The Influence of Physical Self-Efficacy on the Relationship Between Physical Activity and Depressive Symptoms in Post-COVID Sufferers

Bachelor Thesis

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Abstract

Background: Many people currently suffer from post-COVID, which affects their physical and mental health with long-lasting symptoms. Previous research already linked physical activity and depression but not in the context of post-COVID. Therefore, this study aimed to investigate the relationship between depressive symptoms and physical activity in post-COVID sufferers and whether this relationship is mediated by physical self-efficacy (an individual's belief in their capacity to be physically active).

Method: Through convenience sampling, 59 valid responses (M_{age} = 35.6, SD_{age} = 13.3, 74.6% female) have been collected via an online cross-sectional survey in Qualtrics. The correlation between depressive symptoms and physical activity has been analysed using Kendall's Rank Order Correlation. For the mediation analysis, PROCESS macro for SPSS by Hayes was used.

Results: There was no significant correlation between depressive symptoms and physical activity, and no mediating effect of physical self-efficacy has been found.

Conclusion*:* The non-significant correlation between depressive symptoms and physical activity was not expected, and the mediating effect of physical self-efficacy on that relationship could not be confirmed either. Those results might be caused by several limitations of that study, namely violation of assumptions and choice of instruments. Another interesting finding is that the expectation that high levels of physical activity would cause low levels of depressive symptoms could not be confirmed as scores for both variables have been high in this sample. Future studies should change the design and instruments and control for confounding variables that might influence this relationship.

Keywords: Post-COVID, Physical Activity, Depression, Physical Self-Efficacy, Mediation Analysis

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The Influence of Physical Self-Efficacy on the Relationship Between Physical Activity and Depressive Symptoms in Post-COVID Sufferers

The relationship between depression and physical activity has already been researched a lot. However, in the setting of a global COVID-19 pandemic, in which post-COVID is a new challenge to the global health system, this relationship has not been investigated yet. Post-COVID is elicited by the novel coronavirus disease SARS-CoV-2, which significantly impacts the human body, mental health, and social aspects of humanity. The virus can attack the body in various ways, causing impairments to the nervous system, cardiovascular system, digestive system, and respiratory system. These impairments most commonly lead to symptoms like fatigue (Alimohamadi et al., 2020; Raveendran et al., 2021), shortness of breath (Alimohamadi et al., 2020; Ceban et al., 2022), cognitive dysfunction (Ceban et al., 2022) and generally have an impact on everyday functioning (Humphreys et al., 2021; Malik et al., 2021). Other symptoms include headaches, abdominal pain, chest pain, fever, coughing, and more (Baz et al., 2021; Raveendran et al., 2021; Woods et al., 2020). Besides, those symptoms appear not only during the typical two weeks of illness but can also last for months. This is often referred to as post-COVID or post-COVID syndrome (Raveendran et al., 2021; Yong, 2021). For this study, the formulation "post-COVID" will be used. The World Health Organization (2021) defines post-COVID as a condition occurring in individuals *"with a history of probable or confirmed SARS CoV-2 infection, usually three months from the onset of COVID-19 with symptoms and that last for at least two months and cannot be explained by an alternative diagnosis."* Symptoms "… *may be new-onset, following initial recovery from an acute COVID-19 episode, or persist from the initial illness"* and "… *fluctuate or relapse over time."* (World Health Organization, 2021, p. 1).

Due to its high infection rate and deadliness, incidences and reported death cases vastly proliferate (Wang et al., 2020). As of June 2022, over 540 million people got infected, and more than six million deaths connected to the virus have been reported (Statista, 2022).

One method to counteract the adverse effects of post-COVID could be being physically active (Humphreys et al., 2021; Maugeri & Musumeci, 2021). This research paper tries to build upon that by identifying several variables connected to physical activity. It will be investigated to what extent there is a relationship between depressive symptoms (DS) and physical activity (PA) in post-COVID sufferers and if physical self-efficacy (PSE) mediates this association.

Physical Activity in Post-COVID Sufferers

The symptoms, as mentioned earlier, lead to many post-COVID sufferers reporting struggles with being physically active after overcoming their acute infections. In the study of Humphreys et al. (2021), post-COVID sufferers reported being tired and quickly exhausted while having problems concentrating. This often affects people that try to return to their normal state of life, including their mental health and physical activity. Physical activity (PA) can be described as any movement involving skeletal muscle causing energy expenditure like walking, gardening chores, running or sitting on the couch and reading (Stockwell et al., 2021). This can be classified into three categories: Light PA, moderate PA, and vigorous PA. Those categories depend on the metabolic equivalents (METs) required to perform a particular activity (Sylvester et al., 2017). Behaviours that require less than 1.5 METs, like working in front of a computer, would be described as sedentary behaviour (Barnes et al., 2012). According to Harvard (2017), one example of light PA (<3.0 METs) would be going for a slow walk, whereas walking quickly (about 6.4 km/h) would be considered moderate PA (3.0-6.0 METs). PA exceeding the 6.0 METs mark would be defined as vigorous PA, such as hiking or playing soccer.

Two critical distinctions must be made regarding PA. The first lies between being and getting physically active. Being physically active implies a person that is currently actively exercising regularly. Getting physically active is more about building one's PA to the moment where one considers oneself physically active. The second distinction is between exercising

and PA in everyday life. Exercising describes any bodily activity that enhances or maintains PA and overall health and is done in addition to daily PA that is necessary for everyday life (ADL). ADL thus can be walking from the bedroom to the bathroom, cooking, or doing household chores. This distinction is crucial in post-COVID since many infected people have reported problems with the latter definition of PA in everyday life (Humphreys et al., 2021; Malik et al., 2021). They mainly reported being tired and quickly exhausted while having problems concentrating (Humphreys et al., 2021; Malik et al., 2021). People who struggle with ADL tasks like doing laundry or cooking dinner might not have the energy to engage in any PA in addition to those activities, which, as mentioned earlier, is considered helpful in recovery.

Depression in Post-COVID Sufferers

The problem of not having any energy left for doing ADLs often affects people's mental health and their attempts to be physically more active (Malik et al., 2021; Meyer et al., 2020). Additionally, Stockwell et al. (2021) state that those physical problems might lead to mental issues. This negative impact on mental health caused by deficient PA has already been reported before the COVID-19 pandemic. Especially the relationship between PA and depression has been investigated in detail (Bailey et al., 2018; Kandola et al., 2019; Nyström et al., 2015). People showing signs of depression are most commonly described as experiencing *"... a lack of interest and pleasure in daily activities, significant weight loss or gain, insomnia or excessive sleeping, lack of energy, inability to concentrate, feelings of worthlessness or excessive guilt and recurrent thoughts of death or suicide*" (American Psychology Association, 2021, p.1). For example, Kandola et al. (2019) mention that PA might have a similar effect on depression as antidepressants. Similar brain regions are active, eliciting comparable changes to the brain as seen in antidepressants which are more protective against depression. Another explanation for this correlation between DS and PA might be that, for many people, being physically active is part of daily life. This includes doing some

household chores or walking but also intense PA, like going for a run three times a week. If those habits are disturbed by either the restrictions through the government or the effects of an infection, this could cause people to feel more DS (Lai et al., 2021).

Furthermore, several studies investigated to what extent post-COVID sufferers felt a decrease in their quality of life (Malik et al., 2021; Meyer et al., 2020; Shanbehzadeh et al., 2021). It has been found that around 37.5% of post-COVID sufferers reporting a reduction in their quality of life, especially had to fight symptoms of anxiety and depression (Malik et al., 2021). This could be caused by limitations in their usual way of living and physical abilities (Malik e al., 20121; Meyer et al., 2020). Thus, the negative influence of post-COVID on the mental health of people suffering from post-COVID might cause a reduction in the amount of PA.

Physical Self-Efficacy in Post-COVID Sufferers

One question that remains is whether there is another variable that might help to explain this correlation between DS and PA. A psychological concept that seems promising in association with PA and depression, in general, is self-efficacy (Bodin & Martinsen, 2004; Cortis et al., 2017). Self-efficacy is an individual's belief in their capacity to execute behaviours necessary to produce a specific performance or action (Bodin & Martinsen, 2004; Cortis et al., 2017; Peers et al., 2020). However, physical self-efficacy (PSE) is those beliefs in the context of PA (Thornton et al., 1987). Peers et al. (2020) found PSE to be a determinant of PA. It describes one’s belief in their capacity to perform certain physical activities.

Interest in this field has existed for a long time (Ewart, 1992; Ryckmann et al., 1982). The majority of conducted research focuses on the effect of PSE on different forms of PA (mainly exercising to certain levels of intensity) and the treatment of health-related risks like cardiovascular deficiencies (Ewart, 1992). In general, (physical) self-efficacy seems to positively affect the health of chronically ill people (Buckelew et al., 1995; López-Roig et al., 2021). This should be kept in mind when investigating the impact of PSE on post-COVID

sufferers since there are similarities between chronic illnesses like fibromyalgia or chronic obstructive pulmonary disease (COPD) and post-COVID in their symptoms (Buckelew et al., 1995; Selzler et al., 2020). For example, the study by Buckelew et al. (1995) identified self-efficacy's value in predicting physical activity among individuals with fibromyalgia.

The body of research seems to be undetermined regarding the role of self-efficacy as a mediator in the relationship between DS and PA. On the one hand, several studies have reported promising outcomes of those relations. For example, Craft (2005) and Kandola et al. (2019) investigated the antidepressant effects of PA, focusing on the psychological mechanisms of distraction and coping self-efficacy via a quasi-experimental intervention that promoted exercise for nine weeks in the experimental group. However, the emphasis of these studies did not lie on pre-existing levels of PSE but more on how exercise might increase self-efficacy and whether its antidepressant effects decrease feelings of depression. On the other hand, research has also been conducted where PSE could not be established as a mediator between PA and depression. For example, Pickett, Yardley, & Kendrick (2012) could not find a significant effect that confirmed their hypothesis that PSE would mediate the decrease of DS.

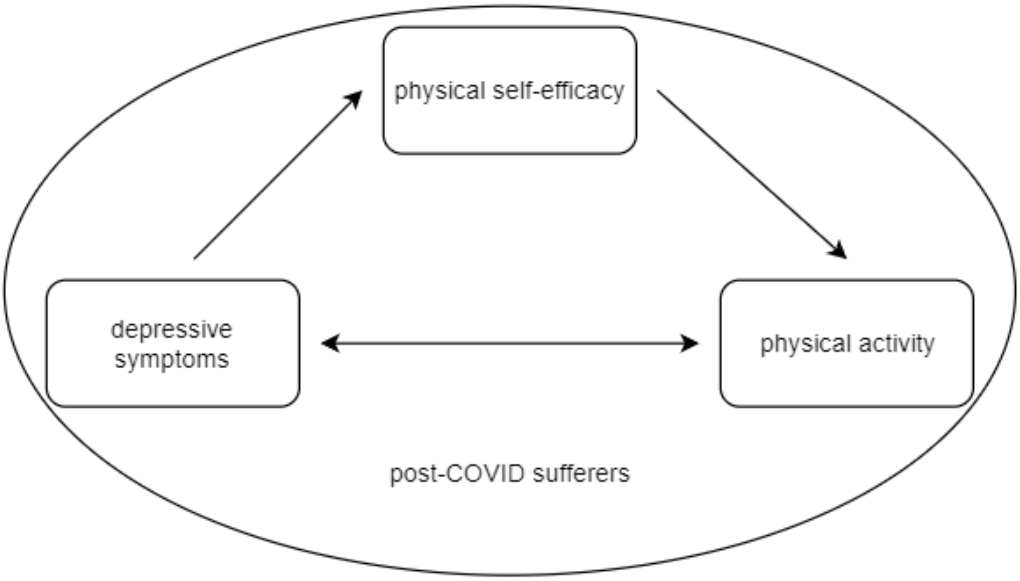
The Current Study

After reviewing several studies, it seems vital that more approaches should be investigated to support the recovery processes of individuals suffering from post-COVID. Research has shown that many infected individuals do not feel understood and struggle with help from professionals (Humphreys et al., 2021). Besides the impact on the human body, the effects of the virus on the mental health of people suffering from post-COVID-19, including depression, need to be taken seriously (Malik et al., 2021; Meyer et al., 2020; Shanbehzadeh et al., 2021). Thus, this study will investigate the relationship between DS and PA, resulting in the first hypothesis (**H1**): *Higher scores in depressive symptoms significantly correlate with lower scores on physical activity in post-COVID suffers*. Additionally, it is expected that PSE

helps to explain the relationship between DS and PA (Figure 1). Therefore the second hypothesis (**H2**) will be: *Physical self-efficacy mediates the correlation between depressive symptoms and physical activity*. This could be an interesting approach for future interventions, especially if PA is associated with better recovery from post-COVID symptoms.

Figure 1

Relation of the variables.



Methods

Design

The conducted study was a cross-sectional survey designed in Qualtrics. Several questionnaires were used to investigate the level of physical self-efficacy, amount of time spent being physically active, and the number of depressive symptoms of post-COVID sufferers. For the mediation, PA worked as the dependent variable while PSE was the mediator variable. All variables were measured in a joint data collection, including more constructs and questionnaires that were irrelevant for this study. The survey was available in English and German to reach a larger group of people. Short versions of the questionnaires have been selected to ease the participants' burden from a too-long questionnaire. The data collection ran for 43 days, from the 8th of April 2022 to the 21st of May 2022. Before the

study went online, a pilot study with six participants (acquaintances of the researchers) was conducted to identify remaining problems like uncertainties and ensure the feasibility and functionality of the surveys.

Participants

Participants were recruited through convenience sampling via social media like Instagram, WhatsApp or Reddit. A recruitment text was formulated to gather a sufficient number of people that participated in the study (see Appendix G), and the survey had to be reposted several times in different groups and sub-Reddits. For the sample, the following inclusion criteria have been relevant: Participants needed to be 18 years or older, have sufficient German or English proficiency, access to the internet, and a confirmed SARS CoV-2 infection, three months from the onset of COVID-19 with persisting symptoms. To estimate a sufficient sample size for mediation analysis, the statistical software G*Power has been chosen. The software suggested a total number of 73 participants ($\alpha = .05$, $f^2 = 0.15$, $[1-\beta] = .90$; using three predictors).

Materials and Measures

Informed Consent and Demographic Questionnaire

The informed consent was the first part of the survey (see Appendix A). It ensured that individuals participating in this study understood the study's intention and that their participation was entirely voluntary. Participants had to actively agree to the informed consent to proceed with the questionnaires. A short demographic questionnaire containing age, gender, and country of origin was included. Additionally, questions about how participants got their diagnosis ("*How did you find out about your infection?*"), presence of symptoms (e.g. "*fatigue/ tiredness*", "*cough*", or "*difficulties concentrating, memory problems, and/ or confusion*"), hospitalisation ("*Were you hospitalised due to COVID-19?*"), physical impairments ("*Do you suffer from any physical impairments and if "yes" which (e.g.*

wheelchair)"), and time of infection ("*When were you originally infected with COVID-19? (approximately)*") have been integrated.

International Physical Activity Questionnaire Short Form (IPAQ-SF)

The IPAQ-SF has been chosen to measure people's time being physically active (see Appendix B). The questionnaire assessed the intensity to which people participate in PA and sitting behaviour in their daily lives. It subdivided PA into light, moderate, vigorous physical activities and sitting time. The IPAQ-SF measures the time in minutes and hours spent per week. An example item for moderate PA would be, "*During the **last seven days**, on how many days did you do **moderate** physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.*" In the IPAQ-SF, walking accounts for 3.3 METS, moderate activities for 4 METS and vigorous activities for 8 METS. To compute the score, the given value needs to be multiplied by the minutes of the activity and then again by the days the activity was carried out. For example, 20 minutes of walking for four days a week results in a total $MET_{minutes}$ score of 3.3 x 20 x 4 = 264 $MET_{minutes}$ per week (see Appendix B). For this study, the $MET_{minutes}$ have been divided by 60 to compute the MET_{hours} of participants to prevent scores that could have been complicated in handling the data.

The IPAQ is a commonly used questionnaire. Craig et al. (2003) did a psychometric review for 12 countries and found that the questionnaires' psychometric qualities are more than acceptable. It showed good reliability for the long and short forms with $r = .76$ and a moderate criterion validity with a median $p = .30$ (Craig et al., 2003). Furthermore, Spearman's rho for validity is clustered around the aforementioned median score because this is a self-report questionnaire that is not administered by a professional (Craig et al., 2003).

Patient Health Questionnaire (PHQ-9)

The PHQ-9 (see Appendix C) has been chosen to measure symptoms in sufferers of DS. This questionnaire was initially developed to subclassify sufferers into disorders corresponding to specific DSM-IV diagnoses like major depressive or panic disorders. It

contains nine items about the frequency of feelings during the past two weeks, e.g. "*Little interest or pleasure in doing things*" or "*Moving or speaking so slowly that other people could have noticed. Or the opposite being – so fidgety or restless that you have been moving around a lot more than usual*". These items can then be answered on a 4-point Likert scale with either 1 = "*not at all*", 2 = "*Several days*", 3 = "*More than half the days*", to 4 = "*Nearly every day*". Depending on the added number of symptoms answered with the last three answers, the severity of the DS is assessed (Kroenke, Spitzer, & Williams, 2001; see Appendix C).

The PHQ-9 showed good psychometric qualities with an internal consistency of $\alpha = .87$ in patients with various psychiatric disorders like mood disorders, anxiety disorders, personality disorders, and psychotic disorders (Beard et al., 2016). It has also been found that the questionnaire is more feasible than other depression questionnaires (Patten et al., 2015).

Self-Efficacy for Physical Activity Scale (SEPAS)

The last questionnaire was the Self-Efficacy for Physical Activity Scale (SEPAS; see Appendix D). Participants answered six questions regarding their beliefs about performing certain activities ranging from light to moderate. An example item would be, "*How confident are you that you can walk at least 30 minutes taking advantage of daily situations like, for example, going to work, shopping or taking the dog out despite feeling fatigued?*" Those questions had to be answered on a 10-point Likert scale ranging from 1 ("*not at all confident*") to 10 ("*very confident*"). Scoring the scale works by adding up the scores that have been obtained through the survey.

As for the IPAQ and the PHQ-9, the choice was heavily influenced by the situation's novelty, which led to many questionnaires not being tested in the context of the virus. This scale was initially designed to determine the PSE of female fibromyalgia patients (López-Roig et al., 2021). Because of similarities between fibromyalgia and post-COVID symptoms (fatigue/ tiredness, difficulties moving and talking, myalgia or shortness of breath

[Raveendran et al., 2021; Twomey et al., 2021]), this questionnaire became interesting. Still, some items had to be reformulated to suit the topic of COVID-19 better. This questionnaire only existed in Spanish and English and thus had to be translated into German by the researchers.

Procedure

Ethical approval was obtained from the University of Twente committee of the BMS Ethical Review responsible for the Domain for Humanities and Social Sciences (request number: 220405). Before the participants could accept to answer the questionnaires, they received an explanation of the procedure, purpose, and informed consent of this study included in the survey. After the informed consent had been actively agreed on, the questionnaires were presented. The questionnaires relevant for this particular study were the IPAQ-SF, PHQ-9, and SEPAS. The survey ended with questions regarding the demographics and illness-related characteristics. A specific order to display the different questionnaires has been chosen to counteract reactivity or other unpleasant side effects. Additionally, a halfway message has been included to motivate and encourage the participants, as well as a short notice in the informed consent to take breaks if needed (see Appendix A). Lastly, participants were presented with a quick debriefing message thanking them for taking part and providing an email address of one of the researchers for further questions.

Data Analysis

The IBM Statistic Package for Social Studies (SPSS) 26 was used to analyse the data. Before the primary analyses were performed, the assumptions were checked. The demographic and illness-related sample characteristics were retrieved. Internal consistency and translation validity for the SEPAS questionnaire was tested. Additionally, internal consistency for the PHQ-9 was tested.

To answer the first hypothesis, Kendall's Tau was conducted to investigate how the scores of the PHQ-9 and the IPAQ-SF are correlated. This non-parametric test has been

chosen since not all assumptions for a Pearson correlation have been met (van den Berg, 2019). The focus was on the one-tailed sigma for this analysis, indicating $p < .05$. To assess the second hypothesis, the PROCESS macro package of Hayes (2004) was used to investigate the mediation effect of the SEPAS score on the relation between depressive symptoms (independent variable) and physical activity (dependent variable). PROCESS macro also involves the bootstrapping method by Preacher and Hayes (2004), which was used to determine whether the mediation effect that has been found appears to be significant and to counteract the non-normal distribution of the IPAQ-SF score in this sample. This method produces a reliability interval for the model's different paths, which has been set to 5000 resamples for this analysis. To clarify whether the mediation effect turned out to be significant, the interval of the bootstrapping method should not include a value of zero.

Results

Descriptive Statistics

During data collection, 332 participants were collected. After excluding unusable responses, the sample included 59 participants. In total, 273 participants did not meet the inclusion criteria. First, 113 answers had to be removed because they did not give informed consent, and further, 153 participants were excluded because they did not finish the survey. Secondly, one person because of no reported symptoms, one under-aged participant, and one deficient reply (one missing answer to the PSE questionnaire) were excluded. Following the recommendations of the IPAQ-SF, four outliers with extreme/ not possible values have been excluded. Additionally, two more people's scores had to be truncated (but not excluded).

The remaining 59 participants were mostly female (n = 44, 74.6%), from Germany (n = 23, 43,1%) or the USA (n = 16, 27.1%), and had an average age of 35.6 (SD = 13.3) years ranging from 18 years to 62 years. The most common symptoms were fatigue (n = 54, 91.5%), cognitive dysfunction (n = 48, 81.4%), and changes in mood and/ or anxiety (n = 38,

64,4% [Table 1]) with average total symptoms of 5.3 (*SD* = 1.9). Four participants (6.8%) have been hospitalised, suffering from several of those symptoms.

Table 1

Socio-demographic characteristics of the sample population (N =59).

Item	Category	Frequency	Percentage
Gender	Female	44	74.6
	Male	14	23.7
	Other	1	1.7
Nationality	German	23	39.0
	American	16	27.1
	British	4	6.8
	Canadian	4	6.8
	Other [a]	8	13.6
Symptoms	Fatigue/ tiredness	54	91.5
	Cough	14	23.7
	Fever and chills	9	15.3
	Shortness of breath	38	64.4
	Difficulties moving or talking	31	52.5
	Loss of smell and taste	16	27.1
	Cognitive dysfunction	48	81.4
	Pain/ aches or soreness	38	64.4
	Changes in mood and/ or anxiety	38	64.4
	Other [b]	27	45.8

Note. Choosing multiple symptoms in this questionnaire was possible. [a] Other nationalities include Dutch, Finish, French, Indian, Italian, Pakistan, and Serbian. [b] Other reported symptoms include cardiac arrhythmia, dysautonomia, insomnia, MACS, nausea, neuropathy, PTSD, seizure, tachycardia, tinnitus, tremor, and vertigo

The PHQ-9 scores indicated moderately high DS among the whole sample of post-COVID sufferers (*M* = 12.2, *SD* = 6.1). The scores of the IPAQ-SF (*M* = 30.5, *SD* = 31.1) ranged from a minimum score of zero to a maximum score of 112.4 MET_{hours} (Figure 1),

revealing a high range in the scores with a focus on shallow scores and explaining the violation of normality (Table 2). For the SEPAS, the mean score was 33.9 (*SD* = 16.9). The skewness of -0.28 and the kurtosis of -1.18 indicate a normal distribution. In general, skewness and kurtosis scores for the questionnaires mainly showed a normal distribution, except for the IPAQ-SF (Table 2).

Table 2

Descriptive statistics for IPAQ-SF, PHQ-9, and SEPAS (N =59).

	Min.	Max.	Mean	*SD*	Skewness		Kurtosis	
					Statistic	S.E.	Statistic	S.E.
Physical activity	.00	112.43	30.54	31.12	1.089	.311	.359	.613
Depressive symptoms [a]	1.00	27.00	12.15	6.14	.290	.311	-.410	.613
Physical self-efficacy [b]	6.00	60.00	33.85	16.91	-.281	.311	-1.175	.613

Note. [a] Scores can range from zero to 30. [b] Scores can range from six to 60.

Reliability and Validity Testing

Internal consistency for the SEPAS showed a Cronbach's alpha of .94, which is an excellent score according to Taber (2018) and promises high reliability. Performing a Mann-Whitney U test showed that the validity of the language differences for the SEPAS questionnaires was sufficient since it indicated no significant differences in the mean scores between user languages (see Appendix F). The PHQ-9 showed a Cronbach's alpha of .83, which is considered a good score for internal consistency.

Correlation Analysis

Since the assumptions of normality, linearity and independence were violated (see Appendix E), Kendall's Rank Order Correlation was used to test the first hypothesis (Table 3). There is no significant correlation between DS and PA, $r_\tau(58) = -.17$, $p = .07$.

Table 3

Correlation Matrix of physical activity, depressive symptoms, and physical self-efficacy.

Variable	1	2	3
1 depressive symptoms			
2 physical activity	-.17		
3 physical self-efficacy	-.31**	.44**	

** Correlation is significant at the 0.01 level (2-tailed).

Mediation Analysis

The second hypothesis predicted a mediation effect of PSE on DS and PA (see Figure 2 for an overview and Table 4 for the statistics). Z-scores were computed for more standardised results before the PROCESS macro was carried out. The mediation analysis also showed no significant main effect between DS and PA (excluding PSE) for the c-path. The DS on PSE (a-path) and PSE on PA (b-path) showed significant relationships between the IV, the DV, and the mediator. Lastly, the confidence interval of the bootstrapping method was used to test the effect of DS on PA, including PSE (c'-path). It indicates no mediation since there was no significant main effect (c-path), and the 95% CI [-.19, .31] includes zero.

Table 4

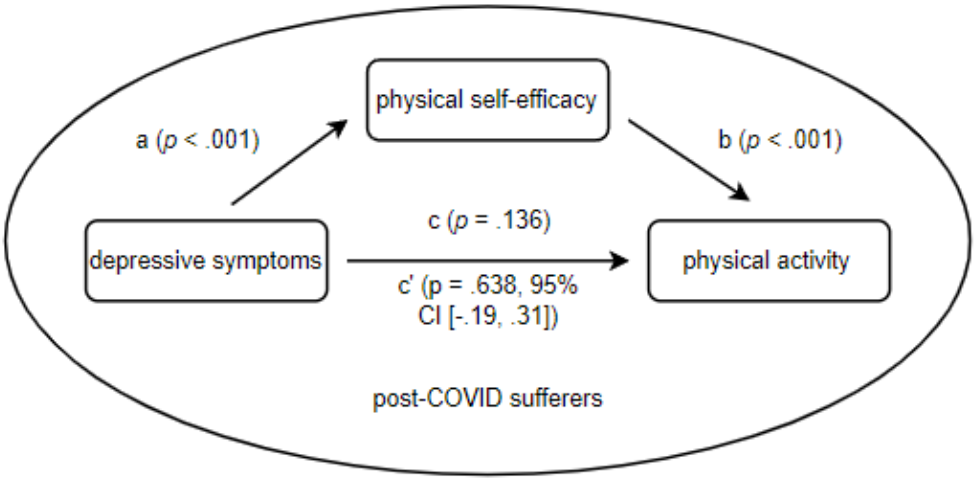
Outcome of the mediation analysis.

Path	Coefficient	SE	*t*	*p*	Bootstrap 95% CI LLCI	ULCI
a	-.46	.12	-3.87	<.001	-.69	-.22
b	.56	.13	4.43	<.001	.31	.82
c	-.20	.13	-1.51	.14	-.46	.06
c'	.06	.13	.47	.64	-.20	.31

Notes. Paths a = depressive symptoms on physical self-efficacy, b = physical self-efficacy on physical activity, c = depressive symptoms on physical activity, and c' = depressive symptoms on physical activity with physical self-efficacy. Abbreviations: LLCI = lower limit confidence interval, SE = standard error, ULCI = upper limit confidence interval.

Figure 2

Mediation model of physical self-efficacy on depressive symptoms with physical activity.



Discussion

Findings

In this study, it was predicted that depressive symptoms would negatively correlate with physical activity in post-COVID sufferers (H1) and that physical self-efficacy would mediate this relationship (H2). The first hypothesis, contrary to the expectations, could be rejected because there was no significant correlation to be observed. The second hypothesis was also rejected since depressive symptoms were not a statistically significant predictor of physical activity, which, according to Baron and Kenny (1986), is one of the requirements for a mediation effect. Additionally, the bootstrapping method by Preacher and Hayes (2004) suggests that the 95% CI should not include zero as a value which is the case for this study, supporting the rejection of H2.

Evaluating the First Hypothesis – Depressive Symptoms and Physical Activity

Surprisingly, the correlation analysis to test the first hypothesis was not significant. Previous literature found different results indicating a correlation (Bailey et al., 2018; Kandola et al., 2019; Nyström et al., 2015). However, post-COVID is still new to research

and thus has a relatively small body of research regarding this relationship. Investigating the possible reasons, the participants' high scores on the IPAQ-SF were interesting.

In general, a strikingly high amount of PA was observed . Those high scores of the IPAQ-SF do not align with other research regarding PA in post-COVID sufferers like the studies of Meyer et al. (2020) or Shanbehzadeh et al. (2021). This is contrary to the expectations as their research only found low PA in post-COVID sufferers. One reason for that seems to be that the IPAQ-SF compared to other measures for PA, tends to let participants report higher amounts of vigorous PA (Dyrstad et al., 2014). Additionally, although the scores of the IPAQ-SF already appear to be relatively high, one has to keep in mind that it only measures physical exercise and does not assess ADLs.

Taking these restrictions into account might be a valid explanation for the findings of this study and why there is no significant relationship between DS and PA. This would indicate that post-COVID sufferers are physically more active than expected and that this physical activity does not correlate with DS.

Evaluating the Second Hypothesis – Physical Self-Efficacy as Mediator

For the second hypothesis, no mediation effect of PSE on the relationship between DS and PA has been found. This does not support previous findings that self-efficacy, especially PSE, plays a role in depression and PA (Bodin & Martinsen, 2004; Cortis et al., 2017). Next, the first hypothesis's non-significant findings already restrict the mediation analysis findings as the main effect should be significant (Baron & Kenny, 1986).

Again, the novelty of the virus might be an explanation for those unexpected outcomes. Questionnaires were not tested in this context before and might have limited the statistical power of this research. However, next to the findings to answer this hypothesis, the mediation analysis revealed that the relationships between DS and PSE as well as between PSE and PA were significant. This was also supported by the correlational analysis conducted to answer the first hypothesis. Taking both correlations into account, people might have been

better able to cope with their limitations caused by post-COVID. One reason could be that post-COVID sufferers knew how to handle their limitations. This could also be another explanation for the high scores in PA since one possible way to recover from post-COVID is to be physically active and to try to counteract the limitations of post-COVID actively.

Strengths and Limitations

The current study had a couple of strengths that set it apart from previous studies. First, it is one of the first ones that investigated the mediating effect of PSE on the relation between DS and physical activity in people suffering from post-COVID. The second strength of this study was its current relevance which might also explain the generally high response rate, even though most of the responses could not be used.

However, next to those strengths, some limitations need to be considered. The assumptions of normality, linearity and independence were violated, decreasing the statistical power of this study. Another limitation, also mentioned as a strength, is the novelty of the situation. Many methods and effects obtained cannot be related to previous findings. Especially the IPAQ-SF seemed to be a wrong choice in material.

The last limitation of the study would be the problem of working in a larger group which made the survey quite long, forcing the researchers to take shorter versions of questionnaires to prevent the participants from being overwhelmed. This could also explain some of the responses that have not been finished because people lost patience during the assessment, could not concentrate anymore, or were not able to finish because they were too fatigued. Especially the last two points seem to be valid reasons for the number of unfinished responses since the prevalence for both symptoms was relatively high in this sample, with 91.5% for fatigue/ tiredness and 81.4% for cognitive dysfunction.

Future Research

This study has provided new insights into the mediating effect of PSE on the relationship between DS and PA, suggesting a better design for future research using other

instruments that better fit the research setting. One implication would be to exchange the IPAQ-SF with another questionnaire that includes ADLS to assess levels of PA. Additionally, a questionnaire specially designed for PSE should be chosen. For this study, no questionnaires were short enough to include, but this might not be a problem in other research.

Furthermore, many different things can influence the correlation between DS and PA, especially for post-COVID sufferers. Therefore, further investigation of this relationship should shed more light on this area. A possible approach could be to control for confounding variables like the circumstances of the pandemic, e.g. social distancing or the generally increased feelings of social isolation and loneliness as indicated in previous studies (Kim & Jung, 2021; Loades et al., 2020). This might be especially interesting as those circumstances are comparable to several depressive symptoms that define depression. Next, the correlations between DS and PSE and PA and PSE should be closely investigated. It could be interesting to find out how those relations can be explained, especially for post-COVID sufferers. This might also help further examine PSE's mediating role on the relationship between DS and PA.

Conclusion

This study investigated the relationship between depressive symptoms and physical activity and whether physical self-efficacy would mediate this relationship. Contrary to the expectations, both hypotheses had to be rejected. There was no significant correlation between depressive symptoms and physical activity, and there was no mediating effect of physical self-efficacy on that relationship. The leading cause for those findings, which has been outlined during the writing process of this research, could be that the IPAQ-SF was not the right choice to assess physical activity in post-COVID sufferers. Future research should use better-suited research tools and consider other potential influences on the relationship between depressive symptoms and physical activity.

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Appendices

Appendix A: Informed Consent.

Informed Consent - Physical Activity in Post-COVID Patients

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Inclusion Criteria

Only participants with probable or confirmed SARS-Cov-2 infection, usually 12 weeks from the onset of COVID-19 with symptoms that last for at least 8 weeks and cannot be explained by an alternative diagnosis, are eligible for this study.

Purpose of the Study

This study is carried out as part of a bachelor's research project on the physical activity of post-COVID patients. Before you decide to participate in this study, it is essential to know why the research is done and what it will involve. Please read the following information carefully.

Managing physical activity can be difficult for individuals with post-COVID not only because of physical symptoms such as fatigue but also because of physiological symptoms that often accompany the syndrome. Therefore, investigating this relationship is important to enabling more informed decision-making in developing interventions or other efforts to facilitate the recovery process of individuals suffering from post-COVID.

If there are any questions, do not hesitate to approach one of the researchers for more information or, if you feel more comfortable talking to a more experienced professional, the supervisor.

Study Procedures

The study consists of seven short questionnaires that need to be filled in. Participation is entirely voluntary, and the procedure can be stopped at any time without giving any reason for it. The questionnaires will take around 20 minutes to complete, and if you feel the need to take a break, you can do so.

Confidentiality

Your response to this survey will be anonymous; the researchers will only know you by a number. Participants' data will be kept confidential except in cases where the researchers are legally obligated to report specific incidents. These incidents include, but may not be limited to, incidents of abuse and suicide risk. Data will be stored safely and no longer than two years before being deleted.

Appendix B: IPAQ-SF.

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the **last 7 days**. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

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

1. During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, digging, aerobics, or fast bicycling?
_____ **days per week**
No vigorous physical activities ***Skip to question 3***

2. How much time did you usually spend doing **vigorous** physical activities on one of those days?
_____ **hours per day**
_____ **minutes per day**
 Don't know/Not sure

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

3. During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.
_____ **days per week**
No moderate physical activities ***Skip to question 5***

4. How much time did you usually spend doing **moderate** physical activities on one of those days?
_____ **hours per day**
_____ **minutes per day**
 Don't know/Not sure

Think about the time you spent **walking** in the **last 7 days**. This includes at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure.
5. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time?
_____ **days per week**
No walking ***Skip to question 7***

6. How much time did you usually spend **walking** on one of those days?
_____ **hours per day**
_____ **minutes per day**
 Don't know/Not sure

The last question is about the time you spent **sitting** on weekdays during the **last 7 days**. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.
7. During the **last 7 days**, how much time did you spend **sitting** on a **week day**?
_____ **hours per day**
_____ **minutes per day**
 Don't know/Not sure

Scoring Key – Trinity College Dublin

There are both long and short forms of the IPAQ. This documents will help you to interpret the results you get on the short form IPAQ. Results may help you track an individual's progress over time or compare results with public physical activity recommendations.

Firstly it is important to note that there is no international consensus on a correct method of describing physical activity levels derived from self-report questionnaires or surveys. This can be problematic when trying to compare between different methods. The scoring method described in this document is recommended for use with the IPAQ. A more comprehensive guide on scoring the IPAQ is available at www.ipaq.ki.se (click the "IPAQ scoring protocol" tab on the left). At the site you will also find an excel file which automatically calculates the results of the IPAQ. All you need to do is to download the file and use the dropdown menus in the answer panels to complete the questionnaire. The result will appear on the second sheet entitled "Report". Alternatively read below directions on how to manually score the IPAQ.

Note: The IPAQ is suitable for adults between 15 and 69 years of age and is primarily used for population surveillance of physical activity levels.

It will take time to score the IPAQ. Give yourself time to do this exercise.

Scoring the IPAQ

Background

There are two forms of output from scoring the IPAQ. Results can be reported in categories (low activity levels, moderate activity levels or high activity levels) or as a continuous variable (MET minutes a week). MET minutes represent the amount of energy expended carrying out physical activity.

A MET is a multiple of your estimated resting energy expenditure. One MET is what you expend when you are at rest. Therefore 2 METS is twice what you expend at rest. To get a continuous variable score from the IPAQ (MET minutes a week) we will consider walking to be 3.3 METS, moderate physical activity to be 4 METS and vigorous physical activity to be 8 METS.

Physical activity categories:

Scoring a **HIGH** level of physical activity on the IPAQ means your physical activity levels equate to approximately one hour of activity per day or more at least a moderate intensity activity level.

Those who score **HIGH** on the IPAQ engage in

- Vigorous intensity activity on at least 3 days achieving a minimum total physical activity of at least 1500 MET minutes a week

OR

- 7 or more days of any combination of walking, moderate intensity or vigorous intensity activities achieving a minimum total physical activity of at least 3000 MET minutes a week.

Scoring a **MODERATE** level of physical activity on the IPAQ means you are doing some activity more than likely equivalent to half an hour of at least moderate intensity physical activity on most days.

Those who score **MODERATAE** on the IPAQ engage in

- 3 or more days of vigorous intensity activity and/or walking of at least 30 minutes per day

OR

- 5 or more days of moderate intensity activity and/or walking of at least 30 minutes per day

OR

- 5 or more days of any combination of walking, moderate intensity or vigorous intensity activities achieving a minimum total physical activity of at least 600 MET minutes a week.

Scoring a **LOW** level of physical activity on the IPAQ means that you are not meeting any of the criteria for either MODERATE of HIGH levels of physical activity.

Calculating results

TIPS: Remember that bouts of activity lasting less than 10 minutes duration are not counted.

Convert all activity to minutes before calculating MET minutes. Doing the math in hours will give you incorrect results.

It is recommended that activity bouts of greater than 3 hours are truncated. That is to say that a bout cannot be longer than 3 hours (180 minutes). This means that in each category a maximum of 21 hours of activity are permitted a week (3 hours X 7 days)

To calculate MET minutes a week multiply the MET value given (remember walking = 3.3, moderate activity = 4, vigorous activity = 8) by the minutes the activity was carried out and again by the number of days that that activity was undertaken. For example if someone reports walking for 30 minutes 5 days a week then the total MET minutes for that activity are 3.3 X 30 X 5=495 Met minutes a week.

You can add the MET minutes achieved in each category (walking, moderate activity and vigorous activity) to get total MET minutes of physical activity a week.

Appendix C: PHQ-9.

Patient Health Questionnaire – Short Form

Nine Symptom Checklist

Over the last 2 weeks, how often have you been bothered by any of the following problems?

	Not at all	Several days	More than half the days	Nearly every day
1. Little interest or pleasure in doing things.....	0	1	2	3
2. Feeling down, depressed, or hopeless.....	0	1	2	3
3. Trouble falling or staying asleep, or sleeping too much.....	0	1	2	3
4. Feeling tired or having little energy.....	0	1	2	3
5. Poor appetite or overeating.....	0	1	2	3
6. Feeling bad about yourself - or that you are a failure or have let yourself or your family down.....	0	1	2	3
7. Trouble concentrating on things, such as reading the newspaper or watching television.....	0	1	2	3
8. Moving or speaking so slowly that other people could have noticed? Or the opposite - being so fidgety or restless that you have been moving around a lot more than usual.....	0	1	2	3
9. Thoughts that you would be better off dead or of hurting yourself in some way.....	0	1	2	3

(For office coding: Total Score _____ = ___ + ___ + ___)

If you checked off any problems, how difficult have these problems made it for you to do your work, take care of things at home, or get along with other people?

Not difficult at all	Somewhat difficult	Very difficult	Extremely difficult
☐	☐	☐	☐

From the Primary Care Evaluation of Mental Disorders Patient Health Questionnaire (PRIME-MD PHQ). The PHQ was developed by Drs. Robert L. Spitzer, Janet B.W. Williams, Kurt Kroenke and colleagues. For research information, contact Dr. Spitzer at rls8@columbia.edu. PRIME-MD® is a trademark of Pfizer Inc. Copyright© 1999 Pfizer Inc. All rights reserved. Reproduced with permission.

Scoring Key

Interpreting PHQ-9 Scores

Diagnosis	Total Score	For Score	Action
Minimal depression	0-4	≤ 4	The score suggests the patient may not need depression treatment
Mild depression Moderate depression	5-9 10-14	5 - 14	Physician uses clinical judgment about treatment, based on patient's duration of symptoms and functional impairment
Moderately severe depression Severe depression	15-19 20-27	> 14	Warrants treatment for depression, using antidepressant, psychotherapy and/or a combination of treatment.

Appendix D: SEPAS.

Self-Efficacy

The following 6 questions will test a psychological construct that is called Self-efficacy. It describes someones belief in their own ability to perform a certain action. In this case, all questions aim to assess your belief in your ability to perform certain physical activities. It is important to note here, that the questions do not ask whether you are actually doing those things but whether you think you ***could*** do those things. Please indicate to what extend you feel confident regarding the scenarios described below.

	Not at all confident									very confident
1. How confident are you that you can walk at least 30 minutes taking advantage of daily situations like for example, going to work, shopping or taking the dog out despite feeling fatigue?	○	○	○	○	○	○	○	○	○	○
2. How confident are you that you can walk at least 30 minutes taking advantage of daily situations like for example going to work, shopping or taking the dog out despite experiencing other symptoms (for example: pain, shortness of breath, depressed mood)?	○	○	○	○	○	○	○	○	○	○
3. How confident are you that you can 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 feeling fatigue?	○	○	○	○	○	○	○	○	○	○
4. How confident are you that you can 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 experiencing other symptoms (for example: pain, shortness of breath, depressed mood)?	○	○	○	○	○	○	○	○	○	○
5. How confident are you that you can spend at least 30 minutes doing a moderate physical activity (that somewhat increases your breathing and perspiration) like dancing or cycling at a regular pace, despite feeling fatigue?	○	○	○	○	○	○	○	○	○	○
6. How confident are you that you can spend at least 30 minutes doing a moderate physical activity (that somewhat increases your breathing and perspiration) like dancing or cycling at a regular pace, despite experiencing other symptoms (for example: pain, shortness of breath, depressed mood)?	○	○	○	○	○	○	○	○	○	○

Appendix E: Assumptions

Assumption (Correlation): Normality

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
MET_Hrs	,166	59	,000	,864	59	,000
TDEP	,089	59	,200*	,979	59	,412
SE_Sum	,110	59	,073	,932	59	,003

*. This is a lower bound of the true significance.

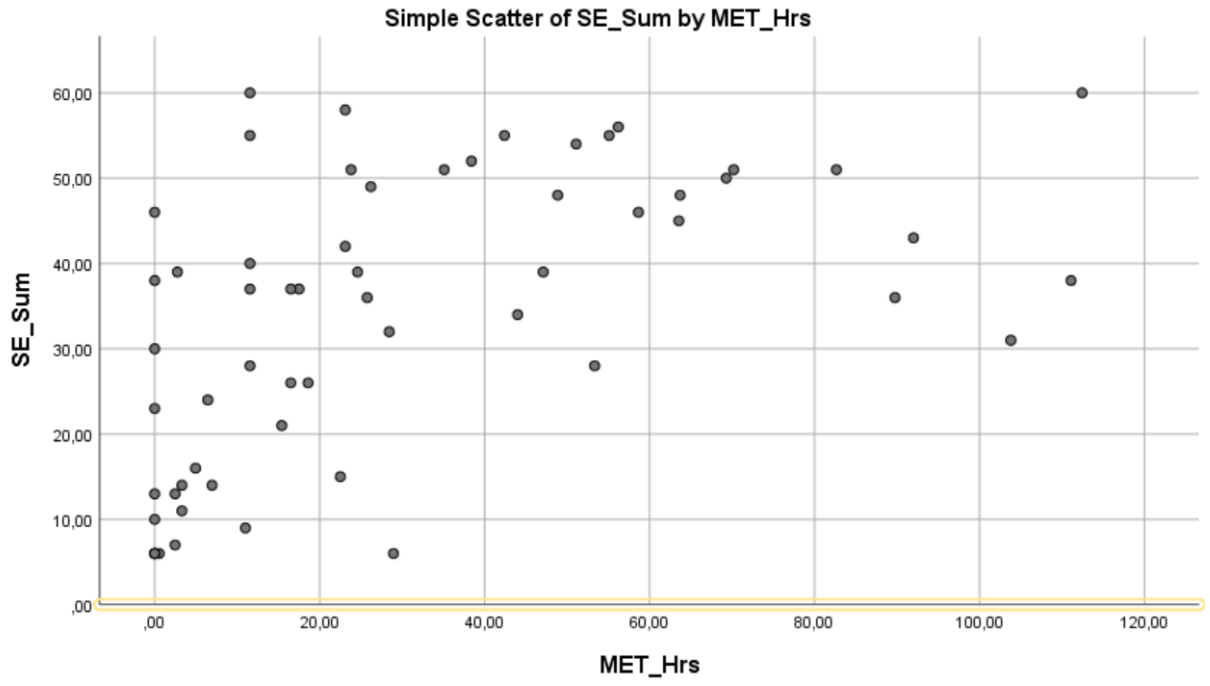
a. Lilliefors Significance Correction

➔

Descriptive Statistics

	N	Minimum	Maximum	Sum	Mean		Std. Deviation	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
TDEP	59	1,00	27,00	717,00	12,1525	,79992	6,14428	37,752	,290	,311	-,410	,613
MET_Hrs	59	,00	112,43	1801,63	30,5360	4,05176	31,12213	968,587	1,089	,311	,359	,613
SE_Sum	59	6,00	60,00	1997,00	33,8475	2,20140	16,90931	285,925	-,281	,311	-1,175	,613
Valid N (listwise)	59											

Assumption (Correlation): Linearity



Assumption (Mediation): Independence

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,537[a]	,289	,263	26,71294	,458

a. Predictors: (Constant), SE_Sum, TDEP

b. Dependent Variable: MET_Hrs

Appendix F: Validity Testing

Table A

Independent-Samples Mann-Whitney U Test to check validity for the SEPAS questionnaire.

Total N	59
Mann-Whitney U	395.500
Wilcoxon W	515.500
Test Statistic	395.500
Standard Error	57.403
Standardized Test Statistic	1.141
Asymptotic Sig. (2-sided test)	.254

Appendix G: Recruitment Text

Hey!

Do you suffer from long-COVID and sometimes feel frustrated by the lack of knowledge regarding the condition? Coping with a scarcely researched disease is a tough challenge. Especially dealing with physical activity is an obstacle in the recovery process and in daily life. This is why our team of six student researchers at the University of Twente (Netherlands) decided to study the relationship between physical activity and various psychological concepts in the context of long-COVID.

Are you interested in contributing to this research, and therefore helping with developing new treatment options, gaining new insights into your own daily activities and symptoms? Then please consider taking part in this study by filling out our questionnaire (approx. 20min). Any questions before starting the survey? Contact k.s.rosen@student.utwente.nl.

Thank you in advance!