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Examining COVID-19 Long-Haulers Along Gender, Race Stress and Social Support Variables

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Examining COVID-19 Long-Haulers Along Gender, Race, Stress, and Social Support Variables

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Biography

The author was born in Green Bay, Wisconsin, on June 27, 1995. Brianna graduated from Bay Port High School in Howard-Suamico, Wisconsin in 2014. She received her Bachelor of Arts in Psychology from Beloit College in 2018.

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Abstract

Unfortunately, the United States has experienced approximately 575,000 deaths as a direct result of COVID-19, with elderly, Hispanic, and Black Americans experiencing the greatest risk (CDC, 2020). Although most individuals recover from mild to moderate COVID-19 infections within a few weeks, some may experience lingering symptoms for many months (Mayo Clinic, 2020). These individuals are commonly known as COVID-19 long-haulers. In order to properly assist in the well-being of COVID-19 long-haulers, more needs to be understood in terms of how gender, race, stress, and social support impact symptomatology within this population. The present study seeks to address this gap in the literature by examining the frequency and severity of symptoms experienced by COVID-19 long-haulers throughout their illness. Independent *t*-tests were used to assess the differences in symptoms between females and males, and also White and BIPOC participants. Regression analyses were conducted to determine the prediction of COVID-19 symptom frequency and severity by stress, social support, gender, and race. Results indicate that both social support and stress predict COVID-19 severity and frequency in several symptom domains. In addition, being female predicts COVID-19 symptom severity and frequency in the pain and neurocognitive domains. The implications of this study's findings include helping COVID-19 long-haulers in managing their stress, potentially through increasing social support. This is especially important for female long-haulers.

Keywords: COVID-19, long-haulers, gender, race, stress, social support

Examining COVID-19 Long-Haulers Along Gender, Race, Stress, and Social Support Variables

Introduction

In November 2019, the world changed as a result of the global pandemic caused by the severe acute respiratory syndrome coronavirus 2 (SARS CoV-2) and the resulting coronavirus disease (COVID-19). In all areas of the globe, communities have struggled to keep up with the demands placed on health care systems, businesses, and daily life. In the United States, nearly a quarter of middle-income and half of lower-income individuals lost their jobs or took pay cuts in April 2020 (Parker et al., 2020). A majority of families have needed to make adjustments as their children stayed home and engaged in some form of distance learning (McElrath, 2020). And as individuals faced increased stress and decreased social support as a result of the pandemic, increases in mental health and substance use concerns have occurred (Czeisler et al., 2020). It is clear that the COVID-19 pandemic has impacted at least some aspect of life for everyone and has been a true global crisis.

Although the pandemic has indeed impacted everyone, it has not had equal effects on each individual. One group that is experiencing a unique set of challenges on top of the "average" pandemic stressors is COVID-19 long-haulers, a group of individuals who do not recover from the COVID-19 disease within a two-week period and experience lingering symptoms for many months (Mayo Clinic, 2020). This group is particularly susceptible to increases in stress and decreases in social support, as they often experience severe symptoms that can cause an inability to maintain full-time jobs (Mohan, 2020) and maintain close relationships as a result of quarantining during the course of the illness.

While it is clear that this group faces increased levels of stress and decreased levels of social support after contracting the virus, it is not clear whether those experiences may also increase the likelihood of experiencing long-term symptoms common to the COVID-19 long-hauler population. In addition, demographic characteristics, such as gender and race, may increase the probability of experiencing long-term effects as a result of COVID-19.

COVID-19

COVID-19 is a type of coronavirus (Sauer, 2020) that is primarily spread through person-to-person contact (Centers for Disease Control and Prevention [CDC], 2020; World Health Organization [WHO], 2020). Although older individuals and those with underlying medical conditions are more at risk for developing severe complications, such as needing ventilator support (CDC, 2020; WHO, 2020), the virus has negatively and severely impacted people of all ages and backgrounds. Symptoms of the disease vary, ranging from the more common fever, dry cough, and fatigue to the less common sore throat, rash, and loss of taste and smell (WHO, 2020). Unfortunately, the United States has experienced approximately 575,000 deaths as a direct result of COVID-19, with Hispanic and Black Americans experiencing the greatest vulnerability to infection and death (Rossen et al., 2020). This stress associated with losing a family member—a key source of social support—greatly impacts the well-being of the surviving family and community members, who themselves may be battling the virus.

COVID-19 Long-Haulers. The experience of an infection with COVID-19 is different for each person and the course of illness is largely unpredictable. Individuals usually recover from mild to moderate COVID-19 infections (i.e., not needing to be

hospitalized or intubated) within a few weeks, however some individuals may experience lingering symptoms for many months (Mayo Clinic, 2020). Like the symptoms of the virus itself, these persisting symptoms are multi-system. These symptoms can include fatigue, joint pain, loss of hair, blood clots, and challenges associated with memory and concentration (Mayo Clinic, 2020). Individuals who are experiencing this "long COVID" have either not fully recovered from their initial infection or have recovered but still experience symptoms intermittently (Mahase, 2020). These individuals often self-identify as COVID-19 long-haulers and have come together as a group to draw attention to their unique plight.

Chronic Illness

It is becoming clear that the experiences and recoveries of COVID-19 long-haulers are similar to those who have suffered long-term effects as a result of other viral infections, such as the Spanish flu (Radusin, 2012), Ebola (Wilson et al., 2019), and the Epstein-Barr virus (Buchwald et al., 2000). Most notably, a commonality between COVID-19 long-haulers and other post-viral groups is persistent fatigue after minimal physical or mental effort, often known as post-exertional malaise (PEM; CDC, 2019). Also similar to COVID-19 long-haulers, individuals with various chronic illnesses have shown varying levels of adaptation to their illness as a result of perceived stress and social support available to the individual affected with the illness (Acciari, 2019; Doeglas et al., 1994; Griffin et al., 2001). Stress and social support affect both psychological adjustment to the illness as well as physiological outcomes. In addition, factors that may affect an individual's level of stress and social support are the person's gender and race (Curtis et al., 2010; Duru, 2012). Overall, understanding which factors are influential to

health outcomes for COVID-19 long-haulers is critical to supporting this group and those most vulnerable within the group.

Stress. As a result of this current pandemic, understanding the effects of stress is essential to assisting individuals, especially those directly affected by the COVID-19 illness. It goes without saying that the COVID-19 pandemic has been a source of added stress for a majority of people the world over. Sources of stress include loss of work, threat of loss of housing, fear of contracting the virus through work, and changes in daily routines. It is necessary to acknowledge that different populations have not been affected equally by the COVID-19 pandemic. Many vulnerable groups, such as people who are low-income, experienced an already elevated level of stress prior to the pandemic and have been most susceptible to increased insecurity and stress during this time (Karpman et al., 2020).

Stress has often been connected to the development of chronic illness and how one is able to cope with the illness. Serious, prolonged stress, such as that related to post-traumatic stress disorder (PTSD), has been linked to an increased risk of developing chronic illness (Nobles, 2015). In addition, for people with myalgic encephalomyelitis/chronic fatigue syndrome (ME/CFS), stress has been found to be a significant contributor to the illness onset and progression, affecting especially psychological functioning and levels of fatigue (Devendorf et al., 2016; Hatcher et al., 2003; Salit, 1997). The experience of stress has also been connected to the development of other illnesses, such as HIV/AIDS, upper respiratory tract infections, and autoimmune diseases (Cohen et al., 2007). In essence, stress is a critical factor for the susceptibility to and the progression of chronic illness. Although physical symptoms may fluctuate or

even improve over time for people experiencing chronic illness, functionality related to psychological and other neurocognitive symptoms has been shown to worsen in people experiencing elevated amounts of stress (Devendorf et al., 2016). As a result, when considering vulnerability to the COVID-19 disease, stress may be a significant factor in susceptibility to the illness, the length of recovery time, and an indicator for prolonged psychological impacts.

Social Support. In addition to the added stress caused by the loss of job security, normalcy in daily life, and that generally brought upon by this pandemic, understanding how the loss of social support has impacted quality of life is also essential. Like levels of stress, social support access varies based on several factors, such as the ability to access technology and form a "bubble" of family or friends who have been able to successfully quarantine for the recommended two-week time period. Generally, however, the loss of social support has come in the form of government-mandated lockdowns and quarantines (Wu et al., 2020) intended to drastically isolate individuals from everyday interactions that would otherwise organically occur outside of the household. Some specific examples of this have taken the form of working from home, canceling large family gatherings, and limiting everyday trips to local businesses. These seemingly small and insignificant social interactions, once taken for granted by many, traditionally add up to form networks of support. Now, as the pandemic continues to rage on, the number of daily interactions in all forms, inconsequential or deeply meaningful, have been severely limited. As a result, people are left to handle the stress of the pandemic with far less social support.

Social support is a crucial factor in chronic illness outcomes. Individuals who receive adequate levels of support in dealing with their illness are better able to cope and

manage their illness (Gallant, 2003). One reason this may be is that social support is critical to handling stress that may arise from not being believed or the potential stigma related to chronic illness. Individuals with less social support anticipate experiencing greater stigma from family, friends, colleagues, and medical providers, which then increases stress and lowers quality of life (Earnshaw et al., 2011). In addition, social support may impact actual health outcomes related to chronic illness. Social support has been shown to decrease levels of fatigue by those experiencing chronic illness (Jason et al., 2010). This is significant, as one of the major symptoms reported by COVID-19 long-haulers is fatigue (Mayo Clinic, 2020), which can greatly interfere with the ability to accomplish basic, everyday tasks. As a result, increasing ways to access and maintain social support during the pandemic can have very real effects on one of the major symptoms lowering the quality of life of COVID-19 long-haulers.

Gender. Women have dealt with an increase in burden as a result of the COVID-19 pandemic. Millions of women considered leaving work to provide childcare (Kashen et al., 2020; Masterson, 2020) and approximately one in three jobs held by women have been labeled “essential” (e.g., hospitality, retail, and health care), which increases the risk of exposure to COVID-19 (Robertson & Gebeloff, 2020). Although COVID-19 has caused the death of more men than women, in the United States, women are more likely to contract the virus (CDC, 2020). Based on previous knowledge of post-viral long-term effects, such as those related to ME/CFS (CDC, 2018), women may be more likely to experience long-lasting effects of COVID-19. Although women are less likely to develop severe complications or die as a result of the disease, women are being exposed at higher rates. As a result, women are more likely to contract COVID-19 and have been more

likely to self-identify as being COVID-19 long-haulers (O'Rourke, 2021; Rubin, 2020; Velasquez-Manoff, 2021).

Along with logistical reasons, such as exposure rates, women may be more susceptible to long-term effects of different illnesses as a result of stress and social support levels. It has been found that women who perceive greater stress and lesser social support have a more difficult time adjusting to their chronic illness (Curtis et al., 2010). The loss of social support is significant because it is connected to several health factors, including reactivity to stress, perceived lower quality of life, and a decreased ability to cope with pain related to illness (Zautra et al., 1999). For women in particular, social support is essential to quality of life, as many women rely on their friends and extended family for support in dealing with stressful situations (Hintikka et al., 2000). For women with chronic illness, it has been demonstrated that the loss of this support can have a direct effect on physical and psychological difficulties associated with their illness (Hintikka et al., 2000; Zautra et al., 1999), which is necessary for understanding the vulnerability women may have to becoming COVID-19 long-haulers.

One group that is clearly experiencing an increase in stress during the COVID-19 pandemic is medical providers. It is difficult to imagine the level of stress felt by medical providers at this time, especially when considering that many choose to isolate away from family in order to prevent transmission of the virus (Weise, 2020). Specifically, nurses, an occupation overwhelmingly composed of women (Schnur, 2020), may be at a unique risk of becoming COVID-19 long-haulers. Because of their occupation, they may be exposed to the virus on a daily basis. In addition, the stress associated with the threat of contracting COVID-19, along with the stress of working in an environment that may not

be safe (due to lack of personal protective equipment, for example), may be associated with illness-related symptoms reported by women experiencing the hallmark symptom of fatigue (Wagner & Jason, 1997).

Race. Although the virus is most detrimental in terms of death to the elderly population and those who have prior comorbidities (CDC, 2020), there have been concerning data showing that Black, Indigenous, and People of Color (BIPOC) have also faced disproportionate rates of death (Golestaneh et al., 2020; Ledur, 2020). Due to several factors ranging from living situations and type of work to a lack of strong community health systems, BIPOC have been more likely to contract COVID-19 and, unfortunately, die from the illness (Marshall, 2020). For BIPOC communities, which have historically faced structural oppression that has resulted in continual discrimination and economic disadvantage, COVID-19 has been devastating and requires immediate amelioration. This is especially vital for limiting the rate of individuals who become COVID-19 long-haulers among this population. In addition, understanding how COVID-19 impacts this population specifically is crucial for providing long-term resources, especially once the pandemic begins to recede.

In addition to the discrimination felt broadly in society, discrimination from the health care system specifically contributes to stress and decreased health outcomes. Disparities in health outcomes among BIPOC are well-documented (Copeland, 2005), with BIPOC experiencing higher rates of maternal death (Holdt Somer et al., 2017), diabetes (Peek et al., 2007), and cancer (Singh & Jemal, 2017), compared to White individuals. These disparities continue to occur during the current pandemic and have directly affected outcomes related to COVID-19 infections in BIPOC in America. The

allostatic load created by this chronic life stress experienced by BIPOC individuals, especially Black Americans, has been connected to increased health disparities, including increased mortality, compared to White Americans (Duru, 2012). Black individuals who experience extreme long-lasting stress, such as that related to PTSD and social inequalities, are more likely than White individuals to develop chronic illnesses such as diabetes (Nobles et al., 2015). This is important given that BIPOC individuals may be at an increased risk of developing COVID-19 as a result of this prolonged stress.

The stress endured by BIPOC communities is undeniably compounded at this time. Dealing with inadequate or non-existent health care systems, the loss of family members (key forms of social support), insecure employment, the threat of losing one's home, and many other stressors compound the stress already faced by BIPOC individuals as a result of historical discrimination. Along with the COVID-19 pandemic, the BIPOC community, especially Black Americans, has been dealing with another pandemic in the form of racism and its various, negative outcomes (Laurencin, 2020). As a result of these factors, the BIPOC community is uniquely susceptible to becoming COVID-19 long-haulers and may be more vulnerable to the long-term hardships associated with the condition—physically, socially, and economically.

Theory: Psychosocial Theory

The connection between chronic stress, social support, and illness has been established. In addition, previous research on chronic illness has revealed that women and racial minorities are more at risk for developing a variety of illnesses, which may include COVID-19, and having poorer long-term outcomes associated with these illnesses. One theory developed to encompass this idea is the psychosocial theory. This theory explains

that chronic social stressors alter susceptibility to illness and can bring about health damaging behaviors, which can include those related to substance use and poor diet (Krieger, 2012).

This framework provides an understanding for how the social environment and demographic variables impact health outcomes. Psychosocial factors have been shown to contribute to psychological well-being, whether or not a person has a chronic illness. But for those who do have a chronic illness, these factors may be especially impactful. For those who report strong social support in terms of having a partner and perceived support, for example, feelings of depression are lowered for those living with a chronic illness (Bisschop, 2004). This theory has also been used in several real-world settings, one of which being the workplace. Psychosocial factors, such as work-related stress as a result of conflicting demands and excessive workload, contribute to the onset of cardiovascular disease through increasing blood pressure (Gilbert-Ouimet, 2014), which demonstrates the link between one's environment, stress level, and illness outcome.

When trying to understand the link between stress, social support, and chronic illness, it is necessary to consider how stress and social support may impact various phases of an illness. Psychosocial theory provides a framework for describing how these factors can impact the onset, severity, and progression of a disease (Cohen, 1988). The interaction of stress and social support is significant, as social support may provide a buffer for stress, which may lessen the biological responses that can influence the course of chronic illness (Cohen, 1988).

Because of the discrimination felt by women and BIPOC in American society generally and the increased health risk of experiencing stress as a result of that

discrimination, especially during the current pandemic, it can be predicted that women and BIPOC are more susceptible to developing long-lasting symptoms of COVID-19. In addition, as many have lost frequent and reliable social support, an increase in stress can be expected, therefore having a negative impact on those experiencing lasting symptoms of COVID-19.

Rationale

There is no previous research related to symptomatology that is analyzed with consideration to gender, race, stress, and social support variables among people experiencing COVID-19. Understanding how these factors influence the experience of COVID-19 in the long-hauler population is essential to addressing the specific needs of this group, which is a group that has been frequently overlooked during this time. In order to properly assist in the well-being of COVID-19 long-haulers—a group that will only continue to grow in number—more needs to be understood in terms of who is most vulnerable to and how stress and social support may impact on-going symptomatology. When this is done, finding effective ways to decrease stress and increase social support in the most vulnerable can be achieved. This will become especially important as the pandemic begins to abate and attention towards those afflicted with long-lasting COVID-19 symptoms starts to dissipate.

The present study seeks to address this gap in the literature by examining the frequency and severity of symptoms experienced by COVID-19 long-haulers, averaged and grouped into domains. The primary symptoms considered will be those reported by participants during the two most recent weeks of their illness. As these participants self-identify as COVID-19 long-haulers, it is necessary to determine how their symptoms are

affecting them after an extended period of time of being ill. In addition, these symptoms will be examined along several key variables critical at this time: gender, race, stress, and social support. When researchers understand how these variables relate to symptom frequency and severity among COVID-19 long-haulers, local and federal governments can direct more resources to those communities and populations most likely to experience long-term impacts of the disease in order to equitably aid in prevention and recovery.

Hypotheses

Hypothesis I

There will be significant differences in COVID-19 symptomatology between participants who identify as being female and participants who identify as male, with participants identifying as female reporting more severe and more frequent COVID-19 symptoms.

Hypothesis II

There will be significant differences in COVID-19 symptomatology between participants who identify as being White and participants who identify as being a racial or ethnic minority, with participants identifying as a minority reporting more severe and more frequent COVID-19 symptoms.

Hypothesis III

Elevated levels of stress and decreased levels of social support will account for a statistically significant prediction of more frequent and more severe COVID-19 symptoms in nine symptom domains.

Hypothesis IV

Elevated levels of stress, decreased levels of social support, identifying as female,

and identifying as an ethnic or racial minority will account for a statistically significant prediction of more frequent and more severe COVID-19 symptoms in nine symptom domains.

Method

Participants

Participants were recruited from an online sample, primarily through the use of social media. The sample was diverse across age, gender, education, and income. Participants were adults over the age of eighteen who self-identified as being a COVID-19 long-hauler with symptoms lasting for longer than two weeks after initial infection. After accounting for significant amounts of missing survey information, a final sample of 299 adults was examined.

Recruitment. The participants for this study were recruited on the basis of experiencing COVID-19 symptoms for longer than the CDC's standard two-week length of illness. Participants were recruited using various online methods, including email and postings on social media outlets, particularly those related to supporting COVID-19 long-haulers. Scripted messages directed participants to REDCap, a secure web application, and all aspects of participation were completed online. Participants provided informed consent and completed several questionnaires. Those who consented to completing the questionnaires reflected on their symptomatology for two time periods: the first time period being the first two weeks of illness with COVID-19 and then, second, within the past week of illness. Participants reflected on the impacts the pandemic has had on their lives in a separate questionnaire. Participants were not compensated for completing the survey.

Materials

DePaul Symptom Questionnaire (DSQ). Participants completed the DePaul Symptom Questionnaire (Jason & Sunnquist, 2018), a 54-item self-report measure of myalgic encephalomyelitis/chronic fatigue syndrome symptomatology. Participants rated the symptoms in terms of frequency during the first two weeks of their illness on a 5-point scale with 0 = "none of the time," 1 = "a little of the time," 2 = "about half the time," 3 = "most of the time," and 4 = "all of the time." In addition, participants were asked to rate the severity of each symptom on a 5-point scale with 0 = "symptom not present," 1 = "mild," 2 = "moderate," 3 = "severe," and 4 = "very severe." The frequency and severity score for each symptom were then multiplied by 25, creating 100-point scales. The 100-point score for both frequency and severity were then averaged, creating a final composite score for each symptom. Jason and Sunnquist (2018) reviewed research on the DSQ and found excellent psychometric properties of both reliability and validity.

In addition, composite scores for various symptom domains were computed by averaging all 100-point scores for the symptoms within each domain. These domains are groupings of the symptoms, including immune system symptoms, neuroendocrine symptoms, pain symptoms, gastro-intestinal symptoms, sleep symptoms, post-exertional malaise symptoms, neurocognitive symptoms, and orthostatic symptoms (see Appendix A for symptoms in each domain).

CDC symptoms. The CDC lists several additional symptoms of COVID-19 on their website (CDC, 2020). These items include dry cough, loss of taste and smell, difficulty breathing, diarrhea, nasal congestion, and loss of hair. As these items are not on the original DSQ, they were added to the survey completed by the COVID-19 long-

hauler sample and participants rated these symptoms on the basis of frequency and severity during the first two weeks and past two weeks of illness. These symptoms were transformed into composite scores in the same way as the original DSQ symptoms. This grouping was its own, additional domain.

Coronavirus Impact Scale. Participants completed the Coronavirus Impact and Pandemic Stress Scale (Stoddard & Kaufman, 2020). The Coronavirus Impact Scale is a 12-item questionnaire assessing various dimensions of daily life, including routines, food access, medical/mental healthcare access, and employment. Respondents rated whether and how much the COVID-19 pandemic has affected and changed daily life on a four-point scale with 0 = "no change," 1 = "mild change," 2 = "moderate change," and 3 = "severe change."

This is a newly developed scale created to meet the unique and pressing concerns of the current pandemic and has therefore not been tested extensively for its reliability and validity. However, the authors found in the summer of 2020 that initial validation performed on four samples suggests that items one through eight are well distributed with acceptable distributions for psychometric analysis. The scale has continued to be widely used during this time and has been registered as part of the NIH OBSSR suite of common instruments (Stoddard & Kaufman, 2020). For this study, the scale in its entirety was not used. Instead, the analyses focused on two survey items: "Access to extended family and social support" and "Experience of stress related to the coronavirus pandemic."

Procedure

Prior to completing the questionnaires, participants completed a consent form, which detailed information about the survey, including the time to complete all parts

(approximately 30 minutes) and who to contact with questions. After consenting, participants then completed the demographics portion, which included questions specific to COVID-19 (e.g., "When did you get sick with COVID-19"). Following the demographics portion, participants completed the DSQ twice: first reflecting on symptoms during the first two weeks of illness with COVID-19, then reflecting on symptoms experienced within the last week of illness. After DSQ completion, participants completed the Coronavirus Impact Scale. Participants finished the survey by completing questions regarding fatigue and medical history.

Results

Participant Characteristics

Participants in this study were 299 adults primarily from the United States of America (approximately 90%). Participants self-reported symptoms of COVID-19 lasting for an extended period of time (average length since symptoms began and survey completion being approximately five months [M = 21.3 weeks, SD = 8.1 weeks]). Participants comprised a diverse sample of race, sex (reported as gender in this study), and socioeconomic status. See Table 1 for demographic information[1].

Demographic Groupings. For the gender variable, female and male were the two categories considered in the analyses, as non-binary did not meet the standard n = 20 participants required for analysis. In a similar way, race was split into two categories, White and BIPOC, in order to achieve a sufficiently sized group comparison to White. Participants were grouped into White if they checked the White box on the survey and only the White box (n = 248). Participants were placed into the BIPOC group if they

[1] The survey allowed participants to select more than one racial category, creating a total number of participants in the race section greater than that in the overall survey.

checked one or more of the following: Hispanic/Latino, Multiracial/Other, Asian/Pacific Islander, American Indian/Alaskan Native, and Black/African American. Participants who checked White and any other racial category box were also placed in the BIPOC group (n = 51).

Table 1. Demographic characteristics

	Participants (N = 299)
Age	M (SD) 45.10 (20.69)
	% (n)
Gender	
Female	81.6 (244)
Male	15.7 (47)
Non-binary	1.7 (5)
Race	
White	90.3 (270)
Hispanic/Latino	7.4 (22)
Multiracial/Other	7.0 (21)
Asian/Pacific Islander	3.3 (10)
American Indian/Alaskan Native	2.3 (7)
Black/African American	1.7 (5)
Highest degree or level of education	
Graduate or professional degree	38.8 (116)
Standard college degree	30.4 (91)
Partial college or specialized training	11.7 (35)
High school or G.E.D.	4.0 (12)
Some or less than high school	1.0 (3)
Missing	14.0 (47)

Preliminary Analyses

All data were analyzed using SPSS version 23.0 (IBM Corp., 2015).

Missing Data. Five hundred and ninety-six participants began the online survey

but a large portion (approximately 49.8%) of these responses contained significant amounts of missing data. Participants with missing data were excluded on the basis of not completing ten percent or more of the DSQ symptomatology questions. The surveys of the remaining 299 participants were examined for response compliance and outliers, which were found to meet qualifications.

Assumptions. Normality was assessed by examining the dependent variables, which in this study were the DSQ symptom domains at time one and time two. Each of the nine domains at each time point were assessed on its mean, standard deviation, skewness, and kurtosis. The analyses revealed that skew was the most pressing concern with the data. One domain was shown to have a significantly high skew greater than 1.0: immune domain at time point two (Skew[*1.25*]). To increase interpretability with comparison to the other domains, the immune domain at time two was not transformed for analyses and considered a limitation of the study.

Hypothesis I

An independent-samples *t*-test was conducted to determine if there were significant differences between COVID-19 symptomatology reported by females and males at each time point. A *t*-test was completed for the mean composite scores for each of the nine symptom domains. To account for multiple *t*-tests being conducted with this sample and to reduce the probability of Type I error, the *p*-value was set at the .01 alpha-level, instead of the traditional .05 level (Mudge et al., 2012).

During the first two weeks of illness, participants identifying as female reported significantly higher symptom frequency and severity in several, but not all, domains (Table 2). Females reported higher severity and frequency of symptoms in the PEM

domain (M = 68.5, SD = 28.9) as compared to males (M = 56.2, SD = 32.1), $t(290)$ = 2.63, $p < .01$. For the immune domain, females (M = 44.1, SD = 23.0) reported higher symptom severity and frequency as compared to males (M = 32.0, SD = 23.0), $t(290)$ = 3.28, $p < .001$. In the neuroendocrine symptom domain, females (M = 39.2, SD = 23.8) again reported higher symptoms frequency and severity as compared to men (M = 26.8, SD = 25.2), $t(290) = 3.35$, $p < .001$. For the orthostatic domain, females (M = 49.0, SD = 25.1) reported higher symptom severity and frequency as compared to males (M = 36.6, SD = 28.0), $t(290) = 3.05$, $p < .01$. Finally, for the CDC domain, females (M = 38.7, SD = 19.2) reported higher symptom severity and frequency as compared to males (M = 29.1, SD = 17.5), $t(290) = 3.15$, $p < .01$.

Table 2. Independent *t*-test for each symptom domain for females and males at time one.

	Female		Male		
	M	*SD*	*M*	*SD*	*t*-score
Sleep	56.7	24.8	46.9	24.3	2.51
PEM	68.5	28.9	56.2	32.1	2.63*
Neurocog	48.5	30.6	39.5	34.1	1.81
Immune	44.1	23.0	32.0	23.0	3.28**
Neuroend	39.2	23.8	26.8	25.2	3.35**
Pain	52.4	31.8	47.5	31.0	0.98
Gastro	34.9	29.4	24.4	27.0	2.29
Ortho	49.0	25.1	36.6	28.0	3.05*
CDC	38.7	19.2	29.1	17.5	3.15*

*$p < .01$. **$p < .001$.

The second set of *t*-tests were conducted for the domains at the second time point, which was the participants past two weeks of illness. At this time point, participants identifying as female reported significantly higher symptom frequency and severity in seven out of the nine domains, as compared to males (Table 3). Females reported higher severity and frequency of symptoms in the PEM domain (M = 61.7, SD = 24.7), as

compared to males (M = 45.3, SD = 32.3), t(290) = 3.94, p = .000. Similarly, females (M = 52.1, SD = 26.9) reported higher severity and frequency of symptoms in the neurocognitive domain, as compared to males (M = 36.0, SD = 29.0), t(290) = 3.72, p = .000. In addition, females (M = 23.7, SD = 20.3) reported higher symptom severity and frequency in the neuroendocrine domain, as compared to males (M = 15.1, SD = 21.0), t(290) = 2.65, p < .01. For the pain domain, females (M = 47.7, SD = 30.1) reported higher symptom severity and frequency, as compared to males (M = 32.8, SD = 32.4), t(290) = 3.05, p < .01. Females (M = 29.8, SD = 25.8) also reported higher severity and frequency of symptoms for the gastro-intestinal domain, as compared to males (M = 16.5, SD = 21.5), t(290) = 3.31, p < .001. For the orthostatic domain, females (M = 37.4, SD = 21.5) again reported higher symptom severity and frequency, as compared to males (M = 27.7, SD = 22.4), t(290) = 2.79, p < .01. Finally, for the CDC domain, females (M = 25.5, SD = 17.9) reported significantly higher symptom severity and frequency, as compared to males (M = 17.3, SD = 15.8), t(290) = 2.94, p < .01.

Table 3. Independent *t*-test for each symptom domain for females and males at time two.

	Female		Male		
	M	*SD*	*M*	*SD*	*t*-score
Sleep	48.4	23.5	40.9	24.9	1.99
PEM	61.7	24.7	45.3	32.3	3.94***
Neurocog	52.1	26.9	36.0	29.0	3.72***
Immune	19.5	18.1	13.3	16.5	2.22
Neuroend	23.7	20.3	15.1	21.0	2.65*
Pain	47.7	30.1	32.8	32.4	3.05*
Gastro	29.8	25.8	16.5	21.5	3.31**
Ortho	37.4	21.5	27.7	22.4	2.79*
CDC	25.5	17.9	17.3	15.8	2.94*

*p < .01. **p < .001. ***p = .000.

Hypothesis II

After the two race groups (White and BIPOC) were established, independent-samples *t*-tests were conducted to determine if there were significant differences between COVID-19 symptomatology reported by White and BIPOC participants at each time point. A *t*-test was completed for the mean composite scores for each of the nine symptom domains. The independent-samples *t*-tests found that, for race, participants identifying as White and BIPOC did not differ significantly in any of the nine symptom domains at time one (first two weeks of illness; Table 4). In addition, the independent-samples *t*-tests found that participants identifying as White and BIPOC did not differ significantly in any of the nine symptom domains at time two (last two weeks of illness; Table 5).

Table 4. Independent *t*-test for each symptom domain for White and BIPOC at time one.

	White		BIPOC		
	M	*SD*	*M*	*SD*	*t*-score
Sleep	54.8	25.2	56.9	24.5	-0.53
PEM	66.9	29.7	64.3	30.2	0.56
Neurocog	45.6	31.0	51.3	33.1	-1.18
Immune	42.2	22.2	43.2	28.3	-0.29
Neuroend	37.1	25.1	37.1	25.1	0.00
Pain	50.9	31.1	54.9	32.7	-0.83
Gastro	33.5	28.3	32.3	31.8	0.28
Ortho	47.3	25.4	47.2	28.7	0.02
CDC	36.9	18.3	38.6	22.5	-0.56

*$p < .01$.

Table 5. Independent *t*-test for each symptom domain for White and BIPOC at time two.

	White		BIPOC		
	M	*SD*	*M*	*SD*	*t*-score
Sleep	47.1	23.4	49.7	27.1	-0.69
PEM	59.5	26.6	58.0	27.7	0.37

Neurocog	49.1	27.6	52.4	29.1	-0.79
Immune	18.4	17.3	21.2	22.0	-1.00
Neuroend	22.5	20.2	22.7	22.5	-0.07
Pain	45.9	30.0	42.3	33.7	0.77
Gastro	27.4	45.5	29.7	25.7	-0.59
Ortho	35.7	21.4	39.0	25.3	-0.95
CDC	24.5	17.3	22.2	19.7	0.85

*$p < .01$.

Hypothesis III

A Pearson product-moment correlation coefficient was conducted to measure the strength of the relationship between stress and social support to discover whether these two variables violated the assumption of multicollinearity. Stress and social support were found to be moderately positively correlated, $r(293) = .31$, $p = .000$. This indicates that these variables violate the assumption. Therefore, separate multiple regression analyses were conducted for stress and social support.

Hypothesis IV

To assess the proportion of variance that is accounted for by stress, social support, gender, and race, multiple linear regression analysis was used. This model allowed for the variance of each variable to be accounted for while keeping the other variables constant. The variables were entered into the model using forced entry of the three primary variables for each set of regression analyses (stress, gender, and race; social support, gender, and race), along with reported symptom domain scores at time one. A fifth variable was entered into each model to account for the time a participant reported first becoming sick with COVID-19 to the time they took the survey. A multiple linear regression analysis was run for each of the symptom domains using this method.

To assess the proportion of variance that is accounted for by stress, gender, and

race on participants symptom domain scores during the last two weeks of illness, these variables were entered into a multiple regression analysis model. Time one domain scores were also entered into the model as a predictor. In addition, to account for participant duration of illness, this variable was entered into the model as well.

A multiple regression analysis was run to determine how time one sleep domain scores, duration of illness, gender, race, and stress predicted symptom scores for the sleep domain at time two (Table 6). Multiple $R^2 = 0.33$, $F(5, 280) = 29.27$, $p = .000$. This model demonstrated prediction of time two symptom scores for the sleep domain from time one scores and stress scores, with an increase in time two sleep domain scores connected to an increase in time one sleep domain score and stress scores. When time one sleep domain score is held constant, time two score $b = 0.45$ and $p = .000$. When stress is held constant, time two sleep domain score $b = 6.80$ and $p = .000$. This indicates that time one sleep domain scores and stress scores account for a significant prediction of time two sleep domain scores, whereas duration of illness, gender, and race do not.

Table 6. Regression analysis summary for stress predicting sleep domain score at time two.

Predictors	B	95% CI	β	*t*	*p*
(Constant)	11.76	[1.44, 22.08]		2.24	.026
T1Sleep	0.45	[.35, .55]	0.46	9.11	.000
Duration	-0.04	[-.33, .24]	-0.01	-0.30	.768
Female	-1.75	[-7.74, 4.24]	-0.03	-0.58	.566
BIPOC	1.72	[-4.31, 7.76]	0.03	0.56	.575
Stress	6.80	[4.15, 9.45]	0.26	5.05	.000

A multiple regression analysis was run to determine how time one PEM domain scores, duration of illness, gender, race, and stress predicted symptom scores for the PEM domain at time two (Table 7). Multiple $R^2 = 0.25$, $F(5, 280) = 20.20$, $p = .000$. This

model demonstrated prediction of time two symptom scores for the PEM domain from time one scores and stress scores, with an increase in time two PEM domain scores connected to an increase in time one PEM domain score and stress scores. When time one PEM domain score is held constant, time two score $b = 0.38$ and $p = .000$. When stress is held constant, time two PEM domain score $b = 5.20$ and $p < .001$. This indicates that time one PEM domain scores and stress scores account for a significant prediction of time two PEM domain scores, whereas duration of illness, gender, and race do not.

Table 7. Regression analysis summary for stress predicting PEM domain score at time two.

Predictors	B	95% CI	β	*t*	*p*
(Constant)	18.20	[5.86, 30.53]		2.90	.004
T1PEM	0.38	[.29, .47]	0.42	8.04	.000
Duration	0.00	[-.34, .34]	0.00	0.01	.995
Female	6.52	[-.53, 13.57]	0.10	1.82	.070
BIPOC	0.46	[-6.63, 7.55]	0.01	0.13	.899
Stress	5.20	[2.14, 8.25]	0.18	3.34	.001

A multiple regression analysis was run to determine how time one neurocognitive domain scores, duration of illness, gender, race, and stress predicted symptom scores for the neurocognitive domain at time two (Table 8). Multiple $R^2 = 0.32$, $F(5, 280) = 26.08$, $p = .000$. This model demonstrated prediction of time two symptom scores for the neurocognitive domain from time one scores, identifying as female, and stress, with an increase in time two neurocognitive domain scores connected to an increase in time one neurocognitive domain score, being female, and stress score. When time one neurocognitive domain score is held constant, time two score $b = 0.40$ and $p = .000$. When considering the female gender, time two neurocognitive domain score $b = 7.78$ and $p = .031$, which indicates that females report a higher change in neurocognitive domain

scores compared to males. When stress is held constant, time two neurocognitive domain score $b = 7.23$ and $p = .000$. This indicates that time one neurocognitive domain scores, the female gender, and stress scores account for a significant prediction of time two neurocognitive domain scores, whereas duration of illness and race do not.

Table 8. Regression analysis summary for stress predicting neurocognitive domain score at time two.

Predictors	B	95% CI	β	*t*	*p*
(Constant)	10.27	[-1.51, 22.04]		1.72	.087
T1Neurocog	0.40	[.31, .48]	0.44	8.77	.000
Duration	0.00	[-.34, .34]	0.00	0.02	.984
Female	7.78	[.73, 14.83]	0.11	2.17	.031
BIPOC	2.12	[-5.01, 9.26]	0.03	0.59	.558
Stress	7.23	[4.18, 10.29]	0.24	4.66	.000

A multiple regression analysis was run to determine how time one immune domain scores, duration of illness, gender, race, and stress predicted symptom scores for the immune domain at time two (Table 9). Multiple $R^2 = 0.30$, $F(5, 280) = 25.40$, $p = .000$. This model demonstrated prediction of time two symptom scores for the immune domain from time one scores, with an increase in time two immune domain scores connected to an increase in time one immune domain score. When time one immune domain score is held constant, time two score $b = 0.42$ and $p = .000$. This indicates that time one immune domain scores account for a significant prediction of time two immune domain scores, whereas duration of illness, gender, race, and stress do not.

Table 9. Regression analysis summary for stress predicting immune domain score at time two.

Predictors	B	95% CI	β	*t*	*p*
(Constant)	1.43	[-6.27, 9.13]		0.33	.715
T1Immune	0.42	[.34, .50]	0.55	10.72	.000
Duration	-0.72	[-.29, .14]	-0.33	-0.65	.517

Female	-0.56	[-5.12, 3.99]	-0.12	-0.24	.809
BIPOC	2.43	[-2.15, 7.02]	0.05	1.04	.297
Stress	0.51	[-1.48, 2.50]	0.03	0.51	.614

A multiple regression analysis was run to determine how time one neuroendocrine domain scores, duration of illness, gender, race, and stress predicted symptom scores for the neuroendocrine domain at time two (Table 10). Multiple $R^2 = 0.36$, $F(5, 280) = 31.54$, $p = .000$. This model demonstrated prediction of time two symptom scores for the neuroendocrine domain from time one scores and stress, with an increase in time two neuroendocrine domain scores connected to an increase in time one neuroendocrine domain score and stress scores. When time one neuroendocrine domain score is held constant, time two score $b = 0.47$ and $p = .000$. When stress is held constant, time two neuroendocrine domain score $b = 2.25$ and $p = .043$. This indicates that time one neuroendocrine domain scores and stress scores account for a significant prediction of time two neuroendocrine domain scores, whereas duration of illness, gender, and race do not.

Table 10. Regression analysis summary for stress predicting neuroendocrine domain score at time two.

Predictors	B	95% CI	β	*t*	*p*
(Constant)	1.98	[-6.29, 10.24]		0.47	.638
T1Neuroend	0.47	[.39, .56]	0.56	11.30	.000
Duration	-0.11	[-.35, .13]	-0.04	-0.90	.370
Female	0.53	[-4.48, 5.54]	0.01	0.21	.836
BIPOC	0.64	[-4.38, 5.65]	0.01	0.25	.803
Stress	2.25	[.07, 4.43]	0.10	2.03	.043

A multiple regression analysis was run to determine how time one pain domain scores, duration of illness, gender, race, and stress predicted symptom scores for the pain domain at time two (Table 11). Multiple $R^2 = 0.36$, $F(5, 280) = 31.06$, $p = .000$. This

model demonstrated prediction of time two symptom scores for the pain domain from time one scores, gender, and stress scores, with an increase in time two pain domain scores connected to an increase in time one pain domain score and stress score, along with being female. When time one pain domain score is held constant, time two score b = 0.53 and p = .000. When the female gender is considered, time two pain domain score b = 8.55 and p = .026. When stress is held constant, time two pain domain score b = 4.29 and p = .000. This indicates that time one pain domain scores, being female, and stress scores account for a significant prediction of time two pain domain scores, whereas duration of illness and race do not.

Table 11. Regression analysis summary for stress predicting pain domain score at time two.

Predictors	B	95% CI	β	*t*	*p*
(Constant)	6.69	[-6.10, 19.49]		1.03	.304
T1Pain	0.53	[.44, .62]	0.54	11.14	.000
Duration	-0.13	[-.49, .23]	-0.03	-0.71	.479
Female	8.55	[1.04, 16.06]	0.11	2.24	.026
BIPOC	-5.62	[-13.24, 2.01]	-0.07	-1.45	.148
Stress	4.29	[1.02, 7.56]	0.13	2.58	.010

A multiple regression analysis was run to determine how time one gastro-intestinal domain scores, duration of illness, gender, race, and stress predicted symptom scores for the gastro-intestinal domain at time two (Table 12). Multiple R^2 = 0.39, F(5, 280) = 35.63, p = .000. This model demonstrated prediction of time two symptom scores for the gastro-intestinal domain from time one scores, with an increase in time two gastro-intestinal domain scores connected to an increase in time one gastro-intestinal domain score. When time one gastro-intestinal domain score is held constant, time two score b = 0.50 and p = .000. This indicates that time one gastro-intestinal domain scores

account for significant prediction of time two gastro-intestinal domain scores, whereas duration of illness, gender, race, and stress do not.

Table 12. Regression analysis summary for stress predicting gastro-intestinal domain score at time two.

Predictors	B	95% CI	β	*t*	*p*
(Constant)	1.98	[-7.92, 11.87]		0.39	.694
T1Gastro	0.50	[.42, .59]	0.58	12.03	.000
Duration	-0.07	[-.36, .22]	-0.02	-0.45	.651
Female	5.64	[-.34, 11.62]	0.09	1.86	.064
BIPOC	3.71	[-2.34, 9.75]	0.06	1.21	.228
Stress	2.48	[-.14, 5.11]	0.09	1.87	.063

A multiple regression analysis was run to determine how time one orthostatic domain scores, duration of illness, gender, race, and stress predicted symptom scores for the orthostatic domain at time two (Table 13). Multiple $R^2 = 0.36$, $F(5, 280) = 31.39$, $p = .000$. This model demonstrated prediction of time two symptom scores for the orthostatic domain from time one scores and stress, with an increase in time two orthostatic domain scores connected to an increase in time one orthostatic domain score and stress scores. When time one orthostatic domain score is held constant, time two score $b = 0.46$ and $p = .000$. When stress is held constant, time two orthostatic domain score $b = 4.08$ and $p = .001$. This indicates that time one orthostatic domain scores and stress scores account for a significant prediction of time two orthostatic domain scores, whereas duration of illness, gender, and race do not.

Table 13. Regression analysis summary for stress predicting orthostatic domain score at time two.

Predictors	B	95% CI	β	*t*	*p*
(Constant)	10.42	[1.22, 19.62]		2.23	.027
T1Ortho	0.46	[.37, .54]	0.53	10.87	.000
Duration	-0.20	[-.46, .06]	-0.07	-2.51	.133

Female	0.05	[-5.39, 5.49]	0.00	0.02	.987
BIPOC	3.11	[-2.36, 8.48]	0.05	1.12	.265
Stress	4.08	[1.72, 6.44]	0.17	3.40	.001

A multiple regression analysis was run to determine how time one CDC domain scores, duration of illness, gender, race, and stress predicted symptom scores for the CDC domain at time two (Table 14). Multiple $R^2 = 0.43$, $F(5, 280) = 32.85$, $p = .000$. This model demonstrated prediction of time two symptom scores for the CDC domain from time one scores and stress scores, with an increase in time two CDC domain scores connected to an increase in time one CDC domain score and stress scores. When time one CDC domain score is held constant, time two score $b = 0.55$ and $p = .000$. When stress is held constant, time two CDC domain score $b = 2.15$ and $p = .021$. This indicates that time one CDC domain scores and stress scores account for a significant prediction of time two CDC domain scores, whereas duration of illness, gender, and race do not.

Table 14. Regression analysis summary for stress predicting CDC domain score at time two.

Predictors	B	95% CI	β	*t*	*p*
(Constant)	2.51	[-4.40, 9.52]		0.72	.475
T1CDC	0.55	[.47, .64]	0.60	12.55	.000
Duration	-0.19	[-.39, .01]	-0.09	-1.92	.056
Female	1.65	[-2.44, 5.74]	0.04	0.79	.428
BIPOC	-3.26	[-7.39, .86]	-0.07	-1.56	.120
Stress	2.15	[.32, 3.98]	0.11	2.32	.021

To assess the degree of variance that is accounted for by social support, gender, and race on time point two symptom domain scores, these variables were entered into a multiple regression analysis model. Time one domain scores were also entered into the model as a predictor. In addition, to account for participant duration of illness, this variable was entered into the model as well.

A multiple regression analysis was run to determine how time one sleep domain scores, duration of illness, gender, race, and social support predicted symptom scores for the sleep domain at time two (Table 15). Multiple $R^2 = 0.31$, $F(5, 279) = 25.36$, $p = .000$. This model demonstrated prediction of time two symptom scores for the sleep domain from time one scores and social support scores, with an increase in time two sleep domain scores connected to an increase in time one sleep domain score and social support scores. When time one sleep domain score is held constant, time two score $b = 0.49$ and $p = .000$. When social support is held constant, time two sleep domain score $b = 4.86$ and $p < .001$. This indicates that time one sleep domain scores and social support scores account for a significant prediction of time two sleep domain scores, whereas duration of illness, gender, and race do not.

Table 15. Regression analysis summary for social support predicting sleep domain score at time two.

Predictors	B	95% CI	β	*t*	*p*
(Constant)	15.85	[5.49, 26.21]		3.01	.003
T1Sleep	0.49	[.39, .59]	0.51	10.01	.000
Duration	-0.11	[-.41, .18]	-0.38	-0.75	.454
Female	-1.65	[-7.80, 4.50]	-0.03	-0.53	.598
BIPOC	2.69	[-3.53, 8.91]	0.04	0.85	.395
Support	4.86	[2.06, 7.66]	0.17	3.41	.001

A multiple regression analysis was run to determine how time one PEM domain scores, duration of illness, gender, race, and social support predicted symptom scores for the PEM domain at time two (Table 16). Multiple $R^2 = 0.24$, $F(5, 279) = 18.05$, $p = .000$. This model demonstrated prediction of time two symptom scores for the PEM domain from time one scores only, with an increase in time two PEM domain scores connected to an increase in time one PEM domain score. When time one PEM domain score is held

constant, time two score $b = 0.40$ and $p = .000$. This indicates that time one PEM domain scores account for a significant prediction of time two sleep domain scores, whereas duration of illness, gender, race, and social support do not.

Table 16. Regression analysis summary for social support predicting PEM domain score at time two.

Predictors	B	95% CI	β	*t*	*p*
(Constant)	22.72	[10.54, 34.89]		3.67	.000
T1PEM	0.40	[.30, .49]	0.44	8.35	.000
Duration	-0.05	[-.39, .29]	-0.02	-0.28	.780
Female	6.91	[-.25, 14.08]	-0.10	1.90	.059
BIPOC	1.14	[-6.09, 8.37]	0.02	0.31	.756
Support	3.06	[-.20, 6.32]	0.10	1.85	.065

A multiple regression analysis was run to determine how time one neurocognitive domain scores, duration of illness, gender, race, and social support predicted symptom scores for the neurocognitive domain at time two (Table 17). Multiple $R^2 = 0.28$, $F(5, 279) = 22.03$, $p = .000$. This model demonstrated prediction of time two symptom scores for the neurocognitive domain from time one scores, identifying as female, and social support scores, with an increase in time two neurocognitive domain scores connected to an increase in time one neurocognitive domain and social support scores, along with being female. When time one neurocognitive domain score is held constant, time two score $b = 0.40$ and $p = .000$. When the female gender is considered, time two neurocognitive domain score $b = 8.51$ and $p = .021$. When social support is held constant, time two neurocognitive domain score $b = 4.91$ and $p = .004$. This indicates that time one neurocognitive domain scores, being female, and social support scores account for a significant prediction of time two neurocognitive domain scores, whereas duration of illness and race do not.

Table 17. Regression analysis summary for social support predicting neurocognitive domain score at time two.

Predictors	B	95% CI	β	*t*	*p*
(Constant)	16.82	[5.32, 28.32]		2.88	.004
T1Neurocog	0.40	[.31, .49]	0.45	8.71	.000
Duration	-0.07	[-.41, .28]	-0.02	-0.38	.706
Female	8.51	[1.30, 15.71]	0.12	2.32	.021
BIPOC	3.03	[-4.30, 10.36]	0.04	0.81	.417
Support	4.91	[1.61, 8.21]	0.15	2.93	.004

A multiple regression analysis was run to determine how time one immune domain scores, duration of illness, gender, race, and social support predicted symptom scores for the immune domain at time two (Table 18). Multiple $R^2 = 0.32$, $F(5, 279) = 26.30$, $p = .000$. This model demonstrated prediction of time two symptom scores for the immune domain from time one scores and social support, with an increase in time two immune domain scores connected to an increase in time one immune domain score and social support scores. When time one immune domain score is held constant, time two score $b = 0.41$ and $p = .000$. When social support is held constant, time two immune domain score $b = 2.13$ and $p = .045$. This indicates that time one immune domain scores and social support scores account for a significant prediction of time two immune domain scores, whereas duration of illness, gender, and race do not.

Table 18. Regression analysis summary for social support predicting immune domain score at time two.

Predictors	B	95% CI	β	*t*	*p*
(Constant)	-0.21	[-7.57, 7.16]		-0.06	.956
T1Immune	0.41	[.34, .49]	0.53	10.53	.000
Duration	-0.08	[-.30, .14]	-0.04	-0.74	.463
Female	-0.88	[-5.42, 3.66]	-0.02	-0.38	.702
BIPOC	2.93	[-1.66, 7.52]	0.06	1.26	.211
Support	2.13	[.05, 4.22]	0.10	2.01	.045

A multiple regression analysis was run to determine how time one neuroendocrine domain scores, duration of illness, gender, race, and social support predicted symptom scores for the neuroendocrine domain at time two (Table 19). Multiple $R^2 = 0.35$, $F(5, 279) = 30.41$, $p = .000$. This model demonstrated prediction of time two symptom scores for the neuroendocrine domain from time one scores only, with an increase in time two neuroendocrine domain scores connected to an increase in time one neuroendocrine domain score. When time one neuroendocrine domain score is held constant, time two score $b = 0.48$ and $p = .000$. This indicates that time one neuroendocrine domain scores account for a significant prediction of time two neuroendocrine domain scores, whereas duration of illness, gender, race, and social support do not.

Table 19. Regression analysis summary for social support predicting neuroendocrine domain score at time two.

Predictors	B	95% CI	β	*t*	*p*
(Constant)	4.44	[-3.55, 12.42]		1.09	.275
T1Neuroend	0.48	[.40, .57]	0.58	11.55	.000
Duration	-0.13	[-.37, .11]	-0.05	-1.07	.288
Female	0.74	[-4.32, 5.79]	0.01	0.29	.774
BIPOC	0.84	[-4.24, 5.92]	0.02	0.33	.745
Support	1.05	[-1.26, 3.37]	0.04	0.90	.371

A multiple regression analysis was run to determine how time one pain domain scores, duration of illness, gender, race, and social support predicted symptom scores for the pain domain at time two (Table 20). Multiple $R^2 = 0.36$, $F(5, 279) = 30.97$, $p = .000$. This model demonstrated prediction of time two symptom scores for the pain domain from time one scores, identifying as female, and social support scores, with an increase in time two pain domain scores connected to an increase in time one pain domain and social support scores, along with being female. When time one pain domain score is held

constant, time two score $b = 0.53$ and $p = .000$. When the female gender is considered, time two pain domain score $b = 8.57$ and $p = .026$. When social support is held constant, time two pain domain score $b = 4.58$ and $p = .010$. This indicates that time one pain domain scores, identifying as female, and social support scores account for a significant prediction of time two pain domain scores, whereas duration of illness and race do not.

Table 20. Regression analysis summary for social support predicting pain domain score at time two.

Predictors	B	95% CI	β	*t*	*p*
(Constant)	8.53	[-3.73, 20.80]		1.37	.172
T1Pain	0.53	[.43, .62]	0.54	11.07	.000
Duration	-0.18	[-.54, .19]	-0.05	-0.96	.338
Female	8.57	[1.05, 16.10]	0.11	2.24	.026
BIPOC	-4.63	[-12.32, 3.05]	-0.06	-1.19	.236
Support	4.58	[1.11, 8.06]	0.13	2.60	.010

A multiple regression analysis was run to determine how time one gastro-intestinal domain scores, duration of illness, gender, race, and social support predicted symptom scores for the gastro-intestinal domain at time two (Table 21). Multiple $R^2 = 0.39$, $F(5, 279) = 35.80$, $p = .000$. This model demonstrated prediction of time two symptom scores for the gastro-intestinal domain from time one scores only, with an increase in time two gastro-intestinal domain scores connected to an increase in time one gastro-intestinal domain score. When time one gastro-intestinal domain score is held constant, time two score $b = 0.51$ and $p = .000$. This indicates that time one gastro-intestinal domain scores account for a significant prediction of time two gastro-intestinal domain scores, whereas duration of illness, gender, race, and social support do not.

Table 21. Regression analysis summary for social support predicting gastro-intestinal domain score at time two.

Predictors	B	95% CI	β	*t*	*p*

(Constant)	2.73	[-6.73, 12.19]		0.57	.570
T1Gastro	0.51	[.43, .59]	0.58	12.15	.000
Duration	-0.90	[-.38, .20]	-0.03	-0.62	.539
Female	5.66	[-.32, 11.63]	0.09	0.09	.064
BIPOC	4.22	[-1.86, 10.29]	0.07	0.07	.173
Support	2.67	[-.10, 5.43]	0.09	0.09	.059

A multiple regression analysis was run to determine how time one orthostatic domain scores, duration of illness, gender, race, and social support predicted symptom scores for the orthostatic domain at time two (Table 22). Multiple $R^2 = 0.35$, $F(5, 279) = 31.45$, $p = .000$. This model demonstrated prediction of time two symptom scores for the orthostatic domain from time one scores and social support scores, with an increase in time two orthostatic domain scores connected to an increase in time one orthostatic domain score and social support scores. When time one orthostatic domain score is held constant, time two score $b = 0.46$ and $p = .000$. When social support is held constant, time two orthostatic domain score $b = 4.37$ and $p = .001$. This indicates that time one orthostatic domain scores and social support scores account for a significant prediction of time two orthostatic domain scores, whereas duration of illness, gender, and race do not.

Table 22. Regression analysis summary for social support predicting orthostatic domain score at time two.

Predictors	B	95% CI	β	*t*	*p*
(Constant)	11.99	[3.16, 20.83]		2.67	.008
T1Ortho	0.46	[.38, .54]	0.54	10.88	.000
Duration	-0.25	[-.51, .02]	-0.09	-1.86	.064
Female	-0.05	[-5.50, 5.40]	0.00	-0.02	.985
BIPOC	4.10	[-1.41, 9.60]	0.07	1.47	.144
Support	4.37	[1.87, 6.87]	0.17	3.44	.001

A multiple regression analysis was run to determine how time one CDC domain scores, duration of illness, gender, race, and social support predicted symptom scores for

the CDC domain at time two (Table 23). Multiple $R^2 = 0.43$, $F(5, 279) = 42.12$, $p = .000$. This model demonstrated prediction of time two symptom scores for the CDC domain from time one scores and duration of illness, with an increase in time two CDC domain scores connected to an increase in time one CDC domain score and a decrease in scores related to duration of illness. When time one CDC domain score is held constant, time two score $b = 0.57$ and $p = .000$. When duration of illness is held constant, time two CDC score $b = -0.21$ and $p < .033$. This indicates that time one CDC domain scores and duration of illness account for a significant prediction of time two CDC domain scores, whereas gender, race, and social support do not.

Table 23. Regression analysis summary for social support predicting CDC domain score at time two.

Predictors	B	95% CI	β	*t*	*p*
(Constant)	4.07	[-2.67, 10.82]		1.19	.236
T1CDC	0.57	[.49, .66]	0.62	13.31	.000
Duration	-0.21	[-.41, -.02]	-0.10	-2.15	.033
Female	1.63	[-2.49, 5.74]	0.04	0.78	.437
BIPOC	-2.94	[-7.10, 1.23]	-0.06	-1.39	.166
Support	1.36	[-.53, 3.25]	0.07	1.42	.157

Discussion

Although the COVID-19 pandemic has had an impact on nearly every person around the world, not everyone has been impacted equally. Understanding the nuances in the experiences of different groups of people allows for a more in-depth analysis of the effects of the pandemic, which will be necessary for repairing the damage left behind. One group that has been uniquely affected by the coronavirus disease is COVID-19 long-haulers, a group that has been struggling with lasting symptoms of the virus (CDC, 2020; WHO, 2020). Because the course of chronic illness can be impacted by an individual's

experience of stress and social support, garnering a deeper understanding of how these psychosocial factors affect COVID-19 long-haulers specifically is critical to this group's recovery process, which this study sought to do. In addition, understanding who is potentially more vulnerable along certain demographic characteristics within this specific population is also valuable for conceptualizing targeted treatment and intervention plans. Overall, this study aimed to achieve a better understanding of which factors may be associated with an increased vulnerability to long-term effects of COVID-19, which can be used to direct resources to these individuals, give credence to their experiences, and inform the effects future viruses may have on these populations.

One finding of this study supports previous research concerning the differences between females and males in the course of their chronic illness. Results from this study supported the hypothesis that females and males report different levels of symptom severity and frequency related to their COVID-19 long-haul illness. Specifically, females reported experiencing significantly higher symptom severity and frequency in several symptom domains at both time points, compared to males. These symptoms domains include those related to sleep, fatigue, immunological concerns, pain, gastro-intestinal concerns, and orthostatic concerns. Overall, females reported experiencing higher symptom severity and frequency in various areas of the body, which demonstrates the multi-system nature of the COVID-19 long-haul illness. This is especially significant for this long-hauler population, as these symptoms endure for extended periods of time and can therefore disrupt several areas of a person's life.

Related to the demonstrated basic differences between females and males, this study also supported the hypothesis that being female is a predictor of increased COVID-

19 symptom severity and frequency. This finding is significant given the psychosocial theory, which indicates that women have different experiences related to their environments, which is associated with experiencing different levels of stress and social support. Given how the pandemic has affected women and men differently, the results of this study are comprehensible. Specifically, females in this study were more likely to report increased symptom frequency and severity for the neurocognitive and pain domains from time one to time two, compared to males. This is significant as these groups of symptoms have been reported frequently by female COVID-19 long-haulers anecdotally (O'Rourke, 2021; Rubin, 2020; Velasquez-Manoff, 2021).

These gender findings are supported by previous chronic illness research, which has also found that identifying as female is associated with an increased likelihood of experiencing long-term post-viral effects as compared to males, especially symptoms related to pain (Curtis et al., 2010; Wagner & Jason, 1997; Zautra et al., 1999). These findings have implications for treatment and intervention plans, which must consider the unique physical and psychological experiences of women. In addition, these findings offer support to the female COVID-19 long-haulers who experienced increased stress and decreased social support as a result of the pandemic, as well as to those who may feel as though their illness has gone unbelieved and has thus been a source of stigma.

Although gender differences were found in this study, race differences were not. Results from this study do not support the hypothesis that participants who identify as White differ in reported symptom severity and frequency compared to BIPOC participants. More specifically, BIPOC participants did not report significantly increased symptom severity and frequency compared to White participants. In addition, identifying

as a BIPOC participant did not predict increased COVID-19 symptomatology severity and frequency at time two in any of the nine symptom domains. These findings do not support the psychosocial theory, which predicts that the impacts of stress related to racial discrimination negatively affect chronic illness outcomes (Cohen, 1988; Duru, 2012; Gilbert-Ouimet, 2014; Nobles et al., 2015). For this sample of long-haulers, race was not a significant contributing factor to COVID-19 illness severity and frequency.

In addition to gender and race, stress and social support have been shown to be associated with the course of chronic illness (Devendorf et al., 2016; Earnshaw et al., 2011; Gallant, 2003; Hatcher et al., 2003). Results from this study support the hypothesis that both stress and social support are significant predictors of several COVID-19 symptom domains. Particularly, the prediction of stress indicates that, for those reporting increased stress related to the pandemic, there is an increased likelihood in reporting symptoms related to sleep issues, fatigue, cognition difficulties, endocrine concerns, pain, orthostatic concerns, and increased experiences of the hallmark symptoms of COVID-19 reported by the CDC. These findings indicate that stress is associated with the overall decreased physical and psychological functioning of COVID-19 long-haulers.

In addition to stress, the prediction of social support indicates that those reporting decreased social support as a result of the pandemic have been more likely to report increased symptom severity and frequency related to sleep, cognition, immune, pain, and orthostatic concerns. These findings signify that those who have reported being better able to rely on their strong systems of social support have also reported less frequent and severe COVID-19 symptomatology, indicating that they have been better able to cope with their COVID-19 long-haul illness and its symptoms. Overall, these findings align

with the psychosocial theory, which states that increased experiences of stress and decreased social support can be significantly related to the course of chronic illness. Improving these psychological factors for COVID-19 long-haulers will be critical to comprehensive treatment and intervention plans.

Limitations

Overall, there were several factors that may have limited the results of this study. Due to convenience sampling, the sample for this study was composed primarily of White, highly educated, high-income women. Although obtaining the perspective of women is critical, especially because of the specific impacts they have faced as a result of the pandemic (CDC, 2020; O'Rourke, 2021; Robertson & Gebeloff, 2020), educated and wealthy women will have had different experiences related to the pandemic than women who face racial discrimination, for example, or those who are less educated and financially stable. More educated women long-haulers, for example, may have had less stress related to their illness and the pandemic generally because they may have been more likely to be able to work from home or take time off from work altogether.

In addition to the bias in gender sampling, this study did not capture an in-depth view of the differences within the BIPOC group. It is clear that the BIPOC population is not one homogenous group and the analyses for this study failed to capture those differences. By placing all Black/African American participants with all Asian/Pacific Islander participants, for example, the contextual differences brought about by society are overlooked. Both of these groups have experienced increased stress during the pandemic; however, their stress has manifested in different forms. In addition, not all participants were from the United States, which may also account for varying experiences. For future

studies, capturing the experiences of diverse populations is critical. One way this can be done is through targeted recruitment. Because this study was conducted during lockdowns and quarantines as an online survey primarily through social media, it was difficult to specifically recruit long-haulers of diverse backgrounds.

One general concern of the survey is that related to recall effects. Participants were asked to recall their symptoms not only within the last two weeks, but all the way back to their first two weeks of illness, which for some participants was several months in the past. Although time point one was controlled for in regression analyses, recall effects still impact participant response. For example, participants who remember their course of illness as progressively worsening may have under-reported symptom severity and frequency in the first two weeks of illness. This issue of recall is especially problematic for the COVID-19 long-hauler population, as commonly reported symptoms are neurocognitive issues related to memory, which were demonstrated in this study, particularly for female participants.

A statistical limitation of this study is the high skew of the illness domain at time point two. The high skew of this domain showed that participants rated these symptoms as not severe and not frequent, which indicates that the symptoms (e.g., high fever; sore throat) were not of major concern for this group during the past two weeks of their illness. This domain was not transformed in order to retain interpretability in relation to the other symptom domains. However, not transforming this domain remained a problem for the *t*-test and regression model, as normality for this domain could not be assumed and thus imposed limitations on the results.

Future Directions

Further comprehension of the long-term effects of COVID-19 on the long-hauler population will be crucial for future research. Although the pandemic is nearing an end with increased vaccination, long-haulers may endure the effects of the coronavirus for years to come. Finding new ways to reach vulnerable groups (e.g., BIPOC, those without health insurance, people of low socioeconomic status) will be especially important as treatment programs emerge for the more privileged in our society (O'Rourke, 2021; Velasquez-Manoff, 2021). Another factor that will provide insight is understanding how the online support groups of COVID-19 long-haulers have benefited as well as potentially hurt (e.g., through the spread of misinformation) this population throughout the pandemic and how this platform can be expanded to more holistically support those with chronic illness.

Overall, this study has demonstrated that COVID-19 long-haulers are afflicted with a wide variety of symptoms. In addition, this study showed that stress and social support are associated with a wide variety of symptoms experienced by this group. Along with stress and social support, gender differences have also been found, demonstrating that women and men report different levels of psychological and physical symptoms caused by COVID-19, which has also been demonstrated in the course of past viral infections (Buchwald et al., 2000; Radusin, 2012; Wilson et al., 2019). In order to move forward, further exploration of the long-term course of illness within this group needs to be evaluated, especially for racial and ethnic minorities in America. In addition, discovering how to increase social support and decrease stress within the COVID-19 long-hauler population may also be critical in their treatment and recovery, for both

physical and psychological reasons. In addition, understanding the long-term effects of COVID-19 may also be critical for increasing awareness of other long-term chronic illnesses, such as ME/CFS. Although the most pressing concerns related to the pandemic will likely start to abate as more people receive COVID-19 vaccinations, the long-term psychosocial, economic, and cultural consequences of the pandemic are unclear, especially for COVID-19 long-haulers.

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Appendix A: DePaul Symptom Questionnaire Symptoms by Domain

Domain	Symptoms (measured on frequency and severity)
Sleep	● Feeling unrefreshed after you wake up in the morning ● Need to nap daily ● Problems falling asleep ● Problems staying asleep ● Waking up early in the morning (e.g. 3am)
Post-exertional malaise (PEM)	● Dead, heavy feeling after starting to exercise ● Next day soreness or fatigue after non-strenuous, everyday activities ● Mentally tired after the slightest effort ● Minimum exercise makes you physically tired ● Physically drained or sick after mild activity ● Muscle weakness
Neurocognitive (Neurocog)	● Problems remembering things ● Difficulty paying attention for a long period of time ● Difficulty finding the right word to say or expressing thoughts ● Difficulty understanding things ● Only able to focus on one thing at a time ● Slowness of thought ● Absent-mindedness or forgetfulness
Immune	● Sore throat ● Tender / Sore lymph nodes ● Fever ● Flu-like symptoms
Neuroendocrine (Neuroend)	● Cold limbs (e.g. arms, legs, hands) ● Feeling chills or shivers ● Feeling hot or cold for no reason ● Feeling like you had a low temperature
Pain	● Pain or aching in your muscles ● Pain / stiffness / tenderness in more than one joint without swelling or redness
Gastro-intestinal (Gastro)	● Bloating ● Abdomen / Stomach pain ● Irritable bowel problems

Orthostatic (Ortho)	● Chest pain ● Feeling unsteady on your feet, like you might fall ● Shortness of breath or trouble catching your breath ● Dizziness or fainting ● Irregular heart beats
CDC	● Dry cough ● Loss of taste and smell ● Difficulty breathing ● Diarrhea ● Congestion or runny nose ● Hair loss