Physical activity in long COVID sufferers – the effect of social support and self-efficacy

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Abstract

Background. Physical activity appears to be an important factor in the recovery from the novel long COVID disease. It is important to identify psychological variables that motivate physical activity in long COVID sufferers. The current study aimed to investigate the relationship between perceived social support and physical activity in a sample of long COVID sufferers. Further, it was explored to what extent the relationship between social support and physical activity is mediated by self-efficacy.

Method. A cross-sectional survey study was conducted in a sample of long COVID sufferers. The data of 57 participants (*mean age*= 35, *SD*= 13.1, 70.2% female) was analysed. The IPAQ was used to measure physical activity, while adapted versions of the Social provisions scale and the Self-efficacy scale for physical activity were used to measure the relevant constructs.

Results. A simple linear regression analysis revealed a not significant effect of perceived social support on physical activity. For the second hypothesis, no mediation effect was observed, as the indirect effect of perceived social support on physical activity was not significant. Still, a significant effect of self-efficacy on physical activity was detected ($B = .44$, $t(56) = 3.6$, 95% CI [.19,.68]; $p = <.001$).

Conclusion. Despite the fact that the hypotheses could not be confirmed, the current study has important implications for future research on the relationship between social support, self-efficacy and physical activity. For example, self-efficacy appears to be a predictor of physical activity and should be further investigated using different designs. Long COVID sufferers indicate a significantly higher variance regarding their physical activity than would be expected of an impaired population. Additionally, the current study assisted in further exploring symptom- and illness related characteristics of long COVID populations.

Keywords: long COVID, physical activity, social support, self-efficacy, Cross-sectional design, mediation model

Contents

Introduction

Long COVID is a novel disease that affects some individuals who have been infected with the Sars-Cov-2 Virus, that often has a severe negative impact on the daily functioning and mental health of sufferers (Aiyegbusi et al., 2021; Pavli et al., 2021). Long COVID sufferers are often significantly impaired in their ability to manage their daily life due to substantive fatigue among other debilitating symptoms (Aiyegbusi et al., 2021; Pavli et al., 2021). Slow re-uptake of light physical activities is an important aspect of the recovery process (Humphreys et al., 2021; Vij, 2021). Therefore, identifying predictors of physical activity in long COVID sufferers could be beneficial for future interventions. Previous research on general populations and qualitative reviews of the experience of Long COVID sufferers suggest that social support and self-efficacy might be predictors of physical activity (Dishman et al., 2009; Macpherson et al., 2022; Shelley et al., 2021). The current study aimed to investigate the predictive role of social support on physical activity and the potential mediating role of self-efficacy in this context.

Long COVID

COVID-19 is a viral respiratory disease that can present a significant, and in some cases fatal, health hazard to an infected individual (Soriano et al., 2021). The SARS-CoV-2 virus has caused a global pandemic with detrimental consequences for physical and mental health. While the public debate often revolves around the impact of acute COVID-19, the long-term consequences of the infection seem to receive far less attention (Callard & Perego, 2021).

Long COVID refers to a condition that can manifest with a variety of symptoms that either occur after initial recovery from a SARS-CoV-2 infection or persist beyond a period of at least 3 months, without alternative explanation, according to the World Health Organization (WHO) (Soriano et al., 2021). The main symptoms include fatigue, headaches, reduced lung function, difficulties maintaining attention and mental health

issues. While the symptoms appear to vary greatly among affected individuals, fatigue appears to be both the most common and the most debilitating symptom of long COVID (Raveendran et al., 2021). The WHO case definition states that neither a minimum number of symptoms nor a confirmed COVID-19 infection have to be present in an individual to be classified as a long COVID sufferer (Soriano et al., 2021). This, in combination with the variability of the symptoms makes it difficult to establish clear diagnostic criteria for long COVID.

Long COVID symptoms seem to be far more common in individuals who have been hospitalized due to the disease (Pavli et al., 2021). To illustrate, it is estimated that the incidence of long COVID is around 80 percent for hospitalized patients, while it is around 34 percent in non-hospitalized populations (Pavli et al., 2021). This implies that there is a relationship between the severity of symptoms and the likelihood to develop long COVID symptoms (Arjun et al., 2022; Pavli et al., 2021). The prevalence of long COVID is estimated to be around 30 percent among previous SARS-CoV-2 infected (Arjun et al., 2022). However, only a small proportion of long COVID sufferers consider their symptoms severe and highly impairing (Arjun et al., 2022).

Depending on the individual symptoms, long COVID can cause significant impairment for sufferers. In some individuals, extreme fatigue makes them unable to manage their daily life and maintain their normal functioning (Humphreys et al., 2021). Sufferers describe feeling extraordinarily exhausted even after the most profound physical or mental activities (Amdal et al., 2021; Humphreys et al., 2021). Many individuals are at times not able to perform important activities of daily living (ADL) which makes them dependent on the support from others (Amdal et al., 2021; Humphreys et al., 2021). Especially for individuals who were previously independent and physically fit, this often results in feelings of inadequacy and guilt (Humphreys et al., 2021). The general self-reported quality of life as well as the mental well-being seems to be significantly lower for long COVID sufferers (Aiyegbusi et al., 2021; Amdal et al., 2021; Pavli et al., 2021).

Long COVID has been found to be related to Posttraumatic stress disorder (PTSD), depression, and anxiety due to the effects of long term hospitalization that was claimed to have a negative impact on the mental health of some affected individuals. (Aiyegbusi et al., 2021; Amdal et al., 2021; Pavli et al., 2021). Additionally, in the beginning of the pandemic, many sufferers felt as if they were not taken seriously by practitioners as the disease was unknown up to that point (Humphreys et al., 2021). While awareness of the disease has definitely increased ever since, there is still a lot to be learned about the disease itself, as well as the factors that might help patients with recovery. One factor that is repeatedly proposed as a facilitating factor is physical activity (Humphreys et al., 2021; Wallman et al., 2004).

Physical activity and long COVID

It is widely believed that physical activity, either in the form of exercise or pursuing ADL, is important for a successful recovery from fatigue related or respiratory conditions (Humphreys et al., 2021; Wallman et al., 2004). Engaging in ADL, such as walking, cooking, or cleaning is often equal to light physical activity (Humphreys et al., 2021; Pate et al., 2008). Many long COVID sufferers benefit from disease management approaches involving physical activity, as findings from occupational therapy and physiotherapy indicate (Vij, 2021). However, long COVID appears to be a condition that can also be relapsing in nature (Raveendran et al., 2021). Therefore, some sufferers that are not under professional guidance and are fuelled by their initial exercise successes experience an intense symptom relapse, and thus post-exertional malaise, after being too active (Pavli et al., 2021). This makes some affected individuals believe that physical activity is counterproductive to recovery from long COVID, which leads some to cease any efforts to pick up physical activity again and become completely inactive (Humphreys et al., 2021).

Nevertheless, many people affected by a fatigue related condition have made very positive experiences with physical activity (Geraghty et al., 2020; Humphreys et al., 2021;

Vij, 2021). Additionally, sufferers who are seriously impaired by long COVID need to be able to perform their ADL (Humphreys et al., 2021). It appears to be really important to pick up physical activity in a pace that is appropriate to an individual and the unique symptoms they experience. Rather than pressure from general practitioners (GP) or others, to constantly increase the activity level, the sufferers need support both from their GP as well as their social circle, to prevent a relapse and facilitate their recovery (Geraghty et al., 2020; Humphreys et al., 2021). However, with the differing attitudes that affected individuals have towards physical activity, the questions arises which factors play a role in motivating people to become active again.

Social support and physical activity

While the determinants for re-uptake of physical activity by long COVID sufferers might be varied and difficult to identify, one aspect that is repeatedly mentioned by sufferers is the support from others (Humphreys et al., 2021; Shelley et al., 2021). While different types of social support can be differentiated, instrumental support, where others enable individuals to become active, informational support, and emotional support appear to be particularly relevant in this context (Humphreys et al., 2021; Orsega-Smith et al., 2007; Shelley et al., 2021). In the beginning of the pandemic, sufferers connected with each other via social media and shared experiences and support due to the perceived lack of support from medical professionals (Callard & Perego, 2021). In recent qualitative studies, long COVID sufferers stated that the support received online by other sufferers was one of the instrumental aspects that kicked off the recovery process for them (Humphreys et al., 2021; Shelley et al., 2021). While the connection with other sufferers provided them foremost with emotional support by showing them that their experience was not unusual (Shelley et al., 2021), the practical tips and strategies that were shared seem to have inspired sufferers to become active again in many cases (Humphreys et al., 2021). Additionally, it might have shown people that improvements are possible, which prompted

them to pursue ADL or exercise again (Humphreys et al., 2021; Shelley et al., 2021).

In addition to support coming from people online, long COVID sufferers also describe support from friends and relatives as being crucial for re-uptake of physical activity (Shelley et al., 2021). The type of support can be physical help with ADL or exercise, like helping to cook or go for a walk (Shelley et al., 2021). However, simple social interactions that distract the individual are also helpful (Shelley et al., 2021). Again, while multiple mechanisms might be at work here that explain this experience, one of them might be the subjective feeling of empowerment that long COVID sufferers feel due to the support from their friends and relatives (Humphreys et al., 2021; Shelley et al., 2021). Similar conclusions have been drawn about the relationship between social support and physical activity in healthy populations as well (Orsega-Smith et al., 2007). Social support appears to be a significant predictor of exercise behaviour, regardless of age or medical status (Dishman et al., 2009; Orsega-Smith et al., 2007). Since social support is a multifaceted construct that might influence physical activity through a variety of pathways, it is important to hypothesize about the mechanism through which it affects physical activity in this context.

The role of self-efficacy

Self-efficacy is a popular psychological construct originally proposed by Albert Bandura, that has since been used in a multitude of behavioural models and theories (Bandura et al., 1999). It describes the extent to which an individual believes in their ability to perform a particular action (Bandura et al., 1999). Self-efficacy becomes especially important when there are certain barriers that need to be overcome by the individual (Bandura et al., 1999). Self-efficacy has been found to predict of physical activity multiple times, however, mostly in populations who did not suffer from diseases that are comparable to long COVID (Dishman et al., 2009; McAuley & Blissmer, 2000). This relationship might be even stronger in long COVID populations, as the barriers to

engage in physical activity are bigger due to the symptoms these individuals are enduring. This could mean that for long COVID sufferers, even more self-efficacy would be required to facilitate uptake and maintenance of physical activity. After all, findings from qualitative studies suggest that a substantial amount of long COVID sufferers experience symptom relapses which might trigger serious doubts in them regarding their ability to do physical activities (Humphreys et al., 2021; Pavli et al., 2021).

Self-efficacy also has an interesting relationship with physical activity when factoring in social support as well. Social support and self-efficacy appear to be predictors of physical activity also when they are present in the same model (Dishman et al., 2009; Orsega-Smith et al., 2007). There have been multiple attempts to investigate this triangular relationship with different models that posed both either as main independent variable, mediator, or moderator (Dishman et al., 2009; Orsega-Smith et al., 2007). In the case of COVID-19 long COVID sufferers, it appears likely that self-efficacy might be a mediating construct that explains the positive effect of social support on the activity level of sufferers. To elaborate, as sufferers describe a feeling of empowerment after receiving support either online or from their immediate circle (Humphreys et al., 2021; Shelley et al., 2021), it is likely that the practical advice they received, or merely the physical presence of a close person positively impacts their attitude towards their own ability to become active again. This increased confidence in their ability to act would then prompt them to pick up physical activity again. Therefore, it would be interesting to investigate the relationship between social support and physical activity in long Covid sufferers, and the role that self-efficacy plays in this context.

Current study

Supporting long Covid sufferers in their recovery is an important task for medical doctors, but also clinical psychologists, considering the severe negative implications long COVID can have for the mental health of affected individuals (Aiyegbusi et al., 2021;

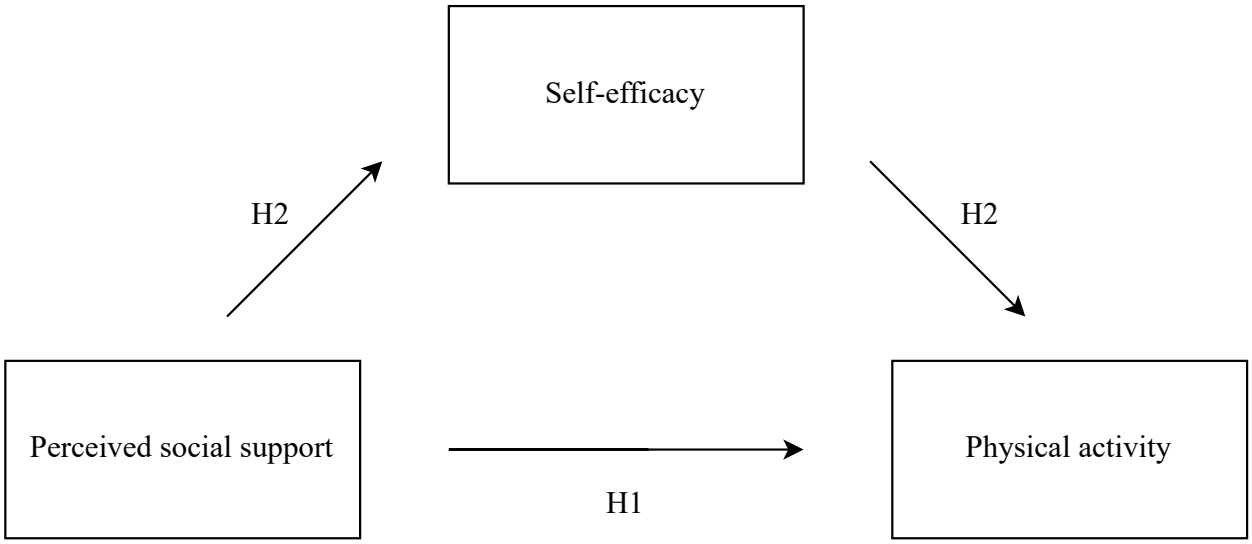
Amdal et al., 2021; Pavli et al., 2021). Therefore, it is important to identify factors that can aid in the recovery of long COVID, that could potentially be influenced in future (positive) psychological interventions. As it seems highly likely that physical activity is an important facilitator of that recovery process, it could be valuable to investigate which factors motivate long COVID sufferers to become active again. Even though the scientific evidence about these are currently still limited, studies already strongly imply that social support might be one predictor of physical activity (Humphreys et al., 2021; Shelley et al., 2021). Additionally, self-efficacy for physical activity has been proposed as a potential mediating factor that partly explains the relationship between social support and physical activity in long Covid populations. For the current study, this leads to the following research questions: *To what extent does social support affect physical activity in long COVID sufferers?* And secondly: *To what extent is the relationship between social support and physical activity explained by self-efficacy in long COVID sufferers?*. An overview of the theoretical model of the current study can be found in figure 1 In line with the implications from previous research, two subsequent hypotheses arise:

H1: Perceived social support predicts physical activity in long COVID sufferers.

H2: Self-efficacy, partially, mediates the relationship between perceived social support and physical activity in long COVID sufferers.

Figure 1

Theoretical Model of the current study.



Methods

Design

The current study used a cross-sectional design to study the relationship between perceived social support and physical activity in long COVID sufferers. Additionally, it was investigated whether this relationship is mediated by physical activity-related self-efficacy. The study was part of a larger research project involving six Bachelor students in total. Therefore, all data collection was performed collectively and the same sample of participants was studied. Data collection was conducted using the online tool *Qualtrics* from 8th of April until 21st of May 2022. The study's compliance with all ethical guidelines was confirmed by the BMS ethics board of the University of Twente (request number: 220405).

Participants

Participants were approached using convenience sampling and snowball sampling, asking friends and family of the research team to whether they know others who experience long COVID symptoms. Additionally, the social media platforms *Reddit*, *Instagram* and *Facebook* were used to reach a larger number of affected individuals. To be included in the study, participants had to be infected with SARS-CoV-2 at least 12 weeks ago or longer from the time of their participation. Participants had to experience at least the symptom fatigue to ensure that at least a certain degree of impairment was present. Other inclusion criteria was that participants had to be fluent in either German or English and at least 18 years old. Based on power calculations by Fritz and MacKinnon for the desired mediation analysis, a sample size of at least 75 participants was originally aimed for (Fritz & MacKinnon, 2007).

Materials

Physical activity

The level of physical activity of the participants was measured using the International Physical Activity Questionnaire short version (IPAQ) (Craig et al., 2003). The IPAQ measures physical activity for walking, moderate and vigorous activities that include sports as well as regular walking (Craig et al., 2003). It was used since there are validated versions in both English and in German available. Additionally, the questionnaire comprises only 7 items. The questionnaire was scored according to a Method proposed by (Craig et al., 2003). For each participant, the total number of minutes of a given physical activity of the previous week was multiplied by the number of days that participant did that activity. The resulting score was multiplied with an additional factor depending on the type of physical activity that was performed (E.g., 8 for vigorous activity). This was repeated for each activity type separately first. Additionally, a total MET score was created by summing the total scores of the three activity types that were used in the

analysis. The questionnaire shows good test-retest reliability, with Spearman's ρ clustering around .8 (Craig et al., 2003). Different measures of validity show mostly acceptable results (Craig et al., 2003; Hagströmer et al., 2006).

Social support

Social support was measured using an adapted version of the Social Provisions scale (SPS) (Motl et al., 2004). The scale measures social support regarding physical activity for adolescents. It was deemed appropriate for the current study as it is one of the few instruments available that measures social support for physical activity specifically in multiple dimensions (Motl et al., 2004). Completion of the scale includes rating statements on a 4-point Likert-type scale, ranging from 1 = *disagree a lot* to 4 = *agree a lot*. Generally, it was aimed to keep the final questionnaire as short as possible to ensure that participants who were struggling with concentration issues or fatigue due to their condition were not overwhelmed by the study. Therefore, ultimately only six items out of the original 24 were used in the finals scale which will be called perceived social support scale (PSS) from here onward. Both the original and the adapted versions of the scale can be found under A1, A2 and A3. Additionally, two items were slightly adapted to reverse the negative wording of the items into a positive wording to keep them more consistent and prevent confusion in the participants. This way, for example, the statement: *There is no one who rewards me for being physically active*, was changed to: *There is someone who rewards me for being physically active*. The scale was translated to German in cooperation with other students who are proficient in both languages.

Self-efficacy

Self-efficacy was measured using an adapted version of a self-efficacy for physical activity scale that was developed to assess the level of self-efficacy for women with fibromyalgia (López-Roig et al., 2021). The scale provides some items that assess self-efficacy regarding the ability to perform physical activities despite symptoms like

fatigue, pain, or sadness (López-Roig et al., 2021). The scale proposes 25 items that participants are asked to rate on a 10-point Likert-type scale that ranges from 1 = *not at all confident* to 10 = *completely confident* (López-Roig et al., 2021). As there is no scale measuring self-efficacy that is widely used and validated and since this scale is also targeted at a clinical population that shares at least some symptomatic similarities with long COVID sufferers, the scale was considered the best option for the current study (López-Roig et al., 2021).

Still, the scale was adapted for multiple reasons. The total number of items and symptoms was reduced. Fatigue and pain were kept as they are also considered very common symptoms of long COVID (Soriano et al., 2021). All other symptoms of the original scale were replaced by the long COVID symptoms shortness of breath and depressed mood. Each statement was once paired with fatigue and once with the three other symptoms together in a list. This resulted ultimately in a total of six items to measure self-efficacy. The 10-point Likert-type scale was adopted from the original questionnaire. A complete list of all original and adapted item of the self-efficacy scale (SES) can be found in the appendix under A4 and A5. The German translation was validated with the help of other students who are also proficient in both languages.

Demographics and illness related variables

The final part of the survey included a number of demographic questions as well as questions exploring the nature of the participants' symptoms. For gender, participants had to indicate whether they were male, female, or other. The question *How old are you?* provided a text-entry box where participants had to enter their age in numbers. The Question *What is your nationality?* gave the answer options *German*, *Dutch* or *Other*, which had an additional text-entry box, so participants could manually indicate their nationality. Another question asked participants whether they found out about their infection due to a PCR test, an Antigen test, or whether they only assumed that they had

been infected by SARS-CoV-2. The next question instructed participants to indicate their current symptoms and provided the following answer options: *fatigue/tiredness; cough; fever and chills; shortness of breath; difficulties moving or talking; loss of taste and smell; difficulties concentrating, memory problems and/ or confusion; pain/aches or soreness; changes in mood and/or anxiety.* Additionally, there was a text-entry box to allow for the inclusion of other symptoms. Finally, in the remaining three questions, participants had to indicate whether they were hospitalized during their original COVID-19 infection, whether they suffered from any physical impairments and what the approximate date of their original infection was.

Procedure

Participants received a link that provided access to the survey on *Qualtrics*. First, participants were provided information about the purpose and content of the study and the confidentiality with which their data would be treated. Afterwards, they were asked for their informed consent. Before the different questionnaires were shown, participants had to indicate whether they had contracted COVID-19 more or less than 12 weeks ago or if they had not had contracted it at all up to that point. In case their answer was anything other than *more than 12 weeks ago* they were immediately forwarded to the end of the survey. Those that fulfilled that inclusion criterion were then presented with all the questionnaires of the survey. Before each new part, participants received a short explanation about the construct and the nature of the questions. After completing the survey, participants were thanked for their participation and were provided with the E-Mail address of one of the researchers, in case they still had any questions or remarks.

Data analysis

All the collected data was exported from the *Qualtrics* platform and imported into *IBM SPSS* version 28.0.1. Participants who did not fulfil the inclusion criterion of having

been infected with COVID-19 12 weeks or longer ago, who did not answer some items or did not indicate fatigue as one of their current symptoms were excluded from the analysis.

Next, the reliability of the used scales was assessed by calculating Cronbach's Alpha. Descriptive statistics were used to explore the data regarding all instruments and all demographic and illness related variables. For every construct, means and standard deviations were calculated. The German translation of the English version of the SES and the PSS was validated by comparing the mean scores of the participants that completed the German questionnaire with the mean scores of the English-speaking participants on both the PSS and the SES with a simple linear model. For this, a language variable was created that indicates which version of the questionnaire was completed by a given participant.

The assumptions of normality, equal variances of residuals and linearity were checked by examining different residuals plots of the models that were needed to answer the hypotheses. To check the assumption of independence of residuals, multiple demographic variables were examined regarding their potential effects on physical activity.

For all the following analyses, standardized z-scores were used to ensure the comparability of the scales. To answer the first hypothesis that perceived social support predicts physical activity, a simple linear regression model was used, treating perceived social support as predictor and the total MET score as outcome.

To answer the second hypothesis, that the relationship between perceived social support and physical activity is mediated by self-efficacy, the macro PROCESS for SPSS was used (Hayes, 2017). To somewhat account for the small sample size, the bootstrapping method was used within the PROCESS macro. The total effect, direct effect and indirect effect of perceived social support on physical activity were examined. the indirect effect, that gives an estimation of the size of mediation effect, was used to answer the hypothesis. For both hypotheses, relevant parameter estimates and 95 percent confidence intervals of the respective analyses were examined.

Results

Participant flow

Originally, 326 Individuals accessed the link to the study. Out of those, 216 gave their confirmed consent and were thus considered participants of the study. Participants who did not meet the inclusion criterion were immediately forwarded to the end of the study. After removing those from the data set, 119 participants were left. Next, the 60 participants who did not indicate fatigue as one of their symptoms or did not answer all the questions assessing the relevant constructs were also excluded from the analysis. One participant was removed from the dataset as they indicated a physical activity level which was unrealistically high. Another participant was excluded as they indicated being 17 years old. The final dataset comprised 57 participants.

Descriptive statistics

A detailed overview of all demographic and illness related variables can be found in tables 1 and 2 for the most common symptoms. Participants were aged between 18 and 62 years old ($M = 35$, $SD = 13.1$). The sample consisted to a large part of females (70.2%, $n = 40$). Aside from German and Dutch, common nationalities include Canadian, US-American and British. Next to fatigue, *difficulties concentrating, memory problems and/or confusion* was the most common symptom (86%, $n= 49$). Only a small fraction of the sample was hospitalized due to their condition (7.0%, $n = 4$). On average, participants reported 6 symptoms while the minimum number of reported symptoms was 2 and the maximum 9.

Table 1

Demographics and Illness-related variables

Variable	*n*	%
Gender		
Male	17	29.3
Female	40	69.0
Other	1	1.7
Nationality		
German	21	36.2
Dutch	2	3.4
Other	35	60.3
Hospitalization	4	6.9
Physical impairment	8	13.8
Diagnosis		
PCR test	35	60.3
Antigen test	10	17.2
Assumed infection	13	21.6

Note. $N = 57$; other nationalities include American, French, Britian, Canadian, Indian, Hungarian, Pakistani, Italian, Finnish,

Table 2

Symptoms of participants in this sample

Symptoms	*n*	%
Fatigue	57	100
Cough	14	24.6
Fever and chills	10	17.5
Shortness of breath	39	68.4
Difficulties moving or talking	32	56.1
Loss of taste or smell	15	26.3
Difficulties concentrating, memory problems and/or confusion	49	86.0
Pain / aches	41	71.9
Changes in mood and/or anxiety	41	71.9
Other	26	45.6

Note. $N = 57$; Other symptoms include tinnitus, neuropathy, insomnia, muscle twitching, throat swelling, post exertional malaise, seizures, nausea, PTSD, Depression

For the three constructs, descriptive statistics can be examined in table 3. No floor or ceiling effects were observed. The scores displayed in table 3 indicate that in this study, participants showed levels of both perceived social support and self-efficacy that are neither and the really high nor at the really low spectrum of the possible scores. For the total MET score, the scores varied significantly, meaning that participants indicated very differing levels of physical activity. The minimum number of hours per week that participants indicated being physically active was 0 while the maximum was 122 ($M = 15.3$, $SD = 22.3$).

Table 3

Descriptive statistics for physical activity, social support and self-efficacy

Construct	Min	Max	*M*	*SD*
Total MET score	0	24549	2638.7	4302.1
Social support	6	24	15.8	3.3
Self-efficacy	6	58	32.8	16.6

Note. $N = 57$

Reliability and validation of translations

Cronbach's α was used to assess the internal consistency of the two adapted scales. The PSS showed unacceptable reliability, with a Cronbach's α of .40. the SES was excellently reliable, with a Cronbach's α of .94. To compare the German and English versions of the SES and PSS scales that were created for this study, a simple linear regression analysis was performed, treating the language variable as predictor and the score on the respective scale as outcome. No significant differences between the mean scores on the SES ($b = 4.49$, $p = .39$) or the PSS ($b = 1.36$, $p = .19$) were observed.

Assumptions of the linear models

The assumptions of linearity, equal variances of residuals, normality, and independence of residuals were checked for every linear model in this study. After removal of the extreme outlier mentioned in the participant flow, no violation of the assumption of linearity or equal variances could be observed. The assumption of normality appeared to be violated for every model. The bootstrapping method was employed used to account for this non-normality. Controlling for the different demographic and illness-related variables in this study did not fundamentally impact any of the effect sizes of the models discussed below. It was therefore concluded that the assumption of independence of residuals was not violated in any model.

Hypothesis testing

Hypothesis 1

To test the first hypothesis that perceived social support predicts physical activity, a simple linear model was used, treating perceived social support as predictor and the total MET scores as outcome. The model was found to be not significant with $R^2 = <.001$, $F(1, 55) = .02$, $p = .88$. The relationship was found to be not significant with (B = -.02, $t(56)$ = -.15, 95% CI [-.29,.25], $p = .88$). This refutes the first hypothesis.

Hypothesis 2

To answer the second hypothesis, that the relationship between perceived social support and physical activity is mediated by self-efficacy, the mediation analysis macro PROCESS for SPSS was used. The overall model using perceived social support as well as perceived self-efficacy as predictors and the total MET scores as outcome was found to be significant with $R^2 = .44$, $F(2, 54) = 6.4$, $p = <.01$. The total effect of perceived social support on physical activity was found to be not significant with (B = -.02, $t(56)$ = -.15, 95% CI [-.29,.25]; $p = .88$). The direct effect of perceived social support on physical activity was found to be not significant with (B = -.04, $t(56)$ = -.33, 95 %CI [-.29,.21], p = .76). To test the hypothesis, the indirect effect of perceived social support was examined and found to be not significant with (B = .02, 95% CI [-.11,.17]). This refutes the second hypothesis. Self-efficacy was found to be a significant predictor of physical activity with (B = .44, $t(56)$ = 3.60, 95 %CI [.19,.68], $p = <.001$). In this study, people that score relatively high on the SES also show relatively high levels of physical activity. A insignificant effect of perceived social support on self-efficacy was observed (B = .05, $t(56)$ = .33, 95% CI [-.23,.32], $p = .74$).

Discussion

In the following sections, the compatibility between the findings of the current study and implications from previous studies will be explored. The current study aimed to investigate the relationship between perceived social support and physical activity in long COVID sufferers, while simultaneously considering a potential mediating role of self-efficacy for physical activity. It was hypothesized that perceived social support predicts physical activity in long COVID sufferers, and that this relationship is partially mediated by self-efficacy for physical activity. These hypotheses study were based on previous qualitative and quantitative studies with long COVID- as well as other populations (Dishman et al., 2009; Humphreys et al., 2021; Orsega-Smith et al., 2007; Shelley et al., 2021). For neither of these two hypotheses, support was found. There are multiple potential reasons for that.

One aspect that might help to understand the findings of the current study is the multidimensionality of the social support construct. It was speculated in this study that instrumental support, informational support, and emotional support could be particularly relevant in this context (Humphreys et al., 2021; Shelley et al., 2021). However, since that assumption was solely based on qualitative statements by sufferers, a certain level of interpretation was necessary to define the relevant constructs for the current study. It is therefore possible that other dimensions of social support might be equally relevant here. After all, definitions of social support and its underlying factors vary greatly and might require different methods of assessment (Motl et al., 2004; Orsega-Smith et al., 2007). This is underlined by the fact that the internal consistency of the PSS was unacceptable in this study, which implies that the scale did not measure one consistent construct. Additionally, the PSS was composed of only six items. While these six items were specifically chosen to measure instrumental, informational and emotional support, it is likely that such a small number of items is unable to grasp the entirety of a construct like social support, especially since the original Social Provisions scale was composed of 24 items. It is therefore possible

that the current study did not manage to assess the exact type of social support that it originally aimed to.

Another important aspect that might explain the findings of the current study is related to the type of physical activity that the IPAQ measures. It has been established that for many long COVID sufferers a substantial part of their physical activity consists of ADL and that due to impairment, actual exercise often becomes difficult (Humphreys et al., 2021; Raveendran et al., 2021). As the IPAQ measures physical activity in the dimensions walking, moderate and vigorous physical activity, ADL are not entirely covered by it (Craig et al., 2003). Therefore, it is possible that a substantial part of the physical activity construct that is relevant here was not measured in the current study. This assumption is supported by the descriptive data this study generated. The variance of the total MET scores was really high. At the same time, there was a significant number of participants who indicated not being physically active at all, which would seem unlikely had the IPAQ also measured ADL, which are necessary for one's survival. Subsequently, it seems likely that the relationship that was assessed in the current study is not necessarily the relationship that was hypothesized about, since the constructs were not measured accurately.

The second hypothesis of the current study proposed that self-efficacy functions as a mediating variable between social support and physical activity in long COVID sufferers, based on previous studies indicating self-efficacy as an important predictor of physical active behaviour (Dishman et al., 2009; Orsega-Smith et al., 2007). This hypothesis could not be confirmed, as the indirect effect of social support on physical activity was insignificant, which refutes the idea of a mediating effect of self-efficacy. While the scientific literature clearly suggests self-efficacy as a predictor of physical activity (Dishman et al., 2009), the idea of a mediating role of self-efficacy in this specific context was based more on logical reasoning rather than hard evidence. After all, current literature does not give a consistent image regarding the specific role that self-efficacy occupies in relation to

social support and physical activity, as some also propose it as a moderator or as a main predictor of physical activity that is mediated by social support (Dishman et al., 2009; McAuley & Blissmer, 2000). This is also supported by the fact that within the mediation model, no effect of social support on self-efficacy could be detected. Therefore, it might either be that self-efficacy is not a mediator for this relationship or that the originally proposed relationship between social support and physical activity does not exist in reality.

However, a substantial part of the mediation model, the effect of self-efficacy on physical activity, turned out to be significant. While this finding has some important implications for the subject, it is not particularly surprising. Self-efficacy has been repeatedly found to be a major predictor of physical activity for many years (Bandura et al., 1999; Bauman et al., 2012). Still, it is interesting that the current study was able to replicate this finding in a novel population. The role of self-efficacy in this case might have some implications for clinical and psychological interventions for long COVID that could aim to increase a patient's self-efficacy and subsequently increase their level of physical activity.

Strengths and limitations

One major strength of the current study is that it is focused on a relatively novel topic that is explored in a population that is still largely unexplored from many scientific angles. The current study is one of the first psychological undergraduate research projects that investigated a sample of long COVID sufferers quantitatively. Even though the current study was not able to use a sample that was large enough to generate the desired power, the sample had some inherent qualities. For example, the pool of participants was relatively diverse regarding age, gender and nationality, which results in very informative descriptive properties. Mapping out the frequencies of common symptoms of long COVID confirmed the findings of previous long COVID studies, which is valuable considering the novelty of the subject. At a such an early point in the history of the condition, any new

quantitative study adds to the collective understanding of its symptoms and causes.

The limitations of the current study are mostly of methodological nature. the first issue concerns the materials that were used to measure the relevant constructs. As established, both the SES as well as the PSS were versions of other questionnaires that were adapted, reduced in size and translated to be applicable to this study and its population. There were no other measures available to compare the materials against and thus to validate them. The same issue affected the validation of the German translation of the scales, since the method of validation that was used only gives a broad indication of the quality of the translation and the German sample was far too small (n= 13) to generate valid findings. This appears to be particularly troublesome for the PSS that showed unacceptable internal consistency as well. These aspects, in combination with the sample size that remained below expectations and is statistically underpowered, significantly limit the theoretical implications that this study is able to generate.

The second limitation of the current study is related to the inclusion criteria for the participants. The inclusion criteria for the current study were kept relatively broad to ensure the largest possible sample size and to prevent unnecessary exclusion based on unproven assumptions about the symptomatology of the disease. The results of the study indicated a great variance of physical activity levels between the participants, where some individuals appeared to be not physically active at all while others displayed levels of physical activity that would not be considered possible for someone who is suffering from (at least) strong fatigue. Hence, it is likely that participants in this study experienced similarly varying severity of symptoms. However, the hypotheses of this study were built on the notion that long COVID sufferers experience a degree of physical impairment that limits their ability to maintain their normal functioning due to their symptoms. It is thus possible, that the theoretical ideas of this study did not apply to a certain part of the sample. In retrospect, it would likely have been a good course of action to establish an additional inclusion criterion that filters participants based on a predefined level of

symptom severity.

Future research

Despite its limitations, the study has some important implications for future research. First, future studies should investigate the relationship between social support and physical activity further, as the literature still strongly implies a possible relationship between these constructs. However, other researchers should first create and validate accurate measures that assess perceived social support regarding physical activity in long COVID sufferers. These measures should assess the various sub dimensions of social support separately and recognize the varying nature of the construct. However, it could be equally valuable to treat the different sub dimensions of social support as separate constructs entirely. This way it can be investigated in detail which types of social support are valuable to motivate long COVID sufferers for physical activity, which could be used in future psychological or clinical interventions.

Next, the potential effect of self-efficacy on physical activity in long COVID sufferers should be further investigated using experimental research designs to have stronger evidence for the causality. As self-efficacy on its own is not a construct that is sufficient to inspire an entire intervention, it could be attempted to integrate self-efficacy into larger behavioural models that predict physical active behaviour in long COVID sufferers. These should utilize other positive psychological constructs that might play a role in this case and would have to be identified by future research. It is important that future researchers recognize the psychological factors that are relevant to this subject, and that future interventions integrate extensive (positive) psychological techniques into their programs.

Conclusion

The aim of the current study was to investigate the relationship between social support, self-efficacy and physical activity in a sample of long COVID sufferers. It was hypothesized that perceived social support would predict physical activity, and that this

relationship would be mediated by self-efficacy. Neither of these hypotheses were supported by the current study. Still, a significant effect of self-efficacy on physical activity was observed. The study posed some important implications for future research. Future studies will have to explore the effect of different types of social support on physical activity further among other potential facilitators, like self-efficacy. Additionally, more specialized measures will have to be developed that capture the essence of the types of physical activity and social support that are relevant here.

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Appendix

Questionnaires

Measures of physical activity

International Physical Activity Questionnaire (IPAQ) Short form (English version)

Think about all the vigorous activities that you did in the last 7 days. Vigorous physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

1. During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling?

_____ days per week

_____ No vigorous physical activities (Skip to question 3)

2. How much time did you usually spend doing vigorous physical activities on one of those days?

_____ hours per day

_____ minutes per day

_____ Don't know/Not sure

Think about all the moderate activities that you did in the last 7 days. Moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you didfor at least 10 minutes at a time.

3. During the last 7 days, on how many days did you do moderate physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis?

_____ days per week

_____ No moderate physical activities (Skip to question 5)

4. How much time did you usually spend doing moderate physical activities on one of those days?

_____ hours per day

_____ minutes per day

_____ Don't know/Not sure

Think about the time you spent walking in the last 7 days. This includes at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure.

5. During the last 7 days, on how many days did you walk for at least 10 minutes at a time?

_____ days per week

_____ No walking (Skip to question 7)

6. How much time did you usually spend walking on one of those days?

_____ hours per day

_____ minutes per day

_____ Don't know/Not sure

The last question is about the time you spent sitting on weekdays during the last 7 days. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

7. During the last 7 days, how much time did you spend sitting on a week day?

_____ hours per day

_____ minutes per day

_____ Don't know/Not sure

Table A1

Original Social Provisions scale

	Items	Response options			
		Disagree a lot	Disagree	Agree	Agree a lot
1	There are people I can count on to be physically active with me.	○	○	○	○
2	I do not have any friends or relatives who are physically active.	○	○	○	○
3	There is no one I can turn to for advice about physcial activity.	○	○	○	○
4	There are people who depend on me to help them be physically active.	○	○	○	○
5	I know people who enjoy the same physical activities that I do.	○	○	○	○
6	Other people think of me as being physically active.	○	○	○	○
7	I feel personally responsible for helping another person be physically active.	○	○	○	○
8	I am part of a group of people who have the same attitudes about physical activity.	○	○	○	○
9	Other people do not respect my physical skills and abilities.	○	○	○	○
10	There is no one to take over chores for me so I have time to be physically active.	○	○	○	○
11	I am good friends with at least one person who values physical activity.	○	○	○	○
12	There is someone I can talk to about physical activity.	○	○	○	○
13	There are people who recognize my skills and abilities at physical activity.	○	○	○	○
14	There is no one who shares my interests about physical activity.	○	○	○	○
15	No one relies on me for help with their physical activity.	○	○	○	○
16	There is a person I can turn to for advice if I have problems with physical activity.	○	○	○	○
17	I have close relationships with people who make me feel good about myself.	○	○	○	○
18	There is no one who rewards me for being physically active.	○	○	○	○
19	There is no one who i feel comfortable talking about physical activity.	○	○	○	○
20	There are people who admire my talents and abilities regarding physical activity.	○	○	○	○
21	I am not close to anyone who values physical activity.	○	○	○	○
22	There is no one who likes the same physical activites I do.	○	○	○	○
23	There are people who will change their schedule to be physically active with me.	○	○	○	○
24	No one counts on me to be physically active with them.	○	○	○	○

Table A2

Adapted Social Provisions Scale (SPS)

	Items	Response options			
		Disagree a lot	Disagree	Agree	Agree a lot
1	There are people I can count on to be physically active with me.	○	○	○	○
2	There is a person i can turn to for advice if I have problems with physical activity.	○	○	○	○
3	There is someone to take over chores for me so I have time to be physically active.	○	○	○	○
4	There are people who will change their schedule to be physically active with me.	○	○	○	○
5	There is someone who rewards me for being physically active.	○	○	○	○
6	I have close relationships with people who make me feel good about myself.	○	○	○	○

Table A3

Adapted Social Provisions Scale (SPS) German version

	Items	Antwort Optionen			
		Stimme überhaupt nicht zu	Stimme nicht zu	Stimme zu	Stimme voll zu
1	Es gibt Menschen, bei denen ich darauf zählen kann, dass die mit mir körperlich aktiv sind.	○	○	○	○
2	Es gibt eine Person, die ich um Rat fragen kann, wenn ich Probleme mit körperlicher Aktivität habe.	○	○	○	○
3	Es gibt jemanden, der mir die Hausarbeit abnimmt, damit ich Zeit habe, körperlich aktiv zu sein.	○	○	○	○
4	Es gibt Menschen, die ihren Zeitplan ändern würden, um mit mir körperlich aktiv zu sein.	○	○	○	○
5	Es gibt jemanden, der mich belohnt, wenn ich körperlich aktiv bin.	○	○	○	○
6	Ich habe enge Beziehungen zu Menschen, die mir ein gutes Gefühl geben.	○	○	○	○

Table A4

Original self-efficacy for physical activity for fibromyalgia scale

item	How confident are you that you can ...	Response options									
		Not at all confident									Completely confident
	... walk fast to do exercise over 30 minutes at least twice a week despite...										
1	Experiencing pain	○	○	○	○	○	○	○	○	○	○
2	Feeling fatigue	○	○	○	○	○	○	○	○	○	○
3	Suffering from bad weather (heat, cold, rain)	○	○	○	○	○	○	○	○	○	○
4	Feeling stressed, sad or worried	○	○	○	○	○	○	○	○	○	○
5	Having a bad day due to fibromyalgia	○	○	○	○	○	○	○	○	○	○
	... walk fast to do exercise over 60 minutes at least twice a week despite...										
6	Experiencing pain	○	○	○	○	○	○	○	○	○	○
7	Feeling fatigue	○	○	○	○	○	○	○	○	○	○
8	Suffering from bad weather (heat, cold, rain)	○	○	○	○	○	○	○	○	○	○
9	Feeling stressed, sad or worried	○	○	○	○	○	○	○	○	○	○
10	Having a bad day due to fibromyalgia	○	○	○	○	○	○	○	○	○	○
	...walk at least 30 minutes taking advantage of going to work, shopping or taking the dog out despite ...										
11	Experiencing pain	○	○	○	○	○	○	○	○	○	○
12	Feeling fatigue	○	○	○	○	○	○	○	○	○	○
13	Suffering from bad weather (heat, cold, rain)	○	○	○	○	○	○	○	○	○	○
14	Feeling stressed, sad or worried	○	○	○	○	○	○	○	○	○	○
15	Having a bad day due to fibromyalgia	○	○	○	○	○	○	○	○	○	○
...spend at least 30 minutes doing a light physical activity (not increase your breathing) like going upstairs or swimming despite...											
16	Experiencing pain	○	○	○	○	○	○	○	○	○	○
17	Feeling fatigue	○	○	○	○	○	○	○	○	○	○
18	Suffering from bad weather (heat, cold, rain)	○	○	○	○	○	○	○	○	○	○
19	Feeling stressed, sad or worried	○	○	○	○	○	○	○	○	○	○
20	Having a bad day due to fibromyalgia	○	○	○	○	○	○	○	○	○	○
	...spend at least 30 minutes doing a moderate physical activity										
	(increase somewhat your breathing and perspiration) like dancing or cycling at a regular pace, despite...										
21	Experiencing pain	○	○	○	○	○	○	○	○	○	○
22	Feeling fatigue	○	○	○	○	○	○	○	○	○	○
23	Suffering from bad weather (heat, cold, rain)	○	○	○	○	○	○	○	○	○	○
24	Feeling stressed, sad or worried	○	○	○	○	○	○	○	○	○	○
25	Having a bad day due to fibromyalgia	○	○	○	○	○	○	○	○	○	○

Table A5

Adapted self-efficacy for physical activity scale (SES)

item	How confident are you that you can ...	Response options									
		Not at all confident									Completely confident
	...walk at least 30 minutes taking advantage of daily situations like for example going to work, shopping or taking the dog out despite...										
1	Feeling fatigue	○	○	○	○	○	○	○	○	○	○
2	Experiencing other symptoms (for example: pain, shortness of breath, depressed mood)	○	○	○	○	○	○	○	○	○	○
	...spend at least 30 minutes doing a light physical activity (that does not increase your breathing) like walking stairs, cooking or doing the dishes, despite...										
3	Feeling fatigue	○	○	○	○	○	○	○	○	○	○
4	Experiencing other symptoms (for example: pain, shortness of breath, depressed mood)	○	○	○	○	○	○	○	○	○	○
	spend at least 30 minutes doing a modearte physical activity (that somewhat increases your breathing and perspiration) like dancing or cycling at a regular pace, despite...										
5	Feeling fatigue	○	○	○	○	○	○	○	○	○	○
6	Experiencing other symptoms (for example: oain, shortness of breath, depressed mood)	○	○	○	○	○	○	○	○	○	○

Table A6

Adapted self-efficacy for physical activity (SES) German version

item	Wie sicher sind sie dass sie...	Antwort Optionen									
		Überhaupt nicht sicher									Sehr sicher
	...mindestens 30 Minuten zu Fuß gehen können, wenn Sie Alltagssituationen wie z. B. den Weg zur Arbeit, zum Einkaufen oder den Spaziergang mit dem Hund nutzen, trotz...										
1	Müdigkeit oder Erschöpfung	○	○	○	○	○	○	○	○	○	○
2	Anderer Symptome (Schmerzen, Kurzatmigkeit, gedrückte Stimmung)	○	○	○	○	○	○	○	○	○	○
	...in der Lage sind, mindestens 30 Minuten eine leichte körperliche Tätigkeit (die Ihre Atmung nicht erhöht), z. B. Treppensteigen, Kochen oder Abwaschen ausüben können, trotz...										
3	Müdigkeit oder Erschöpfung	○	○	○	○	○	○	○	○	○	○
4	Anderer Symptome (Schmerzen, Kurzatmigkeit, gedrückte Stimmung)	○	○	○	○	○	○	○	○	○	○
	...mindestens 30 Minuten lang eine gemäßigte körperliche Aktivität (die Ihre Atmung und ihr Schwitzen etwas erhöht) wie Tanzen oder Radfahren in einen gleichmäßigem Tempo ausüben können, trotz...										
5	Müdigkeit oder Erschöpfung	○	○	○	○	○	○	○	○	○	○
6	Anderer Symptome (Schmerzen, Kurzatmigkeit, gedrückte Stimmung)	○	○	○	○	○	○	○	○	○	○