Understanding daily life of women and men with the post-COVID-19 syndrome: studying fatigue symptoms with ESM methodology.

An experience sampling method-study on the association between the experience of affect and physical fatigue

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Abstract

Background. Many people are left with persistent symptoms that remain long after the acute infection with COVID-19. This condition is now called post-COVID-19 syndrome and is often characterised by enduring fatigue, especially physical fatigue. However, there is just limited knowledge regarding the course and the risk factor of fatigue over time. **Objective.** The association between physical fatigue and (positive and negative) affect and gender as a potential moderator variable were investigated over 14 days to improve knowledge about physical fatigue as a post-COVID-19 syndrome symptom. **Method.** This study has used the Experience Sampling Method (ESM) to collect repeated measurements six times a day concerning the current levels of physical fatigue and positive and negative affect from ten Dutch ex-hospitalised people with the post-COVID-19 syndrome (Mage = 59.7, 50% women;) for 14 successive days. Additionally, Linear Mixed Modelling was utilised to analyse the association between physical fatigue and affect and the between- and within-person effects over time. A LMM with one-moment lagged (T-1) scores were executed to explore this association further. Furthermore, a moderation analysis was applied to analyse if gender moderates the relationship between physical fatigue and affect. **Results.** Moderately to strong negative associations were found between physical fatigue and positive affect over 14 days (Overall β = -.682, p = <.001; between-person β= -.808, p = <.001; within-person β = -.554, p = <.001). Furthermore, moderately to weak positive associations were found between physical fatigue and negative affect over 14 days (Overall β = .576, p = <.001; between-person β = .264, p = <.001; within-person β = .024, p= <.001). A non-significant interaction effect was found for gender on the overall association between physical fatigue and positive affect (β = -.050, p = .055). However, for the relationship between physical fatigue and negative affect, a significant and weak interaction effect was detected (β = .187, p = <.001). A significant and strong predictive association was found between positive affect at the prior measurement and physical fatigue two hours later **(**β = -.707, p < .001). Similarly, a significant and strong positive association was found between negative affect at the prior measurement and physical fatigue two hours later (β = .564, p < .001). **Conclusion.** Physical fatigue seems to be a severe and frequent symptom of the post-COVID-19 syndrome, although interindividual differences could be observed. The results of the study demonstrated that post-COVID-19 syndrome patients who reported more positive affect tend to feel less physical fatigued. Similarly, when reporting more negative affect, they seemed to feel more physical fatigued. Furthermore, weaker within-person and stronger between-person associations were found. Being male also seemed to work as a moderator by increasing the relationship between physical fatigue and negative affect. Lastly, fewer positive or more negative affect seemed to increase physical fatigue two hours later.

Keywords. Experience sampling method, post-COVID-19 syndrome, physical fatigue, positive affect, negative affect

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Introduction

Globally, up to now, there have been around 452 million confirmed cases of the infectious disease SARS-Cov-2 or COVID-19, and the number is still rising from day to day (WHO, 2022). Approximately 6 million people have died (WHO, 2022). The larger proportion of people suffering from COVID-19 experience mild to moderate symptoms which do not require any medical treatment to recover. However, some people will develop a more severe progression of the disease. These include ,inter alia elderly or people with another medical precondition (WHO, n.d.). Even though COVID-19 is still counted as a novel virus, with the progression of the pandemic, increased evidence has come to light. Specifically, researchers have found out that patients with COVID-19 experienced complications and symptoms beyond the main period of the acute infection (Venkatesan, 2021). Typically, patients recover from COVID-19 within a timeframe of two to four weeks. However, other patients experience symptoms that last for weeks or even months (Venkatesan, 2021). In this case, one may have referred to Long COVID (WHO, n.d.). However, there is a discussion going on to define it according to time-bound terms since this will help to facilitate, inter alia, the service planning and access to support services (Shah et al., 2021). Therefore, three new definitions have been developed. First, the acute COVID-19 infection is defined by symptoms of COVID-19 for up to four weeks (Shah et al., 2021). Next, symptoms and signs of COVID-19 present from four weeks and up to 12 weeks are defined as ongoing symptomatic COVID-19 (Shah et al., 2021). Lastly, symptoms that occurred during or after an infection with COVID-19 that are present for more than 12 weeks and are not attributable to another medical condition are called post-COVID-19 syndrome (Shah et al., 2021). Hence, the last definition will replace the primary label of Long COVID. In general, the catalogue of new and persisting complaints stated by the patients is far-reaching. This includes the most common symptoms of shortness of breath, extreme fatigue, and cognitive dysfunction (Venkatesan, 2021). A study from Italy has shown that 87 per cent of patients rehabilitated and released from hospitals suffered from at least one symptom after 60 days after discharge. Of these, 32 per cent have experienced one or two symptoms, and in 55 per cent of the patients, three or more indications have persisted (Raveendran et al., 2021).

Although there is still limited information about the risk factors of the post-COVID-19 syndrome, there seems to be a relationship between a few patients' characteristics and the development of the post-COVID-19 syndrome. Specifically, it seems that females tend to be more vulnerable to the development of the post-COVID-19 syndrome compared to men (23.6%

versus 20.7%) (Crook et al., 2021). Furthermore, people aged 35 to 49 years are affected mainly by the post-COVID-19 syndrome (Crook et al., 2021). This is interesting since men and people aged over 50 years are more inclined to develop severe COVID-19. Therefore, it can be hypothesised that a severe progression does not necessarily have to increase the risk of suffering from the post-COVID-19 syndrome. Next to that, other risk factors for not recovering from COVID-19 are the presence of asthma and other comorbidities or obesity (Tenforde et al., 2020; Crook et al., 2021). Moreover, if a person suffers more than five symptoms during the acute phase of the disease, the risk of developing the post-COVID-19 syndrome increases (Crook et al., 2021). However, even patients with a mild to moderate course of COVID-19 can possibly to develop the post-COVID-19 syndrome or not reclaim their pre-COVID health condition (Raveendran et al., 2021). Nevertheless, patients who have been treated on an outpatient basis seem less prone to develop the post-COVID-19 syndrome compared to hospitalised patients (Raveendran et al., 2021).

There are also some cases where patients have not matched any of these characteristics (Tenforde et al., 2020). Therefore, the risk factors need further investigation. Another limitation of the present studies is their focus on socio-demographic and physiological aspects (Tenforde et al., 2020). However, it is essential to acknowledge that different behaviours or cognitive patterns might also contribute to the development of the post-COVID-19 syndrome. Thus, the psychosomatic interplay should not be neglected. Several studies have already indicated that some behaviours or cognitions can impair the rehabilitation from certain diseases or even worsen the intensity of the symptoms or pain (Ryan et al., 2007). Contrastingly, some symptoms lead to a disruption of certain behaviours. For example, there seems to be a reciprocal relationship between physical inactivity and the severity of the symptoms (Ellingson et al., 2014). In other words, when being physically inactive, the chance of being fully recovered from the symptoms decreases. In turn, when a person is experiencing some symptoms, the chance of being physically active also decreases.

Especially fatigue is a widespread problem in several diseases and the post-COVID-19 syndrome. Across present research, the most often reported symptom of the post-COVID-19 syndrome seems to be fatigue (Lopez-Leon et al., 2021; Raveendran et al., 2021). The study of Raveendran et al. (2021) has shown that approximately 50 per cent of their participants have suffered from fatigue ten weeks after their COVID-19 infection. Feeling fatigued has far-reaching consequences for the individual and his/her quality of life. There seems to be a strong relationship between fatigue and mental/physical health (Müller et al., 2017). For instance, there is a reciprocal relationship between tiredness and recovery (Williamson et al., 2005). In

other words, when feeling fatigued, the chance of being fully recovered decreases. In turn, when a person still experiences symptoms, the chance of experiencing tiredness increases. Usually, fatigue acts as a protection mechanism against any physical or mental overload since it often reflects a desire to rest (Ryan et al., 2007). However, when fatigue cannot be counteracted by a break or will be extended to its maximum, it might become an issue.

Fatigue is a subjective construct with a multi-dimensional nature; therefore, it can only be understood from self-reports. Consequently, many different definitions are available (Shen et al., 2006). To keep it simple, fatigue can be defined as a subjective feeling of weakness, tiredness and/or lack of energy (Stone & Minton, 2008). Additionally, it can be differentiated into physical and mental fatigue. According to Shen et al. (2006), physical fatigue is defined as a 'loss of maximal force-generating capacity during muscular activity…'. In other words, physical fatigue includes disrupted physical performance and a muscular extension. Often, it is associated with bodily reactions such as sleep disturbance, fever, or muscular problems (Shen et al., 2006). In contrast, mental fatigue is often related to reduced motivation, loss of concentration or a state of mental exhaustion. Additionally, it is often related to stress or other severe emotional experiences. The relationship between both types of fatigue is complex and can differ among different populations and diseases. For instance, some studies have reported a reciprocal association between physical and mental fatigue. Another cross-sectional study has discovered a relationship between both (Lenaert et al., 2020), but whether there is a causal relationship between both types remains unclear. Regarding the post-COVID-19 syndrome, there is still not much information about the characteristics and severity of fatigue during the different weekdays and the day itself available (Lenaert et al., 2020). This thesis focuses only on one aspect of fatigue, namely physical fatigue.

A potential risk factor that seems to predict general fatigue and physical fatigue is the experience of emotions. As found in several cancer-related studies, the experience of positive emotions seems to help patients establish coping strategies (Strebkova, 2020; Haghighat et al., 2003). Furthermore, the patients acquire meaning to their disease, which supports a better dealing with it (Strebkova, 2020). Moreover, it is found that negative emotions such as depressive symptoms can predict feelings of fatigue (Haghighat et al., 2003). Thus, it can be hypothesised that the experience of positive affect leads to a decrease in physical fatigue, whereas the experience of negative affect might further increase physical fatigue. However, the association between fatigue and the experience of emotions is not one-sided. Several studies have demonstrated that feelings of fatigue also lead to an increased feeling of negative affect (Stone & Minton, 2008; van Dijk-Lokkart et al., 2019). For instance, research about cancer-

related fatigue has shown that fatigue often leads to the development of a depressive episode (van Dijk-Lokkart et al., 2019).

There are some limitations concerning measuring the different constructs in the previous studies. Often, fatigue is measured via conventional fatigue questionnaires such as the Fatigue Severity Scale (FSS) (Brys et al., 2020). However, these types of questionnaires give an overview of the fatigue severity instead of showing a more detailed insight into the variations and other factors contributing to the experience of fatigue (Brys et al., 2020; Shen et al., 2006). For instance, the severity of fatigue may differ at different times of the day. Furthermore, conventional questionnaires are more vulnerable to biases such as memory bias. This, in turn, can lead to misrepresenting the actual symptom occurrence due to their retrospective nature. Moreover, the recall of the symptoms is strongly affected by the intensity and variability during recall (Brys et al., 2020). For instance, people who suffer intensively from recall symptoms often overestimate their overall symptoms. Lastly, the emotional states at the time of the recall also seem to influence the symptom recall (Brys et al., 2020). Specifically, the more a person feels emotionally stressed (increased negative affect or physiological arousal caused by an emotional stimulus), the less they can adequately recall their symptoms (Visser, 2017).

There seems to be a lack of consensus among the general population regarding gender differences in the experience of negative and positive affect. This is primarily due to the different measurements of affect. Some studies have focused on the valence of the emotion, while others have emphasised the different emotions of negative or positive affect (Deng et al., 2016). Furthermore, there seems to be a difference between the experience of emotion and the emotional response. Thereby, healthy women seem to report more severe emotional responses, especially to negative affect in general (Deng et al., 2016). Furthermore, they tend to display higher arousal of most emotions than men, although men have shown greater experiences of anger (Deng et al., 2016). Next to that, the study by Gentile et al. (2009) has shown that women tend to experience more positive and negative affect compared to men. Regarding the measurement of mood, some obstacles need to be considered. For instance, there is a high moment-to-moment variability concerning mood and emotions. In other words, a person might feel relaxed in one moment but can feel irritated just an hour after that (Deng et al., 2016). Therefore, it is not sufficient when a measurement assesses an emotion once a day. Furthermore, like fatigue, positive and negative affect are subjective constructs that rely on self-reports. Therefore, it might differ from subject to subject (Deng et al., 2016).

A methodology that can overcome some of the abovementioned disadvantages, such as the overestimation regarding fatigue or the moment-to-moment variability of the mood, is the

Experience Sampling Method (ESM). ESM is about tracing experiences at the actual time and in the real world via self-reports (Myin-Germeys & Kuppens, 2021). It is a method that comes with numerous benefits. One benefit is that participants can be very detailed and more specific about their current feeling or behaviour, as converse to standard study designs, e.g., cross-sectional studies (Van Berkel et al., 2018).

Another advantage is that it prevents the typical recall bias since the behaviour, thoughts, and feelings are assessed in real-time (Verhagen et al., 2016). Furthermore, people are completing their self-reports in their natural environment. Thus, the representation of the patient's natural behaviour is more accurate (Van Berkel et al., 2018). The natural environment also promotes a better understanding of the relationship between two variables since they occur in everyday life. Therefore, it will give a more detailed insight into the behaviours or activities contributing to the feelings of fatigue. Additionally, the repeated measurement in ESM allows the display of the different variations over the day and the week (Verhagen et al., 2016). So, not only can the variations of one variable be monitored, but also the variance in the relationship between two variables, such as the relation of experience of emotions on fatigue, can be analysed. This will increase validity and reliability, which in turn might improve the research on fatigue, its relation to positive and negative affect and the post-COVID-19 syndrome itself.

Lastly, an ESM study allows the analysis of different associations. Since there is a time-varying covariate, within-person and between-person effects can be examined (Curran & Bauer, 2011). Significantly, the within-person effect is essential since it is often ignored in psychology research due to the need for longitudinal designs. Specifically, the within-subject effect deals with the degree to which the experience of negative affect varies within a respondent concerning their experience of physical fatigue in particular situations (Curran & Bauer, 2011). In contrast, the between-person effect includes the degree to which a person who experiences higher levels of physical fatigue is also more likely to report higher levels of negative emotions than the other persons (Curran & Bauer, 2011). Moreover, the ESM study allows us to execute a time-lagged analysis that entails several benefits (Falkenström et al., 2020). For instance, it can track time-by-time changes at the within-patient level. As a result, causal inferences can be drawn, which helps to develop an effective and personalised intervention that can be implemented at specific treatment phases (Falkenström et al., 2020). Thus, the ESM study design allows a deeper understanding of the relationship between both variables.

Up to now, concerning post-COVID-19 syndrome, most research projects have focused on general fatigue instead of differentiating between both types of fatigue. However, according to the study by Elanwar et al. (2021), people who suffered from the post-COVID-19 syndrome

experienced more physical fatigue than mental fatigue. Comparable results were also found in another Dutch study that reports higher levels of physical fatigue than mental fatigue in post-COVID-19 syndrome patients (Wensink, 2022). Therefore, the present study used ESM to investigate the relationship between individuals' amount of (positive and negative) affect and the level of physical fatigue over time. Additionally, the relation between the level of physical fatigue and affect at the within- and between-subject level will be examined. Thus, based on the beforementioned paragraphs, this study includes the following research questions:

How prevalent is physical fatigue and affect over time in Dutch people with the post-COVID-19 syndrome at least six months after hospital discharge?

To what extent is affect (negative or positive) associated with physical fatigue over 14 days in Dutch people with the post-COVID-19 syndrome at least six months after hospital discharge?

Are there differences in the association between physical fatigue and affect when comparing between persons and within persons over 14 days in Dutch people with the post-COVID-19 syndrome at least six months after hospital discharge?

Is the association between physical fatigue and affect different for women or men over 14 days in Dutch people with the post-COVID-19 syndrome at least six months after hospital discharge?

Does affect at a prior measurement predict physical fatigue at the subsequent measurement in Dutch people with the post-COVID-19 syndrome at least six months after hospital discharge?

Method

The current research paper involves an exploratory ESM study design that works complementary to the longitudinal cohort study on health after COVID-19 hospital discharge from the Medisch Spectrum Twente (MST) Hospital in Enschede (Wensink, 2022). Thereby, patients had to fill in a questionnaire after their hospital discharge. Furthermore, different demographic characteristics seem to increase the chance of developing the post-COVID-19 syndrome were collected.

Participants

Participants were recruited via the purposive sampling method. Specifically, ex-patients from the MST hospital in Enschede were invited to fill in a questionnaire directly, three months, six months, nine months, and twelve months after hospital discharge. Inclusion criteria were a) discharged from the hospital after PCR-confirmed acute COVID-19; b) ≥18 years of age; c) proficient in Dutch; and d) written informed consent.

On the basis of the self-reported health changes compared to one year ago (before their hospitalisation), forty-two patients were selected. Based on the Dutch SF-36, patients who demonstrated a score equal to or above 50 compared to a year ago were considered as recovered or non-recovered with a score below 25 (Ware et al.,1998). All 32 non-recovered patients were invited for an interview. The recovery status was reassessed based on the participants' responses about their current health. Furthermore, 10 out of the 32 non-recovered patients refused their invitation. Two other participants were excluded based on their Dutch proficiency or health issues. Furthermore, four not-recovered patients were considered as recovered because of the reassessment. Consequently, the final sample consisted of 16 non-recovered. Out of the 16 non-recovered participants, 11 were enrolled in the study. Additional inclusion criteria of the ESM study were a persistent and severe impact by symptoms such as fatigue, pain, dyspnoea and/or cognitive dysfunction) that were attributed (primarily) to Long-COVID/lack of recovery from COVID-19 by the participant. Lastly, one participant had to be excluded from the analysis due to a dropout after the fourth day of the ESM assessment. Therefore, N=10 equalled the final sample size for the current research.

The age of the sample ranged from 48 years to 76 years. Thus, the resulting mean age was 59.7 years (Sd= 7.65). The number of male participants was equal to that of female participants (n=5, 50 %). Furthermore, eight respondents had reported one or more comorbidities, and two participants reported no comorbidity. Lastly, four people in the sample were obese (BMI of ≥30 kg per m2), and four participants demonstrated an overweight (BMI of ≥25 kg per m2). The remaining two participants had a healthy weight.

Material

The ESM study was created with the online tool Ethica data which enables the design of online research studies (Ethica Data Services Inc, 2022). Due to the app's design, the ESM study will be easily accessible to respond to the survey. The daily questionnaire includes two questionnaires; and the first consists of a survey concerning physical fatigue, and the second one includes a questionnaire regarding positive and negative affect. All questions from both questionnaires could be answered using a 7-Point-Likert Scale (e.g., 1 = not at all → 7= a lot).

The questionnaire regarding fatigue contains one question about physical fatigue (e.g., 'Right now, I feel bodily more tired as before') that needs to be answered by all respondents six times a day. The question is invalidated but based on other ESM studies on similar topics, such as fatigue in chronic fatigue syndrome, based on items from a validated questionnaire. Specifically, the item regarding physical fatigue was one item from the PHQ-9 (Kroenke et al., 2001).

Secondly, the survey about positive and negative affect contains six questions that must be answered six times a day. Thereby three questions concern positive affect ('Right now, I am feeling cheerful'; 'Right now, I am feeling relaxed'; Right now, I am feeling satisfied') and the other three questions related to negative affect (e.g., 'Right now, I am feeling sad'; 'Right now, I am feeling irritated', 'Right now, I am feeling disappointed'). These items were also based on several other related ESM studies that included validated questionnaires to measure affect (Brys et al., 2020; Dietvorst et al., 2021; Maes et al., 2015; Worm-Smeitink et al., 2021).

Design

The current ESM study follows a signal-contingent sampling strategy. Thus, throughout the day, respondents got unforeseeable notifications at random times with an equal time frame. Furthermore, since not all participants started on the same day, it was important that for each person, weekdays and weekends were included (Myin-Germeys & Kuppens, 2021). This is necessary because some activities and moods might look different on the weekend than on a weekday. Thus, to produce a representative sample, the study lasted 14 consecutive days with an added fifteenth day. Furthermore, a shorter duration leads to a higher response rate since it is crucial not to overstretch respondents' burdens (Conner & Lehmann, 2013; van Berkel et al., 2018). As this study dealt with ill respondents, it was essential to reduce the burden. Therefore, the time to fill in the physical fatigue and mood survey expired after fifteen minutes. This is also following Van Berkel et al. (2017) since he reported a high probability that people interact with an app within five minutes after the notification.

Procedure

Data was gathered by the MTS Hospital between September 1 and November 5, 2021. The survey was pilot tested by a research team that acted as participants (n=7) and non-hospitalised patients with post-COVID-19 syndrome symptoms (n=4). Before the interview started and at the beginning of the ESM study, participants had to sign an informed consent form. The study was approved in May 2021 by the Ethical Committee of the University of Twenty (request number: 210799). Additionally, Ethica sent reminders and notifications to remind the participants to fill in the following survey. This, in turn, will help to increase respondents' attendance. In the beginning, participants received an invitation to participate in the study. After that, they just had to download the app on their smartphones. Furthermore, on the first day, participants got access to a test version of the actual research questionnaire to become familiar with the application. Since every respondent started the study after being interviewed, the start day differs from patient to patient. For the mood and physical fatigue survey, participants received six notifications between 8 am and 8 pm (e.g., between 8 am and 10 am, between 10 am and 12 pm, etc.) (see Table1).

Table 1

The Schedule of the Study for all Days, Including Relevant Variables, Points in Time, Expire time and Notification for the Different Questionnaires

Day	Questionnaire	Relevant Variables	Points in time	Expire time	Notifications
1	Demographics	All		No	1
				No	1
2-15 (14 days)	Daily questionnaire	Mood and physical fatigue	8 am- 10 am 10 am- 12 pm 12 pm- 2 pm 2 pm-4 pm 4 pm-6 pm 6 pm- 8 pm	Yes, after 15 minutes	1 (6 in total/each day)

Data Analysis

The data was imported to IBM SPSS Statistics Version 27 (IBM Corp, 2017). Next, the data was checked, and participants with potential errors were removed. A potential error could be no variance in responses for each item (Conner & Lehmann, 2013). Furthermore, participants, who had not completed at least 50 per cent of the reports, were removed (Conner & Lehmann, 2013). Afterwards, respondents' demographics were examined via descriptive statistics. Visualisations were created to get a better overview of the sample and the relevant variables. This includes multiple line graphs that display the mean score of all variables (physical fatigue, positive and negative fatigue) for the six-time points of the day, the week, or the whole assessment period. Additionally, a variable regarding the six measurements of affect and physical fatigue for each day was created. The fourteen days duration of the data collection was summarised in one time variable.

Because the respondents suffer from symptoms and the assessment interval of 14 consecutive days, there is a high probability of a missed assessment. Therefore, Linear Mixed Model seems to be an appropriate statical model because it can deal with greater amounts of missing data (Myin Germeys & Kuppens, 2021). For all variables, z-scores were calculated, and a p-value of 0.01 was used as a significance level for the analyses. According to Cohen (1988), a regression coefficient of >.1 (-.1) reflects a small effect, a beta of >.3 (-.3) reflects a moderate effect, and a beta of >.5 (-.5) reflects a strong effect.

A series of Linear Mixed models were applied to test the association between physical fatigue and the experience of positive and negative affect. Thereby, physical fatigue was set as the dependent variable and positive and negative affect as the fixed covariates. Furthermore, the total time points across the study were set as repeated measures.

For the third research question, a person means score (for between-person relations) and a person-mean centred score (for within-person relations) of physical fatigue was created. LMM was executed where physical fatigue was set as the dependent variable, and the person means centred score and the person means score of negative and positive affect were set as independent variables.

Next, in LMM, a moderation analysis with gender as the moderator variable was executed. The interaction effect between gender and positive/ negative affect was executed. Afterwards, a Linear Mixed Model was performed with physical fatigue as the dependent variable and positive and negative affect (separately), gender, and the interaction effect as the independent variable.

Lastly, another series of Linear Mixed Models were executed where one-moment lagged (T-1) scores of the daily positive and negative affect were separately set as the fixed factor, and physical fatigue was set as the dependent variable. Thus, the time-lagged variables represented associations with physical fatigue approximately two hours later the same day. To circumvent the risk that the positive affect and negative affect scores of the latest timepoint of the day (T6) predict physical fatigue at the first timepoint the next morning (T1), the first timepoints of each day were removed from the analysis.

Results

Altogether, participants reacted on average to 62 out of 98 requests, reflecting an average response rate of 60.8% (SD = 20%). The mean physical fatigue score of the whole sample during the 14-days-period was 4.86 (SD = 1.6). Additionally, the scores have ranged from 1 (not at all fatigued) to 7 (the whole time fatigued). The mean positive affect score of the entire sample during the total assessment time equalled 4.29 (SD= 1,43), and the mean negative affect score was 2.82 (SD= 1.68).

Physical fatigue in people with the post-COVID-19 syndrome

Figure 1 shows the individual respondents' mean physical fatigue score per timepoint over the whole study period. Physical fatigue appeared to be relatively constant for most respondents during the day. In other words, for most participants, there were just small fluctuations between the morning, lunch, and evening scores. However, considering participants 8, 9, and 10, more significant changes in the physical fatigue score could be detected. For instance, participant 10 seemed to experience the most physical fatigue between 10, and 11 am in the morning. On the contrary, participant 8 reports physical fatigue relatively often in the morning between 10 and 11 am and midday between 3 and 5 pm. Next, for Participant 9, the experience of physical fatigue ranged from just a bit fatigued during the morning and lunchtime to moderate fatigue between 4 and 5 pm. After that, the experience of fatigue appeared to decrease again. Furthermore, for participants 1, 5 and 9, the mean physical fatigue tends to increase from time to time. Thus, they can be clustered as "climbers". In contrast, just for participant 6, the mean level of fatigue tends to decrease over the day. Additionally, when looking at each time point separately, it becomes clear that between 8 and 9 am, thus in the morning, the highest inter-individual differences can be detected. Between 6 and 8 pm, the slightest differences in the individual level of physical fatigue can be observed. In general, each respondent differed in the severity and variations of physical fatigue. Specifically, whereas participant 6 has seldom felt severely fatigued, participant 3 experienced severe but stable physical fatigue most of the whole assessment time.

Figure 1

Mean physical fatigue score per timepoint during the day over the whole assessment period

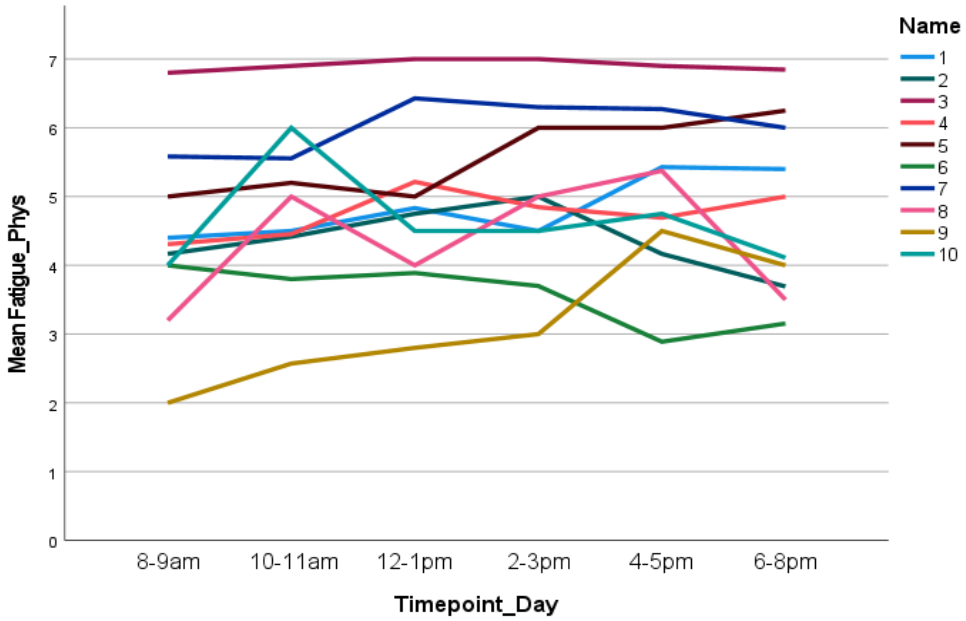


Figure 2 displays the individual respondents' mean physical fatigue score per day during the total assessment time, showing that physical fatigue fluctuated clearly over the different days. Most participants experienced differences in their level of fatigue during the period. For instance, participant 8 experienced just a bit of fatigue on the 10th day, but experience severe fatigue on the 12th day. Participant 6 started the study feeling a great extent of physical fatigue. After that, there were up and downs. Specifically, the participant just felt a bit fatigued on the fourth day. However, on the sixth day, he/she returned to her original level of fatigue. So, huge variations between the 14 days can be detected. Additionally, Participant 1 reported moderate to more severe fatigue, and Participant 3 seemed to experience extreme physical fatigue the whole time. For Participants 1, 3, 7, and 10, the mean physical fatigue score seemed relatively stable over the entire 14 days-period. This could also be seen when comparing the variance of the mean physical fatigue per day (see Table 2). Whereas Participants 1, 3, 5, 7, and 10 display relatively low variances in their daily mean physical fatigue, Participants 6 and 8 display the most remarkable variances in their daily mean. When comparing the physical fatigue on the different weekdays (see Figure 3), different patterns can be detected even though physical fatigue highly fluctuates on the different weekdays. For instance, it becomes clear that all participants except 1, 3 and 4 increased in physical fatigue from Sunday to Monday. Next, while half of the sample reports a peak of physical fatigue on Wednesdays, the other half experience

a minimum level of physical fatigue that day. Furthermore, for all participants except Participants 1 and 5, the level of physical fatigue decreased from Friday to Saturday, even though some participants reported an increase in physical fatigue the following day. Thus, it cannot be generalised that physical fatigue is higher during the week than on the weekend.

Figure 2

Mean physical fatigue score by day by participants during the total assessment period

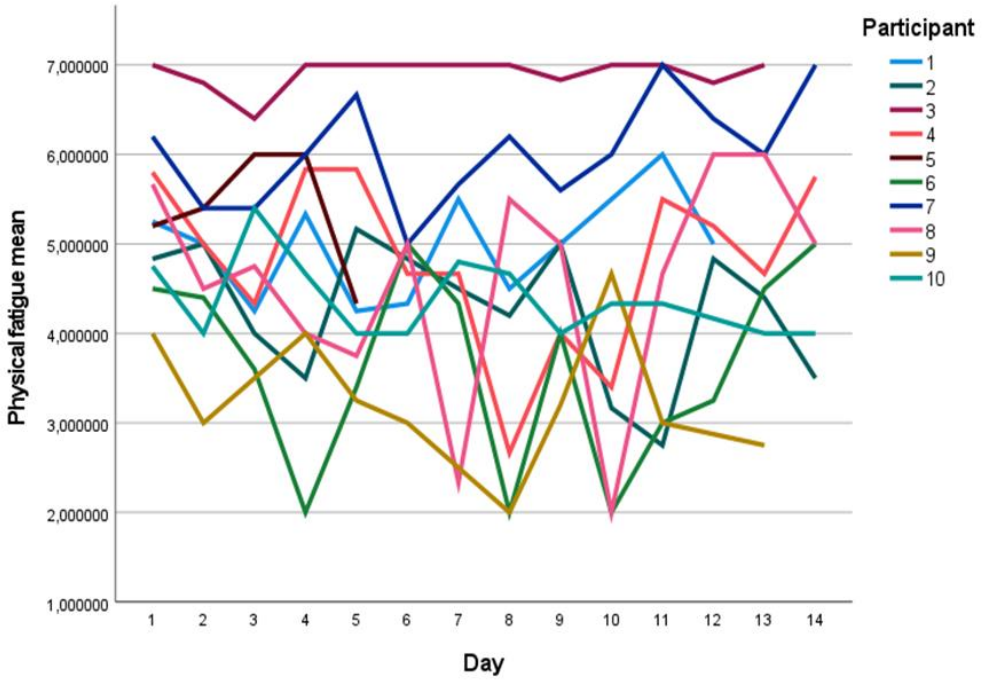


Table 2

Variance Of Positive Affect, Negative Affect, and Physical fatigue over 14 days per individual

Individual	Var Positive Affect	Var Negative Affect	Var Physical Fatigue
1	,13	,17	,11
2	,10	,19	,18
3	,07	,06	,03
4	,18	,25	,20
5	,10	,26	,13
6	,12	,24	,30
7	,10	,05	,10
8	,05	,33	,27
9	,03	,00	,22
10	,10	,03	,10

Figure 3

Two days mean physical fatigue score per weekday by participants during the total assessment period

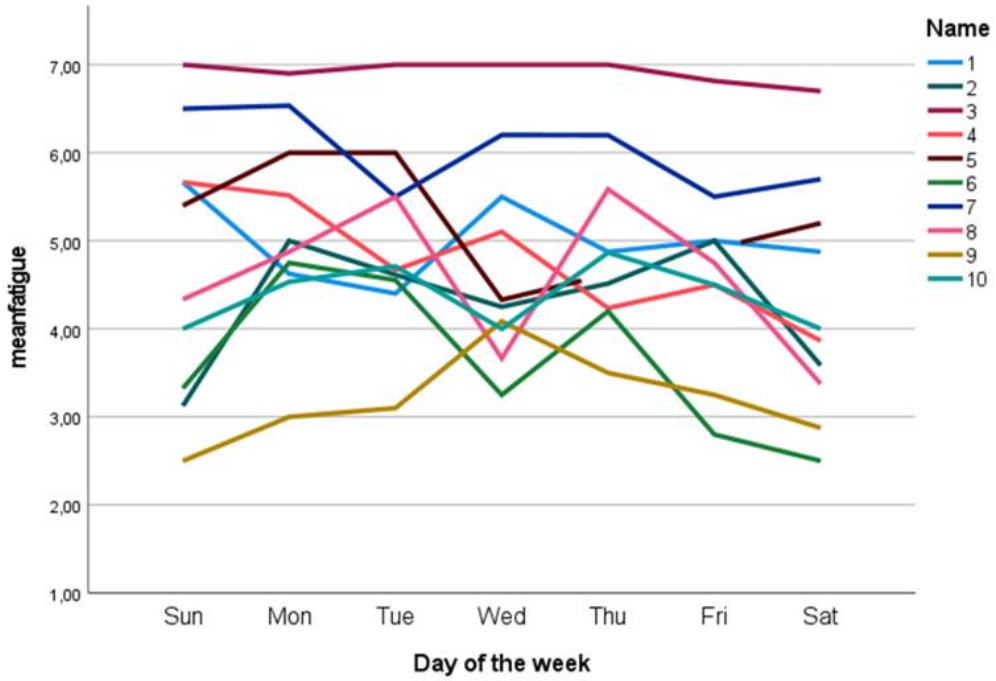
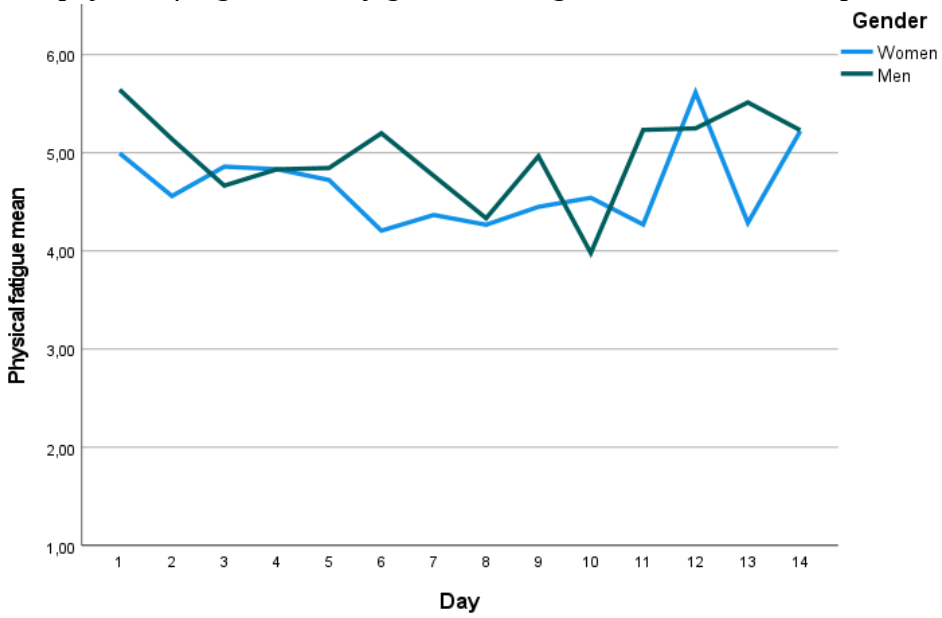


Figure 4 represents the mean physical fatigue score separated by gender. Thereby, gender differences in the experience of physical fatigue can be detected. Especially for men, the mean score of physical fatigue demonstrated many variations. It seemed to be relatively stable for women, although a considerable variation between the 11th and 13th days can be detected. In general, men and women tended to experience similar levels of physical fatigue over the total assessment period. However, men seemed to encounter more physical fatigue than women, even though women scored higher on the 10^{th} and 12^{th} days.

Figure 4

Mean physical fatigue score by gender during the total assessment period



Positive and negative affect in people with the post-COVID-19 syndrome

As shown in Figure 5, which represents the individuals' mean positive affect score per day during the total assessment period, most of the respondents experienced many fluctuations in their experience of positive affect. For instance, high variations could be seen in the mean score of Participant 6, showing an increase from 4 to 6 in two days. Additionally, Participant 4 experienced moderate levels of positive affect on the first and high levels on the 3rd day. On the 4th day, there was a decrease in the origin level again. When comparing the variances, it became apparent that Participants 3, 8, and 9 displayed the lowest variance (see Table 2). In contrast, participant 4 showed the highest variance ($s^2 \approx .18$). Furthermore, several clusters can be detected when comparing the mean positive affect score on the different weekdays (see Figure 6). For instance, most participants showed an increase in positive affect from Friday to Saturday. Furthermore, just the Participants 3, 4, and 7 experienced an increase in positive affect after the weekend (From Sunday to Monday). Thus, in this sample, most participants experienced more positive affect on the weekend than on weekdays. Additionally, it can be detected that 50 per cent of the sample experienced one (or a second) peak in the middle of the week (Wednesday). On the contrary, the other 50 per cent experienced another low point on Wednesday. Interestingly, participants 3 and 7 also showed comparatively low levels of positive affect over the whole period of the study. Overall, a difference in severity and variation in either positive or negative affect per individual could be observed.

Different results were found with the individuals' mean negative affect score per day during the total assessment period, shown in Figure 7. Thereby, negative affect seemed to be consistent for most of the respondents. Thus, just small fluctuations between the days can be detected. For instance, for Participant 4, the mean negative affect score drastically increased after the 7th day, remained static until the 11th day, and went up and down again. In contrast, the mean negative affect score from participant 6 shows two maximum peaks on the 6th and 13th days. Overall, the severity of negative affect varied from participant to participant. Participants 2 and 10 experienced just a few negative emotions, whereas participants 7 and 3 experienced negative affect over the assessment period. Thus, for those four participants, there were no significant fluctuations visible. This is also confirmed by the low variance of these four participants (see Table 2). Additionally, Participant 9 is the only participant who displayed no variance ($s^2 = 0$). In contrast, Participants 4, 5, 6, and 8 showed the highest variances. No general pattern can be detected when comparing the negative affect score on the different weekdays (see Figure 8). In other words, some participants experienced more negative affect on the weekend, while other participants experienced more negative affect during the week.

Figure 5

Mean positive affect score by day by participants during the total assessment period

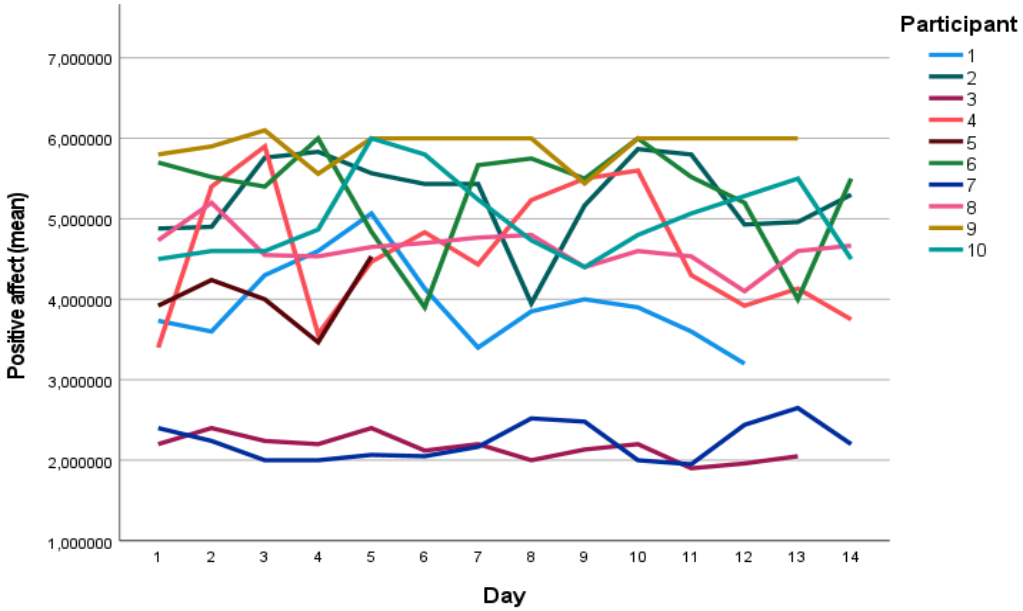


Figure 6

Mean positive affect score per weekday by participants during the total assessment period

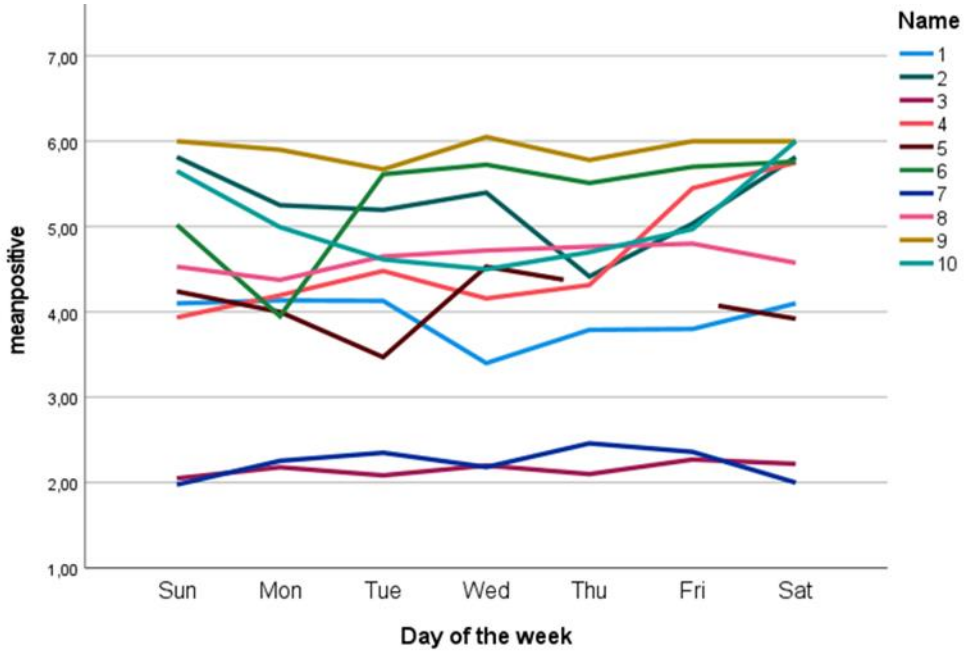


Figure 7

Mean negative affect score by day by participants during the total assessment period

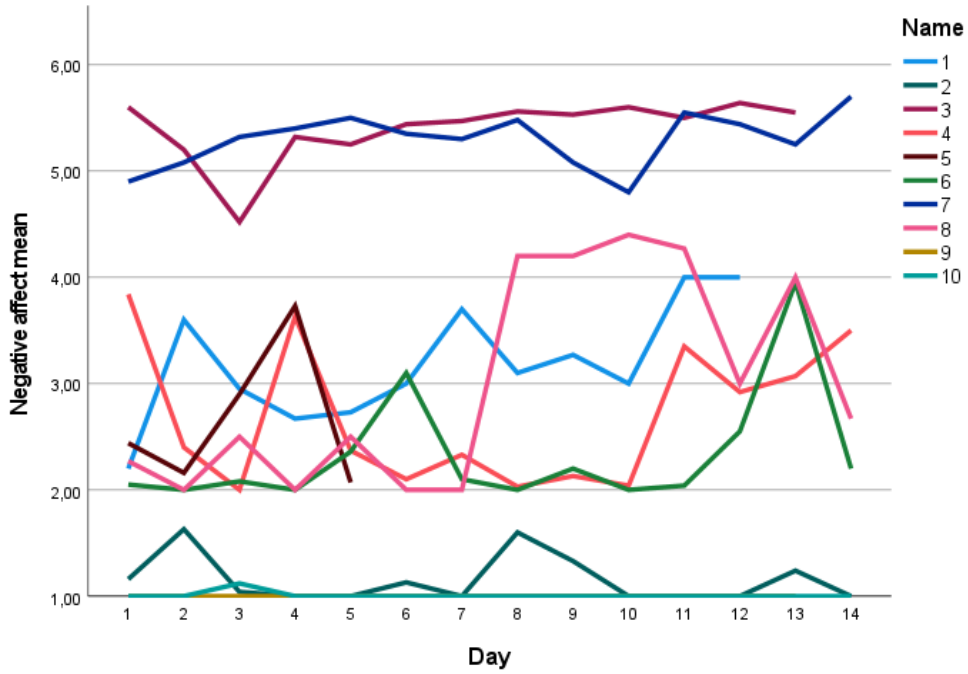


Figure 8

Mean negative affect score per weekday by participants during the total assessment period

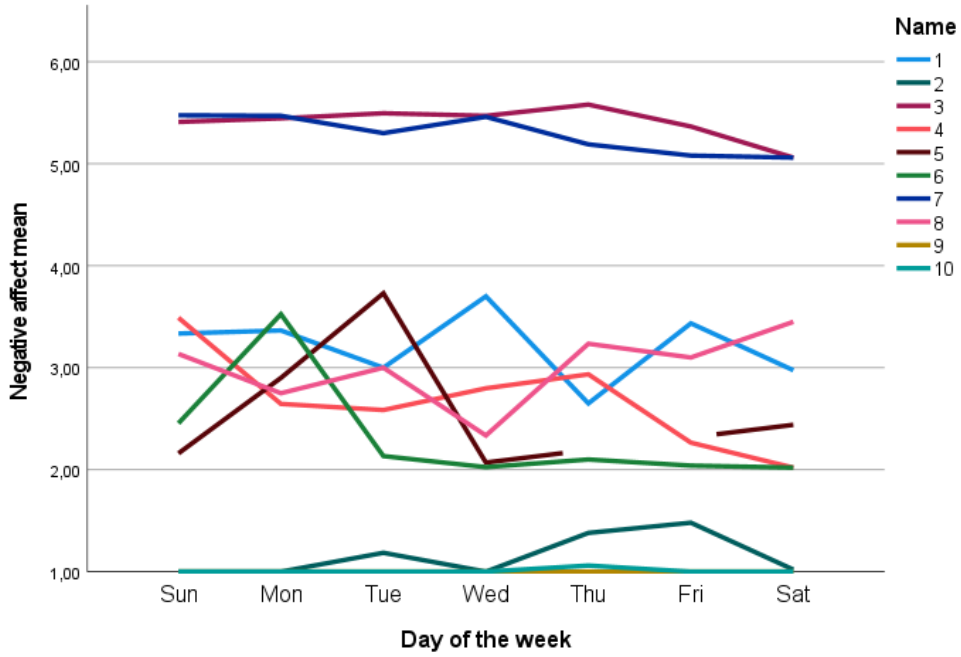


Figure 9 and 10 represents the mean positive affect score and mean negative affect score separated by gender. Thereby, gender differences can be detected in the experience of positive and negative affect. Whereas the mean score of positive affect showed many variations over the period, the mean score of negative affects stayed relatively consistent for both women and men over time.

Regarding negative affect, men appeared to experience more negative emotions than women on average per day. Considering positive affect, women tend to experience more positive emotions than men. However, there are three timepoints where men and women seemed to share the same level of positive emotions on average per day. On the 14th day, men scored even higher compared to women.

Figure 9

Mean positive affect score by gender during the total assessment period

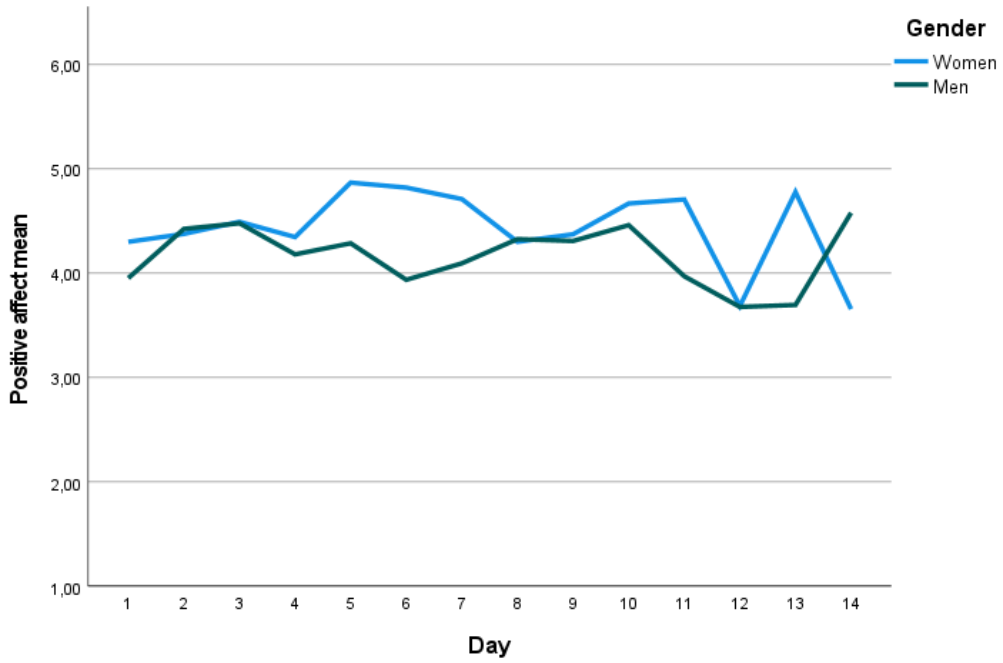
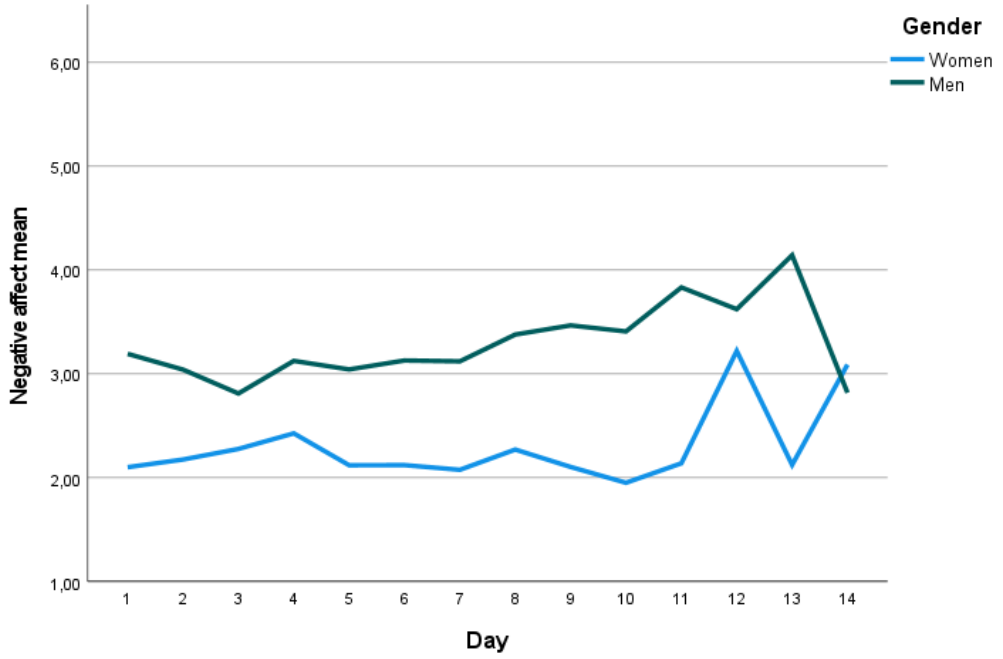


Figure 10

Mean negative affect score by gender during the total assessment period



Relationship between physical fatigue and positive affect

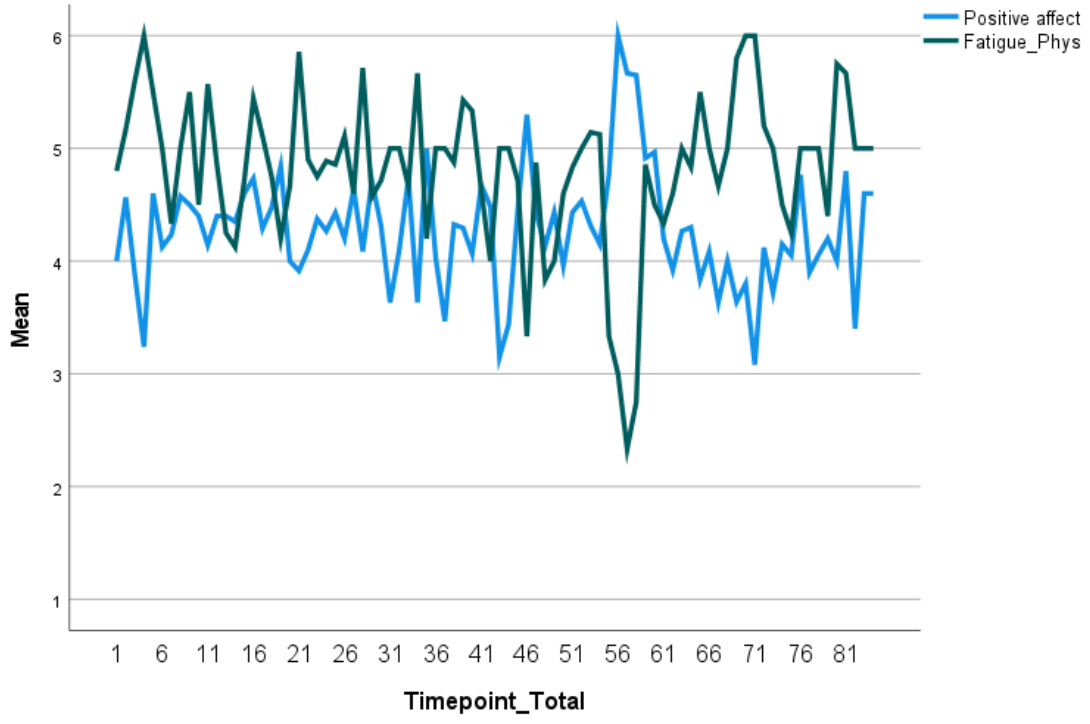
For an overall momentary association covering all time points, Linear Mixed Model analysis revealed that physical fatigue was significant and strongly negative associated with positive affect (β = -.682, SE = .026, p = <.001) at the same timepoint. Figure 11 displays this clear association at the group level over time.

Between persons and within-persons effects

A similar but higher relationship between positive affect and physical fatigue between persons and within persons was detected. In general, a significant and higher negative association was found between persons (β= -.808, SE = .021, p = <.001). Thus, when a participant experienced more positive affect than another participant on average, they experienced less physical fatigue. A significant but moderate within-person association was found (β = -.554, SE = .089, p = <.001). In other words, when participants experienced more positive affect than usual, they felt less physical fatigue.

Figure 11

Mean physical fatigue and positive affect score of the sample during the total assessment period



Relationship between physical fatigue and negative affect

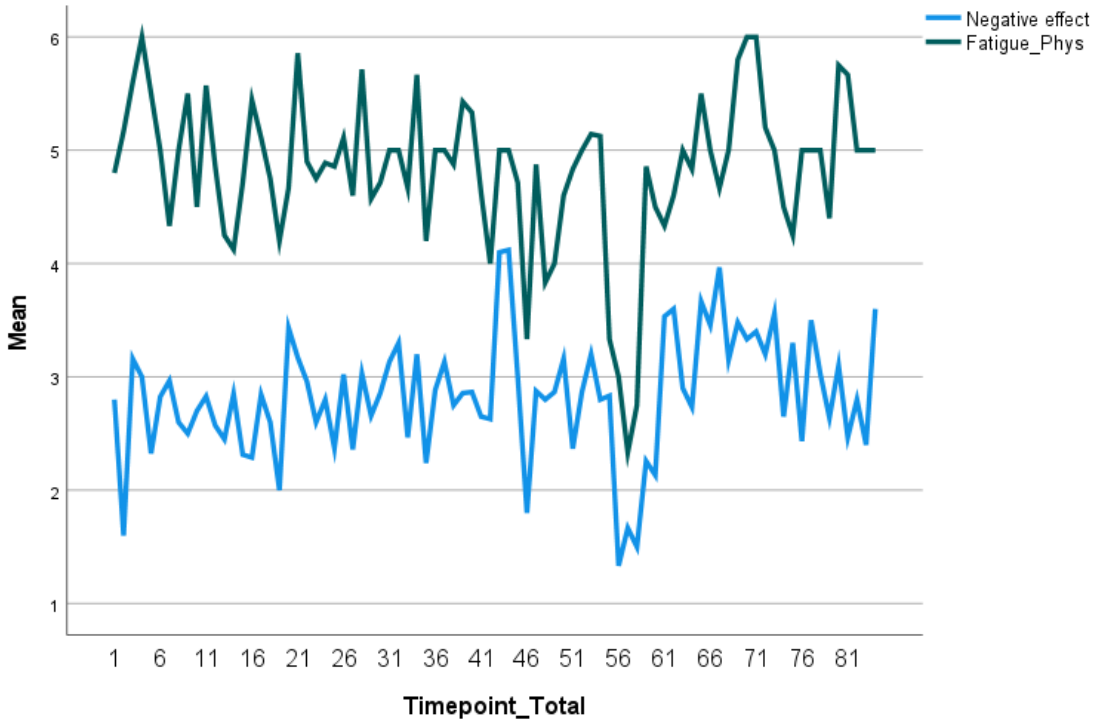
For an overall momentary association covering all time points, Linear Mixed Model analysis revealed that physical fatigue was significant and moderately positive associated with negative affect (β = .576, SE = .029, p = <.001) at the same timepoint. Figure 12 visualises this association.

Between-persons and within-person effects

A similar but weaker relationship between positive affect and physical fatigue between persons and within persons was detected. In general, a significant and low positive association was found between persons (β = .264, SE = .016, p = <.001). Thus, when a participant experienced more negative affect than another participant on average, they experienced more physical fatigue. A non-significant within-person association was found (β =.024, SE = .019, p= >.001). In other words, when a participant experienced more negative affect than usual, it did not predict their level of physical fatigue.

Figure 12

Mean physical fatigue and negative affect score of the sample during the total assessment period



Moderation by gender

A non-significant interaction effect was found for gender on the overall bidirectional relation between physical fatigue and positive affect (β = -.050, SE = .026, p = .055). In other words, gender did not affect the relationship between positive affect and physical fatigue (see Table 3). However, for the relationship between physical fatigue and negative affect, a significant but only small interaction effect was detected (β = .187, SE = .056, p = <.001). This

means that being men positively affected the relation between physical fatigue and the experience of negative affect (see Table 4; Figure 13).

Figure 13

Moderation effect of gender on the relation between physical fatigue and negative affect

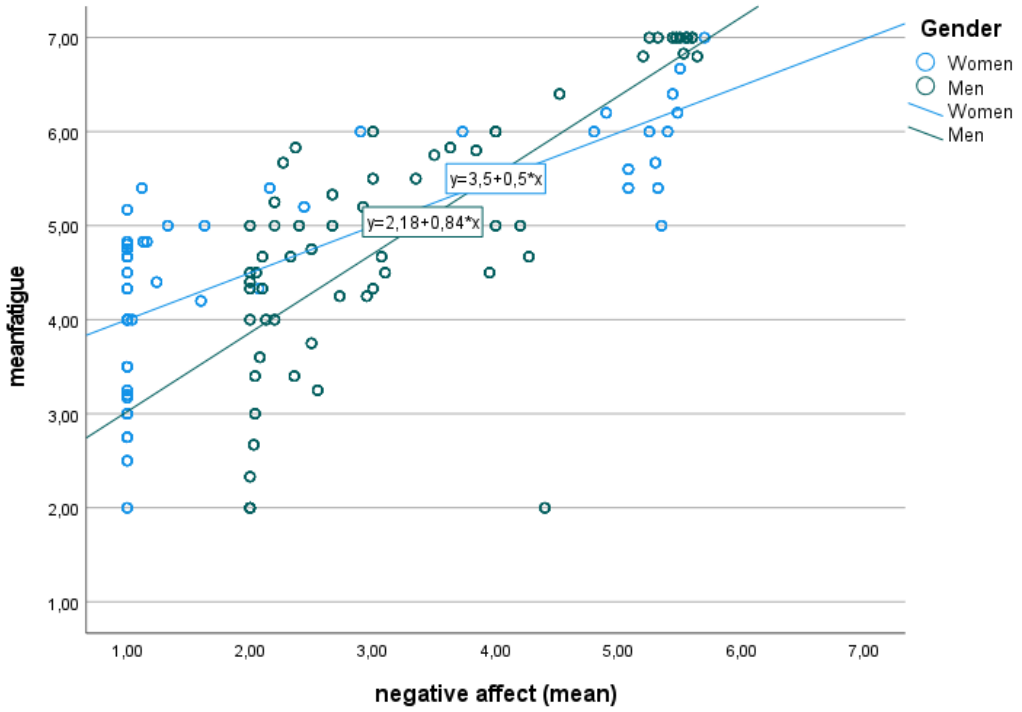


Table 3

The Moderation Analysis for Positive Affect With Standardised Values

						95% Confidence Interval	
Parameter	Estimate	Std. Error	df	t	Sig.	Lower Bound	Upper Bound
Intercept	,054	,026	190,551	2,120	,035	,004	,105
z_positive	-,687	,026	226,815	-26,303	<,001	-,739	-,636
ZGender	-,005	,026	197,181	-,204	,839	-,056	,045
INTP	-,050	,026	231,786	-1,930	,055	-,102	,001

Note. Dependent Variable: z_fatiguephy.

Table 4

The Moderation Analysis For Negative Affect With Standardised Values

						95% Confidence Interval	
Parameter	Estimate	Std. Error	df	t	Sig.	Lower Bound	Upper Bound
Intercept	-,004	,029	244,608	-,137	,891	-,061	,053
z_negative	,661	,030	257,722	21,720	<,001	,601	,721
ZGender	-,119	,029	249,803	-4,094	<,001	-,177	-,062
INTNE	,187	,030	256,289	6,261	<,001	,128	,245

Note. Dependent Variable: z_fatiguephy.

Predictive value of positive and negative affect on physical fatigue at the next measurement

When using the positive affect scores at a prior measurement to predict physical fatigue at the subsequent measurement (approximately two hours later the same day), a significant and strong negative association was observed ($\beta = -.707$, SE = .047, $p < .001$). Experiencing more positive affect at a prior measurement predicts physical fatigue at the subsequent measurement. Reversely, when using the negative affect score at a previous measurement to predict physical fatigue in the next measurement, a significant and strong positive association was found ($\beta = .564$, SE = .044, $p < .001$). Thus, experiencing negative affect at a prior measurement predicts physical fatigue at the next measure.

Discussion

This study aimed to clarify the interplay between physical fatigue and affect (positive or negative) over 14 days in people with the post-COVID-19 syndrome, using concurrent and predictive analyses. In addition, intra-individual differences, and inter-individual differences in the concurrent relationship between fatigue and affect over time were investigated. Furthermore, the purpose was to examine whether the association between physical fatigue and affect might differ for women and men.

The descriptive statistics of this study have shown that physical fatigue is a severe and prevalent symptom among this sample of patients with the post-COVID-19 syndrome. This is consistent with the results of several previous studies (Carfì et al., 2020; Lopez-Leon et al., 2020; Mandal et al., 2021, Wensink, 2022). The severe impact was also visible in the relatively high physical fatigue day scores over the whole assessment period. However, it also became clear that these scores varied in intensity and variance during and between the days among individuals. While some individuals showed high variability in their physical fatigue during the day or across the week, others demonstrated low variance in their physical fatigue. Furthermore, while some respondents experienced severe physical fatigue most of the time, others experienced just low fatigue at some time points. Hence, patients who underwent very high or low physical fatigue, seemed pretty stable across the day or week, whereas the intermediate group showed the most variability. The disease burden might explain the stability of high physical fatigue. So, patients who feel exceptionally fatigued might be too tired to undertake measures to counteract fatigue. Furthermore, physical fatigue impair daily life, which, in turn, also increases fatigue (Puetz, 2006).

Regarding affect, the descriptive results have shown that the whole sample reported higher levels of positive affect than negative affect. This is against expectation since, for instance, in cancer-related fatigue, positive affect is often associated with better coping strategies and negative affect with more feelings of fatigue (Strebkova, 2020). Thus, a higher level of negative affect was hypothesised based on the relatively high physical fatigue scores . A possible reason for that could be that affect was additionally influenced by other variables, e.g., character traits. Furthermore, it might be the case that the intraindividual level of positive or negative affect has already changed due to their health condition. So, a decreased positive affect dominance would already signify a disease burden. Next, the results have shown high daily fluctuations in the positive affect scores over the total assessment period, even though the variance of all respondents demonstrated relatively low levels of positive affect. Additionally, most respondents experienced more positive affect on the weekend than on weekdays. In

contrast, negative affect seems relatively stable, even though individual differences exist. While some individuals experienced just low levels of negative affect, others experienced high levels over the whole assessment period. The results are also in line with previous studies, which showed that some individuals experience quite a stable level of affect and do not vary from their average level. In contrast, others experienced more mood swings (Jacobs et al., 2012). Furthermore, the difference between positive and negative affect might also be influenced by the character trait neuroticism. Hence, people high in neuroticism often experience more negative affect (Aschwanden et al., 2020). Lastly, it seems that men in this sample experience more negative affect than women, whereas women tend to experience more positive affect on average over the assessment period. This is not in line with previous studies that found more positive and negative affect in women than men (Deng et al., 2016; Gentile et al., 2009). Nevertheless, there is still a discrepancy in the consensus about affect due to the different constructs that were measured in several previous studies of emotion, affect, and arousal (Deng et al., 2016). Another explanation might be the other target groups included in the analysis. While the study of Deng et al. (2016) included healthy participants, the current study design was based on the response from ill people. Thus, the different results on the gender differences might be the effect of men and women dealing with the post-COVID-19 syndrome.

The second research question examined whether there was a significant overall correlation between physical fatigue and affect (positive or negative). Previous studies found a relationship between fatigue and affect in people suffering from cancer-related fatigue (Müller et al., 2017; Ryan et al., 2007). Thereby, positive affect seemed to work as a buffer for physical fatigue, and reversely, negative affect seemed to increase fatigue further. Another study by Townsend et al. (2020) among people suffering from the post-COVID-19 syndrome confirms this association between negative affect and fatigue. Thus, following previous literature, the results of this study also suggest a relationship between affect and physical fatigue in people with the post-COVID-19 syndrome. As hypothesised beforehand, negative affect tends to increase physical fatigue, whereas positive affect decreases physical fatigue over time in people with the post-COVID-19 syndrome.

Additionally, the within and between-person associations were analysed separately to investigate the relation in more depth. Thereby the results suggest different between- and within-person effects. Specifically, it was found that an individual who showed higher levels of positive affect on average over time than another person would also feel less physical fatigue compared to that person. Similarly, an individual who showed higher levels of negative affect on average over time than another person would also feel more physical fatigue than that person.

Interestingly, physical fatigue also demonstrated deviation within persons. Notably, when someone experienced more positive affect over time, as usual, they reported lower levels of physical fatigue. Similarly, when someone experienced more negative affect over time, as usual, they reported higher levels of physical fatigue. Unfortunately, the literature did not yet investigate within- and between effects of the relationship between affect and physical fatigue in patients with the post-COVID-19 syndrome. Therefore, the results of this study give significant input for future interventions since it indicated that psychological processes indeed play an essential role in the development of the post-COVID-19 syndrome. So, interventions concentrating on increasing positive or decreasing negative affect might reduce physical fatigue within an individual too. For instance, when an individual shows less positive or more negative affect than usually, just-in-time and tailored interventions can be applied to reduce negative or increase positive affect. Concurrently, the increase in physical fatigue symptoms might also be counteracted.

Regarding the fifth RQ, which demonstrates a further extension of RQ2, the results of this study showed that positive and negative affect predicts physical fatigue approximately two hours later. These findings could work as a basis for the development of future interventions since it indicates that positive and negative affect predicts physical fatigue in the future. Thus, if an intervention aimed at reducing negative affect or enhancing positive affect is applied just in time when the levels negatively change, physical fatigue can be counteracted in the future. This follows the goal of just-in-time adaptive interventions (JITIAs) that aims to provide the proper support at the right time by adapting to individuals changing state (Nahum-Shani et al., 2017). Especially for affect, there are already promising interventions that work according to the principles of Positive Psychology and can be used by the individual (Seear & Vella-Brodrick, 2012). Nevertheless, the best opportune moment where the intervention needs to intervene still needs to be researched, although the results of this study suggested a strong and robust relationship between affect at a prior measurement and physical fatigue approximately two hours later. Additionally, these results showed that the post-COVID-19 syndrome is rather a psychosomatic phenomenon than just a biologically thriven symptomatology. Hence, there is an interplay between the psychological, social, and physiological aspects, suggesting the use of the biopsychosocial model to further investigate the phenomenon of the post-COVID-19 syndrome in more depth. As beforementioned, limited knowledge is available about the relationship between affect and physical fatigue symptoms in patients with the post-COVID-19 syndrome. Therefore, this study aimed to examine this relationship further.

Concerning the fourth research question of whether gender might be a moderator for increasing the relationship between physical fatigue and (positive and negative) affect in people with the post-COVID-19 syndrome, the current study has shown that gender indeed acts as a moderator on the association between physical fatigue and negative affect. Thereby, the association seems to be stronger for men compared to women. Interestingly, the association between positive affect and physical fatigue was not moderated by gender. As abovementioned, previous research has demonstrated that gender influences the level of affect an individual experience (Deng et al., 2016; Gentile et al., 2009). Thereby, women tend to experience more negative and positive affect than men. All in all, the moderation is less strong than expected since only a small or no moderation effect was found. However, it is necessary to consider that these gender differences were found in a healthy population. Additionally, no comparable results can be found since previous studies did not specifically examine gender as a potential moderator meaning that the relationship between affect and physical fatigue is different for men than women. Hence, this research aimed to investigate this moderator relation.

Strengths and limitations

One major strength of this study is that it did not apply a cross-sectional design as most prior studies regarding fatigue and the post-COVID-19 syndrome have used it (Conner & Lehman, 2012). ESM enabled the exploration of the association over time and gave more insight than a mere relation at one timepoint. This allows researchers also to understand the variability of fatigue and affect. Additionally, it can assess within and between-person variations. Secondly, affect and physical fatigue was measured in real-time and in the natural environment of the participant. Thus, the potential risk for a recall bias was limited, and the ecological validity of the study was enhanced (Verhagen et al., 2016). In other words, the study is more representative and generalisable to the everyday life of people suffering from long-COVID. The richness of the data from the current study is also beneficial for developing future interventions to decrease the symptoms of physical fatigue since different time points during the day and the week are included. Furthermore, behaviours or traits that increase or decrease physical fatigue, such as affect, can be incorporated. So, the intervention can directly intervene in real-time or can counteract risk factors before physical fatigue increases. Furthermore, it can include and strengthen protective factors, for instance, positive affect. Lastly, the study demonstrated a relatively high response rate, especially considering the target group. Typically, ESM studies aim for a response rate of 70% or higher, but this relates to a healthy population (Van Berkel et al., 2017). However, this study included data from ex-hospitalised patients with persistent post-COVID-19 syndrome symptoms. Thus, the experience of current symptoms

might have impaired the participation and response to the survey. Therefore, a response rate of 60 per cent is still high.

A limitation of the study is that the comprehensive study design is often more demanding than a cross-sectional design for the participants. Thus, the data collection is time-consuming and might be related to an assessment burden for respondents. Furthermore, it is still questionable if this method can be used in the general population and, specifically, in a vulnerable population. On the one hand, previous studies have found evidence supporting the practicability of using ESM in vulnerable sampling including people with mental health problems (Myin-Germeys et al., 2018). But on the other side, in Napa Scollon et al. (2009) research, older people with depression struggled with completing ESM studies due to poor volition and concentration difficulties. Furthermore, chronic illnesses also negative influences participation. Thus, further developments tailored to different groups and, particularly people with the post-COVID-19 syndrome need to be done to enhance feasibility (Myin-Germeys et al., 2018).

Furthermore, monitoring emotions, symptoms, and behaviours might act as an intervention itself. In other words, being repeatedly asked about particular thoughts or behaviours might induce these thoughts or behaviours. In addition, ESM might even cause participants to modify their behaviours (Myin-Germeys et al., 2018). Applied to this study, it means by being more aware of one's symptoms and behaviours; respondents might try to reduce physical fatigue or negative affect. Thus, whiles respondents seemed to feel optimistic about the repeated measuring during ESM; it might lead to a conscious or unconscious altering of their thought and behaviours (Myin-Germeys et al., 2018). Measurement reactivity remains a common challenge for ESM research since it is still a relatively under-researched aspect. Therefore, it is crucial to minimise measurement reactivity by selecting appropriate ESM measures. Another limitation of the study is that physical fatigue was just controlled by one item. However, physical fatigue seems to be highly dependent on other external factors, e.g., sleep quality or activity. For instance, several studies have proven a reciprocal relationship between physical fatigue and physical activity (Sallis et al., 2021). In other words, increased physical fatigue often leads to decreased physical activity and vice versa. So, physical inactivity could be a predictor or risk factor of physical fatigue. Therefore, it would have been preferable if other variables had also controlled physical fatigue to circumvent the risk of being biased by other hidden factors.

Future research

For future research, it would be interesting also to conduct research on the relationship between other risk factors next to positive or negative affect and physical fatigue in ex-hospitalised post-COVID-19 syndrome patients. Specifically, previous research has shown that sleep quality also tends to influence individuals' levels of physical fatigue in other chronic lung diseases (Şahin & Dayapoğlu, 2015). According to the research of Wensink (2022), sleeping more hours at night seems to decrease physical fatigue the next day. Thus, inspecting different sleeping patterns or sleeping quality in more depth would be interesting for future research. Another risk factor that might contribute to the experience of physical fatigue is physical activity, particularly physical inactivity. In line with previous research, there is a strong relationship between physical (in)activity and fatigue, and thus, sedentary behaviour tends to increase physical fatigue and vice versa. (Ellingson et al., 2014; Sallis et al. 2021). Therefore, future research could examine the relationship between different sleeping patterns or physical inactivity and physical fatigue over time by combining the usual self-reported ESM design with physiological measurements, e.g., to test the sleep quality or track the daily steps of an individual. Furthermore, different within- and between-person effects and a time-lagged analysis could be applied to understand this possible association better.

Secondly, in the future, it might also be of interest to extend the research on non-hospitalized persons suffering from the post-COVID-19 syndrome since this study has included only ex-hospitalised patients. Hence, patients who experienced a mild to moderate course of acute COVID-19 infection are also at risk of suffering from covid-19 symptoms beyond the acute or ongoing COVID-19 infection (Raveendran et al., 2021). Thereby, similarities and differences between the different patients group might be found. As a result, similar interventions can be applied, or further adaptions or even different treatments need to be implemented.

Next, the findings of this study suggested intra-individual and inter-individual differences in the level of physical fatigue. Hence, future research should investigate why physical fatigue fluctuates for some individuals while remaining stable for other ones. So, there might be different fatigue clusters based on different characteristics, e.g., level of neuroticism or daily activities. This could be done by incorporating more questions about the person himself or by including data about daily activities.

Additionally, the results showed a strong and robust relationship between negative and positive affect on the prior measurement and physical fatigue on the next timepoint. Future research might consider executing a reversed time-lagged analysis to explore if fatigue also

predicts positive and negative affect at the next timepoint to the same extent. Next, the exploration of time-lagged associations for different measurement time points would be necessary. Therefore, future research should examine at which prior moment the relationship is the highest. For instance, if the effect is higher or lower several timepoints or hours earlier. This might help to find the best possible moment where to implement an intervention to counteract physical fatigue or even to prevent the development of physical fatigue.

Conclusion

According to the ESM results from this study, physical fatigue was found to be a common and severe symptom in women and men with the post-COVID-19 syndrome. However, differences per individual were found. For some people, fatigue seemed stable over the day or the week; for others, huge fluctuations were found. Thus, different post-COVID-19 syndrome clusters might exist. Furthermore, a negative association between positive affect and physical fatigue were found, suggesting that an increase in positive affect seemed to decrease physical fatigue. These results are also backed up by the between and within-person effects representing a negative association. Meanwhile, negative affect is positively associated with physical fatigue, meaning that a higher experience of negative affect leads to more physical fatigue. For men, the association between negative affect and physical fatigue seems to be stronger than for women. Lastly, whereas positive affect at a prior measurement seemed to decrease physical fatigue at the subsequent measurement, negative affect at a prior measurement increases physical fatigue at the next measurement.

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