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CONTENTS

Theoretical Background

Long COVID is a rather new disease. Despite rapidly growing research, there are still many open questions regarding, for example, psychological consequences and suitable treatment approaches. It is of utmost importance to evaluate the mechanisms underlying long COVID disease, and to research upon effects on the patient group. Knowledge of factors that promote or hinder the link between symptom severity and mental health consequences is vital. In the following, the relationship between symptom severity (i.e., fatigue severity) and symptoms of anxiety and depression in long COVID patients is studied. A deeper look is taken at the role individual illness perceptions and perceived stress play in this relationship. Increased knowledge about this coherence within long COVID patients can help develop suitable treatment approaches that reduce the development of mental health issues. Firstly, an overview is given regarding long COVID disease with a special focus on the symptom of fatigue. Secondly, the mediating roles of individual illness perceptions and perceived stress on the relation between fatigue severity and symptoms of anxiety and depression are described.

Long COVID Disease

Coronavirus disease 2019 (COVID-19) is caused by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2). In the World Health Organization's (WHO) classification system, the International Statistical Classification of Diseases and Related Health Problems 11th edition (ICD-11), the disease is treated as COVID-19 (RA01) under codes for special purposes (chapter 25) (World Health Organization, 2022). It is a multiorgan disease with symptoms occurring in respiratory, digestive, and general areas (Dhama et al., 2020). Symptom severity ranges from asymptomatically to mild to severe courses (Aiyegbusi et al., 2021; Hu et al., 2021). Main symptoms of an acute infection are fever, fatigue, myalgia, and cough followed by sputum production, headache, haemoptysis, diarrhoea, and dyspnoea (Dhama et al., 2020; Huang et al., 2020; Sisó-Almirall et al., 2021). Recovery time after an acute infection is approximately two to three weeks (Aiyegbusi et al., 2021). Nevertheless, symptoms can last for several weeks after an acute SARS-CoV-2 infection or new symptoms can occur weeks later. In general, these long-term consequences are summarized under the term long COVID (disease), if they persist after four weeks of an acute SARS-CoV-2 infection (Koczulla et al., 2021; Sivan & Taylor, 2020). In the following section, long COVID disease will be described in more detail. A special focus lies on the cardinal symptom of fatigue and its relationship with mental health outcomes (i.e., anxiety and depression) since this relationship is at the heart of this master thesis.

In their meta-analysis, Chen et al. (2022) found an estimated global prevalence rate of post-COVID symptoms of 43 %, meaning that 43 % of previously infected COVID-19 patients showed symptoms at least 28 days after infection. As described above, the term long COVID disease denotes the persistence of symptoms or the appearance of new symptoms four weeks after an acute SARS-Cov-2 infection regardless of the duration of symptoms (Koczulla et al., 2021). Considering the time aspect, the term can further be broken up in two distinct terms: ongoing symptomatic COVID-19 describes a condition where symptoms last from four weeks after acute infection up to twelve weeks. Post COVID-19 syndrome describes a condition where symptoms last for more than twelve weeks after an acute infection (Shah et al., 2021). Fernández-de-Las-Peñas et al. (2021) proposed another terminology also focusing on the time aspect. Their model differentiates between acute post-COVID symptoms (week 5 to week 12 after symptoms onset), long post-COVID symptoms (week 12 to week 24) and persistent post-COVID symptoms (after week 24). Although a more detailed breakdown of the phenomenon using time-bound terms can provide advantages in certain areas (Fernández-de-Las-Peñas et al., 2021; Shah et al., 2021), the more general term long COVID will be used in this thesis because the term is patient-centred (Callard & Perego, 2021). Within the scope of this study, all long COVID patients are of interest regardless of their symptom duration.

Currently, a variety of possible pathways for the development of long COVID disease after an acute SARS-CoV-2 infection is discussed (Koczulla et al., 2021). It is unclear exactly how long COVID develops, and which mechanisms are causative for its manifestation. A multifactorial, individual pathogenesis is assumed, which can be triggered by various factors. Furthermore, certain virus and host factors represent risk factors for the development of long COVID disease (Koczulla et al., 2021; Peluso & Deeks, 2022; Puta et al., 2021). In a recent article, Peluso and Deeks (2022) provided an overview of proposed pathogenetic mechanisms that is in line with an earlier review by Puta et al. (2021). It is assumed that persisting tissue damages due to the virus infection as well as to excessive inflammatory response and post viral autoimmunity form a possible pathway. Functional limitations of affected organ systems caused by inflammation and tissue damages may lead to symptoms typical for long COVID. The persistence of viral pathogens in some patients adds to the list of pathways as well as a reactivation of human herpesviruses, endothelial dysfunction, blood clotting disorders, thromboembolism, and alterations in the gut microbiome (Peluso & Deeks, 2022; Puta et al., 2021). Female gender as well as higher age form risk factors for the development of long COVID. In addition, a high number of symptoms during the acute infections constitutes a third important risk factor (Sudre et al., 2021). At the moment, a combination of these three risk

factors seems to be a promising approach to predict the development of long COVID disease (Puta et al., 2021).

For diagnostic purpose, the ICD-11 code RA02 Post COVID-19 condition can be used if the present disorder is related to a preceding acute COVID-19 infection without COVID-19 being still present (World Health Organization, 2022). Diagnostic criteria for long COVID disease according to the Austrian guidelines for the treatment of Long Covid are (1) the SARS-CoV-2 infection occurred at least four weeks ago, (2) symptoms that occurred during or after the infection fit COVID-19 symptoms (e.g., shortness of breath), and (3) symptoms are not better explained by any other cause (Koczulla et al., 2021). A more detailed proposal for diagnostic criteria by Raveendran (2021) differentiates between symptomatic and asymptomatic courses of disease during the acute COVID-19 disease. Both cases can be classified as confirmed, probable, possible, or doubtful depending on the level of evidence for a preceding SARS-Cov-2 infection. This (A) essential criterion is supplemented by (B) clinical criterion (i.e., long COVID symptoms), and (C) duration criterion which in turn is divided in a duration criterion for symptomatic and asymptomatic individuals.

As defined above, symptoms of long COVID disease need to fit COVID-19 symptoms. Eligible symptoms are described in the following section. Long COVID patients may experience a variety of possible symptoms which affect different organ systems and may vary in intensity and their presence over time (Davis et al., 2021). Aiyegbusi et al. (2021) identified ten most frequently reported symptoms as well as further common and less common symptoms by reviewing 27 quantitative and qualitative studies on adult patients with ongoing COVID-19 or post COVID syndrome. The three most common symptoms and their pooled prevalence rates were fatigue 47 % (95% *CI* [.31, .63]), dyspnoea 32 % (95% *CI* [.18, .47]) and myalgia (95 % *CI* [.13, .37]). Table 1 shows these symptoms and pooled prevalence rates for the ten most common symptoms according to Aiyegbusi et al. (2021). The authors classified all symptoms according to the organ systems affected into five domains: cardiopulmonary, naso-oropharyngeal, musculoskeletal, neuro-psychological, and miscellaneous. The general division into different organ system-domains is in line with other research groups (Davis et al., 2021; Raveendran, 2021; Sisó-Almirall et al., 2021) although the exact number and label of domains varies. In addition to this form of classification there is an effort to differentiate syndromes or patterns of disease. Sudre et al. (2021), for example, described two patterns: (1) patients experiencing fatigue, headache, and upper respiratory complaints, and (2) patients additionally experiencing multi-system complaints (i.e., fever, gastroenterological symptoms). Another way of clustering different syndromes is proposed by Fernández-de-Las-Peñas et al. (2021). Here, a

differentiation is made between so-called post-intensive care syndrome, post-viral fatigue syndrome, permanent organ damage and long-term COVID syndrome. A more detailed consideration of these would go beyond the scope of this thesis. However, this classification demonstrates the prominent role of the symptom of fatigue. As previously described, this is the most common symptom and therefore of special interest within this thesis. The following section will take a closer look at this symptom and its correlation with mental health outcomes in general and in long COVID patients.

Table 1

Pooled Prevalence Rates for the 10 Most Common Long COVID Symptoms

	Symptom	Pooled Prevalence Rate	95 % CI
1	fatigue	47 %	[.31, .63]
2	dyspnoea	32 %	[.18, .47]
3	myalgia	25 %	[.13, .37]
4	joint pain	20 %	[.13, .27]
5	headache	18 %	[.09, .37]
6	cough	18 %	[.12, .25]
7	chest pain	15 %	[.09, .20]
8	altered smell	14 %	[.11, .18]
9	altered taste	7 %	[.04, - .10]
10	diarrhoea	6 %	[.04, .09]

Note. CI = confidence interval. Adapted from Aiyegbusi et al. (2021).

Fatigue and Mental Health

To illustrate the connection between fatigue, as one of the main long COVID symptoms, and the adverse mental health outcomes of anxiety and depression which is at the heart of this

master thesis, firstly the mental health status of long COVID patients is described. Secondly, fatigue is defined. Fatigue occurring in long COVID patients is compared to chronic fatigue syndrome (CFS). In the end, the route connecting fatigue as a long COVID symptom to anxiety and depression is depicted.

Long COVID patients in general are faced with negative effects of their condition and mental health consequences. Reduced quality of life and functional impairments including negative effects on everyday life have been observed in long COVID patients across several studies (Aiyegbusi et al., 2021). A reduced ability to return to work is a further negative effect long COVID patients are often faced with (Townsend et al., 2020). These findings are in line with other studies examining long term mental health consequences following an acute SARS-CoV-2 infection (Huang et al., 2021; Koczulla et al., 2021; Poyraz et al., 2021; Shanbehzadeh et al., 2021). In their review, Shanbehzadeh et al. (2021) examined 34 studies on physical and mental consequences after an acute SARS-CoV-2 infection with a maximum follow-up period of three months. They identified anxiety, depression, posttraumatic stress disorder (PTSD) symptoms as well as sleep difficulties to be most frequently reported mental health problems. Houben-Wilke et al. (2022) examined the mental health status of 239 long COVID patients with a maximum follow-up period of six months. After six months, 34.7 % suffered from clinically relevant symptoms of anxiety, 40.6 % from clinically relevant symptoms of depression, and 26.8 % from symptoms of PTSD.

Fatigue is a highly prevalent symptom of long COVID, with approximately 47 % of patients being affected (Aiyegbusi et al., 2021). Fatigue is not only a frequent symptom in long COVID patients but also a symptom viewed as particularly burdensome by those affected (Bierbauer et al., 2022). In general, it is defined as a subjective state of exhaustion that is disproportionate to previous effort, may include somatic, cognitive as well as psychological levels, does not improve sufficiently through relaxation or sleep, and has a negative impact on daily life (Koczulla et al., 2021; Schwarz et al., 2003). In general, fatigue symptoms worsen during phases of exertion of any kind (i.e., physical, emotional, mental) and severity alternates over time (Bansal et al., 2012). This definition clarifies the difference to the everyday use of the word fatigue. In everyday language, fatigue describes a state of tiredness or exhaustion preceded by exertion or lack of sleep (Strahler et al., 2016). In the following thesis, the term fatigue refers to a clinical definition as described above. Furthermore, fatigue is viewed as a multidimensional construct, including the dimensions of general fatigue, physical fatigue, reduced activity, reduced motivation, and mental fatigue as proposed by Smets et al. (1995). Somatic symptoms that are not directly attributable to tiredness (e.g., headache) are not part of

the fatigue definition used (Smets et al., 1995). CFS describes a severe and limiting fatigue that cannot be explained by medical circumstances and lasts for at least 6 months (Afari & Buchwald, 2003). CFS and post viral fatigue in the aftermaths of an acute COVID-19 infection resemble each other a lot. Consequently, a connection between both conditions is presumed (Komaroff & Bateman, 2020). In their systematic review, Wong and Weitzer (2021) compared twenty-one studies reporting long COVID symptoms to a list of 29 CFS symptoms. They identified 25 of these symptoms to be mentioned by at least one long COVID study. Symptoms common in CFS but not mentioned in long COVID studies were motor disturbance, tinnitus and double vision, lymph node pains, and sensitives to, for example, chemicals or food. The authors name fatigue as well as reduced daily activity and post-exertional malaise as the three main symptoms of CFS. All three symptoms – especially fatigue – were reported several times by long COVID studies (Wong & Weitzer, 2021). The emergence of profound fatigue in long COVID patients is in line with findings of post-viral fatigue in other viral infections such as Severe Acute Respiratory Syndrome (SARS), Middle East Respiratory Syndrome (MERS), Epstein-Barr Virus or Dengue virus (Poenaru et al., 2021; Raveendran, 2021; Sisó-Almirall et al., 2021). There is no all-encompassing explanation for the mechanisms underlying post-viral fatigue at the time (Puta et al., 2021) although Wong and Weitzer (2021) discuss the possibility of similarities in the aetiology of CFS and long COVID. The overlapping between CFS and post-viral fatigue in terms of symptoms as well as aetiology indicates the possibility that existing treatments for CFS patients might also be helpful for long COVID patients (Wong & Weitzer, 2021). Townsend et al. (2020) were the first to investigate fatigue following an acute SARS-CoV-2 infection. They were not able to find any correlation between symptom severity during the acute phase and the emergence or severity of following fatigue. These findings highlight the importance of fatigue in long COVID patients. On one hand, Townsend et al. (2020) were able to show that post COVID fatigue concerns a wide range of possibly affected patients since its emergence is not limited to patients with severe acute SARS-CoV-2 infections. On the other hand, they shed initial light on the burden of post COVID fatigue regarding a reduced ability for affected individuals to return to work as well as their reduced self-perceived health status. Another burden is described by Raveendran et al. (2021) as the possibility of disrupted doctor-patient trust relationship due to the lack of objective and safe diagnostic possibilities. This is in line with findings regarding general feelings of being stigmatized and feeling lost reported by long COVID patients (Ladds et al., 2020). Negative impact of post COVID fatigue on different aspects of functioning and quality of life are in line with general

findings regarding negative psychosocial and physiological effects of fatigue and CFS (Afari & Buchwald, 2003).

Regarding the relationship between fatigue and mental health outcomes of anxiety and depression which is at the heart of this master thesis, the study conducted by Skapinakis et al. (2004) is of special interest. The authors investigated an international dataset collected by WHO. A total of 3,201 participants were studied. They were interviewed at two time points (baseline and follow up after 12 months). In their analysis of this longitudinal data, Skapinakis et al. (2004) were able to show that preceding depression increases the risk for subsequent fatigue but that the same is true for the other direction, that is that fatigue can act as a risk factor for the development of depression. Jacobsen and Weitzner (2004) outlined possible routes for the relationship between fatigue and depression in cancer patients and provided evidence for the assumption that fatigue can promote the development of depression. This cause-effect relationship has also been found in a study investigating postpartum depression (Bozoky & Corwin, 2002). Brown and Kroenke (2009) conducted a systematic review on the relations between cancer-related fatigue and anxiety and depression. They included 59 studies with a total sample size of N = 12,103 patients. They confirmed the correlation between fatigue and depression as well as anxiety in cancer patients. Regarding long COVID disease, this connection has not yet been studied. On a more general level, Zhang et al. (2016) outlined a model in which disease severity is associated with negative mental health outcomes such as the development of anxiety and depression in patients with Crohn's disease. In general, depression and anxiety are the most common psychological reactions to medical conditions (Cassem, 1990). This thesis is partly based on assumptions postulated by Zhang et al. (2016) but with a special focus on the role that fatigue severity, in contrast to more general disease severity, plays in the development of adverse mental health outcomes in long COVID patients. This focus was chosen due to the frequent occurrence of fatigue in long COVID patients as well as its possible negative impact on mental health. A deeper understanding of this relationship and possible mediators holds the possibility of averting or mitigating negative effects by developing appropriate interventions and improving patients' psychological health status. Although some attempt has been made to investigate psychological consequences in the aftermaths of an acute COVID-19 infection, there is limited data that explicitly looks at patients diagnosed with long COVID. At this moment, there is also uncertainty regarding appropriate treatment services due to limited data (Puta et al., 2021). Current treatment recommendations are based on consensus of experts (Koczulla et al., 2021). In general, a personalized and multidisciplinary treatment

approach that focuses on specific symptoms as well as on improvement of functional impairments due to long COVID disease is recommended (Pertl et al., 2012; Yong, 2021).

The Mediating Role of Individual Illness Perceptions

When individuals are faced with a health threat or illness, they develop cognitive and emotional representations of their illness. These individual illness perceptions influence how much stress patients with various diseases experience, as well as behavioural and health outcomes in a wide range of patient groups, including patients with unexplained conditions (e.g., McAndrew et al., 2019). For example, individual illness perceptions have been shown to influence how much stress patients faced with chronic diseases such as gastrointestinal cancer (Miceli et al., 2019) or psoriasis (Fortune et al., 2002) experience. Additionally, coping behaviour is influenced by individual illness perceptions. This in turn influences mental and physical health outcomes such as recovery time, healthcare use and functioning (Fortune et al., 2002; Petrie & Weinman, 2006). Hence, a modification of unfavourable individual illness perceptions offers the chance to positively influence patients' level of perceived stress as well as other relevant outcomes such as anxiety and depression. In this way, individual illness perceptions open a further access to understand what patients with long COVID disease are experiencing. They also show possible routes to influence the course of disease as well as perceived burden, adverse mental health outcomes and stress. In the following, a definition of individual illness perceptions and their different dimensions is given against the background of the underlying Common-Sense model of Self-Regulation (CSM). Furthermore, the correlation between fatigue, as a main symptom of long COVID, and individual illness perceptions and its influences on mental health outcomes (i.e., symptoms of depression and anxiety) will be outlined.

The concept of individual illness perceptions is widely based on the CSM (Leventhal et al., 1980; Leventhal et al., 2016). According to CSM, an illness (e.g., a certain symptom) acts as a stimulus evoking the generation of emotional and cognitive illness representations based on information from various sources available to the patient. The sources include information from medical staff, as well as from lay people (e.g., friends), general knowledge and significant current experiences made by oneself (Hagger & Orbell, 2003). The model consists of three stages and a recurring feedback loop. In a first step, the actual illness representation is formed, secondly, coping behaviour is incorporated, and, thirdly, the coping behaviour is checked regarding its efficacy. This process is repeated in the form of a continuous feedback loop

(Broadbent et al., 2006). Illness representations can be divided into cognitive and emotional representations. Cognitive representations are further split up into five dimensions. The (1) identity dimension describes the label a person gives his or her illness, i.e., the name of the illness and which symptoms he or she believes to be part of the illness. The (2) consequences dimension describes expected influence of the illness on the patient's life. The (3) causal dimension refers to the reasons to which individuals attribute the development of their disease. The (4) timeline dimension refers to patients' ideas about how long the illness will last, whether it is chronic, acute, or reoccurring in nature. The (5) cure/control dimension of individual illness perceptions describes the degree to which a patient believes to be able to influence the course of illness as well as general beliefs about possible treatments and cure (Baines & Wittkowski, 2013; Broadbent et al., 2006; Lau & Hartman, 1983; Leventhal et al., 2016). In addition to these cognitive illness representations, emotional responses are built in parallel when faced with an illness or health threat (Broadbent et al., 2006). Individual illness perceptions are subjective in nature and this lay view of illness might vary from the way healthcare professionals view the illness (Petrie et al., 2007). For example, a patient might believe a symptom to be part of their illness while the medical staff attributes this symptom to be a side effect of the treatment. The CSM incorporates the formation of an illness representation based on the dimensions described as well as the decision for behaviour that seems suitable to regulate emotions and influence the illness and its evaluation in a positive way. In this way, individual illness perceptions influence a patient's behaviour as well as medical outcomes (Broadbent et al., 2015).

To date, some effort has been made to investigate the role of individual illness perceptions in the context of the COVID-19 pandemic in different samples (Aqeel et al., 2020; Dias Neto et al., 2021; Hamama & Levin-Dagan, 2021; Skapinakis et al., 2020; Ting et al., 2021). To the best of our knowledge, only one study investigated individual illness perceptions in the context of long COVID disease (Bierbauer et al., 2022). They performed a cross-sectional study and collected data of 248 long COVID patients. The authors investigated the profile of cognitive and emotional illness representations in this patient group and the effects on mental health outcomes such as anxiety and depression. They were able to show that long COVID patients' illness perceptions were characterized by a low sense of coherence and controllability. Furthermore, illness perceptions were able to account for more than one quarter of the variance of mental health outcomes in this study. A deeper understanding of how exactly individual illness perceptions influence mental health outcomes in long COVID patients is of great importance since they shape people's health behaviour and adjustment. This holds the potential

for future prevention efforts to mitigate the harmful effects that negative illness perceptions can bring about.

Fatigue and Individual Illness Perceptions

In the case of long COVID patients, fatigue can be viewed as one symptom or stimulus shaping the generation of an individual's illness perception. Studies have shown certain stable patterns of illness perceptions depending on the chronic or acute disease examined (Pertl et al., 2012). Patients with CFS are characterized by high expressions on the dimensions of identity, consequences, and timeline. They show that many symptoms are part of their condition, that CFS has severe consequences for their life and suspect it to be a long-term disease. This pattern is distinct for CFS and stable over time (Gray & Rutter, 2007; Moss-Morris et al., 1996). Alsén et al. (2010) took a detailed look at the correlations between individual illness perceptions and fatigue by correlating each dimension of individual illness perception with each dimension of fatigue as described by the Multidimensional Fatigue Inventory [MFI-20 (Smets et al., 1995)] in patients with myocardial infarction. The MFI-20 differentiates five subscales, namely general fatigue, physical fatigue, reduced activity, reduced motivation, and mental fatigue. They found the illness perception dimensions of timeline, consequences, and emotional representations to be positively correlated with all subscales of the MFI-20. Additionally, dimensions of personal as well as treatment control were negatively correlated with all fatigue subscales. Illness coherence was not associated with all dimensions of fatigue, but weak negative associations were found with reduced activity, reduced motivation, and mental fatigue. Thus, the authors conclude that patients with myocardial infarction who are more severely fatigued also expect a longer duration of illness, more serious consequences, and have more negative emotional representations. Fatigue levels are also elevated the lower both forms of control beliefs are and the less one understands one's illness (Alsén et al., 2010). To date, no such studies have been performed in fatigued individuals with long COVID disease. It stands to reason that characteristics of CFS and the pattern of interrelationship between individual illness perceptions and fatigue are also reflected in the fatigue symptom experienced by long COVID patients.

Individual Illness Perceptions and Mental Health

A causal relationship between illness perceptions and health outcomes is at the heart of the CSM (Baines & Wittkowski, 2013). The CSM incorporates the formation of an illness representation as well as the decision for behaviour that seems suitable to regulate emotions and influence the illness and its evaluation in a positive way. In this way individual illness perceptions influence a patient's health behaviour as well as medical outcomes (Broadbent et al., 2015). The role of individual illness perceptions in the context of mental health outcomes

was studied in many diseases, including CFS. Heijmans (1998) was able to detect a connection between certain illness perceptions and greater impairments in self-reported mental health status of CFS patients. More precisely, dimensions of consequences (i.e., a feeling of serious consequences of the condition), cure/control (i.e., the feeling of no control over the illness) and timeline (i.e., chronic timeline) seem to play an important role in this context. Pertl et al. (2012) studied illness perceptions in patients with cancer-related fatigue and were able to show that illness representations accounted for a significant part of emotional stress in such patients. Emotional stress was partly operationalized by measurements of anxiety and depression. In their meta-analysis, Hagger and Orbell (2003) analysed 45 empirical studies on CSM based illness representations and their influence on various health outcomes such as psychological distress and well-being. Psychological distress included measures of anxiety and depression. Dimensions of consequences, timeline, and identity were found to be negatively associated to adaptive illness outcomes (e.g., psychological well-being) and positively related to maladaptive outcomes (i.e., psychological distress). An opposite correlation was found for the control dimension, meaning that higher levels of perceived control were positively related to adaptive illness outcomes. This view was confirmed by Broadbent et al. (2015) who found similar correlations between the single dimensions of individual illness perceptions and measures of anxiety and depression in their systematic review and meta-analysis. The meta-analysis included 188 papers collecting data in a wide range of clinical conditions. Especially dimensions of consequences and identity were strong predictors for adverse mental health outcomes. They additionally identified emotional representations to be associated with outcomes such as anxiety and depression. Correlations between dimensions of consequences, identity, timeline, and control as well as emotional representations with the maladaptive illness outcome of psychological distress as supported by meta-analysis by Hagger and Orbell (2003) and Broadbent et al. (2006) shed initial light on the role individual illness perceptions play for adverse mental health outcomes such as anxiety and depression. In their study on long COVID patients Bierbauer et al. (2022) were able to show that certain illness perceptions were associated with anxiety and depression. In general, illness perceptions explained 36 % and 34 % of the variance in depressive symptoms and anxiety in their sample. More symptoms (i.e., identity dimension) and higher emotional representations were associated with higher levels of anxiety and depression. Regarding the control dimension findings were mixed. In the case of depressive symptoms higher perceptions of treatment control were associated with lower levels of depressive symptoms. Personal control did not play a role in this context. In the case of anxiety findings were opposite, here personal control was significantly associated with fewer

symptoms but not treatment control. Dimensions of timeline, consequences, and coherence were neither associated with depressive symptoms nor with anxiety outcomes in this study. The study by Bierbauer et al. (2022) is a first step in the understanding of the role individual illness perceptions play for mental health outcomes in long COVID patients but knowledge has to be extended by further research.

The Mediating Role of Perceived Stress

One goal of this master thesis is to examine the relationship between perceived stress and mental health outcomes in long COVID patients as well as the role the symptom of fatigue and individual illness perceptions play in this context. Therefore, firstly a general definition of perceived stress and a description of the general role of stress in disease is given. Furthermore, pathways connecting the construct of perceived stress to fatigue, mental health outcomes, and individual illness perception are described. Thus, an overview of the suspected and multilayered role perceived stress plays for long COVID patients is given. A deeper understanding of this relationship is needed to detect highly burdened patients and to be able to develop tailored and effective interventions for this new group of patients.

With their transactional stress model, Lazarus and Folkman (1984) give a general and well established definition of stress. According to the model, a potentially stressful situation (stressor) triggers a stress reaction if the individual's appraisal of the situation itself and the available coping options reveal that the demands of the situation exceed an individual's resources. This definition illustrates the difference between a stressor and a stress reaction – two concepts which are often used synonymously in colloquial language (Nater et al., 2020) – as well as the role of the individual's perception and evaluation of the stressor in the development of a stress reaction. In this manner, the model integrates different approaches in its definition of stress namely the environmental, biological, and psychological approach (Cohen et al., 1997). Following Lazarus and Folkman (1984), Cohen et al. (1997) extended their definition around the role of stress in disease by stating that a situation in which the demands of a situation exceed capabilities to deal with it "result […] in psychological and biological changes that may place persons at risk for disease" (Cohen et al., 1997, p.3). According to Klein et al. (2016), especially the psychological level of stress plays an important role in the context of stress and disease. At its core, the psychological approach considers the individual's appraisal of a potential stressor as defined by Lazarus and Folkman (1984). This appraisal is divided into two steps and a reappraisal. The primary appraisal includes firstly the assessment of a situation as irrelevant, benign-positive, or stressful. A stressful situation is in

turn assessed as a harm/loss (i.e., damage has already occurred), threat (i.e., anticipated harm/loss, accompanied by negative emotions), or challenge (i.e., anticipated load that is assumed to be mastered, accompanied by positive emotions) or as a combination of those assessments. A primary appraisal of a potential stressor as a threat or challenge is followed by a secondary appraisal focusing on available resources and assessing what is at stake. The secondary appraisal shows whether a potential stressor can be managed with the individual resources available and which consequences may occur. If a situation's requirements exceed a person's resources a stress reaction is triggered. In a third step, reappraisal of a situation can take place against the background of new information concerning the situation and/or gained experiences regarding the effectiveness of the resources used. The psychological approach can, therefore, be viewed as considering stress against the background of a reciprocal person-environment relationship (Klein et al., 2016; Lazarus & Folkman, 1984). The concept of perceived stress is based on this psychological stress approach and takes into account that the sole consideration of objectively stressful situations is not sufficient but that individual appraisals play a crucial role in the emergence of stress (Cohen et al., 1983). An unfavourable combination of stressors and available resources (i.e., of primary and secondary appraisal) leading to perceived stress and in the long term to chronic stress has the potential to influence the development as well as maintenance of illnesses and can lead to an aggravation of symptoms (Klein et al., 2016; Krähenmann & Seifritz, 2019; Nater et al., 2020). The relationship between disease and perceived stress is bidirectional (Zhang et al., 2016).

Although there is little evidence directly concerning perceived stress and long COVID disease, it is clear that levels of perceived stress are connected. For example, Ladds et al. (2020) show that the lack of knowledge about the diseases on the part of medical staff leads to patients feeling at the mercy of the disease. This leads to stress, as they do not know how to influence setbacks themselves. Stress was also found to constitute a trigger for setbacks or relapses during a long COVID disease (Davis et al., 2021; Puta et al., 2021). Official guidelines for the treatment of long COVID disease uniformly recommend methods of stress reduction for the treatment of long COVID patients which also shows the important role perceived stress plays in the disease (Koczulla et al., 2021; Shah et al., 2021).

Fatigue and Perceived Stress

Besides this general role of stress in disease, there are further pathways connecting long COVID disease and perceived stress. In particular, one of the main long COVID symptoms, namely fatigue, has been shown to be associated with perceived stress in general population (Kocalevent et al., 2011) as well in a sample of university students (Doerr et al., 2015).

According to Kocalevent et al. (2011), fatigue and stress can be considered overlapping constructs while Doerr et al. (2015) additionally highlight the reciprocal character of the relationship between stress and fatigue comparable to a vicious circle. Using several measurements over a five-day period and thus a longitudinal design, they were able to firstly confirm previous studies identifying stress as preceding fatigue, and to secondly show that fatigue was also able to predict following stress. The authors suggested that this direction of relationship between fatigue and stress can be explained by viewing preceding fatigue as a factor lowering an individual's abilities to deal with arising stressors. Thus, fatigue seems to influence the secondary appraisal within the transactional stress model and, therefore, influence the level of perceived stress an individual experiences.

There is limited evidence concerning the role the relationship between fatigue and stress plays in clinical samples. Hirsch and Sirois (2016) investigated the relationship between fatigue and perceived stress in a sample of patients with chronic inflammatory diseases. Perceived stress and fatigue were positively correlated in their sample consisting of patients with fibromyalgia, arthritis, and inflammatory bowel disease. To the best of our knowledge, there is no study investigating the relationship between fatigue severity and perceived stress in long COVID patients. Manning et al. (2022) investigated the relationship between fatigue severity, COVID-19 related perceived stress, and mental health outcomes in a sample of 563 adults. Noteworthy, participants did not need to be affected by an acute COVID-19 disease to take part in the study. The authors found that the relationship between COVID-19 related perceived stress and adverse mental health outcomes, such as anxiety and depression, was partly explained by fatigue severity. Interestingly, they also investigated a reverse model. Results provide initial indications that fatigue severity might also influence the level of COVID-19 related stress and thus influence adverse mental health outcomes.

Perceived Stress and Mental Health

High levels of stress are associated with different health outcomes including psychological components such as anxiety and depression as well as with disease severity (Keegan et al., 2015). In their study on patients with Crohn's disease, Zhang et al. (2016) were able to confirm a model viewing stress as a mediator in the relationship between disease severity and mental health outcomes such as anxiety and depression. Higher levels of perceived stress were correlated with higher levels in anxiety and depression in their sample of chronically ill patients. Bovier et al. (2004) identified stress to have the strongest negative relationship with mental health of all constructs examined in a study on 2,000 young adult and thus representing a vital risk factor for adverse mental health outcomes. The relation between perceived stress

and mental health was negative and of gradual nature. The authors were not able to detect any sort of threshold in the relation. Stress experience can influence mental health directly on a physiological level and indirectly via alternating health behaviours such as exercises. The latter path has the potential to influence the interrelationship between stress and mental health outcomes in a positive as well as a negative way (Larzelere & Jones, 2008). Therefore, the linkage between perceived stress and mental health not only provides a way to better understand the health status and burden of long COVID patients, but also provides a starting point for the development of possible interventions aimed at improving the mental health of those affected. To the best of our knowledge, no study investigated the relationship between perceived stress and mental health outcomes such as anxiety and depression in a sample of long COVID patients.

Individual Illness Perceptions and Perceived Stress

The relationship between individual illness perceptions and perceived stress is of special interest for this thesis. Both, individual illness perceptions and perceived stress can be viewed as predictors for mental health status and, therefore, play a role when it comes to prevention as well as treatment of adverse mental health outcomes in patients (Nasiri et al., 2020). The concepts of individual illness perceptions and perceived stress are also associated with one another. For example, Zhang et al. (2016) were able to detect that patients with Crohn's disease who viewed their illness as more threatening or benign had higher levels of perceived stress. Fortune et al. (2002) studied the role of illness perception on psychological outcomes such as distress and stress in patients with psoriasis. They assumed that individual illness perceptions influence coping behaviour and, therefore, outcomes such as psychological stress. The authors were able to confirm the importance of individual illness perceptions in the development of distress and stress in their sample but found mixed results regarding the role of coping behaviour. Individual illness perceptions accounted for 50 % of the variance in psoriasis-related stress. Especially the dimension of consequences (i.e., more serious consequences) played an important role in this context. In line with these early findings, Westbrook et al. (2016) found similar correlations between cancer-specific stress and individual illness perceptions in a sample of patients with chronic lymphocytic leukaemia. In the field of cognitive illness representations, again consequences were the only dimension which was significantly related to cancer-specific stress. In the case of emotional representations, both dimensions (concern and emotions) were significantly related to the outcome. Miceli et al. (2019) studied the relation between perceived stress and individual illness perceptions in patients with gastrointestinal cancer. They found a positive correlation between these constructs. Illness perceptions accounted for 36.1 % of the variance in perceived stress. In line with results by Fortune et al.

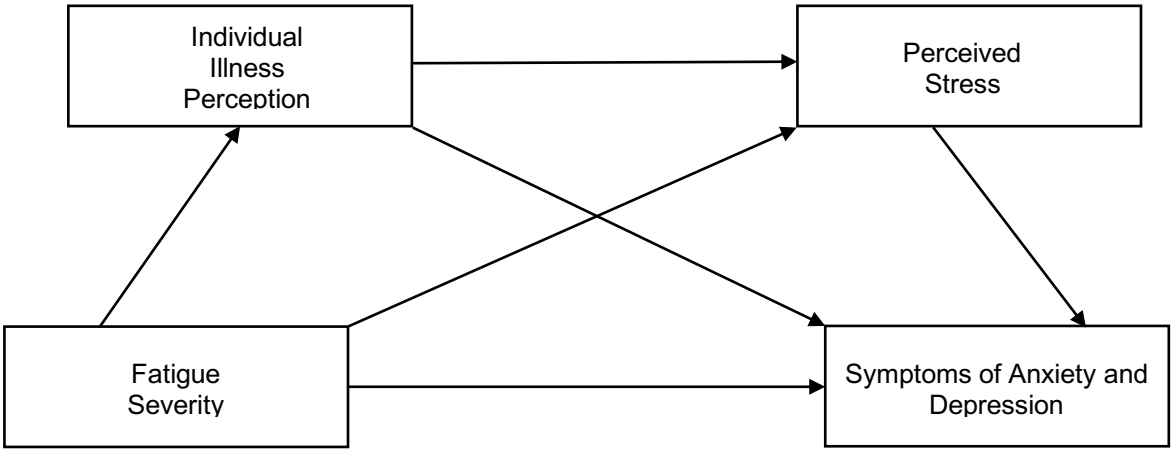
(2002) and Westbrook et al. (2016), the dimensions of consequences also played an important role here. Additionally, dimensions of coherence, emotional representations, and identity were important components in the context. Uniformly, the cognitive dimension of consequences was associated with perceived stress respectively disease-specific stress but regarding the role of the other dimensions of individual illness perceptions, differences prevail depending on the disease studied. Some effort has already been made to investigate the role of individual illness perceptions in COVID-19 patients and the COVID-19 pandemic in general (e.g., Dias Neto et al., 2021; Hamama & Levin-Dagan, 2021; Skapinakis et al., 2020; Ting et al., 2021). To the best of our knowledge, only one study investigated individual illness perceptions in long COVID patients but did not take into account the influence of individual illness perceptions on perceived stress levels (Bierbauer et al., 2022). To develop tailored interventions to reduce perceived stress and enhance the mental health of long COVID patients it is of importance to take a closer look at the relationship between individual illness perceptions and stress in this sample. Especially the identification of dimensions of illness perceptions that play a crucial role is helpful in the development of tailored interventions.

Research Questions and Hypotheses

Based on the state of research to date, the goals of the master thesis are twofold. Firstly, the master thesis aims at taking a closer look at the German-speaking long COVID sample and its perceived stress level as well as their level of fatigue and symptoms of anxiety and depression. Secondly, interrelationships between fatigue severity, individual illness perceptions, perceived stress, and adverse mental health outcomes (i.e., symptoms of anxiety and depression) are at the heart of this master thesis. It is hypothesized that the sample shows elevated levels of perceived stress, fatigue, depression, and anxiety. Furthermore, positive interrelationships between perceived stress, fatigue severity, individual illness perceptions, and adverse mental health outcomes are hypothesized. Within the framework of the hypothesized model, unfavourable individual illness perceptions and perceived stress mediate the relationship between fatigue severity and adverse mental health outcomes (anxiety and depression), hence a serial mediation model will be tested (see figure 1). The following research question and derived hypotheses will be answered.

Figure 1

Proposed Serial Mediation Model Illustrating the Influence of Individual Illness Perceptions and Perceived Stress on the Association between Fatigue Severity and Mental Health in Long COVID Patients.



Research question 1: How can the German-speaking long COVID sample be described regarding perceived stress, fatigue severity and symptoms of anxiety and depression?

Hypothesis 1.1.: Compared to the German norm sample, the German-speaking long COVID sample shows elevated levels of perceived stress.

Hypothesis 1.2.: Compared to the German norm sample, the German-speaking long COVID sample shows elevated levels of fatigue.

Hypothesis 1.3.: Compared to the German norm sample, the German-speaking long COVID sample shows elevated levels of symptoms of anxiety and depression.

Research question 2: Are perceived stress, fatigue severity, individual illness perceptions, and symptoms of anxiety and depression interrelated?

Hypothesis 2.1.: Fatigue severity is positively related to symptoms of anxiety and depression.

Hypothesis 2.2.: The relationship between fatigue severity and symptoms of anxiety and depression will be mediated by individual illness perceptions.

Hypothesis 2.3.: The relationship between fatigue severity and symptoms of anxiety and depression will be mediated by perceived stress.

Hypothesis 2.4.: The relationship between fatigue severity and symptoms of anxiety and depression will be serially mediated by individual illness perceptions and perceived stress.

Methods

The master thesis was embedded in the larger research project CoMind Vienna of Institut für Klinische und Gesundheitspsychologie (Universität Wien) (Univ.-Prof. Dr. Urs Nater, Hannah Tschenett, MSc), Ambulante Lungenreha Therme Wien Med (Dr. Ralf Harun Zwick) and Karl Landsteiner Institut für Lungenforschung und Pneumologische Onkologie (Mag. Alexandra Propst). The project aims at developing and evaluating a digital Mind-Body-Intervention (MBI) for long COVID patients waiting for a rehabilitation place. In a first step, a cross-sectional online questionnaire survey was conducted to obtain an accurate picture of the target group and their readiness to use an online MBI. The master thesis took place within the framework of this survey. In the following sections, a description of the sample (i.e., participant characteristics and sampling procedure) and used materials (i.e., questionnaires and norm samples) will be given and the data analytic plan will be outlined.

Participants

Due to the novelty of long COVID disease it is difficult to conduct a priori power calculations to determine the size of the target population. The explorative nature of the project itself continues to make this difficult. Therefore, the target sample size was estimated based on the number of members in self-help groups on social media where participants were planned to be recruited. It can be assumed that approximately 6,000 – 7,000 persons can be reached here, resulting in 200 – 350 participants with an estimated responds rate of 3 – 5 %. Therefore, the target sample size is a minimum of 200 participants. Recruitment was stopped as soon as the target sample size had been reached. The final sample consisted of 204 participants who filled out the complete online questionnaire. All participants were at least 18 years old, fluent in German and either diagnosed with long COVID disease or experienced symptoms indicative of long COVID disease and suspected to have the disease.

Procedure

Ethics approval was obtained by the Ethics Committee of the City of Vienna (serial number: EK-21-279-VK) before recruitment begun. Adult long COVID patients were invited to fill out the online questionnaire. Participants were recruited via social media (e.g., long COVID self-help Facebook groups in Austria, Germany, and Switzerland) and flyers pinned up in relevant health care facilities in Vienna (e.g., rehabilitation centres). Additionally, relevant institutions such as hospitals, non-profit associations, and practitioners were contacted with the

request to distribute the study flyer. Individuals who were interested in taking part in the study were able to assess the survey via a link. In a first step, participants had to accept the declaration of consent and were informed about the study's goals and procedure as well as data handling. Secondly, inclusion criteria were checked (i.e., language skills, age and long COVID diagnosis). Participants who did not meet the criteria were not able to continue the questionnaire. After creating a personal codeword, the actual questionnaire battery started. In the end, participants were able to take part in a raffle for vouchers worth up to 200 €. Participants were included if they were at least 18 years old, accepted the declaration of consent, spoke, and understood German fluently and either had been diagnosed with long COVID or were experiencing symptoms indicative of long COVID and suspected to have the disease. The survey took place between January and June 2022. 1,053 participants clicked on the link to read the study information. 27.73 % (n = 292) fulfilled the inclusion criteria and generated a study code to participate in the survey. 19.56 % (n = 206) finished the study. The total sample consisted of 204 participants who met the above-mentioned inclusion criteria and filled out the questionnaire. None of those had to be excluded for further reasons.

Since the main goal of the first step of the project was to get an in-depth picture of the target group of German speaking long COVID patients, the instrument of an online questionnaire was chosen. In this way it was possible to address German speaking participants from different countries and reach as many participants as possible while simultaneously the complicated situation of contact restriction, social distancing, and regional lockdowns was adhered to. The complete online questionnaire battery took approximately 50 minutes to finish. This sample is not well studied yet which is why a long questionnaire was developed to gain deeper insights. To relieve the highly burdened target group in the best possible way during the questionnaire, requests for breaks were included at two points. At the beginning of the questionnaire inclusion criteria were queried via filter question so that unsuitable persons were directly sorted out and were not unnecessarily occupied with the further answering of the questions. The questionnaire consists of eight established scales for the assessment of different psychological constructs as well as self-report measures concerning sociodemographic and medical information and attitude towards MBIs as well as four items which serve to check the attention of the participants.

Materials

In the following section, all measures that were included in the analysis of the present study will be described in detail.

Sociodemographic and Medical Variables

The following sociodemographic and medical information were assessed using self-report measures: sex, age, place of residence, native language, level of education, ability to work, long COVID diagnosis, diagnosis provider, time of diagnosis, pre-existing physical and mental conditions and received long COVID therapy/treatment.

Perceived Stress Scale

The German version of the validated self-report measure Perceived Stress Scale [PSS-10 (Cohen et al., 1983; Klein et al., 2016)] was used to assess perceived stress in a sample of German speaking adult long COVID patients. The PSS-10 takes approximately 2 minutes to finish. It consists of 10 items inquiring feelings of uncontrollability, overwhelm and unpredictability in the last month. Items are rated on a 5-point Likert scale (0 = never, 1 = almost never, 2 = sometimes, 3 = fairly often, 4 = very often). An example item for the PSS-10 is “In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?”. After inverting four positive directed items (items 4, 5, 7 and 8) a sum score can be calculated. The PSS-10 sum score, with scores between 0 and 40, describes the level of perceived stress in the last months where a higher sum means more stress. The PSS-10 does not have cut-offs. The PSS-10 demonstrated good internal consistency with Cronbach’s alpha of $\alpha = .84$ in the German validation study (Klein et al., 2016) as well as in the current German speaking long COVID sample ($\alpha = .87$).

Multidimensional Fatigue Inventory

The MFI-20 (Smets et al., 1995) was used in this study to assess fatigue. In the current study, a German version of the MFI-20 was used (Schwarz et al., 2003; Westenberger et al., 2022). This self-report measure consists of 20 items and takes approximately 5 minutes to finish. Each item is rated on a 5-point Likert scale (from 1 = yes, that is true to 5 = no, that is not true). An example item for the MFI-20 is “Physically I feel only able to do a little”. The MFI-20 is a multidimensional measure capturing fatigue on the five dimensions of general fatigue (items 1, 5, 12, 16), physical fatigue (items 2, 8, 14, 20), reduced activity (items 3, 6, 10, 17), reduced motivation (items 4, 9, 15, 18) and mental fatigue (items 7, 11, 13, 19). Each dimension is covered by 4 items. After inverting 10 items (items 2, 5, 9, 10, 13, 14, 16, 17, 18, 19) a total sum score as well as sum scores for each dimension can be calculated where higher scores show higher levels of fatigue respectively of each dimension. These scores can reach values between 20 and 100 for the total sum score and 4 and 20 for the sum scales for each subscale (i.e., each of the five dimensions of fatigue). Due to unclearness concerning the factorial structure of the MFI-20 Schwarz et al. (2003) recommend using a total sum score

consisting of all 20 items rather than sum scores for each dimension separately. In their study, Westenberger et al. (2022) were not able to confirm the five-factor structure of the MFI-20 as postulated by Smets et al. (1995) but detected a two-factor structure with a general factor with 6 items all phrased positively (items 3, 8, 20, 4, 1, 15) and a mental/motivational factor with four items all phrased negatively (items 13, 9, 18, 19). The MFI-20 does not have cut-off values. The German version of the MFI-20 demonstrated good to acceptable internal consistency for all five subscales with α = .87 (general fatigue), α = .90 (physical fatigue), α = .88 (reduced activity) α = .79 (reduced motivation) and α = .83 (mental fatigue) (Westenberger et al., 2022) which is in line with the original version (Smets et al., 1995). In the current German speaking long COVID sample an excellent internal consistency of α = .90 for the total sum score as well as good to acceptable internal consistencies for the subscales with α = .90 (general fatigue), α = .83 (physical fatigue), α = .79 (reduced activity), α = .72 (reduced motivation) and α = .83 (mental fatigue) were detected.

Brief Illness Perception Questionnaire

The Brief Illness Perception Questionnaire [B-IPQ (Broadbent et al., 2006)] was used to assess individual illness perceptions. The B-IPQ is a short self-report questionnaire assessing emotional and cognitive representations of individual illness perceptions (Broadbent et al., 2006). In this study, the German version was used. The questionnaire consists of 9 items and takes approximately 2 minutes to finish. The first eight items are answered on an 11-point scale (from 0 to 10) while the ninth item is open-ended. An example item for one of the first eight items is “How much does your illness affect your life?” (0 = no affect at all, 10 = severely affects my life). The open-ended item is “Please list in rank-order the three most important factors that you believe caused your illness“. It assesses causal beliefs about the illness. Cognitive illness representation is assessed via the first five items where each item assesses one dimension of cognitive illness representation [i.e., consequences (item 1), timeline (item2), personal control (item 3), treatment control (item 4), identity (item 5)]. Items 6 and 8 assess emotional representation [i.e., concern (item 6), emotions (item 8)] and item 7 assesses illness comprehensibility (i.e., coherence score) (Broadbent et al., 2006). Within the scope of this master thesis, the first eight questions are of interest. After reversing items 3, 4 and 7 a total sum score can be computed and used to assess the degree to which an illness is perceived as threatening. Higher scores mean a more threatening or benign individual illness representation. This sum score can reach values between 0 and 80. For this use, the authors strongly recommend checking the internal consistency of the sum score. In addition, each dimension can be considered individually by examining responses to each item. Those subscores can reach values

between 0 and 10. The B-IPQ does not have cut-off values. In the current German speaking long COVID sample an acceptable internal consistency of α = .78 for the total sum score was detected. Cronbach's alpha was not calculated for each subscale since this measurement cannot be applied to scales consisting of single items (Broadbent et al., 2015).

Hospital Anxiety and Depression Scale

The Hospital Anxiety and Depression Scale [HADS (Zigmond & Snaith, 1983)] is a self-report questionnaire to assess symptoms of depression and anxiety in the last week in patients with physical complaints. In the current study, a German version of the HADS was used (Herrmann-Lingen et al., 2011). The questionnaire consists of 14 items and takes approximately 5 minutes to finish. Each item is rated on a 4-point scale (from 0 to 3). The HADS consists of the two subscales depression (HADS-D; items 2, 4, 6, 8, 10, 12, 14) and anxiety (HADS-A; items 1, 3, 5, 7, 9, 11, 13). An example item for the depression subscale is "I feel cheerful" (0 = not at all, 1 = not often, 2 = sometimes, 3 = most of the time). An example item for the anxiety scale is "Worrying thoughts go through my mind" (0 = only occasionally, 1 = sometimes, 2 = not often, 3 = most of the time). Sum scores of the two subscales can be computed where higher scores represent higher levels of depression or anxiety. The sum scores for each subscale can reach values between 0 and 21. Cut-off values are defined as follows: 0-7 = non-cases, 8-10 = doubtful cases, 11-21 = cases by the authors of the test (Zigmond & Snaith, 1983). Petermann (2011) report more small-stepped cut-off values for each subscale of 0-7 = safely unobtrusive, 8-10 = marginal, 11-14 = severe symptoms and 15-21 = very severe symptoms. In the current German speaking long COVID sample, a good internal consistency of α = .85 for the anxiety subscale and a good internal consistency of α = .83 for the depression subscale was detected.

Control Variables

Research suggests that the odds for developing long COVID after an acute infection as well as the risk for psychological symptoms in the aftermath of an acute infection have been higher for women which is why gender was incorporated as a covariate (Huang et al., 2021; Shanbehzadeh et al., 2021; Sudre et al., 2021). Additionally, the odds of developing long COVID after an acute infection have been found to be higher with higher age (Sudre et al., 2021). Thus, gender and age were incorporated as covariates in the analysis.

Norm Values

To answer the first research question, values regarding levels of perceived stress, fatigue, anxiety, and depression determined in the present sample are compared with the values

from norm samples found in the literature. The following is a brief description of the norm samples used. The psychometric characteristics and population norms of the German version of the PSS-10 were assessed by Klein et al. (2016). The representative sample of the German population consists of 2,527 participants between 14 and 95 years old and was recruited in 2014. There were 1,350 women and 1,177 men in the sample. Results revealed good internal consistency ($\alpha = .84$). Mean values for the PSS-10 sum score for the total sample was $M = 12.57$, $SD = 6.42$. Women scored significantly higher than men. Additionally, younger age was associated with higher perceived stress values. Westenberger et al. (2022) studied psychometric characteristics and population norms of the German version of the MFI-20 for a representative German population. The sample consists of 2,509 participants (1,276 women; 1,230 men) between 16 and 95 years old. Cronbach's alpha revealed good to excellent internal consistency for all subscales of the MFI-20. Mean values for the MFI-20 sum score for the total sample was $M = 41.69$, $SD = 17.54$. Women scored significantly higher on the MFI-20 sum scale and all subscales except for reduced motivation than men. In general, higher age was associated with higher levels of fatigue. Hinz and Brahler (2011) provide normal values for the German version of the HADS. Their representative sample consists of 4,410 participants (2,481 women; 1,929 men) with a mean age of 50.3 years. Mean values for the HADS for the total sample were $M = 4.7$, $SD = 3.5$ for anxiety and $M = 4.7$, $SD = 3.9$ for depression and $M = 9.45$, $SD = 6.8$ for a total score. Regarding cut-off values 21.0 % exceeded the cut-off value for elevated scores for anxiety, 23.7 % for depression and 30.2 % for the total score in this representative sample. An age trend was found for the anxiety scale but not depression meaning that females showed higher anxiety scores than men. Higher age was positively related to higher levels of both anxiety and depression, although this trend was stronger in the depression subscale.

Data Analytic Plan

The anonymous web-based questionnaire was provided via the platform Unipark. Obtained data was downloaded from Unipark in the end of the study and IBM SPSS Statistic 27 and SPSS PROCESS macro (version 4.0) by Hayes (2018) were used to analyse data. At the beginning of each analysis, the assumptions of the respective statistical procedure were checked. The entire hypothesis testing is performed at an alpha level of $\alpha < 0.05$. To assess hypothesis 1.1 to 1.3 one sample t-tests were conducted using SPSS Statistics 27. This procedure tests whether the mean score in a sample (i.e., the German speaking long COVID sample) is similar to the mean of a population (Bortz & Schuster, 2011). In our case, population means were obtained from studies of representative samples of the German population that investigate the psychometric properties and provide norm values of the questionnaires used

(Hinz & Brahler, 2011; Klein et al., 2016; Westenberger et al., 2022). To compute a one-sample t-test the dependent variable must be measured at interval or ratio level, observations must be independent, data should be free from significant outliers, and the dependent variable should be approximately normally distributed (Field, 2018). Graphical outliner analyses were conducted using boxplots. Normal distribution was evaluated for using histograms and QQ plots as well as Shapiro-Wilk test. If the graphical analyses were indicative of an approximately normal distribution this was sufficient even if Shapiro-Wilk test contradicts this finding due to the robustness of the t-test against violations of this assumptions as well as the sample size of more than 50 subjects (Field, 2018). To test the hypotheses 2.1 to 2.4, a serial mediational analysis was conducted using Hayes (2018) model 6 of the PROCESS macro. The PROCESS macro can calculate total, direct, and indirect effects. For a serial mediation it assesses for a particular ordering that is entered by the data analyst. In this way it is possible to analyse both isolated indirect effects of both mediators as well as the indirect effect that combines both mediators in a series (van Jaarsveld et al., 2010). Calculations were performed using 5,000 bootstrap resampling and 95 % bias-corrected confidence intervals. Effects were considered significant when the confidence interval did not include zero (Hayes, 2018). PROCESS does not test for statistical assumptions. Therefore, statistical assumption tests were conducted in advance using IBM SPSS Statistic 27. Hayes (2018) recommends testing following four assumptions while on the same time emphasizing the robustness against violations of assumptions of the used bootstrapping tool: linearity, normal distribution of residues, homoscedasticity, and independence. The assumption of linearity was tested for visually via scatterplots after LOESS smoothing. Normal distribution of residues was tested graphically via histograms and PP-plots as well as analytically using Shapiro-Wilk test. The assumption of homoscedasticity was tested visually via a scatterplot of standardized predicted values with standardized residuals as well as the Breusch-Pagan test.

Results

This chapter presents the results of the analysis regarding the research questions as well as the results of further exploratory analysis in the end. At first, general results are reported.

General Results

In the following section, firstly a detailed description of the sample will be given concerning relevant sociodemographic and medial characteristics. Secondly, general results will be presented.

Most participants, 84.8 % (*n* = 173), were women and 14.2 % (*n* = 29) men while 0.5 % (*n* = 1) did not report their sex and 0.5 % (*n* = 1) reported their sex as "other". The participants' age ranged from 19 to 83 years old with a mean age of 40 (*SD* = 12.09). Almost half of the participants, 48.0 % (*n* = 98), lived in Germany while 35.8 % (*n* = 73) lived in Austria, 14.7 % % (*n* = 30) in Switzerland, and 1.5 % (*n* = 3) in other countries. 92.2 % (*n* = 188) reported German to be their native language and 7.8 % (*n* = 16) reported to have another native language. Regarding their level of education, 0.5% (*n* = 1) had a completed secondary school, 6.9 % (*n* = 14) commercial school or specialized school, 21.1 % (*n* = 43) apprenticeship (with or without master's certificate), 25.5 % (*n* = 52) high-school diploma, 7.8 % (*n* = 16) Diploma degree, 17.6 % (*n* = 36) Bachelor's degree, 17.5 % (*n* = 35) Master's degree and 3.4 % (*n* = 7) Dr./PhD or higher. A bit more than half of the participants, 51 % (*n* = 104), reported to currently be unable to work due to their long COVID disease, respectively 48.5 % (*n* = 99) reported being able to work and one person (0.5 %) did not answer this question. Regarding their long COVID diagnosis 71.1 % (*n* =145) reported having been diagnosed with long COVID and 28.9 % (*n* = 59) reported experiencing symptoms indicative of long COVID and suspecting to have the disease. When asked about who made the long COVID diagnosis, 25.5 % (*n* = 52) reported a suspected diagnosis, in 32.8 % (*n* = 67) a general practitioner diagnosed long COVID, in 17.2 % (*n* = 35) a specialist diagnosed long COVID, 8.3 % (*n* = 17) reported the diagnosis to be made by "hospital", while 5.9 % (*n* = 12) reported "centre for rehabilitation", 9.8 % (*n* =20) neurologist, and 0.5 % (*n* = 1) did not know who diagnosed their long COVID disease. Regarding the question "How many months ago were you diagnosed with long COVID?", the subjects reported a mean of 12.1 months (*SD* = 10.54, *Mdn* = 13.00, range: 1 – 29 months). Regarding a pre-existing physical disease 69.1 % (*n* = 141) reported none, while 8.8 % (*n* = 18) reported a previous physical condition and 22.1 % (*n* = 45) reported a current – acute or chronic – condition. The three most frequently reported physical conditions were asthma with 9.3 % (*n* = 19), thyroid diseases with 7.8 % (*n* = 16), and hypertension with 4.9 % (*n* = 10). Regarding pre-existing mental disorders 71.1 % (*n* = 145) reported none, 16.7 % (*n* = 34) reported a previous mental disorder, and 12.3 % (*n* = 25) a current – acute or chronic – mental disorder. Most frequently reported mental disorders were depression with 20.1 % (*n* = 41), anxiety disorder with 8,8 % (*n* = 18), and sleep disorders as well as post-traumatic stress disorder both with 6.9 % (*n* = 14). Concerning the question "Have you received any of the following therapies/treatments for your long COVID symptoms?" 21.6 % (*n* = 44) reported having received none of the listed therapies/treatments or "other" treatments while the remainder, 78.4 % (*n* = 160), reported having received at least one form of therapy or treatment.

Most mentioned forms included medication therapy with 46.1 % (*n* = 94), physiotherapy with 44.6 % (*n* = 91), and psychological or psychotherapeutic treatment with 32.4 % (*n* = 66).

A summary of means, standard deviations, variable range, internal consistency, and intercorrelations for the main study variables is provided in table 2. According to the classification postulated by Cohen (1988) strong significant correlations could be found between the main variables of the hypothesized model. Cohen defines effect sizes from r = .10 as small, r = .3 as medium and r = .5 as large.

There is unclearness in the literature concerning the factorial structure of the MFI-20. Following recommendations by Schwarz et al. (2003) the total sum score was analysed. In addition, table 3 provides means and standard deviation of the five dimensions of the MFI-20 and correlation with the other relevant variables. In terms of their mean values, general fatigue and physical fatigue show the strongest expressions followed by reduced activity, mental fatigue, and reduced motivation in descending order. MFI-20 dimensions show low to strong positive significant correlations with individual illness perceptions, perceived stress, anxiety, and depression. General fatigue has strong correlations with all relevant variables except for a medium correlation with anxiety. Physical fatigue strongly correlates with individual illness perceptions, shows medium correlations with perceived stress and depression, and the weakest correlation with anxiety. Reduced activity shows medium correlation with all variables except for small correlation with anxiety. Reduced motivation shows a medium correlation with individual illness perceptions and strong correlation with all other variables. Mental fatigue exhibits medium correlations with all relevant variables.

The B-IPQ consists of eight dimensions each measured by a single item. In addition to the first overview of the relevant study variables, the dimensions of individual illness perceptions as measured by the B-IPQ were also analysed. Due to the single-item structure of the subscales it was not possible to calculate Cronbach's alpha for the dimensions of illness perception separately. The overall sum score of the B-IPQ in the German-speaking long COVID sample is *M* = 50.19 *SD* = 11.27 (range: 12-75). Means and standard deviation of the dimensions of the B-IPQ and correlation with the other relevant variables are provided in table 4. In relation to their mean values the dimensions of consequences and identity have the strongest mean values, followed by concern, emotion, personal control, timeline, treatment control, and coherence in descending order. Dimensions have small to large significant correlations with fatigue severity, perceived stress, anxiety, and depression. The correlation between consequences and anxiety and between coherence and fatigue as well as perceived stress are

not significant. The first five dimensions of the B-IPQ measure cognitive illness representations. Timeline, personal control, and treatment control all show small correlations with fatigue severity, perceived stress, anxiety, and depression. Consequences show medium to large correlations and one non-significant correlation and identity small to large correlations. Items 6 and 8 measure emotional illness representations. Correlations between concern (item 6) and fatigue severity, perceived stress, anxiety, and depression are medium to large. Emotions (item 8) correlate strongly with all relevant constructs. Item 7 assesses illness comprehensibility and exhibits the weakest correlation with all relevant constructs as well as two non-significant correlations.

Table 2

Descriptives and Bivariate Correlations Among All Main Study Variables

Variables		*M*	*SD*	*Range*	α	MFI-20	B-IPQ	PSS-10	HADS-A	HADS-D
1	MFI-20	73.86	13.79	24-100	0.90	—	.59**	.64**	.39**	.59**
2	B-IPQ	50.19	11.27	12-75	0.73		—	.56**	.44**	.58**
3	PSS-10	22.35	6.78	4-38	0.87			—	.69**	.68**
4	HADS-A	7.95	4.47	0-19	0.85				—	.68**
5	HADS-D	8.19	4.17	0-19	0.83					—

Note. $N = 204$, M = Mean; SD = standard deviation, α = Cronbach's alpha.
*$p < 0.05$, **$p < .01$, ***$p < .001$.

Table 3

Descriptives and Correlations Among MFI-20 Dimensions and Other Relevant Study Variables

MFI-20 Dimensions		*M*	*SD*	*Range*	B-IPQ	PSS-10	HADS-A	HADS-D
1	General Fatigue	16.88	3.16	4-20	.56**	.52**	.24**	.41**
2	Physical Fatigue	16.38	3.69	4-20	.53**	.46**	.17*	.37**
3	Reduced Activity	15.44	3.52	4-20	.48**	.49**	.22**	.47**
4	Reduced Motivation	10.50	3.95	4-20	.40**	.54**	.55**	.63**
5	Mental Fatigue	14.73	3.89	4-20	.34**	.43**	.30**	.39**

Note. $N = 204$, M = Mean; SD = standard deviation.
*$p < 0.05$, **$p < .01$, ***$p < .001$.

Table 4

Descriptives and Correlations Among B-IPQ Dimensions and Other Relevant Study Variables

B-IPQ Dimensions		*M*	*SD*	*Range*	MFI-20	PSS-10	HADS-A	HADS-D
1	Consequences	7.53	2.07	2-10	.57**	.33**	.10	.32**
2	Timeline	6.24	1.97	2-10	.25**	.25**	.22**	.27**
3	Personal Control	6.27	2.36	0-10	.24**	.25**	.22**	.32**
4	Treatment Control	5.10	2.62	0-10	.16*	.21**	.17*	.22**
5	Identity	7.34	2.12	0-10	.61**	.43**	.18*	.36**
6	Concern	6.85	2.52	0-10	.45**	.45**	.39**	.47**
7	Coherence	4.51	2.67	0-10	.09	.13	.16*	.16*
8	Emotions	6.34	2.63	0-10	.52**	.60**	.61**	.61**

Note. $N = 204$, M = Mean; SD = standard deviation.
*$p < 0.05$, **$p < .01$, ***$p < .001$.

Research Question 1

One goal of the study is to describe and analyse the German-speaking long COVID sample regarding their levels of perceived stress, fatigue, and symptoms of depression and anxiety. Hence, a light is shed on the patient group's psychological burden. To evaluate

hypotheses 1.1, 1.2 and 1.3, one-sample t-tests are calculated using IBM SPSS Statistic 27. In a first step statistical assumptions for the t-test were checked.

Statistical Assumption Tests

In the following, one-sample t-tests will be calculated for the PSS-10 sum score, the MFI-20 sum score and the HADS scores for the anxiety subscale and depression subscale. All variables met the conditions of interval level measure and independence of data. Graphical outliner analysis using boxplots revealed no outliners for each HADS subscale. For PSS-10 and MFI-20 sum scores individual cases could be identified below the 0^{th} percentile. In the case of PSS-10 one case was identified. Regarding the MFI-20 11 cases were identified below this percentile. These cases are characterized by particularly low levels of perceived stress or fatigue and are, therefore, less loaded than the entire sample. Since it is the goal of this thesis to provide a broad picture of a German speaking long COVID sample and since the outliners rather impede the confirmation of hypothesis due to their direction they will not be excluded from analysis. A graphical test for normal distribution via histograms and QQ plots revealed approximately normal distribution for all relevant scales. The normal distribution was further assessed via Shapiro-Wilk test, here, noteworthy results were shown for all scales. However, since the sample consists of more than 50 subjects, the significant result of the test can be neglected, and the normal distribution can still be assumed (Field, 2018). The t-test is robust against violations of this assumption, therefore, an approximately normal distribution is sufficient for this analysis (Field, 2018). Last, a presumed mean value based on population measures or theoretical assumptions is needed to calculate a one-sample t-test. There are current norm values for the German population for each questionnaire used in this analysis available and described above.

One-Sample t-Tests

To assess how the German-speaking long COVID sample can be described regarding perceived stress and if their perceived stress levels are elevated in comparison to a German norm sample, the PSS-10 was analysed. The PSS-10 sum score results from the German speaking long COVID sample was compared to norm values provided by Klein et al. (2016). The German-speaking long COVID sample reported significantly higher levels of perceived stress ($M = 22.35$, $SD = 6.78$; range: 4-38) than the German-speaking norm sample ($M = 12.57$, $SD = 6.42$), $t(203) = 20.60$, $p < .001$, $d = 1.44$ confirming hypothesis 1.1. Furthermore, the German-speaking long COVID sample was described regarding their levels of fatigue. For this purpose, the MFI-20 sum score as well as all five subscores were calculated and compared to values from a German-speaking norm sample provided by Westenberger et al. (2022). The German-speaking long COVID sample reported significantly higher levels of fatigue ($M =$

73.86, *SD* = 13.79; range: 24-100) than the German-speaking norm sample (*M* = 41.69, *SD* = 17.54), *t*(203) = 33.31, *p* < .001, *d* = 2.33. The present sample also showed significantly higher levels of general fatigue (*M* = 16.88, *SD* = 3.16; range: 4-20), physical fatigue (*M* = 16.38, *SD* = 3.69; range: 4-20), reduced activity (*M* = 15.44, *SD* = 3.52; range: 4-20), reduced motivation (*M* = 10.50, *SD* = 3.95; range: 4-20), and mental fatigue (14.73, *SD* = 3.89; range: 4-20) compared to norm values of general fatigue (*M* = 8.66, *SD* = 3.92), *t*(203) = 31.15, *p* < .001, *d* = 2.60, physical fatigue (M = 8.45, *SD* = 4.28), *t*(202) = 30.64, *p* < .001, *d* = 2.15, reduced activity (*M* = 8.36, *SD* = 4.00), *t*(203) = 28.73, *p* < .001, *d* = 2.01, reduced motivation (*M* = 8.13, *SD* = 3.48), *t*(203) = 8.58, *p* < .001, *d* = 0.60, and mental fatigue (*M* = 8.08, *SD* = 3.49), *t*(203) = 24.42, *p* < .001, *d* = 1.71. In this way findings support hypothesis 1.2. To answer hypothesis 1.3., the HADS scores for the anxiety subscale and depression subscale were calculated separately and compared to German norm values provided by Hinz and Brahler (2011). In comparison to the norm values for anxiety (*M* = 4.7, *SD* = 3.5; range: 0-19) and depression (*M* = 4.7, *SD* = 3.9; range: 0-19) the German-speaking long COVID sample showed elevated levels of anxiety (*M* = 7.95, *SD* = 4.47), *t*(203) = 10.38, *p* < .001, *d* = .73 and depression (*M* = 8.19, *SD* = 4.17), *t*(203) = 11.96, *p* < .001, *d* = .84. In the present sample 51.5 % (*n* = 105) exceeded the cut-off of 8+ for elevated levels of anxiety and 52.5 % (*n* = 107) for depression. Table 5 provides an overview of all t-test results.

Table 5

One-Sample t-Test Results Comparing a German-Speaking Long COVID Sample to German Norm Samples

	Present Sample		Norm Sample				
Variables	*M*	*SD*	*M*	*SD*	*t(203)*	*p*	*d*
PSS-10	22.35	6.78	12.57	6.42	20.60	< .001	1.44
MFI-20 (sum)	73.86	13.79	41.69	17.54	33.31	< .001	2.33
MFI-20 (general fatigue)	16.88	3.16	8.66	3.92	31.15	< .001	2.60
MFI-20 (physical fatigue)	16.38	3.69	8.45	4.28	30.64	< .001	2.15
MFI-20 (reduced activity)	15.44	3.52	8.36	4.00	28.73	< .001	2.01
MFI-20 (reduced motivation)	10.50	3.95	8.13	3.48	8.58	< .001	0.60
MFI-20 (mental fatigue)	14.73	3.89	8.08	3.49	24.42	< .001	1.71
HADS-A	7.95	4.47	8.19	4.17	10.38	< .001	.73

HADS-D	8.19	4.17	4.70	3.90	11.96	< .001	.84

Note. N = 204, M = Mean; SD = standard deviation, d = Cohens d.

Research Question 2

The study assessed a serial mediation with individual illness perceptions and perceived stress serially mediating the relationship between fatigue severity and symptoms of anxiety and depression. To evaluate hypotheses 2.1., 2.2., 2.3., and 2.4., a serial mediation analysis was calculated using model 6 of the SPSS Macro PROCESS by Hayes (2018). Sex and age were entered as covariates in all analyses. However, the covariates were consistently non-significant. Thus, all models were re-run without covariates.

Statistical Assumption Tests

In a first step, an outliner analysis was conducted for the B-IPQ total score. For outliner analysis for the other relevant questionnaires see above. Graphical outliner analysis using boxplots revealed five individual cases below the 0^{th} percentile. These cases are characterized by lower threatening or benign individual illness representations and individuals, therefore, are less loaded than the entire sample. The outliners impede the confirmation of hypothesis due to their direction. In parallel to the argumentation for handling of outliners above, these cases were not excluded from the analysis. Visual analysis of linearity of all variables involved in the mediation via scatterplots after LOESS smoothing revealed approximately linear relationships of all relevant variables. Visual test of the normal distribution of residues via histograms as well as PP-plots showed no violation of assumption. The Shapiro-Wilk test was not significant which also indicates a normal distribution of residues. Visual analysis of the assumption of homoscedasticity revealed unconclusive results for both anxiety and depression. The Breusch-Pagan test was not significant which means that homoscedasticity was present. It can be assumed that criteria for independence of data are met since the study uses cross-sectional data which is not clustered or hierarchically.

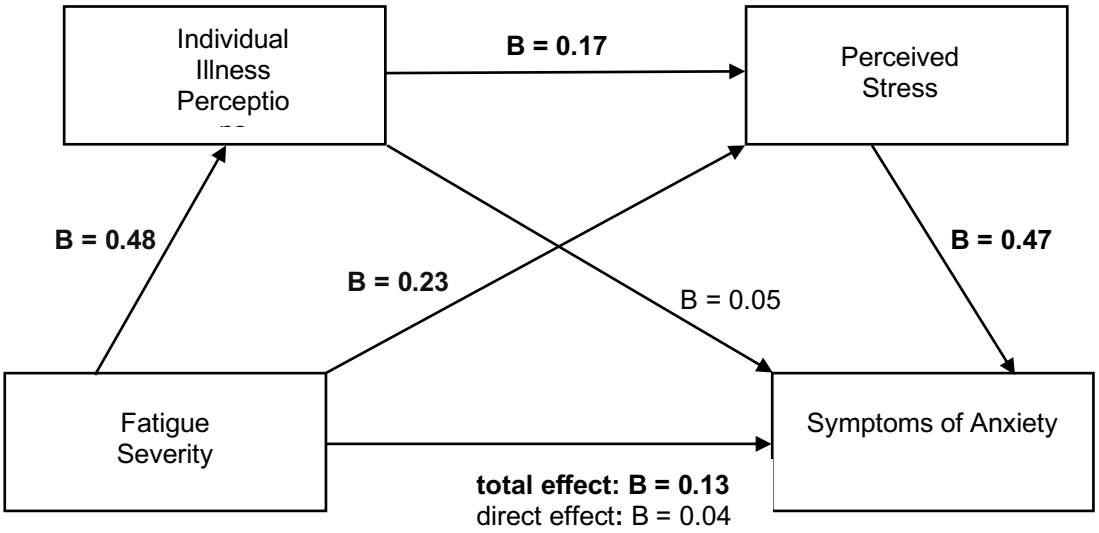
Serial Mediation Analyses

A serial mediation was performed to analyse whether fatigue severity predicts anxiety and depression in a sample of long COVID patients and whether the direct path would be serially mediated by individual illness perceptions and perceived stress. Figures 2 and 3 illustrate the model and show Beta coefficients of the single pathways between each construct. An effect of fatigue severity on anxiety (total effect; B = 0.13, 95 % *CI* [0.09, 0.17]) and depression (total effect; B = 0.18, 95 % *CI* [0.15, 0.21]) was observed confirming hypothesis

2.1. When the mediators were included, this effect was no longer significant in the case of anxiety and was reduced but still statistically significant in the case of depression (direct effect; B = 0.04, 95 % *CI* [< 0.01, 0.08]). Fatigue severity was also found to be a positive predictor of individual illness perceptions (B = 0.48, 95 % *CI* [0.391, 0.57]) and perceived stress (B = 0.23, 95 % *CI* [0.17, 0.30]). To evaluate hypothesis 2.2. the indirect effect of fatigue severity on anxiety and depression through individual illness perceptions was examined. While this indirect effect was non-significant for anxiety, there was a significant effect for depression (B = 0.04, 95 % *CI* [0.01, 0.06]). Therefore, hypothesis 2.2. can be confirmed in the case of depression but must be rejected in the case of anxiety as dependent variable. To evaluate hypothesis 2.3., the indirect effect of fatigue severity on adverse mental health outcomes through perceived stress was examined. The indirect effect was found to be significant for both anxiety (B = 0.11, 95 % *CI* [0.08, 0.15]) and depression (B = 0.07, 95 % *CI* [0.05, 0.10]). Hence, hypothesis 2.3. can be confirmed in both cases. Finally, to evaluate hypothesis 2.4., the indirect effect of fatigue severity on adverse mental health outcomes via both mediators was examined. This serial mediation was significant for both anxiety (B = 0.0376, 95 % *CI* [0.02, 0.06]) and depression (*B* = 0.0252, 95 % *CI* [0.01, 0.04]), confirming hypothesis 2.4. To summarize, there was an indirect relationship between fatigue severity and adverse mental health outcomes and this relationship was fully mediated by individual illness perceptions and perceived stress levels in the case of anxiety and partially mediated in the case of depression. Table 6 demonstrates the results of the serial mediation analyses.

Figure 2

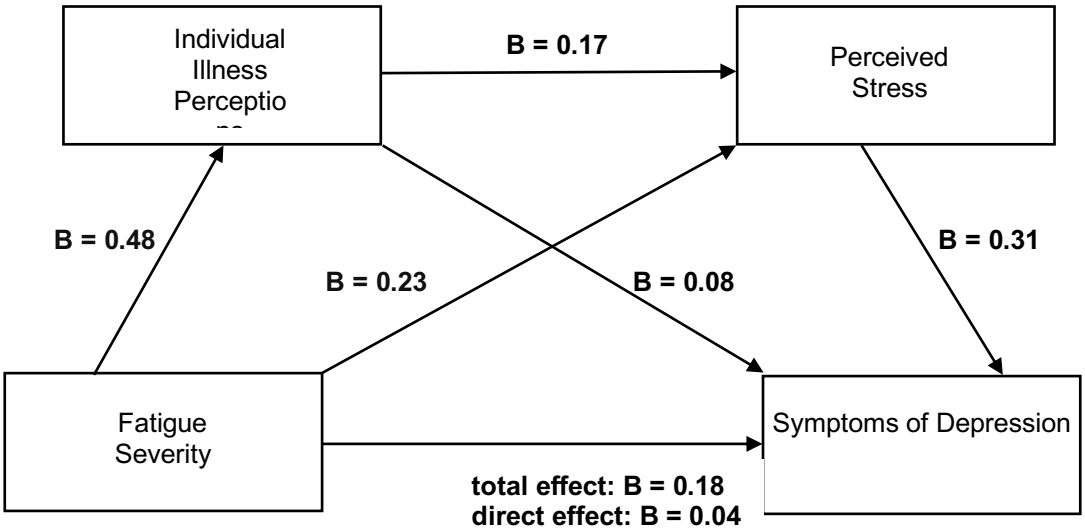
Serial Mediation Model Illustrating the Influence of Individual Illness Perceptions and Perceived Stress on the Association between Fatigue Severity and Anxiety in Long COVID Patients



Note. N = 204. Beta values are interpreted as significant if confidence intervals did not contain zero and presented in bold. Results are based on 5,000 bootstrap samples.

Figure 3

Serial Mediation Model Illustrating the Influence of Individual Illness Perceptions and Perceived Stress on the Association between Fatigue Severity and Depression in Long COVID Patients



Note. N = 204. Beta values are interpreted as significant if confidence intervals did not contain zero and presented in bold. Results are based on 5,000 bootstrap samples.

Table 6

Total, Direct, and Indirect Effects of Fatigue Severity on Anxiety and Depression via Individual Illness Perceptions and Perceived Stress (Serial Mediation Model)

	Anxiety (Y1)			Depression (Y2)		
	Boot effect	*Boot SE*	*CI*	*Boot effect*	*Boot SE*	*CI*
Total effect of X on Y	**0.13**	0.02	**[0.09, 0.17]**	**0.18**	0.02	**[0.37, 0.71]**
Direct effect of X on Y	-0.04	0.02	[-0.09, < 0.01]	**0.04**	0.08	**[-0.23, 0.08]**
Indirect effect of X on Y through **illness perceptions**	0.02	0.01	[< -0.01, 0.05]	**0.04**	0.01	**[0.01, 0.06]**
Indirect effect of X on Y through **perceived stress**	**0.11**	0.02	**[0.08, 0.15]**	**0.07**	0.01	**[0.05, 0.10]**
Indirect effect of X on Y through **illness perceptions** and **perceived stress**	**0.04**	0.01	**[0.02, 0.06]**	**0.03**	0.01	**[0.01, 0.04]**

Note. *N* = 204. X = Independent variable; Y = Dependent variable; *SE* = Standard error; *CI* = Confidence interval.
*CI*s not containing zero are interpreted as significant and presented in bold. Analyses were run separately for each dependent variable. Results are based on 5,000 bootstrap samples.

Since fatigue is defined as a multidimensional construct additionally to the above analyses which used the MFI-20 total sum score, further analyses were conducted testing the model using each of the five dimensions of fatigue as measured by the MFI-20 as independent variables. This was done for anxiety and depression as dependent variables separately. Table 7 shows the results for anxiety as dependent variable. When mental fatigue was used as independent variable, the same pattern of significant and non-significant effects occurred as in the model with the MFI-20 total sum score as independent variable. When general fatigue physical fatigue, or reduced activity were used as independent variables, all effects were significant, and the direct effect was negative and significant. When reduced motivation was the independent variable, all effects were significant except for the indirect effect between reduced motivation and anxiety through individual illness perceptions. Table 8 shows the results for depression as dependent variable. The model with reduced motivation as independent variable showed the same pattern of significant and non-significant effects as the model with the MFI-20 total sum score. In all other cases the direct effect was non-significant.

Table 7

Total, Direct, and Indirect Effects of Single Fatigue Severity Dimensions on Anxiety via Individual Illness Perceptions and Perceived Stress (Serial Mediation Model)

	General fatigue		Physical fatigue		Reduced activity		Reduced motivation		Mental fatigue	
	Boot effect	*Boot SE [CI]*	*Boot effect*	*Boot SE [CI]*	*Boot effect*	*Boot SE [CI]*	*Boot effect*	*Boot SE [CI]*	*Boot effect*	*Boot SE [CI]*
Total effect of X on Y	**0.34**	**0.10 [0.15, 0.53]**	**0.21**	**0.08 [0.04, 0.37]**	**0.27**	**0.09 [0.10, 0.45]**	**0.63**	**0.07 [0.50, 0.76]**	**0.34**	**0.08 [0.19, 0.50]**
Direct effect of X on Y	**-0.33**	**0.09 [-0.50, -0.16]**	**-0.30**	**0.07 [-0.44, -0.16]**	**-0.25**	**0.07 [-0.40, -0.10]**	**0.28**	**0.07 [0.15, 0.41]**	-0.01	0.07 [-0.14, 0.12]
Indirect effect of X on Y through **illness perceptions**	**0.14**	**0.07 [0.02, 0.28]**	**0.11**	**0.05 [0.03, 0.21]**	**0.08**	**0.04 [0.01, 0.17]**	0.02	0.03 [-0.04, 0.08]	0.03	0.03 [-0.02, 0.09]
Indirect effect of X on Y through **perceived stress**	**0.31**	**0.08 [0.16, 0.46]**	**0.20**	**0.07 [0.07, 0.33]**	**0.26**	**0.07 [0.14, 0.41]**	**0.23**	**0.05 [0.14, 0.33]**	**0.21**	**0.05 [0.1, 0.30]**
Indirect effect of X on Y through **illness perceptions** and **perceived stress**	**0.22**	**0.05 [0.13, 0.33]**	**0.20**	**0.04 [0.12, 0.29]**	**0.18**	**0.04 [0.11, 0.26]**	**0.10**	**0.02 [0.06, 0.15]**	**0.12**	**0.03 [0.06, 0.18]**

Note. *N* = 204. X = Independent variable; Y = Dependent variable; *SE* = Standard error; *CI* = Confidence interval.

*CI*s not containing zero are interpreted as significant and presented in bold. Analyses were run separately for each independent variable. Results are based on 5,000 bootstrap samples.

Table 8

Total, Direct, and Indirect Effects of Single Fatigue Severity Dimensions on Depression via Individual Illness Perceptions and Perceived Stress (Serial Mediation Model)

	General fatigue		Physical fatigue		Reduced activity		Reduced motivation		Mental fatigue	
	Boot effect	*Boot SE [CI]*	*Boot effect*	*Boot SE [CI]*	*Boot effect*	*Boot SE [CI]*	*Boot effect*	*Boot SE [CI]*	*Boot effect*	*Boot SE [CI]*
Total effect of X on Y	**0.54**	**0.08 [0.15, 0.21]**	**0.42**	**0.07 [0.27, 0.57]**	**0.55**	**0.07 [0.40, 0.70]**	**0.66**	**0.06 [0.55, 0.77]**	**0.41**	**0.07 [0.28, 0.55]**
Direct effect of X on Y	-0.07	0.08 [-0.23, 0.08]	-0.05	0.06 [-0.17, 0.08]	0.10	0.07 [-0.03, -0.23]	**0.32**	**0.06 [0.21, 0.43]**	0.07	0.06 [-0.04, 0.18]
Indirect effect of X on Y through **illness perceptions**	**0.21**	**0.06 [0.10, 0.32]**	**0.16**	**0.05 [0.08, 0.26]**	**0.13**	**0.04 [0.06, 0.22]**	**0.09**	**0.03 [0.04, 0.16]**	**0.09**	**0.03 [0.04, 0.16]**
Indirect effect of X on Y through **perceived stress**	**0.24**	**0.06 [0.12, 0.37]**	**0.15**	**0.05 [0.05, 0.25]**	**0.19**	**0.05 [0.09, 0.30]**	**0.17**	**0.04 [0.11, 0.25]**	**0.16**	**0.04 [0.09, 0.25]**
Indirect effect of X on Y through **illness perceptions** and **perceived stress**	**0.17**	**0.04 [0.10, 0.25]**	**0.15**	**0.03 [0.09, 0.22]**	**0.13**	**0.03 [0.08, 0.19]**	**0.07**	**0.02 [0.04, 0.11]**	**0.09**	**0.03 [0.05, 0.15]**

Note. *N* = 204. X = Independent variable; Y = Dependent variable; *SE* = Standard error; *CI* = Confidence interval.

*CI*s not containing zero are interpreted as significant and presented in bold. Analyses were run separately for each independent variable. Results are based on 5,000 bootstrap samples.

Explorative Analyses

In a further explorative analysis, the single B-IPQ dimensions were analysed within the framework of the serial mediation model. The pattern from table 4 as well as literature regarding the CSM suggest a difference between cognitive and emotional individual illness perceptions. To assess the influence of each of the eight dimensions of individual illness perceptions, the serial mediation model was calculated with each single dimension of the B-IPQ as mediator one separately. In this explorative analysis, the MFI-20 sum score was used as independent variable. Analyses were conducted for anxiety and depression as dependent variables. Table 9 and 10 show the results of this explorative analyses and provide beta coefficients, standard deviations, and confidence intervals.

Regarding anxiety as dependent variable (see table 9), the pattern found for the total score of B-IPQ with a significant total effect (*B* = 0.13, 95 % *CI* [0.09, 0.17]), a significant indirect effect of fatigue severity on anxiety through perceived stress (*B* = 0.11, 95 % *CI* [0.08, 0.15]), and a significant serial mediation (*B* = 0.04, 95 % *CI* [0.02 0.06]) was also found for the B-IPQ-dimension of concern (an emotional dimension) with a significant total effect (*B* = 0.13, 95 % *CI* [0.09, 0.17]), a significant indirect effect of fatigue severity on anxiety through perceived stress (*B* = 0.13, 95 % *CI* [0.09, 0.16]), and a significant serial mediation (*B* = 0.02, 95 % *CI* [0.01, 0.04]). The second emotional dimension (emotions) also shows a significant indirect effect of fatigue severity on anxiety through perceived stress (*B* = 0.09, 95 % *CI* [0.06, 0.12]) and a significant serial mediation (*B* = 0.04, 95 % *CI* [0.02, 0.06]). Additionally, here the direct effect (*B* = -0.05, 95 % *CI* [-0.09, -0.01]) as well as the indirect effect through the B-IPQ-dimension emotions (*B* = 0.06, 95 % *CI* 0.03, 0.08]) was significant. All other B-IPQ-dimensions had significant total effects (*B* = 0.13, 95 % *CI* [0.09, 0.17]), non-significant serial mediations, and non-significant direct effects. The indirect effect through perceived stress was significant for all not yet reported illness perception dimensions: consequences (*B* = 0.16, 95 % *CI* [0.12, 0.20]), timeline (*B* = 0.45, 95 % *CI* [0.35, 0.56]), personal control (*B* = 0.15, 95 % *CI* [0.11, 0.19]), treatment control (*B* = 0.15, 95 % *CI* [0.12, 0.18]), identity (*B* = 0.15, 95 % *CI* [0.11; 0.18]), and coherence (*B* = 0.15, 95 % *CI* [0.12, 0.19]). Results were mixed regarding the indirect effect through the single B-IPQ-dimensions. Significant effects were found for the dimensions of consequences (*B* = -0.03, 95 % *CI* [-0.05, -< 0.01]), identity (*B* = -0.03, 95 % *CI* [-0.06, < -0.01]), and emotions (*B* = 0.06, 95 % *CI* [0.03, 0.08]).

The pattern found for the total score of B-IPQ when depression was the dependent variable (see table 10) was a significant total effect (*B* = 0.18, 95 % *CI* [0.15, 0.21]), a significant

direct effect (*B* = 0.04, 95 % *CI* [<0.01, 0.21]), a significant indirect effect through individual illness perceptions (*B* = 0.04, 95 % *CI* [0.01, 0.06]), a significant indirect effect through perceived stress (*B* = 0.07, 95 % *CI* [0.05, 0.10]), and a significant effect through both mediators (*B* = 0.03, 95 % *CI* [0.01, 0.04]). This pattern was also true for both emotional dimensions (concern and emotions). Regarding the dimension of concern the effects were as follows: a significant total effect (*B* = 0.18, 95 % *CI* [0.15, 0.21]), a significant direct effect (*B* = 0.06, 95 % *CI* [0.02, 0.09]), a significant indirect effect through concern (*B* = 0.02, 95 % *CI* [0.01, 0.04]), a significant indirect effect through perceived stress (*B* = 0.09, 95 % *CI* [0.06, 0.12]), and a significant effect through both mediators (*B* = 0.02, 95 % *CI* [0.01, 0.03]). Regarding the dimension of emotions the effects were: a significant total effect (*B* = 0.18, 95 % *CI* [0.15, 0.21]), a significant direct effect (*B* = 0.05, 95 % *CI* [0.02, 0.09]), a significant indirect effect through emotions (*B* = 0.04, 95 % *CI* [0.02, 0.06]), a significant indirect effect through perceived stress (*B* = 0.06, 95 % *CI* [0.04, 0.09]), and a significant effect through both mediators (*B* = 0.03, 95 % *CI* [0.02, 0.04]). All other dimensions were characterized by significant total effects (*B* = 0.18, 95 % *CI* [0.15, 0.21], non-significant indirect effects through both mediators, and significant indirect effects through perceived stress: consequences (*B* = 0.12, 95 % *CI* [0.08, 0.15]), timeline (*B* = 0.10, 95 % *CI* [0.077, 0.14]), personal control (*B* = 0.10, 95 % *CI* [0.07, 0.14]), treatment control (*B* = 0.11, 95 % *CI* [0.08, 0.14]), identity (*B* = 0.10, 95 % *CI* [0.07, 0.14]), and coherence (*B* = 0.11, 95 % *CI* [0.08, 0.14]). Results were mixed regarding direct effects as well as indirect effects through the single B-IPQ-dimensions not yet reported. Direct effects were significant for consequences (*B* = 0.07, 95 % *CI* [0.02, 0.11]), timeline (*B* = 0.06, 95 % *CI* [0.03, 0.10]), treatment control (*B* = 0.07, 95 % *CI* [0.03, 0.10]), identity (*B* = 0.08, 95 % *CI* [0.03, 0.12]), and coherence (*B* = 0.07, 95 % *CI* [0.03, 0.10]). The direct effect was not significant for the dimension of personal control. Indirect effects through the single B-IPQ-dimensions were non-significant except for the cognitive dimension of personal control with a significant indirect effect from fatigue severity on depression through personal control (*B* = 0.01, 95 % *CI* [< 0.01, 0.02]).

Table 9

Total, Direct, and Indirect Effects of Fatigue Severity on Anxiety and Depression via Single Illness Perception Dimensions and Perceived Stress (Serial Mediation Model) with Dependent Variable Anxiety

Illness Perception Dimension		Total effect of X on Y	Direct effect of X on Y	Indirect effect of X on Y through illness perception dimension	Indirect effect of X on Y through perceived stress	Indirect effect of X on Y through illness perception dimension and perceived stress
1	Consequences	**0.13** (SE = 0.02; CI [0.09; 0.17])	< 0.01 (SE = 0.02; CI [-0.05, 0.05])	**-0.03** (SE = 0.01; CI [-0.05, < -0.01])	**0.16** (SE = 0.02; CI [0.12, 0.20])	-0.01 (SE = 0.01; CI [-0.02, 0.01])
2	Timeline		-0.01 (SE = 0.02; CI [-0.07, 0.01])	0.01 (SE = < 0.01; CI [< -0.01, 0.05])	**0.45** (SE = 0.06; CI [0.35, 0.56])	0.02 (SE = 0.01; CI [< -0.01, 0.05])
3	Personal control		-0.03 (SE = 0.02; CI [-0.07, 0.01]	< 0.01 (SE = 0.01; CI [-0.01, 0.02])	**0.15** (SE = 0.02; CI [0.11, 0.19])	0.01 (SE = < 0.01, CI [-< 0.01, 0.02]
4	Treatment control		-0.03 (SE = 0.02; CI [-0.07, 0.01])	< 0.01 (SE = < 0.01; CI [< -0.01, 0.01])	**0.15** (SE = 0.02; CI [0.12, 0.18])	< 0.01 (SE = < 0.01; CI [< -0.01, 0.01])
5	Identity		< -0.01 (SE =0.02; CI [-0.05, 0.05])	**-0.03** (SE = 0.01; CI [-0.06, < -0.01])	**0.15** (SE = 0.02; CI [0.11; 0.18])	0.01 (SE = 0.01; CI [-0.01, 0.03])
6	Concern		-0.04 (SE = 0.02; CI [-0.08, < 0.01])	0.02 (SE = 0.01; CI [0.00, 0.04])	**0.13** (SE = 0.02; CI [0.09, 0.16])	**0.02** (SE = 0.01; CI [0.01, 0.04])
7	Coherence		-0.03 (SE = 0.02; CI [-0.07, 0.01])	< 0.01 (SE = < 0.01; CI [< -0.01, 0.01])	**0.15** (SE = 0.02; CI [0.12, 0.19])	< 0.01 (SE = < 0.01; CI [< -0.01, 0.01]

8	Emotions	**-0.05** (SE = 0.02; CI [-0.09, -0.01])	**0.06** (SE = 0.01; CI [0.03, 0.08])	**0.09** (SE = 0.01; CI [0.06, 0.12])	**.004** (SE = 0.01; CI [0.02, 0.06])
9	Total score	-0.04 (SE = 0.02; CI [-0.09, < 0.01])	0.02 (SE = 0.01; CI [< -0.01, 0.05])	**0.11** (SE = 0.02; CI [0.08, 0.15])	**0.04** (SE = 0.01; CI [0.02, 0.06])

Note. *N* = 204. X = Independent variable; Y = Dependent variable; *SE* = Standard error; *CI* = Confidence interval.
*CI*s not containing zero are interpreted as significant and presented in bold. Results are based on 5,000 bootstrap samples.

Table 10

Total, Direct, and Indirect Effects of Fatigue Severity on Anxiety and Depression via Single Illness Perception Dimensions and Perceived Stress (Serial Mediation Model) with Dependent Variable Depression

Illness Perception Dimension		Total effect of X on Y	Direct effect of X on Y	Indirect effect of X on Y through illness perception dimension	Indirect effect of X on Y through perceived stress	Indirect effect of X on Y through illness perception dimension and perceived stress
1	Consequences	**0.18** (SE = 0.02; CI [0.15, 0.21])	**0.07** (SE = 0.02; CI [0.02, 0.11])	< 0.01 (SE = 0.01; CI [-0.02, 0.02])	**0.12** (SE = 0.02; CI [0.08, 0.15])	< -0.01 (SE = 0.01; CI [-0.02, 0.01])
2	Timeline		**0.06** (SE = 0.02; CI [0.03, 0.10])	0.01 (SE = < 0.01; CI [< -0.01, 0.02])	**0.10** (SE = 0.02; CI [0.08, 0.14])	< 0.01 (SE = < 0.01; CI [-0.01, 0.01])
3	Personal control		0.06 (SE = 0.02; CI [0.03, 0.10])	**0.01** (SE = < 0.01; CI [< 0.01, 0.02])	**0.10** (SE = 0.02; CI [0.07, 0.14])	< 0.01 (SE = < 0.01; CI [< -0.01, 0.01])
4	Treatment control		**0.07** (SE = 0.02; CI [0.03, 0.10])	< 0.01 (SE = < 0.01; CI [< -0.01, 0.01])	**0.11** (SE = 0.02; CI [0.08, 0.14])	< 0.01 (SE = < 0.01; CI [< -0.01, 0.01])
5	Identity		**0.08** (SE = 0.02; CI [0.03, 0.12])	-0.01 (SE = 0.011 CI [-0.03, 0.01])	**0.10** (SE = 0.02; CI [0.07, 0.14])	0.01 (SE = 0.01; CI [-0.01, 0.02])
6	Concern		**0.06** (SE = 0.02; CI [0.02, 0.09])	**0.02** (SE = 0.01; CI [0.01, 0.04])	**0.09** (SE = 0.01; CI [0.06, 0.12])	**0.02** (SE = 0.01; CI [0.01, 0.03])
7	Coherence		**0.07** (SE = 0.02; CI [0.03, 0.10])	< 0.01 (SE = < 0.01; CI [< -0.01, 0.01])	**0.11** (SE = 0.02; CI [0.10, 0.14])	< 0.01 (SE = < 0.01; CI [< -0.01, 0.01])

8	Emotions	**0.05** (SE = 0.02; CI [0.02, 0.09])	**0.04** (SE = 0.01; CI [0.02, 0.06])	**0.06** (SE = 0.01; CI [0.04, 0.09])	**.02** (SE = 0.01; CI [0.02, 0.04])
9	Total score	**0.04** (SE = 0.02; CI [< 0.01, 0.21])	**0.04** (SE = 0.01; CI [0.01, 0.06])	**0.07** (SE = 0.01; CI [0.05, 0.10])	**0.03** (SE = 0.01; CI [0.01, 0.04])

Note. *N* = 204. X = Independent variable; Y = Dependent variable; *SE* = Standard error; *CI* = Confidence interval.
*CI*s not containing zero are interpreted as significant and presented in bold. Results are based on 5,000 bootstrap samples.

Discussion

In the following chapter, the results are first summarized and discussed in relation to the respective research questions. Practical implications are derived based on the discussed findings. This is followed by a discussion of the general strengths and limitations of the results and a concluding summary.

Primary Discussion

One goal of this master thesis was to describe the psychological burden of a German-speaking long COVID sample. Furthermore, the relationship between fatigue severity and the mental health outcomes of anxiety and depression and possible mediators of this relationship were at the heart of this thesis. In such manner, the thesis aimed to add to the literature and to show ways to tackle psychological consequences of long COVID disease. Based on existing knowledge about long COVID as well as other (chronic) diseases, levels of fatigue, perceived stress, depression, and anxiety in the long COVID sample and the pattern of illness perceptions were of special interest.

The German-speaking long COVID sample is characterized by a high psychological burden and reports elevated levels in all investigated areas compared to norm samples of the general population. The present sample shows levels of perceived stress increased by almost 1.8 times compared to a German-speaking norm sample. Regarding the symptom of fatigue, the present sample shows elevated levels of the total level of fatigue as well as elevated levels of all dimensions of fatigue as measured by the MFI-20. Findings of elevated fatigue levels as measured by the MFI-20 in long COVID patients are in line with other studies on this patient group. Lier et al. (2022) studied long COVID patients six months post infection and found comparable levels of elevated fatigue scores in all dimensions measured by MFI-20 as well as the total score. Noteworthy, the ranking of the dimensions differed between the present sample and the norm sample as well as the sample conducted by Lier et al. (2022). In all three samples the dimensions of general fatigue, physical fatigue, and reduced activity were the most pronounced. While these were followed by reduced motivation and mental fatigue in the norm sample and in the study by Lier et al. (2022), mental fatigue took fourth place in the present sample followed by reduced motivation. The present sample is also heavily burdened by symptoms of anxiety and depression. Mean values of depression and anxiety as measured by the HADS are elevated in comparison to a German-speaking norm sample. In the present sample 51.5 % exceed the cut-off for elevated levels of anxiety and 52.5 % exceed the cut-off for elevated levels of depression compared to only 21.0 % and 23.7 % in the norm sample.

Findings of elevated levels of anxiety and depression are in line with studies on the mental health of long COVID patients. Houben-Wilke et al. (2022) found comparable but smaller mean values in their sample of long COVID patients six months post infection. It, therefore, becomes clear that the target group is heavily burdened and that further investigations in the psychological field are of utmost importance. There are many open questions concerning long COVID disease and its treatment. A closer look at subjective conceptions individuals form about their illness are a promising approach to gain a deeper understanding of the connection between long COVID symptoms and mental health outcomes. The identification of a certain pattern of perceptions is a promising starting point since it offers a wide range of possible treatment approaches. Patterns of illness perceptions have been shown to be distinct for certain diseases and to be stable over time (Hagger & Orbell, 2003). The present sample of long COVID patients is characterized by a strong belief that the illness affects their life a lot (dimension of consequences) and by a strong expression on the identity dimension. This means that they experience many symptoms to be part of their illness. Interestingly, the two dimensions of emotional representations, namely concern and emotions, also play a prominent role here. The pattern of illness perceptions found in this sample of long COVID patients shares some commonalities with the pattern found in CFS patients (Gray & Rutter, 2007). In both cases, the dimensions of consequences and identity are pronounced. In contrast to CFS patients, long COVID patients show less pronounced values in the timeline dimension but are more heavily burdened by emotional representations. In contrast to mixed results regarding the dimensions of cognitive representations, the emotional dimensions are both moderately to strongly associated with all relevant constructs (i.e., fatigue, perceived stress, and symptoms of anxiety and depression). Especially the dimension of emotions, expressing how much the patient feels emotionally affected by the illness, shows strong correlations with all other constructs. This unique position of emotional representations in long COVID patients is in line with Bierbauer et al. (2022) who also attributes a special role to emotional representations in long COVID patients. It is reasonable that emotional representations play a vital role in the relationship between disease severity and psychological outcomes and that a transformation of these representations through targeted interventions is a promising approach. The special role of emotional dimensions also becomes evident when looking at the serial mediation model: To gain a deeper understanding of the mechanisms connecting the symptom of fatigue and the psychological consequences of long COVID disease, the interconnection between fatigue severity, individual illness perceptions, levels of perceived stress, and adverse mental health outcomes were evaluated. Drawing on the CSM by Leventhal et al. (2016), the mediating

influence of cognitive and emotional representation of one's own illness on, firstly, the experience of perceived stress and, secondly, on adverse mental health outcomes were tested. Since it is reasonable that the level of perceived stress constitutes a mediator on its own but is also influenced by individual illness perceptions, it was integrated as a second mediator in the model and a serial model was chosen. The results revealed a full serial mediation of illness perceptions and perceived stress on the relationship between fatigue severity and anxiety and a partial serial mediation of the same mediators on the relationship between fatigue severity and depression. Interestingly, when it comes to anxiety as dependent variable, the serial mediation model was significant but the indirect effect of fatigue severity on anxiety only through illness perceptions was not significant. This was contrary to the assumed relationship. However, further explorative analyses showed that this was only true when the total sum score of the B-IPQ was used as mediator one. Analysing each dimension separately supplied exciting insights. Noteworthy, the dimension of emotions as mediator one lead to significant effects for the serial mediation model as well as for the path where emotional representation functioned as a mediator between fatigue severity and anxiety on its own. Again, this finding highlights the special role emotional representations occupy in the relationship studied. This becomes even clearer when it is considered that the serial mediation model was only significant when the total sum score of the B-IPQ or one of the two emotional dimensions (emotions or concern) were used as mediator one. In all other cases, single paths but not the whole model became significant in the case of anxiety as outcome variable. When analysing the same model with depression as dependent variable different patterns emerged. There was a significant partial serial mediation when using the B-IPQ total sum score as mediator one. Explorative analyses showed that the same result became evident when using the two dimensions of emotional representations as mediators one on their own. In all other cases, the whole model became non-significant and the indirect effect of the B-IPQ dimension-mediator only became significant for the dimension of personal control. The indirect effect of fatigue severity on depression through perceived stress became significant in all cases. Once again, these findings highlight the special role emotional representations play in the interconnection between fatigue severity and mental health outcomes. Results show that emotional representations of disease should be tackled in long COVID patients. The CSM incorporates a feedback loop showing that a modification of illness perceptions is within the scope of the underlying theoretical framework. A graded exercise intervention has already been shown to be an effective tool for CFS patients to reduce both mental and physical fatigue mainly through changes in the identity dimension. Patients who attended the exercise group for 12 weeks focused significantly less on their symptoms (Moss-

Morris et al., 2005). The present study shows that illness identity is a very pronounced dimension in the current sample and literature suggests that this dimension is prone to change (Alyami et al., 2021; Moss-Morris et al., 2005). Fortune et al. (2002) showed that cognitive illness representations are an even more suitable starting point for psychological interventions than a more often considered enhancement of coping skills. Since emotional representations take a special position in the interplay between fatigue severity and adverse mental health outcomes, future research should focus on developing and evaluating tailored interventions focusing on emotional illness perceptions. Modifications within the dimensions of concern and emotions hold the potential of mitigating negative psychological consequences of fatigue. Research in other disease (i.e., type 2 diabetes) provides initial indications that these dimensions can be changed (Alyami et al., 2021). Westbrook et al. (2016) also stress the potential of interventions tackling emotional illness representations. Furthermore, they argue that such interventions hold the potential for improving the psychological status of patients as well as mitigating fatigue severity. This is an interesting starting point for future research given the interconnection of fatigue severity, emotional illness representations, and psychological health outcomes that has been shown by this thesis.

In addition, the analyses show the importance of perceived stress both in connection with emotional representations of illness and as an influential factor on its own. The present sample is highly burdened by elevated levels of perceived stress and perceived stress significantly mediates the relationship between fatigue severity and adverse mental health outcomes. Tackling the reduction of how stressed patients feel by their disease holds the opportunity to significantly improve their psychological well-being. The experience of high levels of perceived stress is determined by an unfavourable interplay of the emergence of stressors and the perception of available resources. Long COVID patients experiencing high levels of perceived stress are overwhelmed by various stressors and are not able to apply suitable coping strategies. It is reasonable that the burden of fatigue plays a role here since it inhibits mental and physical activity so that potential resources cannot be used (Doerr et al., 2015). Therefore, possible interventions should include the development of useful coping strategies and the identification, strengthening, and application of already existing resources. In addition, interventions may aim at identifying and reducing stressors, provided this is within the patient's capabilities. The findings of this thesis show that a reduction of perceived stress through such interventions holds the potential for mitigating psychological consequences of long COVID such as symptoms of anxiety and depression thereby improving the quality of life and reducing the burden for those affected. Mind-body interventions are interventions focusing

on the interplay between physical and mental processes within an individual (Carlson & Bultz, 2008). They have been shown to be an effective tool in the reduction of perceived stress (Deckro et al., 2002; Stillwell et al., 2017; Zhang et al., 2021). Additionally, they have the potential to decrease symptoms of anxiety and depression as well as cancer related fatigue (Zhang et al., 2021). Nasiri et al. (2020) evaluated a MBI for patients with acute coronary syndrome. They were able to detect changes in both levels of perceived stress as well as in illness perceptions lasting one month after the intervention. This master thesis has shown the interrelation and importance of all these constructs for long COVID patients thereby stressing the potential MBIs have in the setting of this patient group on different levels. Future research should increasingly focus on the adaption and evaluation of such promising interventions for long COVID patients.

Strengths and Limitations

This master thesis gives exciting insights into the psychological burden of long COVID patients. It is a first and important step in the direction of a deeper understanding of this heavily burdened patient group and shows many promising approaches for the development of effective interventions such as MBIs for long COVID patients. The study has several strengths. Firstly, its big sample size of 204 participants allows for a wide range of possible statistical analyses and precise estimations. Secondly, from a methodological perspective, the choice of the bootstrapping procedure is a major strength, as it is a robust procedure. Thirdly, this study is the first one investigating the interaction between fatigue severity and adverse mental health outcomes in long COVID patients. It throws a spotlight on the role individual illness perceptions and perceived stress play here. The detailed analyses of the single B-IPQ dimensions give promising insights into the role illness perceptions play in long COVID disease. The practical application of knowledge gained from this approach has the potential to significantly improve the lives of those affected. The novelty of the approach is an outstanding strength of this master thesis. Fourthly, the study is patient-centred since the survey was directly addressed at those affected thus giving long COVID patients a voice.

Nonetheless, some limitations need to be considered. Firstly, the present sample and its recruitment calls for a critical evaluation. Participants were self-selected and mainly recruited via social media self-help groups introducing the danger of a selection bias. Long COVID patients actively searching for help, especially on social media, might differ from those who do not do so. Another limitation related to the sample composition is a gender disbalance in the current sample. The sample consists of 84.8 % women restricting generalizability of the findings. This imbalance might also partly be due to social media recruitment. On the other

hand, female gender constitutes a risk factor for the development of long COVID (Bai et al., 2022). In the present analysis, the inclusion of gender as covariate did not influence the results. Secondly, the study design itself limits the way findings can be interpreted. Since it is a cross-sectional design, causality cannot be assumed. Future research should investigate the psychological situation of long COVID patients with the help of longitudinal study designs. Nonetheless, the usage of a cross-sectional design is still reasonable especially since long COVID is a rather new disease and calls for time-efficient research so that new knowledge can be generated quickly and evaluated treatment offers can be provided to those affected as soon as possible. The third area of limitations concerns the questionnaire used in this study. It was rather long and took approximately 50 minutes to finish. Especially against the background of a highly burdened sample in which high fatigue values are to be assumed, this seems to be critical. It is likely that many affected individuals drop out of the questionnaire at an early stage due to exhaustion. This would result in the data depicting only the less burdened individuals. On the other hand, it is also conceivable that especially initiative taking persons, who suffer particularly from their symptoms, fill out the questionnaire to the end. This would result in data being more pronounced than reality. To avoid both cases of selection bias the questionnaire contained the opportunity to be paused whenever necessary. Participants were reminded of this possibility multiple times within the course of their participation. Whenever feasible, short versions of the single questionnaires were used to keep the whole questionnaire as short as possible. This has the consequence that, for example, the dimensions of illness perceptions were only measured with one item per dimension. The longer version of the B-IPQ would have supplied more information and the possibility to calculate Cronbach's alpha for each dimension. Another limitation concerning the data itself is that all information obtained results from self-report measurements. Although this way of data collection is a widespread procedure in psychological research, the combination of different methods would have held the opportunity to get deeper insights into the sample of long COVID patients. It is worth mentioning here that the question about a long COVID diagnosis itself was only to be answered with a self-reported item. Due to unclearness about the term long COVID, especially in the general population, it is unclear what people do actually mean when they say they have long COVID. Nonetheless, keeping the goal of this research project and patient group studied in mind, a time-efficient, easy to apply and less burdensome method such as online self-report measurements were a reasonable decision. Lastly, a fourth area of limitations concerns the content rather than methodological considerations. The use of fatigue severity as independent variable rather than disease severity limits the interpretability and application of results. Future research should

follow Bierbauer et al. (2022) and further investigate the relationships studied on a broader spectrum. However, fatigue occupies a special position as a symptom in long COVID patients and it is valuable to deeply investigate this symptom and its psychological consequences. Another content limitation is the lack of consideration of coping behaviour in the present model. Within the framework of CSM coping skills are an important agent in the relationship between illness perceptions and (mental) health outcomes. Future research should take different forms of coping behaviour into account.

Conclusion

As it is a rather new disease, the investigation and accumulation of knowledge about long COVID is of utmost importance. The present study clearly shows the psychological burden of long COVID patients. Furthermore, it adds to existing long COVID mental health literature by assessing a comprehensive model representing a possible trajectory leading to adverse mental health outcomes in long COVID patients suffering from fatigue. By integrating both individual illness perceptions and perceived stress as mediators into the relationship between fatigue severity and symptoms of depression and anxiety, the study shows several starting points for the development of treatment options. Results show how subjective conceptions of illness influence the development of negative mental health outcomes. It especially highlights the role of emotional representations. Additionally, analyses show that perceived stress – both as a mediator on its own and in the interplay with illness perceptions – is a crucial factor to consider when developing psychological treatment offers for those suffering from long COVID. Research efforts should now focus on developing effective treatment approaches based on current knowledge that can relieve the burden of those affected. Here, the present study shows exciting starting points that should be considered when developing treatment options.

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List of Abbreviations

B-IPQ	Brief Illness Perception Questionnaire
CFS	Chronic fatigue syndrome
COVID-19, COVID	Coronavirus Disease 2019
CSM	Common-Sense model of Self-Regulation
HADS	Hospital Anxiety and Depression Scale
HADS-A	Hospital Anxiety and Depression Scale Anxiety Subscale
HADS-D	Hospital Anxiety and Depression Scale Depression Subscale
ICD-11	International Statistical Classification of Disease and Related Health Problems
MBI	Mind-Body-Intervention
MERS	Middle East Respiratory Syndrome
MFI-20	Multidimensional Fatigue Inventory
PSS-10	Perceived Stress Scale
PTSD	Posttraumatic Stress Disorder
SARS	Severe Acute Respiratory Syndrome
SARS-CoV-2	Severe Acute Respiratory Syndrome Coronavirus 2
WHO	World Health Organization

Appendix

Appendix A: Abstracts

English Version

Long COVID is a new disease occurring in the aftermaths of an acute COVID-19 infection. Many questions concerning, e.g., psychological consequences and treatment options are still unanswered. This poses challenges to patients and health care professionals. The present cross-sectional study investigates a German speaking long COVID sample and evaluates the mediating role individual illness perceptions as well as perceived stress have in the relationship between the symptom of fatigue and the development of symptoms of depression and anxiety. A total of 204 German-speaking long COVID patients between 19 and 83 years (M = 40, SD = 12.09; 84.8 % female, 14.2 % male) completed an anonymous online questionnaire. Results show elevated levels of fatigue, perceived stress and symptoms of anxiety and depression compared to normal values in the general population. Serial mediation analyses revealed a full serial mediation of individual illness perceptions and perceived stress on the relationship between fatigue severity and anxiety and a partial serial mediation of individual illness perceptions and perceived stress on the relationship between fatigue severity and depression. Findings especially highlight the role of emotional illness representations and perceived stress. Therefore, results show that psychological treatments should aim to improve these aspects to mitigate adverse psychological consequences of long COVID.

German Version

Long COVID stellt eine neue Erkrankung dar, die im Anschluss an eine akute COVID-19-Infektion auftreten kann. Viele Fragen, z. B. zu den psychologischen Folgen und den Behandlungsmöglichkeiten, sind noch unbeantwortet. Dies stellt sowohl für Patient:innen als auch für das medizinische Personal eine Herausforderung dar. Die vorliegende Querschnittsstudie untersucht eine deutschsprachige Long COVID Stichprobe und evaluiert die mediierende Rolle, die individuelle Krankheitsvorstellungen sowie wahrgenommener Stress für den Zusammenhang zwischen dem Symptom Fatigue und der Entwicklung von Depressions- und Angstsymptomen haben. Insgesamt nahmen 204 deutschsprachige Long COVID Patient:innen in einem Alter zwischen 19 und 83 Jahren an der anonymen Online-Umfrage teil (M = 40, SD = 12.09; 84.8 % Frauen, 14.2 % Männer). Die Ergebnisse zeigen ein erhöhtes Maß an Fatigue, wahrgenommenem Stress und Symptomen von Angst und Depression im Vergleich zu Normwerten der Allgemeinbevölkerung. Serielle Mediationsanalysen ergaben eine vollständige serielle Mediation von individuellen Krankheitsvorstellungen und wahrgenommenem Stress auf die Beziehung zwischen Fatigue und Angst und eine partielle

serielle Mediation von individuellen Krankheitsvorstellungen und wahrgenommenem Stress auf die Beziehung zwischen Fatigue und Depression. Die Ergebnisse unterstreichen die Rolle der emotionalen Krankheitsvorstellungen und des wahrgenommenen Stresses. Die Ergebnisse zeigen, dass Behandlungsangebote darauf abzielen sollten, diese Aspekte zu verbessern, um die negativen psychologischen Folgen einer Long COVID Erkrankung abzufangen.

Appendix B: Relevant Questionnaires

German Version of the Multidimensional Fatigue Inventory (Schwarz et al., 2003, Westenberger et al., 2022)

Durch die folgenden Aussagen möchten wir erfahren, wie Sie sich in letzter Zeit fühlten.

Nehmen wir das Beispiel an: "Ich fühle mich entspannt".
Wenn Sie glauben, dass dies wirklich zutrifft und Sie sich in letzter Zeit wirklich entspannt fühlten, dann sollten Sie das Kästchen ganz links "Ja, das trifft zu" ankreuzen. Je weniger Sie mit der vorgegebenen Aussage übereinstimmen, umso weiter rücken Sie das Kreuz in Richtung "Nein, das trifft nicht zu".

1. Ich fühle mich leistungsfähig.

   (Ja, das trifft zu) 1 2 3 4 5 (Nein, das trifft nicht zu)

2. Körperlich fühle ich mich in der Lage, nur wenig zu tun.

   (Ja, das trifft zu) 1 2 3 4 5 (Nein, das trifft nicht zu)

3. Ich fühle mich sehr aktiv.

   (Ja, das trifft zu) 1 2 3 4 5 (Nein, das trifft nicht zu)

4. Ich habe Lust, alle möglichen schönen Dinge zu unternehmen.

   (Ja, das trifft zu) 1 2 3 4 5 (Nein, das trifft nicht zu)

5. Ich fühle mich müde.

   (Ja, das trifft zu) 1 2 3 4 5 (Nein, das trifft nicht zu)

6. Ich denke, dass ich an einem Tag viel erledige.

   (Ja, das trifft zu) 1 2 3 4 5 (Nein, das trifft nicht zu)

7. Wenn ich etwas tue, kann ich mich gut darauf konzentrieren.

   (Ja, das trifft zu) 1 2 3 4 5 (Nein, das trifft nicht zu)

8. Körperlich traue ich mir viel zu.

   (Ja, das trifft zu) 1 2 3 4 5 (Nein, das trifft nicht zu)

9. Ich fürchte mich davor, Dinge erledigen zu müssen.

   (Ja, das trifft zu) 1 2 3 4 5 (Nein, das trifft nicht zu)

10. Ich denke, dass ich an einem Tag sehr wenig tue.

    (Ja, das trifft zu) 1 2 3 4 5 (Nein, das trifft nicht zu)

11. Ich kann mich gut konzentrieren.

    (Ja, das trifft zu) 1 2 3 4 5 (Nein, das trifft nicht zu)

12. Ich fühle mich ausgeruht.

    (Ja, das trifft zu) 1 2 3 4 5 (Nein, das trifft nicht zu)

13. Es kostet mich große Anstrengung, mich auf Dinge zu konzentrieren.

    (Ja, das trifft zu) 1 2 3 4 5 (Nein, das trifft nicht zu)

14. Körperlich fühle ich mich in einer schlechten Verfassung.

    (Ja, das trifft zu) 1 2 3 4 5 (Nein, das trifft nicht zu)

15. Ich habe eine Menge Pläne.

    (Ja, das trifft zu) 1 2 3 4 5 (Nein, das trifft nicht zu)

16. Ich ermüde sehr schnell.

    (Ja, das trifft zu) 1 2 3 4 5 (Nein, das trifft nicht zu)

17. Obwohl ich es versuche, bekomme ich nur wenig erledigt.

    (Ja, das trifft zu) 1 2 3 4 5 (Nein, das trifft nicht zu)

18. Ich fühle mich nicht danach, irgendetwas zu tun.

    (Ja, das trifft zu) 1 2 3 4 5 (Nein, das trifft nicht zu)

19. Meine Gedanken schweifen sehr schnell ab.

    (Ja, das trifft zu) 1 2 3 4 5 (Nein, das trifft nicht zu)

20. Körperlich fühle ich mich in ausgezeichneter Verfassung.

    (Ja, das trifft zu) 1 2 3 4 5 (Nein, das trifft nicht zu)

German Version of the Brief Illness Questionnaire (Broadbent et al., 2006)

Bitte kreuzen Sie bei den nachfolgenden Fragen diejenige Antwort an, die am besten auf Sie zutrifft:

1. Wie stark beeinträchtigt Ihre Erkrankung Ihr Leben?

   (Überhaupt keine Beeinträchtigung) 0 1 2 3 4 5 6 7 8 9 10 (sehr starke Beeinträchtigung)

2. Wie lange meinen Sie, dass Ihre Krankheit noch andauern wird?

   (Nur noch ganz kurz) 0 1 2 3 4 5 6 7 8 9 10 (für immer)

3. Wie stark meinen Sie, Ihre Krankheit selbst kontrollieren zu können?

   (absolut keine Kontrolle) 0 1 2 3 4 5 6 7 8 9 10 (extreme Kontrolle)

4. Wie stark meinen Sie, dass Ihre Behandlung bei Ihrer Erkrankung helfen kann?

   (überhaupt nicht) 0 1 2 3 4 5 6 7 8 9 10 (extrem hilfreich)

5. Wie stark spüren Sie Beschwerden durch Ihre Krankheit?

   (überhaupt keine Beschwerden) 0 1 2 3 4 5 6 7 8 9 10 (viele starke Beschwerden)

6. Wie stark machen Sie sich Sorgen über Ihre Krankheit?

   (überhaupt keine Sorgen) 0 1 2 3 4 5 6 7 8 9 10 (extreme Sorgen)

7. Wie gut meinen Sie, Ihre Krankheit zu verstehen?

   (überhaupt nicht) 0 1 2 3 4 5 6 7 8 9 10 (sehr klar)

8. Wie stark sind Sie durch Ihre Krankheit gefühlsmäßig beeinträchtigt? (Sind Sie durch Ihre Krankheit zum Beispiel ärgerlich, verängstigt, aufgewühlt oder niedergeschlagen?)

   (gefühlsmäßig überhaupt nicht betroffen) 0 1 2 3 4 5 6 7 8 9 10 (gefühlsmäßig extrem betroffen)

9. Bitte führen Sie nun die drei wichtigsten Gründe auf, die Ihrer Meinung nach Ihre Krankheit verursacht haben. Die wichtigsten Ursachen meiner Krankheit sind:

   1. _____

2. _____
3. _____

German Version of the Perceived Stress Scale (Klein et al., 2016)

Die folgenden Fragen beziehen sich auf Ihre Gefühle und Gedanken während des letzten Monats.

Bei jeder Frage werden Sie gebeten anzugeben, wie häufig Sie in eine bestimmte Richtung dachten oder fühlten. Obwohl einige Fragen sehr ähnlich wirken, unterscheiden sie sich. Deshalb sollten Sie jede Frage für sich betrachten.

Am besten beantworten Sie alle Fragen zügig und spontan. Versuchen Sie also nicht zu zählen, wie häufig Sie ein bestimmtes Gefühl hatten, sondern schätzen Sie einfach, welche Antwort am ehesten zutrifft.

1. Wie oft wurden Sie im letzten Monat von unerwarteten Ereignissen überrascht?

   0 (nie) 1 (fast nie) 2 (manchmal) 3 (ziemlich oft) 4 (sehr oft)

2. Wie oft hatten Sie im letzten Monat das Gefühl, dass es Ihnen nicht möglich ist, wichtige Dinge in Ihrem Leben zu kontrollieren?

   0 (nie) 1 (fast nie) 2 (manchmal) 3 (ziemlich oft) 4 (sehr oft)

3. Wie oft haben Sie sich im letzten Monat nervös oder „gestresst“ gefühlt?

   0 (nie) 1 (fast nie) 2 (manchmal) 3 (ziemlich oft) 4 (sehr oft)

4. Wie oft haben sie sich im letzten Monat zuversichtlich gefühlt, dass Sie in der Lage sind, persönliche Probleme zu regeln?

   0 (nie) 1 (fast nie) 2 (manchmal) 3 (ziemlich oft) 4 (sehr oft)

5. Wie oft hatten Sie im letzten Monat das Gefühl, dass die Dinge in Ihrem Leben genauso laufen, wie sie es sollten?

   0 (nie) 1 (fast nie) 2 (manchmal) 3 (ziemlich oft) 4 (sehr oft)

6. Wie oft hatten Sie im letzten Monat das Gefühl, dass Sie mit anfallenden Aufgaben nicht zu Rande kommen?

0 (nie) 1 (fast nie) 2 (manchmal) 3 (ziemlich oft) 4 (sehr oft)

7. Wie oft waren Sie in der Lage mit Widrigkeiten des Lebens kontrolliert umzugehen?

   0 (nie) 1 (fast nie) 2 (manchmal) 3 (ziemlich oft) 4 (sehr oft)

8. Wie oft fühlten Sie sich als Herr der Lage?

   0 (nie) 1 (fast nie) 2 (manchmal) 3 (ziemlich oft) 4 (sehr oft)

9. Wie oft haben Sie sich über Dinge geärgert, die außerhalb Ihrer Kontrolle lagen?

   0 (nie) 1 (fast nie) 2 (manchmal) 3 (ziemlich oft) 4 (sehr oft)

10. Wie oft hatten Sie das Gefühl, dass sich Schwierigkeiten so sehr auftürmten, dass sie Ihnen über den Kopf wachsen?

    0 (nie) 1 (fast nie) 2 (manchmal) 3 (ziemlich oft) 4 (sehr oft)

German Version of the Hospital Anxiety and Depression Scale (Herrmann-Lingen et al., 2011)

Dieser Fragebogen bezieht sich auf Ihre allgemeine und seelische Verfassung. Wir bitten Sie, jede Frage zu beantworten, und zwar so, wie es für Sie persönlich in der letzten Woche am ehesten zutraf.

Machen Sie bitte nur ein Kreuz pro Frage und lassen Sie keine Frage aus! Überlegen Sie bitte nicht lange, sondern wählen Sie die Antwort aus, die Ihnen auf Anhieb am zutreffendsten erscheint!

1. Ich fühle mich angespannt oder überreizt.

   O (meistens)

   O (oft)

   O (von Zeit zu Zeit/gelegentlich)

   O (überhaupt nicht)

2. Ich kann mich heute noch so freuen wie früher.

   O (ganz genauso)

   O (nicht ganz so sehr)

   O (nur noch ein wenig)

   O (kaum oder gar nicht)

3. Mich überkommt eine ängstliche Vorahnung, dass etwas Schreckliches passieren könnte.

   O (ja, sehr stark)

   O (ja, aber nicht allzu stark)

   O (etwas, aber es macht mir keine Sorgen)

   O (überhaupt nicht)

4. Ich kann lachen und die lustige Seite der Dinge sehen.

   O (ja, so viel wie immer)

   O (nicht mehr ganz so viel)

   O (inzwischen viel weniger)

   O (überhaupt nicht)

5. Mir gehen beunruhigende Gedanken durch den Kopf.

   O (einen Großteil der Zeit)

   O (verhältnismäßig oft)

   O (von Zeit zu Zeit/aber nicht allzu oft)

   O (nur gelegentlich/nie)

6. Ich fühle mich glücklich.

O (überhaupt nicht)

O (selten)

O (manchmal)

O (meistens)

7. Ich kann behaglich dasitzen und mich entspannen.

O (ja, natürlich)

O (gewöhnlich schon)

O (nicht oft)

O (überhaupt nicht)

8. Ich fühle mich in meinen Aktivitäten gebremst.

O (fast immer)

O (sehr oft)

O (manchmal)

O (überhaupt nicht)

9. Ich habe manchmal ein ängstliches Gefühl in der Magengegend.

O (überhaupt nicht)

O (gelegentlich)

O (ziemlich oft)

O (sehr oft)

10. Ich habe das Interesse an meiner äußeren Erscheinung verloren.

O (ja, stimmt genau)

O (ich kümmere mich nicht so sehr darum, wie ich sollte)

O (möglicherweise kümmere ich mich zu wenig)

O (ich kümmere mich so viel darum wie immer)

11. Ich fühle mich rastlos, muss immer in Bewegung sein.

O (ja, tatsächlich sehr)

O (ziemlich)

O (nicht sehr)

O (überhaupt nicht)

12. Ich blicke mit Freude in die Zukunft.

O (ja, sehr)

O (eher weniger als früher)

O (viel weniger als früher)

O (kaum bis gar nicht)

13. Mich überkommt plötzlich ein panikartiger Zustand.

O (ja, tatsächlich sehr oft)

O (ziemlich oft)

O (nicht sehr oft)

O (überhaupt nicht)

14. Ich kann mich an einem guten Buch, einer Radio- oder Fernsehsendung freuen.

O (oft)

O (manchmal)

O (eher selten)

O (sehr selten)