation of delivery examined implementation domains, including reach, fidelity, and dose, while implementation processes and adaptation were explored in relation to organisational and contextual conditions shaping intervention implementation. The intervention's

programme theory and mechanisms of change, including context influences on intervention functioning, were reported in a previous paper [23] and are therefore not the focus of the present paper.

Setting

The study was conducted between July 2020 and January 2024 and forms part of a broader evaluation of *The Long COVID Rehabilitation Intervention*, including both a process evaluation and an effectiveness evaluation (ClinicalTrials.gov: NCT06544382; registered 9 August 2024). The broader evaluation is based on patients referred to municipal rehabilitation from a hospital-based long COVID clinic, where baseline data were collected for all participants. The quantitative component of this paper draws on the subgroup of these patients receiving the intervention. The effectiveness evaluation is currently being conducted. The process evaluation, reported across the previous programme theory paper [23] and the present implementation paper, was conducted prior to the effectiveness evaluation to minimise the risk that knowledge of outcomes would influence the interpretation of the implementation processes. The intervention was delivered as part of a municipal rehabilitation programme in a Danish municipality with more than 350,000 citizens and was provided by a rehabilitation centre specialised in neurological rehabilitation. The rehabilitation centre furthermore constituted the setting for recruitment of participants to the qualitative component of the process evaluation. Health professionals and the

rehabilitation centre manager contributed to both process evaluation papers, whereas patients were only recruited for the previous programme theory paper [23].

The long COVID rehabilitation intervention

The Long COVID Rehabilitation Intervention was an out-patient, community-based rehabilitation intervention delivered by a long COVID team consisting of occupational therapists and physiotherapists, collectively referred to as health professionals. The intervention was both developed and implemented over time by the long COVID team in response to the increasing number of patients with long COVID referred to rehabilitation. It was based on experiences, evidence, and rehabilitation principles for patients with other infectious and neurological conditions, e.g. meningitis, brain injuries, neurological diseases, and concussions. The key activities, mechanisms of change, contextual factors, and outcomes of the intervention are illustrated in a modified logic model (Fig. 1). The logic model was adapted based on findings from our previous realist-informed paper on the programme theory of the intervention [23]. In that paper, acceptance was identified as an overarching mechanism of change, while peer support, patient education, and a person-centred rehabilitation approach were highlighted as central for facilitating patients' identity transformation and re-engagement in everyday life. Whereas that paper focused on refining the intervention programme theory, the present paper examines how the intervention was delivered, implemented, and adapted over time.

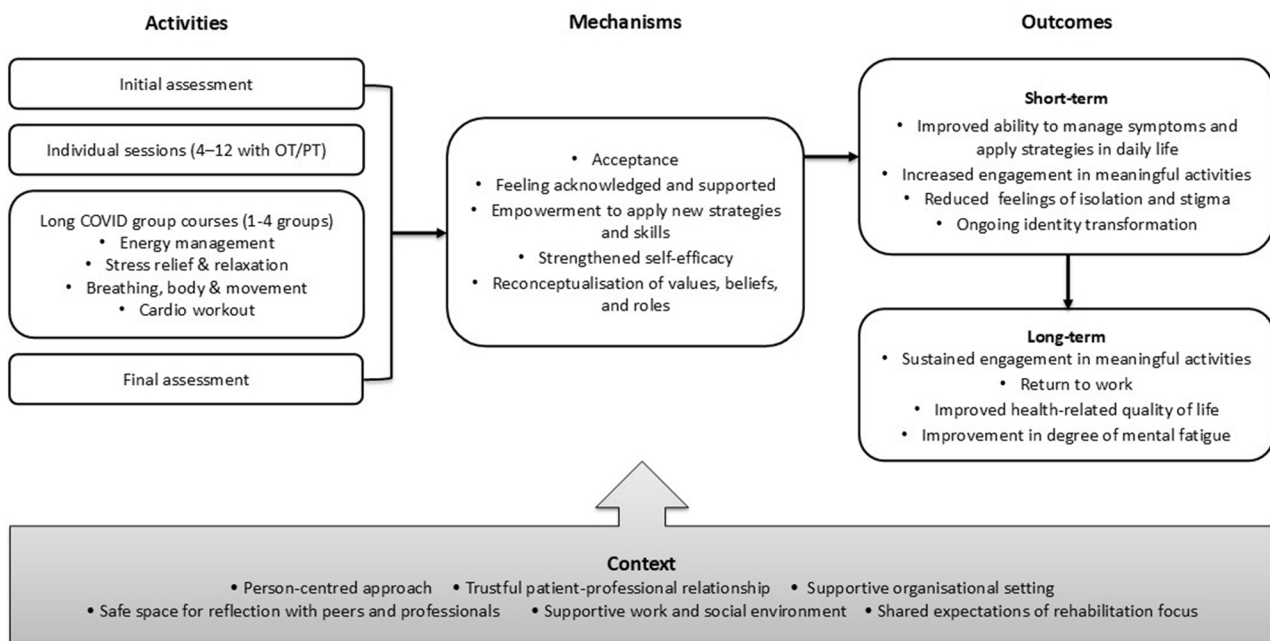


Fig. 1 Modified logic model illustrating the long COVID rehabilitation intervention

The activities comprised:

- an initial assessment covering evaluation of functioning, goal setting, and agreement on the rehabilitation plan.
- 4–12 individual sessions with occupational therapist and/or physiotherapist.
- participation in one or more of four defined long COVID group courses (energy management, stress relief & relaxation, breathing, body & movement, and cardio workout).
- a final assessment with an occupational therapist or physiotherapist, covering re-evaluation of functioning and follow-up on goal setting.

Both individual sessions and group courses built on the principles of energy management and pacing. Additionally, sessions with occupational therapists emphasised strategies to prioritise daily activities at home, at work, or during leisure time, whereas the physiotherapeutic sessions focused on pain management, respiration, mindfulness, and (re)introducing physical exercise in everyday life. Detailed descriptions of the intervention components and content of each activity are available in the supplementary TIDieR description accompanying the previous programme theory paper [23].

Participants and recruitment

Patients aged 18 years or older were recruited during their assessment at the Department of Physiotherapy and Occupational Therapy at a university hospital long COVID clinic. The patients were enrolled in a larger cohort that served as the basis for the planned

effectiveness evaluation. From this cohort, the study population of the present study was drawn and included all patients residing in the municipality delivering *The Long COVID Rehabilitation Intervention*. For the focus group interview, all physiotherapists and occupational therapists who were involved in the development, implementation, and delivery of the intervention were recruited, apart from one occupational therapist who was no longer employed at the rehabilitation centre. Recruitment of health professionals was done in collaboration with the rehabilitation centre manager. The manager was invited to an individual interview due to their responsibility for developing, organising, and overseeing the intervention.

Data sources and data collection

Data sources and the implementation domains they informed are presented in Table 1. Quantitative data addressed the first research question on what was implemented, whereas qualitative data addressed the second research question on how the intervention was implemented. We adopted the definitions of the implementation domains presented in the Medical Research Council guidance for process evaluations [22, 25]. *Reach* refers to whether the relevant target group participated in the intervention, and *dose* explores the quantity of the intervention delivered. Dose can be further divided into *dose delivered* and *dose received* [25], but since this study relies on patient rehabilitation records which only encompassed information on what the patients received, the present study reports on *dose received*. Finally, *fidelity* refers to whether the intervention activities were delivered as intended and can include both quantitative and qualitative information [22]. In the present study, we focused on the quantitative dimension of fidelity. As

Table 1 Overview of the implementation domains and data sources

Implementation domains	Process evaluation domains	Content	Data source
What was delivered	Reach	• Patterns in uptake (number of patients referred to, initiating, and completing rehabilitation) • Characteristics of patients	Baseline questionnaire Rehabilitation routine data
	Dose received	• Rehabilitation length (days) and variation over time • Number of sessions and variation over time • Number and types of groups	Rehabilitation routine data
	Fidelity (quantitative dimension)	Delivery of key activities • Initial assessment • Individual sessions • Group sessions • Final assessment	Rehabilitation routine data
How was it implemented	The implementation processes	The health professionals' and rehabilitation centre manager's experience implementing the intervention	Focus group interview with health professionals Manager interview
	Adaptations	Adaptations to the intervention components and delivery	

the intervention was developed over time, and a major uncertainty persisted in terms of which key intervention activities were delivered, we applied a more explorative and descriptive approach to fidelity than presented in the Medical Research Council process evaluation guidance. Rather than assessing fidelity against a predefined standard, we used an exploratory approach to understanding how the intervention was delivered in practice. We therefore considered fidelity as whether the key activities described in the modified logic model (Fig. 1) were delivered or not. Although fidelity and dose are presented as conceptually distinct implementation domains, they relied on overlapping data sources in this study. They were therefore combined and examined jointly by describing overall intervention delivery and dose received as well as intervention activities specified in the modified logic model (Fig. 1). To evaluate how the intervention was implemented, the *implementation processes* and *adaptations* made to intervention delivery were explored. The implementation processes capture the organisational structures and resources involved when implementing an intervention, whereas adaptations encompass modifications and changes made to the intervention to improve contextual fit [25]. In the present study, exploration of the implementation processes also included a focus on key contextual conditions influencing the implementation process.

Quantitative data comprised both baseline clinical data and routinely collected rehabilitation data. Baseline clinical data were obtained from the Department of Physiotherapy and Occupational Therapy at a Danish university hospital long COVID clinic between 15 July 2020 and 31 December 2023. These data were subsequently linked with routinely collected rehabilitation data for the same patients, capturing rehabilitation courses initiated following referral from the long COVID clinic during the study period. The rehabilitation routine data included the type of rehabilitation session provided (e.g. individual sessions, group sessions, and assessments), the professional group delivering the session, appointment dates, cancellations, reasons for cancellations, and dates for first and last sessions. Due to limitations in the rehabilitation routine data, and informal meetings with the health professionals indicating inconsistency in registration practices, an iterative approach was used to identify whether patients completed the rehabilitation course and received the intervention's key activities. Accordingly, cancellation of the last appointment without rescheduling of appointment was used as a proxy for non-completion of the programme. Additionally, assessments could be registered multiple times during the rehabilitation course, and it was not possible to distinguish whether they represented initial or final assessment. Therefore, the first and last individual sessions were used as proxies for the

'initial assessment' and for 'final assessment', as these sessions typically reflect how these activities are delivered in practise.

The baseline clinical data included a questionnaire covering sex, self-reported living status, educational level, employment status, occupation, main long COVID symptoms, and time since infection with SARS-CoV-2. Educational level was categorised following a Danish national guideline for conducting socioeconomic epidemiological research [26]. Short education comprised primary and lower secondary school as well as preparatory basic education and training. Medium education included middle school, general upper secondary education, vocational education and training, and programmes qualifying for admission. Long education comprised academy profession programmes, professional bachelor's programmes, bachelor's programmes, master's programmes, and PhDs.

Qualitative data consisted of a focus group interview with health professionals and an individual interview with the rehabilitation centre manager. These interviews were the same as described in our previous programme theory paper [23]. Interviews were conducted between December 2023 and January 2024. Semi-structured interview guides were developed for each interview type and were informed by the Medical Research Council guidance for process evaluation [22] and research questions related to the refinement of the programme theory and implementation-related aspects of the intervention. Interview guides for both interview types are available in the supplementary material accompanying the previous programme theory paper [23]. The focus group interview with health professionals was held at the rehabilitation centre, and the interview with the rehabilitation centre manager was performed online. All interviews were audio recorded.

Research team and reflexivity

TBN was the principal investigator of the process evaluation and is a PhD student with experience in long COVID rehabilitation research and clinical experience working with patients with long COVID. The focus group interview was conducted by TBN with assistance from LGO, whereas the individual interview was conducted by TBN. TBN conducted the quantitative analyses and performed the initial coding and qualitative analysis with analytical support and regular discussions with DS and LGO. Interpretation of findings was discussed within the research team consisting of an occupational therapist, nurse, psychologist, and physicians with experience in rehabilitation, long COVID, qualitative research, and process evaluations. The research team had no personal relationship with the participants. However, as the research project unfolded, a professional relationship with the

manager and health professionals was established through ongoing collaboration.

Analysis

Quantitative and qualitative data were obtained and analysed simultaneously during the study period and subsequently integrated. The analysis of quantitative data was carried out using the statistical software Stata 19 [27]. Descriptive statistics were applied to analyse the data and were presented with mean and standard deviation (SD) or median interquartile range (IQR), as appropriate. Interview data were transcribed verbatim and exported to NVivo (Lumivero, version 15) for analysis [28]. All participants were offered the opportunity to review the transcripts for accuracy, but none chose to. The analysis followed the principles of qualitative content analysis by Graneheim and Lundman [29]. Analysis questions concerning how the organisational conditions affected the implementation, how the roles and competences of the health professionals influenced the delivery, and how the implementation strategy and degree of flexibility enabled individual tailoring and adaptation were used to guide the analytic process. Guided by these questions, meaning units were identified, condensed, coded, and grouped into categories representing manifest content. Themes were subsequently developed to answer the research question. Finally, quantitative and qualitative data were integrated to provide a comprehensive understanding of delivery and implementation. Integration followed the principles described by Fetters et al. [24] and was conducted through narrative using a contiguous approach,

with quantitative and qualitative findings presented in different sections. Where data addressed related aspects of the same phenomenon, further integration was undertaken in a dedicated merge section.

Results

What was delivered

Reach

The total study population consisted of 336 patients. The flow of referrals and rehabilitation participation is illustrated in Fig. 2. At inclusion, 325 (97%) patients received a rehabilitation referral during their assessment. The remaining 11 patients (3%) did not have a rehabilitation need or did not wish to participate in rehabilitation. Of the referred patients, seven did not initiate rehabilitation, while three patients initiated rehabilitation despite not having received a referral at inclusion. Taken together, the intervention demonstrated high reach among the eligible patients in relation to uptake of the programme, with 321 (95.5%) initiating the rehabilitation programme (hereafter referred to as rehabilitees). Among rehabilitees, 33 (10.3%) had their last appointment cancelled without rescheduling of appointment, indicating non-completion of the programme as defined by the proxy in the Methods.

Table 2 illustrates the characteristics of the study population at inclusion. Most of the patients were females (71%) and had a mean age of 45 years (13.5). The patients were primarily non-hospitalised during their acute phase of COVID-19 (91%). Almost three quarters reported long education as their highest level of education (69%), and

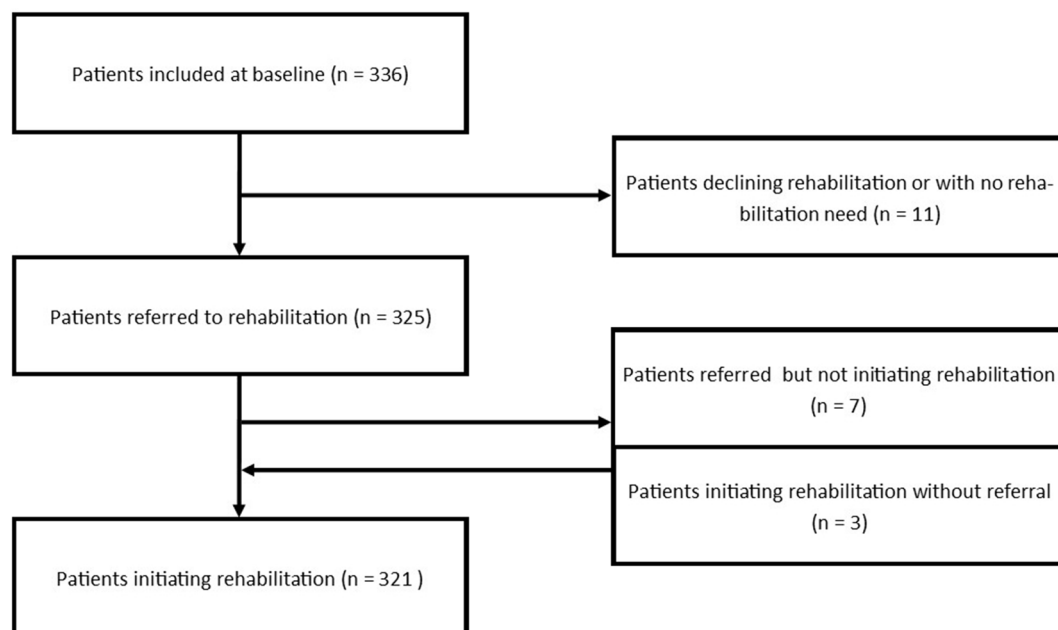


Fig. 2 Flowchart of rehabilitation referrals and rehabilitation uptake

Table 2 Characteristics of study population. *N* = 336

Sociodemographic data	Total (<i>N</i> = 336)
Sex (female), <i>n</i> (%)	240 (71.4%)
Age (y), mean (SD)	44.8 (13.5)
Living with spouse/partner (yes), <i>n</i> (%)	207 (61.6%)
Missing, <i>n</i> (%)	4 (1.2%)
Children living at home (yes), <i>n</i> (%)	134 (39.9%)
Missing, <i>n</i> (%)	4 (1.2%)
Children under 10 years old (yes), <i>n</i> (%)	59 (44.0%)
Missing, <i>n</i> (%)	1 (0.8%)
Educational level, <i>n</i> (%)	
Short education	20 (6.0%)
Medium education	73 (21.7%)
Long education	232 (69.1%)
Missing, <i>n</i> (%)	11 (3.3%)
Employment status prior to COVID-19, <i>n</i> (%)*	
Employed or enrolled in education	302 (89.9%)
Unemployed	6 (1.8%)
Sick leave	8 (2.4%)
Not in the workforce	20 (6.0%)
Current employment status, <i>n</i> (%)	
Working/studying same hours as before	116 (38.4%)
Sick leave	166 (55.0%)
Unemployed	17 (5.6%)
Missing, <i>n</i> (%)	3 (1.0%)
Sick leave – reason and type, (yes) <i>n</i> (%)	
Sick leave caused by long COVID**	152 (91.5%)
On sick leave for other reason	12 (7.2%)
Missing, <i>n</i> (%)	2 (1.2%)
Time since SARS-CoV-2 infection (days), median (IQR)	261.5 (169–396.5)
COVID-19 test (yes), <i>n</i> (%)	
Positive PCR/antigen test or ant	311 (92.6%)
Positive antibody test	15 (4.5%)
No test	10 (3.0%)
Hospitalised during COVID-19 (yes), <i>n</i> (%)	29 (8.6%)

*Unemployed included individuals receiving unemployment or social welfare benefits. Not in the workforce included patients on disability pension, retirement pension, leave of absence, and patients otherwise outside of the labour force. **Sick leave covers both parttime and fulltime sick leave

close to two thirds were living with a spouse or partner (62%). The majority were employed or enrolled in education prior to the acute phase of COVID-19 (90%), but at baseline, more than half of these patients were on sick leave (55%).

Dose and fidelity

Table 3 shows the receipt of the intervention among the rehabilitees. The median rehabilitation length was 183 (131–261) days, and rehabilitation was initiated within 7 days of referral for 98% of the rehabilitees. The rehabilitees received a median of 13 (8–22) sessions, including both individual and group sessions. The median number of cancelled sessions was 4 (1–8), with the primary

Table 3 Receipt of the intervention

Rehabilitation delivery	Total (<i>n</i> = 321)
Rehabilitation length (days), median (IQR)	183 (131–261)
Number of sessions attended, median (IQR)	13 (8–22)
Number of cancellations, median (IQR)	4 (1–8)
Participation in individual sessions (yes), <i>n</i> (%)	321 (100%)
Number of individual sessions attended, median (IQR)	9 (5–15)
Number of cancelled individual sessions, median (IQR)	1 (0–3)
Participation in any group courses (yes), <i>n</i> (%)	254 (79.1%)
Participation in at least one long COVID group (yes), <i>n</i> (%)	244 (76.0%)
Number of distinct group courses attended, median (IQR)	1 (1–2)
Number of cancelled group sessions, median (IQR)	2 (0–5)
Long COVID group types attended, <i>n</i> (%)*	
Energy management	205 (63.7%)
Cardio workout	38 (11.8%)
Stress relief and relaxation	66 (20.6%)
Breathing, body and movement	49 (15.3%)
Other	29 (9.0%)

*The distribution of specific group types is presented for the long COVID-specific groups included in the logic model. Patients could participate in more than one group; hence, the frequencies do not sum to 100%. The category 'other' includes non-established long COVID groups that were piloted for a few patients and were not part of the intervention as defined in the modified logic model (Fig. 1)

reason for cancellation of any session being patient-initiated cancellations. Other reasons included no-shows, rehabilitation centre-initiated cancellations, or administrative errors.

Initial assessment When applying the proxy for initial assessment defined in the Methods, all rehabilitees commenced their rehabilitation course with an individual session, indicating that the intervention activity 'initial assessment' was delivered to all rehabilitees. In the rehabilitation routine data, the first session was recorded as an assessment for 298 (93%) rehabilitees.

Individual sessions Individual sessions were delivered to all rehabilitees. A median of 9 (5–15) sessions was attended over the course of rehabilitation. Relative to the intended range specified in the modified logic model, 172 (54%) rehabilitees received 4–12 individual sessions, while 46 (14%) received fewer and 103 (32%) received more than intended. Most rehabilitees received individual sessions delivered by occupational therapists (85%), with a median of 4 (2–7) sessions, whereas 68% received individual sessions delivered by physiotherapists, with a median of 2 (0–6) sessions. For 37% of rehabilitees, sessions were registered as delivered by either occupational therapists

or physiotherapists. However, the exact professions could not be determined due to registration practises.

Group sessions Participation in any group course was observed for 254 (79%) rehabilitees, with 244 (76%) participating in at least one long COVID-specific group. Among rehabilitees who participated in group sessions, participation most involved long COVID-specific groups only (88%), while smaller proportions participated in mixed-diagnosis groups only (4%) or in both group types (8%). Participation was highest in the long COVID energy management group (64%), whereas participation in the remaining long COVID groups was less frequent.

Final assessment When applying the proxy for final assessment defined in the Methods, 252 (78.5%) patients concluded their rehabilitation with an individual session, indicating delivery of the key activity ‘final assessment’ for more than three quarters of the patients. In the rehabilitation routine data, the last session was recorded as an assessment for 29 (9%) patients.

To examine variation in delivery over time, rehabilitees were grouped based on the year in which they initiated their rehabilitation course. Due to a small sample size of patients initiating rehabilitation in 2020, rehabilitees from 2020 to 2021 were grouped together. In 2020–2021, 163 rehabilitees initiated a rehabilitation course, while the number declined to 106 in 2022 and 52 in 2023. Rehabilitation length varied across years (Fig. 3). The median rehabilitation length declined over time, from 221 (139–309) days in 2020–2021, to 179 (146–227) days in 2022, and further to 129.5 (102.5–185) days in 2023.

Similarly, the median number of sessions (both individual and group sessions) received showed a decline from 15 (9–25) sessions in 2020–2021 to 13 (7–19) sessions in 2022 and 10 (6.5–16) sessions in 2023 (Fig. 4).

How was it implemented

Five health professionals participated in the focus group interview, including three occupational therapists and two physiotherapists. All health professionals involved in delivering the intervention participated, and no health professional declined participation. The focus group interview had a duration of 82 min. All participants were members of the long COVID team and had been involved in delivering the rehabilitation programme since summer 2020, except for one physiotherapist who was specifically recruited for the team in spring 2021. Before joining the long COVID team, all participants had several years of experience within neurological rehabilitation and had worked with patient groups including viral meningitis, traumatic brain injuries, stroke, and other neurological diseases. The interview with the manager lasted 56 min. The rehabilitation centre manager oversaw the implementation and delivery of the intervention throughout the whole implementation period.

Three interrelated themes concerning the implementation process were identified. Table 4 provides an overview of the themes, illustrative quotes supporting the findings (Q1–Q11), and the associated contextual conditions underpinning implementation. The themes are described in detail below, with their contextual conditions integrated within each section. Overall, the findings from the focus group interview and the individual manager

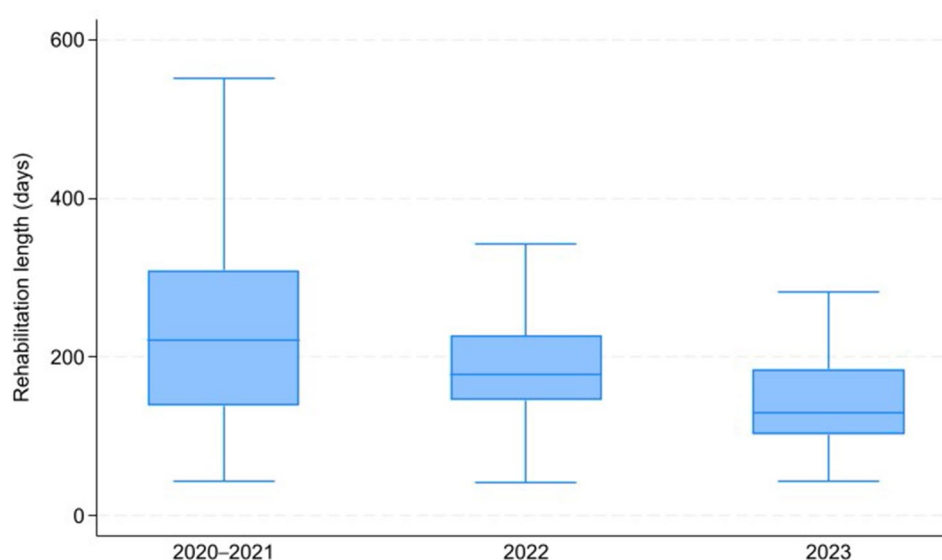


Fig. 3 Rehabilitation length by year of rehabilitation initiation. Box plot of rehabilitation length (days) by year of rehabilitation initiation (2020–2021, 2022, and 2023). Due to the small number of patients initiating rehabilitation in 2020, patients from 2020 and 2021 were combined. Boxes represent the interquartile range (IQR), with the median indicated; whiskers represent values within $1.5 \times$ IQR. Outliers are not displayed

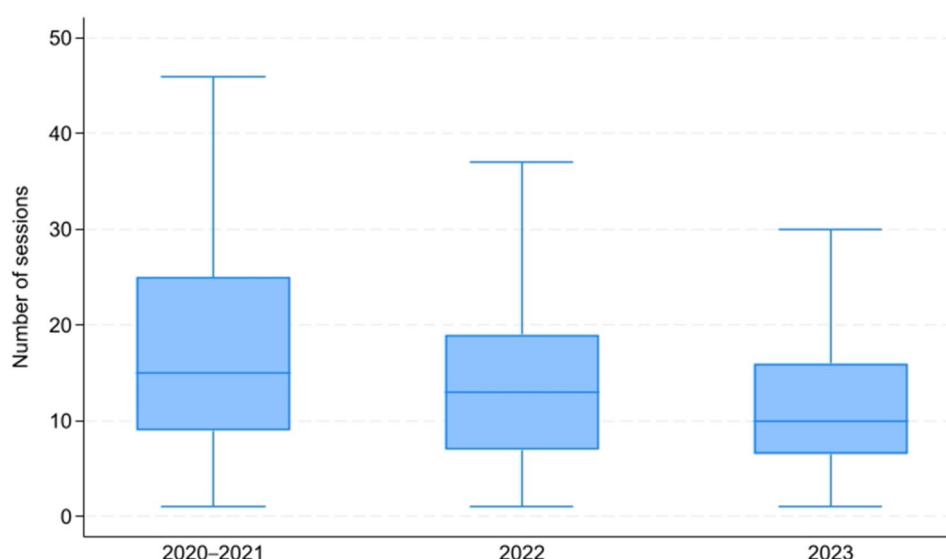


Fig. 4 Total number of sessions by year of rehabilitation initiation. Box plot of total number of sessions by year of rehabilitation initiation (2020–2021, 2022, and 2023). Due to the small number of patients initiating rehabilitation in 2020, patients from 2020 and 2021 were combined. Boxes represent the interquartile range (IQR), with the median indicated; whiskers represent values within $1.5 \times$ IQR. Outliers are not displayed

interview were consistent, and no substantial disagreement between focus group participants was identified.

Flexible implementation process

The implementation of the intervention was characterised by an interplay between a flexible approach and a growing need for structure, supported by the contextual conditions of *flexible delivery within a clear structure* and *space for reflection and ongoing intervention adaptation*. Uncertainty and limited knowledge related to the novelty of long COVID required a high degree of flexibility in delivery. Although the health professionals considered the group courses essential for facilitating peer support, offering patients participation in group courses was deemed necessary to accommodate increased referrals and high workloads (Q1). Likewise, uncertainty regarding long COVID and limited management and referral options after completion of rehabilitation resulted in prolonged rehabilitation courses, with some patients participating for up to a year during the first years of delivering the intervention (Q2). However, increased referrals and high workloads necessitated greater structure, reflected in shorter rehabilitation courses, structured group courses, and fewer and less frequent individual sessions, to ensure timely delivery of the intervention to all referred patients and to reduce workload pressures. Thus, implementation was influenced by both a flexible approach as well as clearer structure, reflected in the contextual condition *flexible delivery within a clear structure*. Despite the growing need for structure, maintaining space for reflection to support adaptation and development of the intervention remained a priority (Q3). These

adaptations concerned both the dose of the intervention (e.g. frequency and number of individual sessions) and the content and format of the group courses offered. The energy management group remained the same, whereas the physiotherapists tested different group course formats and content before establishing the long COVID groups listed in the modified logic model. These ongoing adaptations were particularly necessary due to limited initial knowledge and experience with the patient group and were made in response to accumulating clinical experience. Through regular long COVID team meetings, as well as informal discussions and knowledge sharing among the health professionals, the contextual condition *space for reflection and ongoing intervention adaptation* was facilitated, thereby supporting continued development of the intervention over time.

Health professional role clarification

Knowledge of long COVID and *societal normalisation and acknowledgement of long COVID* were identified as key contextual conditions influencing the health professionals' roles in delivering the intervention. Delivering rehabilitation to this new patient group with long COVID initially generated considerable role uncertainty among the health professionals. Limited knowledge about long COVID, both among the health professionals and society at large, combined with a flexible implementation approach, placed a high degree of individual responsibility on the health professionals (Q4). They described how this individual responsibility, combined with limited onward referral options, as outlined in the previous theme, resulted in prolonged rehabilitation courses and

Table 4 Overview of the themes, illustrative quotes, and the associated contextual conditions for implementation

Theme	Quote No.	Illustrative quote	Contextual conditions for implementation
Flexible implementation process	Q1	<i>"But that [i.e. bringing the patients together in groups] was also simply a way of handling all the many rehabilitation referrals, so in a way it served two purposes at once."</i> Occupational therapist 2	Flexible delivery within a clear structure Space for reflection and ongoing intervention adaptation
	Q2	<i>"We kept all of them [the patients], because we had nowhere to send them on. It was something we only realised along the way"</i> Physiotherapist 1	
	Q3	<i>"It [the large number of referred patients] required some very, very clear boundaries, as well as follow-up to make sure those boundaries were kept, and making time and space for reflection when something new had to be developed"</i> Rehabilitation centre manager	
Health professional role clarification	Q4	<i>"It has basically been up to the individual therapist, in collaboration with the patients. So, there has, of course, been a great deal of responsibility placed on the individual"</i> Occupational therapist 1	Knowledge of long COVID Societal normalisation and acknowledgement of long COVID
	Q5	<i>"In the beginning, I felt like I was almost acting as a counsellor, and patients were just talked, but we were not really doing occupational therapy. I feel that we are doing much more of that now"</i> Occupational therapist 3	
	Q6	<i>"Even the traditional understanding of physical training – I think that has been very, very difficult. If you are to improve your physical fitness, you have to keep increasing close to your maximum, and here it was less, wasn't it? It was really about turning the whole thing upside down."</i> Physiotherapist 1	
	Q7	<i>"We've found our role and can send them on, and we also see now that other health professionals have some knowledge about it. So it's like, 'oh, it's someone with long COVID', just as if it were any other neurological condition"</i> Occupational therapist 1	
	Q8	<i>"We've become better in our professional practice and can set higher expectations for them. But that's also because we've become more specific. When you don't quite know where you stand, you start to hesitate and become unclear"</i> Physiotherapist 2	
Organisational support	Q9	<i>"But overall, I think there has been a great deal of openness, a lot of curiosity, and a very high level of recognition for the way we took on this task and carried it out. And that is both professionally and in terms of collaboration, and in relation to regulations, finances, and politics."</i> Rehabilitation centre manager	Organisational recognition and legitimacy Collaboration and communication with the long COVID clinic
	Q10	<i>"And what was also absolutely crucial was that [the hospital] had a consultant in the long COVID clinic who was appointed to coordinate the work and the collaboration. [...] That openness and willingness to learn more about this together. That was almost what made us feel safe doing this, I would say."</i> Rehabilitation centre manager	
	Q11	<i>"The importance of the dialogue with the long COVID clinic, the dialogue with the doctors. Being able to get a reply when we reached out has always been important. Having the same wording from 'centrally' [i.e. from the long COVID clinic] and out to us, and the other way around."</i> Physiotherapist 1	

frequent individual sessions. In the context of severe fatigue and considerable uncertainty about appropriate rehabilitation approach, particularly the first year of delivery, the health professionals perceived frequent contact and close follow-up as necessary to provide adequate support. For some patients in the early phase of the pandemic, however, this had the unintended consequence of exacerbating fatigue rather than supporting recovery. Moreover, the health professionals described how the complexity of symptoms and vulnerability of the patients further challenged their professional roles, with some health professionals experiencing a shift towards acting more as counsellors providing psychological support and comforting the patients rather than

providing occupational therapy or physiotherapy (Q5). Likewise, the health professionals, particularly physiotherapists, experienced a need to shift their rehabilitation focus from a traditional emphasis on improving physical functioning through high-intensity exercise towards guiding the patients to reduce and pace activities, which contrasted with established professional norms and contributed to initial role uncertainty (Q6). Over time, however, as societal and professional knowledge about long COVID increased and clearer management and referral pathways emerged, the professionals gradually developed skills and confidence in delivering the intervention in line with their professional identities (Q7). Moreover, increased skills and confidence enabled the health

professionals to set clearer expectations regarding patient adherence and to conclude rehabilitation courses when further improvement in functioning was not anticipated (Q8). These findings suggest that knowledge of long COVID as well as the normalisation of long COVID, both societally and clinically, were essential in facilitating role clarity and strengthening the professional positioning of those involved during implementation of the intervention, reflected in the contextual conditions of *knowledge of long COVID* and *societal normalisation and acknowledgement of long COVID*.

Organisational support

Organisational recognition and legitimacy of the rehabilitation centre's role in delivering the intervention together with *collaboration and communication with the long COVID clinic* were highlighted as central enabling conditions for implementation. While the intervention was bounded by overall municipal budgets and broader organisational frameworks, the rehabilitation centre was granted considerable autonomy in the development and implementation of the intervention. The rehabilitation centre manager experienced a high degree of recognition of their role in delivering the intervention from both political and administrative levels within the municipality (Q9). Additional economic resources were allocated in response to the increased number of referrals, allowing for the recruitment of new staff and internal reorganisation to establish a dedicated long COVID team. Thus, *organisational recognition and legitimacy* was identified as a key contextual condition for implementing the intervention. Moreover, professional collaboration with the hospital-based long COVID clinic facilitated coordinated care pathways and was essential for the implementation of the intervention. The rehabilitation centre manager highlighted the willingness and openness of the long COVID clinic to collaborate as central to implementing and delivering the intervention (Q10). Likewise, the health professionals deemed the dialogue and communication with the long COVID clinic and collaboration across sectors as crucial for their work (Q11), contributing to increased professional security and confidence in delivering the intervention despite the novelty of long COVID. This suggests that *collaboration and communication with the long COVID clinic* was another key contextual underpinning the implementation of the intervention.

Merging of results

The quantitative results showed a decrease in both rehabilitation length and number of sessions across the study period. Because this reduction followed a consistent temporal trend, it is unlikely to be explained solely by patient-level tailoring. The qualitative findings contribute to

understanding this temporal pattern. Prolonged rehabilitation courses and a high frequency of individual sessions during the early phase of the intervention were described as a consequence of uncertainty, limited knowledge, and restricted management and referral options, which may explain the initially higher rehabilitation length and number of sessions observed in the quantitative data. The flexible implementation approach with gradual role clarification enabled adaptations to the intervention as health professionals gained more experience with the patient group and responded to increasing referrals, which was reflected in the adjustments in delivery over time. Moreover, adaptations to the content of group courses and the overall rehabilitation approach also occurred over time in response to increased experience with the patient group. Despite these ongoing adaptations, most patients received both an initial and final assessment as well as a combination of individual and long COVID group sessions, indicating that the key activities of the intervention listed in the modified logic model were received by most patients throughout the study period. Taken together, the decrease in rehabilitation length and number of sessions appears to reflect adjustments in how the intervention was delivered rather than changes to its key activities.

Discussion

This study explored the delivery and implementation of *The Long COVID Rehabilitation Intervention* using a mixed-methods process evaluation. Overall, *The Long COVID Rehabilitation Intervention* achieved high reach and broad delivery of its key activities. Reductions in rehabilitation length and session dose reflected the deliberate intervention adaptations. Qualitative data indicate that these adaptations were enabled by a flexible implementation approach, gradual role clarification among health professionals, and organisational support. Together, these findings provide important insights into the delivery and implementation of a real-world, community-based long COVID rehabilitation programme.

The high reach observed in this study, reflected in the high proportion of eligible patients who were referred to and subsequently initiated and completed the rehabilitation programme, may be explained by several factors. Although we defined proxies for non-completion, indicating a non-completion of 10%, providing more accurate estimates was not feasible due to the limitations in the rehabilitation data set. Despite this uncertainty, the reach remains high compared to other rehabilitation efforts, such as cardiac rehabilitation, showing uptake and completion rates of 52% and 37%, respectively [30]. The high uptake and completion of the rehabilitation programme may also be explained by findings from our previous programme theory paper [23]. That paper highlighted how the patients' commitment to engage in the rehabilitation

was increased when they felt acknowledged and supported by health professionals. For some, this mechanism was present already in the long COVID clinic. Thus, feeling acknowledged and supported already at referral from the long COVID clinic may have increased the uptake and completion of the rehabilitation programme.

Moreover, the reach should be interpreted in light of the sociodemographic characteristics of the study population and the structural context shaping the access to the long COVID clinic. The patients of this study had a higher educational level than the general Danish population (69% vs. 44%) [31], which, combined with their labour market participation before illness and cohabitation status, indicates a comparatively strong socioeconomic position relative to the general Danish population. Entry to the long COVID clinic depended on referral from general practitioner, and considering the relatively strong socioeconomic position of the study population, the referral pathway may favour groups with comparatively strong socioeconomic resources. This interpretation aligns with findings from recent studies examining the recovery process of long COVID and access to health services. Andersen et al. [32], described how the lack of support from health professionals created a need to advocate for oneself among the individuals with long COVID potentially leading to a larger individual responsibility for receiving help. Likewise, in a mixed-methods study on building inclusive long COVID services, Mir et al. [17] found that under-represented groups, such as ethnic minorities, experience a large range of barriers for accessing health care support. Similar findings were presented by Goldschmidt et al. [16], who showed how patients with an ethnic minority background experienced more barriers for accessing care and rehabilitation in Denmark. Although we did not have information on ethnicity, the referral pathway may have excluded minorities or socially vulnerable individuals and resulted in the unintended consequence of potentially increasing health inequalities. This may also have introduced selection bias in relation to access to the long COVID clinic and, consequently, in the study population.

Using the proxies for initial and final assessment, all rehabilitees commenced their rehabilitation course with an individual session, suggesting delivery of initial assessment to all patients. In contrast, 79% completed their rehabilitation course with an individual session, indicating that the activity 'final assessment' was not delivered to all patients. When examining the registrations of assessments in the rehabilitation records, 93% of rehabilitees had an assessment registered as their first session, which corresponded closely with the applied proxy for initial assessment. However, only 9% of rehabilitees had an assessment registered as their last appointment, suggesting inconsistencies in registration practices.

Thus, as these findings relied on proxies and rehabilitation records characterised by incomplete registrations, it remains uncertain whether this reflects actual deviations from the modified logic model in the delivery of the activity 'final assessment' (i.e. the assessment was not provided) or limitations in documentation practices. Nevertheless, deviation from the logic model may not reflect poor implementation of the intervention. Carroll et al. [33] highlight that implementation of an intervention does not require delivery of all components as long as the essential components are implemented. In our previous programme theory paper, we found that both individual sessions and long COVID groups were important in the functioning of the intervention, as they provided space for peer support, patient education, a person-centred rehabilitation approach, and identity transformation, enabling mechanisms of acceptance, feeling acknowledged, and empowerment [23]. As most of the patients received a combination of individual sessions and long COVID groups, as described in the modified logic model, we argue that the most essential activities supporting the programme theory were delivered, indicating that the mechanisms identified in the programme theory were likely supported. However, 24% of the rehabilitees did not participate in any long COVID group. For these patients, the mechanisms underpinning peer support may not have been activated, which may have limited opportunities for feeling acknowledged and experiencing a sense of belonging. While mechanisms were not directly assessed in the present study, the documented delivery of these key activities indicated that the intervention functioned largely as intended for most patients, despite variation in receipt. Yet, given limitations in the rehabilitation patient records in providing sufficient detailed descriptions of the content and quality of delivered activities, future research is needed to explore this further.

The contextual conditions identified in this study are essential to understanding the implementation and delivery of *The Long COVID Rehabilitation Intervention*. Although some of the conditions may appear context-specific, similar factors have been emphasised in long COVID rehabilitation frameworks and research priorities. For example, the contextual condition *knowledge of long COVID*, identified in relation to the theme of professional role clarification, aligns with existing frameworks that highlight education of health care providers as a central mechanism for ensuring delivery of long COVID rehabilitation [18, 19]. Moreover, the conditions of *collaboration and communication with the long COVID clinic* and *societal normalisation and acknowledgement of long COVID* align with findings from studies reporting experiences of insufficient support from health care professionals and limited access to long COVID health care services [17, 32], discussed earlier, suggesting that

these conditions may be particularly important for implementation and delivery of long COVID rehabilitation interventions.

Strengths and limitations

Using a mixed-methods design allowed us to ‘create a wider picture’ of the implementation of the intervention [34], which we consider a strength of the study. Although the research questions were centred around either the quantitative or the qualitative data, the final integration and discussion of data were used to answer the overall aim of the study, which would otherwise not have been feasible. No substantial divergences between the quantitative and qualitative findings were identified. However, this may partly reflect that the quantitative and qualitative data addressed different aspects of the research questions, which limited direct comparison between findings. We did not report all domains of the Medical Research Council’s guidance on process evaluations in the present paper, which may be considered a limitation of the study. However, since the programme theory, including mechanisms of change, was reported previously, this paper reported the major uncertainties related to what was implemented and how this implementation was achieved. This approach aligns with Moore et al. [35], who emphasise that the guidance should not be applied passively but requires interpretation in relation to the context of the study. Thus, prioritising these uncertainties strengthened the relevance of the study.

Limitations in both quantitative and qualitative data may, however, have influenced our findings and ability to integrate the methods further. The patient record rehabilitation data may have been influenced by inconsistencies in registration and documentation practices, which may limit the quality of the routine data. Likewise, the quantitative data did not provide any information on the content of each activities delivered, limiting our ability to provide more detailed information on dose delivered as well as the qualitative aspect of fidelity. However, exploring the implementation of an existing long COVID rehabilitation programme using routine and real-life data provided a more realistic insight into how such programmes operate, which may increase the generalisability of our findings.

The initial analysis plan involved subgroup analyses comparing referred and non-referred patients, as well as patients who completed or did not complete the rehabilitation intervention. As almost all patients were referred to rehabilitation, and we had no reliable indicator of completion of the programme, these analyses were, however, not feasible. Together with the potential selection bias resulting in a relatively socioeconomically advantaged patient group being referred to the long COVID clinic, this introduces uncertainty regarding potential

differences in sociodemographic and intervention delivery across patients assessed at the long COVID clinic, referred to rehabilitation, initiating, and completing the programme. These uncertainties limit the interpretation of the reach of the intervention. Future studies should therefore aim to address these issues.

Although patient perspectives are highlighted as important for understanding the implementation of complex interventions [22], they were not incorporated in this paper. Patient experiences and responses to the intervention were explored in the programme theory paper, indicating a general acceptability of the intervention [23]. In the present paper, we therefore deliberately focused on experiences from the health professionals and rehabilitation centre manager to explore the implementation and delivery of the intervention. While the absence of patient perspectives may be considered a limitation of the paper, this focus allowed for a detailed exploration of organisational and professional factors shaping implementation.

Only a focus group interview with five health professionals and an individual interview with the rehabilitation centre manager constituted the qualitative data, which may represent a limitation in relation to the richness and breadth of the qualitative data. However, O’Reilly and Parker [36] emphasise that the appropriateness of data in relation to the research question, rather than solely the number of participants, is central to determining the adequacy and richness of qualitative data. As we included all relevant stakeholders from the rehabilitation centre who were involved in the development and implementation of the intervention, and patient voices were included in the programme theory paper, we consider the data adequate for exploring the delivery and implementation of the intervention. Although semi-structured interview guides supported the interviews, we also allowed exploration of other areas important for the implementation of the intervention. Thus, the focus group interview mainly centred on the context of development, implementation, and conditions for delivering the intervention rather than providing additional insight into reach, dose, and the qualitative dimension of fidelity. Additional qualitative methods, such as observations of individual and group sessions, could have provided richer insight into the content, consistency, and quality of intervention delivery. This approach may also have strengthened the integration of quantitative and qualitative data.

Implications

Long COVID remains recognised as a global health concern by the World Health Organization, underscoring the continued need to ensure access to rehabilitation for patients with this condition. Our findings provide insights into how such services may be organised and implemented. Based on our findings, we recommend that

researchers and clinicians invest early in role clarification and education of health professionals, allow a flexible implementation approach with space for reflection and adaptation, and ensure organisational support and cross-sectoral collaboration. As dedicated long COVID clinics in Denmark have been discontinued, and similar developments are observed in other countries, establishing coordinated cross-sectoral pathways may become more challenging. Attention to maintaining structures that facilitate collaboration and continuity of care across sectors therefore remains important when planning future services. Finally, the sociodemographic characteristics of referred patients suggest that the referral pathways examined in this study may have favoured individuals with comparatively strong resources. This highlights the need to consider equity explicitly when developing and adapting of long COVID rehabilitation services to new contexts to avoid widening existing health inequalities. Future services and research should therefore consider how referral pathways, communication about long COVID, and rehabilitation services can be more inclusive and accessible for individuals from different ethnic backgrounds and with fewer socioeconomic resources.

Conclusion

This process evaluation explored the implementation and delivery of a community-based long COVID rehabilitation intervention. Overall, the intervention reached a large proportion of referred patients and maintained delivery of its key activities while adapting over time in response to a growing need for clearer structure, greater knowledge of long COVID, and gradual role clarification. Implementation was enabled by flexible delivery within a clear structure, space for reflection and ongoing adaptation, organisational recognition and support, and collaboration with a hospital-based long COVID clinic. These findings may inform the development and adaptation of long COVID rehabilitation interventions in other settings by providing insights into how such programmes operate and are delivered within existing healthcare structures. Future research should examine how long COVID rehabilitation interventions can be sustained in changing organisational contexts and how equity in access to such interventions can be ensured.

Abbreviations

COVID-19 Coronavirus disease 2019
SARS-CoV-2 Severe acute respiratory syndrome coronavirus 2

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Author contributions

Conceptualisation: TBN, DS, JH, CVN, SL, BSC, CHL, and LGO. Project administration: TBN, DS, and LGO. Formal analysis: TBN, DS, and LGO. Writing – original draft preparation: TBN, DS, and LGO. Writing – review and editing: TBN, DS, JH, CVN, SL, BSC, CHL, and LGO. All authors have read and agreed to the published version of the manuscript.

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Data availability

To protect participants' privacy in accordance with the European General Data Protection regulation and terms of written informed consent, the datasets supporting the findings of this article are not publicly available. Data may be available from the corresponding author upon reasonable request and subject to appropriate ethical approvals.

Declarations

Ethics approval and consent to participate

The study was carried out in accordance with The Declaration of Helsinki and was approved by Research Ethics Committee at VIA University College, Denmark (R.no.: A23-73802) and the Regional Data Protection Agency (R.no. 1-16-02-655-20). Regional Ethical Committee of Central Denmark Region deemed ethical approval unnecessary (R.no. 1-10-72-1-21). Informed written consent was obtained from all participants.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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