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Pediatric Post-Acute Sequelae of SARS-CoV-2 Infection

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Abstract

Aim: Youth who have not recovered from COVID-19 have been referred to as having Post-Acute Sequelae of SARS-CoV-2 Infection (PASC). The goal of this study was to better understand which symptoms persisted since onset of infection and how these symptoms compare to symptoms experienced by those with myalgic encephalomyelitis/chronic fatigue syndrome (ME/CFS).

Method: A sample of 19 parents who had a child with PASC were recruited using social media to fill out a questionnaire detailing symptoms at two time points. The first time point included their child's current symptoms and the second captured symptoms at initial infection. These participants were compared to a sample of 19 youth with ME/CFS.

Results: Findings indicated significant decreases among several immune, neuroendocrine, pain, post-exertional malaise (PEM), and COVID-19 Centers for Disease Control and Prevention (CDC) domain symptoms from time of acute infection to time of current reporting. Fatigue remained at a high level as did several symptoms within the sleep and PEM domains. Participants with ME/CFS had overall worse symptomatology when compared to participants with PASC, especially in the neurocognitive domain.

Conclusion: Most symptoms of those with PASC decline over time, but several remain at high levels, including fatigue. These findings are helpful in better understanding common symptom presentation profiles for youth with PASC and can be used to more adequately tailor diagnostic criteria and treatment strategies for youth.

Keywords

PASC; Long-Haulers; COVID-19; SARS CoV-2 virus; Public Health Significance; chronic fatigue syndrome; myalgic encephalomyelitis

A review of the literature has found that some individuals will have longer-term fatigue and other symptoms following a viral infection [1]. This certainly is occurring with COVID-19 in which individuals are having prolonged or new, chronic symptoms following initial infection, commonly referred to as Post-Acute Sequelae of SARS-CoV-2 Infection (PASC) [2]. Currently, several case definitions for Post-COVID-19 or PASC have been

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recommended, with length of symptoms ranging from four to twelve weeks post-acute COVID-19, which further complicates universal understanding of illness presentation and prevalence [3]. In one report, the Body Politic COVID-19 support group [4] found after 40 days, 91% of adult respondents had not recovered. In another report, Davis and colleagues [5] found the most common long-term symptoms were fatigue, post-exertional malaise, and cognitive dysfunction. Several publications have documented patients also developing Guillain-Barré [6], Kawasaki disease, and neurological complications [7].

Unfortunately, we know considerably less about COVID-19 among youth. According to the Centers for Disease Control and Prevention [8] accurate prevalence data for COVID-19 in youth is not adequately known due to a number of reasons, such as limited testing, or prioritization of tests for adults or those with underlying medical conditions. Nevertheless, it is very likely rates of COVID-19 in youth have slowly increased since March of 2020 [8]. One review study found prevalence rates for PASC in children and adolescents ranged from 4 to 66% across studies examining, highlighting the potential for large amounts of youth to be impacted by long term symptoms post infection [9]. As youth represent nearly 22% if the population, it is clear that there is a need for more COVID-19 related research with this underrepresented population

There are even fewer studies on long-term sequelae of COVID-19 in youth. In one of the few studies, Abdel-Mannan et al. [10] found new neurological symptoms involving both the central and peripheral nervous systems among 27 youth with COVID-19 pediatric multisystem inflammatory syndrome. In an international study of 38 youth, Lindan et al. [11] found recurring patterns of neuroimaging abnormalities ranging from mild to severe, yet another neuroimaging study of similar scope found only 2 of 42 participants showed acute findings [12]. Clearly, there is a need to better understand the effects of SARS-CoV-2 infection among youth during initial infection and over time.

The current study attempted to determine whether symptoms increase, stay the same, or reduce overtime for youth with PASC to understand more about this medically vulnerable and understudied population. This study explored parents' perceptions of their children's symptoms during the first few weeks of the infection and at the time of survey completion and compared symptomatology to a sample of youth with myalgic encephalomyelitis/ chronic fatigue syndrome (ME/CFS).

Method

PASC sample.

In August of 2020, the authors obtained IRB permission to distribute questionnaires to families where a youth had PASC. The questionnaires were posted on several "long hauler" social media sites and most responses came in from August 2020 to March 2021. Parent participants must have had a child under the age of 18 who had PASC, based on self-reporting of diagnosis, and be able to write and understand English to meet eligibility requirements. Parents completed a symptom questionnaire that captured their child's illness experiences at two time points. The first time point gathered current symptoms (i.e., the week leading up to time of survey completion) and the other time point recounted

experiences from the first two weeks following illness onset. The respondents were not reimbursed for survey completion.

ME/CFS sample.

In November of 2018, IRB permission was obtained to distribute online questionnaires to families who had youth with a diagnosis of ME/CFS. Data was collected from November 2018 to October 2019. The questionnaires were distributed through contacting online support groups and posting on ME/CFS-related social media sites and parents reported on their child's symptomatology. To be eligible, the youth had to have a diagnosis of ME/CFS and the parent had to be able to write and understand English. There were no geographic limitations to be eligible for the study. Due to the online, convenience sample methodology, this study relied on parent-report of ME/CFS diagnosis and did not require official documentation. The respondents were not reimbursed for survey completion.

Measures

The DePaul Symptom Questionnaire.

Participants completed the DePaul Pediatric Symptom Questionnaire (DPSQ) [13], a parent-report measure of ME/CFS symptomatology. Due to similarity in symptoms across PASC and ME/CFS, this survey was used to assess symptomology for youth with both illnesses. Participants with PASC were asked to rate symptoms during the initial two weeks of their illness and at the current time point (i.e., the week leading up to survey completion) and participants with ME/CFS rated symptoms during the past three months. Both the PASC and ME/CFS groups rated the frequencies of each symptom on a 5-point Likert 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. Likewise, both groups of participants rated the severity of each symptom over the time period on a 5-point Likert scale with 0=symptom not present, 1=mild, 2=moderate, 3=severe, and 4=very severe. All frequency and severity scores were averaged to create one composite score per symptom and then standardized to a 100-point scale. These symptoms were then sorted into eight primary symptom domains (i.e., sleep, PEM, fatigue, neurocognitive, immune, neuroendocrine, pain, and orthostatic). Domain composite scores were calculated by averaging the 100-point scores for frequency and severity of each symptom within the domain to create a single 100-point domain composite. Jason and Sunnquist [13] reviewed research on the DPSQ and found excellent psychometric properties.

CDC symptoms.

The CDC lists several key symptoms of acute COVID-19 on their website: https://www.cdc.gov/coronavirus/2019-ncov/downloads/COVID19-symptoms-24x36-en.pdf These items include: dry cough, loss of taste or smell, difficulty breathing, diarrhea, nose congestion, and loss of hair. As these items were not on the DPSQ, they were added to the survey that was completed by the sample with PASC and classified under one additional domain.

The COVID Impact Scale.

All participants with PASC completed the COVID Impact Scale, a 12-item questionnaire developed to assess the impact of the COVID-19 pandemic on children and families [14]. For items 1-11, participants were asked to rate symptoms and overall stress related to the pandemic using a 4-point Likert scale (0=no change, 1=mild, 2=moderate, and 3=severe). For item 12, participants responded to the following short-answer question: “Please tell us about any other ways the coronavirus pandemic has changed your life.” A total score was calculated by adding the sum of items 1-8. The COVID impact scale has demonstrated good reliability and validity (Stoddard & Kaufman, 2020) [14].

Results

The total sample with PASC included 19 youth who were an average of 9.9 (SD = 4.1) years old; 63.2% were female (n = 12) and 36.8% were male (n = 7). The parents’ race was 89.5% White (n = 17), 5.3% Black or African American (n = 1), and 5.3% American Indian or Alaskan Native (n = 1). 26.3% were Latinx (n = 5). The participants had been ill from SARS-CoV-2 for an average of 24.0 (SD = 10.96) weeks.[1]

The total sample with ME/CFS included data on 19 youth who were closely matched for age and gender to the sample with COVID-19. This sample was an average of 12.7 (SD = 2.4) years old; 63.2% were female (n = 12) and 36.8% were male (n = 7). The parents’ race was 94.7% White (n = 18) and 5.3% multiracial (n = 1). 10.5% were Latinx (n = 2) (see Table 1).

Table 2 presents the symptoms for the two time points of COVID-19. Using paired sample t-tests, significant decreases were found among several immune (i.e., sore throat, fever), neuroendocrine (i.e., high temperature), pain (i.e., eye pain, stomach pain), PEM (i.e., feeling drained/sick after mild activity), and CDC domains (i.e., dry cough, loss of taste/smell, nose congestion, overall CDC domain). Table 3 presents change scores for individuals with PASC for each item from time of initial COVID-19 infection to current. It is important to note that for individuals whose symptoms stayed the same over time, most individuals did not report the symptom occurring at either time point. For most symptoms, decreases were found, with the exception of the following symptoms in which a larger proportion of individual reported these symptoms had worsened over time: difficulty falling asleep, dead/heavy feeling after exercise, difficulty remembering things, difficulty finding the right word, trouble with math or numbers, rashes, allergies, muscle twitches, tinnitus, absent-mindedness, chest pain, joint pain, and loss of hair.

When examining symptoms that had scores of 50 or higher at the initial testing (indicating that these symptoms were of moderate severity and occurring for about half the time), these symptoms were mainly in the sleep (i.e., unrefreshing sleep) and post-exertional malaise (PEM) domains (i.e., overall PEM, mentally tired after slightest effort, minimum exercise makes tired, feeling drained/sick after mild activity, soreness after mild activity) but also

[1]Data were not available for 7 youth due to the fact that the survey questionnaire asked about length of time since being diagnosed with COVID-19, and during the early months of the pandemic, testing was not available, so these families did not complete this item. Still, all families indicated that their children were long haulers, and we did not find any differences between those who provided this information versus those that did not.

for fatigue and stomach pain. In terms of symptoms at this moderate threshold, significant decreases over time were found for feeling drained/sick after mild activity and stomach pain. The highest-rated symptom at both time points was fatigue. Table 2 also presents comparisons between the sample with ME/CFS and the sample with PASC at the initial and current time points. Using paired-sample t-tests, participants with ME/CFS demonstrating worse functioning for 'trouble finding the right word' and 'allergies than participants with PASC at the initial time point. At the current time point, participants with ME/CFS demonstrated significantly worse functioning than participants with PASC for the following symptoms: minimum exercise makes tired, feels drained/sick after mild activity, soreness after mild activity, difficulty understanding, loses train of thought, sensitivity to smells, feeling hot/cold, high temperature, low temperature, neuroendocrine domain, and DPSQ total scores At both time points, participants with ME/CFS demonstrated worse functioning than those with PASC at *both* time points for the following symptoms: unrefreshing sleep, difficulty falling asleep, neurocognitive domain, difficulty remembering things, difficulty paying attention, and absent-mindedness.

Participants with PASC reported a mean total score of 19.26 (SD = 4.32) on the COVID Impact Scale. Test-retest reliability was assessed between DPSQ and CDC symptom domains at initial and current time points. Moderate to significant correlations were found among the following domains: fatigue $r(17) = .49$, $p < .05$, PEM $r(17) = .51$, $p < .05$, pain $r(17) = .76$, $p < .01$, neurocognitive $r(17) = .74$, $p < .01$, orthostatic $r(17) = .60$, $p < .01$, and CDC $r(17) = .81$, $p < .01$.

The parent-reported DSQ domain at the initial time point of infection and the COVID Impact Scale total score were moderately correlated for the fatigue domain $r(17) = -.52$, $p < .05$, thus indicating a lack of positive linear relationship between the two. The parent-reported DSQ domains at the current time point and COVID Impact Scale total scores were moderately correlated for the neuroendocrine domain $r(17) = .56$, $p < .05$ and significantly correlated for the immune domain $r(17) = .69$, $p < .01$.

Discussion

The study's main conclusion is that significant decreases occurred over time for participants with PASC in several areas including immune (i.e., sore throat, fever), neuroendocrine (i.e., high temperature), pain (i.e., eye pain, stomach pain), PEM (i.e., feeling drained/sick after mild activity), and CDC domains (i.e., dry cough, loss of taste/smell, nose congestion, overall CDC domain). However, for those symptoms that were scored the highest at the initial time point (i.e., above 50), thus indicating symptoms occurring at least half the time and at moderate or greater severity, only one significantly decreased over time (i.e., feeling drained/sick after mild activity). Therefore, although decreases occurred for most symptoms over time, it should be noted that among the highest rated symptoms (particularly in the sleep and PEM domains), significant decreases only occurred for one symptom. Findings can be used to better understand what may be considered significant symptoms of PASC in youth in diagnostic and treatment context, including symptoms such as difficulty falling asleep, dead/heavy feeling after exercise, difficulty remembering things, difficulty finding

the right word, trouble with math or numbers, rashes, allergies, muscle twitches, tinnitus, absent-mindedness, chest pain, joint pain, and loss of hair based on the current study.

The findings reported suggest that although decreases are found in many symptoms over time for COVID-19, fatigue remains at a relatively high level as do several symptoms within the sleep and PEM domains. These findings are somewhat different from adult studies, including findings from the Body Politic COVID-19 support group (2020), where cognitive problems were the most serious. Additionally, this study found primary differences between ME/CFS and PASC symptomatology occurred in the neurocognitive domain at both time points and in the immune and neuroendocrine domains at the current time point for PASC, with participants with ME/CFS indicating worse functioning across most symptoms. These significant differences in the neurocognitive domain, with participants with ME/CFS indicating worse functioning, are similar to findings by Jason and colleagues (2021) that compared adults with COVID-19 and adults with ME/CFS. It is notable that participants in the current study demonstrated a pattern similar to other viral or pathogenic outbreaks precipitating the onset of ME/CFS; despite virus-specific acute symptom displays, these patients later developed symptom profiles mirroring those of ME/CFS (e.g., PEM, sleep difficulties, fatigue, etc. in the current study). Recently, Komaroff and Linden [15] proposed that the pathogenesis of post-COVID-19 syndrome is similar to that of ME/CFS. These patterns emphasize the need to explore post-viral sequelae of COVID-19 in pediatric populations of a larger sample size to determine if similar symptom trajectories occur.

Regarding the ME/CFS sample, findings are largely consistent with prior symptom profiles identified through both pediatric case definition recommendations and a recent community-based study of ME/CFS in youth [16–17]. Trends within these studies indicate largest impairment within the domains of fatigue, post-exertional malaise, and sleep [17]. These findings indicate consistency in common symptoms of ME/CFS in youth regardless of study methodology (i.e., convenience sample versus community-based sample).

Our study's findings have limitations in that they are parent estimates and not responses from the youth. Further methodologic weaknesses include small sample size, limited racial/ethnic diversity, and somewhat short follow up. Although this is a preliminary study with a small sample, it is possible that given the number of comparisons, some occurred due to chance. More research with larger, diverse samples and with a longer follow-up time is needed. Further, there is chance for recall bias within this study, as parents were reporting on two distinct time points and current symptom severity may have influenced reporting on initial symptoms. In future studies with larger, more diverse samples, a comparison group of individuals with ME/CFS who are diagnosed through physician review would be beneficial, as the current study relied on participant report of diagnosis. Additionally, this study had missing data for illness duration for a subset of participants with PASC due to participants not receiving an official diagnosis of COVID. Future research should more accurately capture illness duration from both date of onset of initial symptoms and from official COVID-19 diagnosis in order to better understand how length of illness may impact severity of symptomatology.

Since launching this investigation, our group has been contacted by several families with youth who are affected with PASC. In our conversations with them, many parents mentioned the precipitous decline in formerly well-functioning youth was extremely upsetting and disruptive to their children both academically and socially. Parents reported considerable difficulties with finding knowledgeable health care professionals that were able to help them deal with the prolonged and disruptive symptoms their children experienced. Based on feedback and concerns voiced by the community as well as data from the current study indicating persistent symptoms across multiple domains, our group is now launching a qualitative study to better assess the effects of PASC on youth.

Pediatric populations represent just one of many underrepresented groups. It is clear COVID-19 can have long term impacts on functioning for youth, based on findings from this study and conversations with families within the community. Future research should aim to include larger, more diverse sample sizes to fully realize the effects of PASC on the greater community. One Chicago-based study revealed a number of racial and social risk factors that precipitated higher rates of COVID-19 [18], while others highlight long-standing health disparities that have exacerbated the impact of COVID-19 on marginalized populations [19]. Researchers are encouraged to form community-based partnerships with existing organizations or outreach programs to better understand the needs of those who have been affected by COVID-19 and lack proper access to care.

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Table 1.

Demographic information for pediatric participants with PASC and ME/CFS

Demographic	PASC (*N* = 19)	ME/CFS (*N* = 19)
	M (SD)	
Age (years)	09.89 (04.15)	12.74 (02.38)
	Range	
	7 – 17	9 - 17
Illness Duration (weeks) [1]	**M (SD)**	
	24.00 (10.96)	128.00 (116.46)
	Range	
	9 - 54	44 - 400
	% (*n*)	
Gender		
Male	36.80 (07)	36.80 (07)
Female	63.20 (12)	63.20 (12)
Parent Race		
White/Caucasian	89.5 (17)	94.70 (18)
American Indian or Alaskan Native	05.30 (01)	00.00 (00)
Black/African American	05.30 (01)	00.00 (00)
Multiracial	00.00 (00)	05.26 (01)
Latino or Hispanic Origin	26.30 (05)	10.50 (02)

Notes:

[1] *N* = 12 for each group due to missing data

Table 2.

DPSQ scores for parents reporting on pediatric participants with PASC during initial and current phases alongside participants with ME/CFS

Domain/Symptom	PASC (*N* = 19)		ME/CFS (*N* = 19)
	Initial	Current	
	M (*SD*)	*M* (*SD*)	*M* (*SD*)
Sleep	41.71 (23.81)	40.00 (28.43)	56.58 (21.88)
Unrefreshing Sleep	55.92 (27.75)	53.29 (36.52)	76.32 (20.37)[ab]
Needing to Nap	41.45 (33.86)	32.89 (33.65)	35.53 (39.15)
Difficulty Falling Asleep	45.39 (35.65)	51.32 (37.01)	76.97 (26.77)[ab]
Difficulty Staying Asleep	39.47 (33.14)	37.50 (35.60)	52.63 (35.98)
Waking up Early	26.32 (33.82)	25.00 (32.54)	41.45 (30.63)
PEM	55.26 (33.79)	46.71 (33.97)	65.92 (23.62)
Heavy Feeling	47.37 (39.66)	51.32 (40.37)	60.53 (34.17)
Mental Fatigue	52.63 (36.22)	46.71 (35.32)	63.16 (28.71)
Minimum Exercise	63.16 (32.40)	52.63 (34.51)	75.00 (22.82)[b]
Feeling Drained	**61.84 (36.20)**	**41.45 (36.57)**	65.79 (29.12)[b]
Soreness	51.32 (36.30)	41.45 (37.51)	65.13 (26.54)[b]
Fatigue	68.42 (27.12)	59.87 (32.43)	73.03 (21.76)
Neurocognitive	23.98 (25.74)	23.30 (24.66)	43.15 (22.93)[ab]
Difficulty Remembering	17.76 (27.42)	20.39 (29.82)	47.37 (24.85)[ab]
Difficulty Paying Attention	37.50 (30.05)	30.26 (27.74)	59.21 (29.71)[ab]
Trouble Forming Words	18.42 (28.68)	21.05 (30.63)	38.16 (25.16)[a]
Difficulty Understanding	22.37 (23.41)	19.08 (22.19)	39.58 (28.84)[b]
Difficulty Focusing	32.89 (29.82)	28.29 (31.96)	42.76 (32.36)
Slowness of Thought	26.97 (36.39)	26.32 (31.70)	42.11 (28.32)
Absent Mindedness	19.08 (29.86)	23.68 (24.61)	45.39 (26.42)[ab]
Loss of Train of Thought	15.79 (28.82)	13.82 (20.79)	32.89 (28.02)[b]
Trouble with Math/Numbers	22.92 (33.00)	25.69 (30.76)	40.13 (30.78)
Immune	22.59 (17.42)	17.11 (18.71)	24.89 (17.31)
Sore Throat	**37.50 (34.61)**	**23.68 (30.30)**	30.26 (23.69)
Lymph Nodes	22.37 (32.96)	15.79 (25.29)	20.39 (25.42)
Fever	**44.08 (31.83)**	**19.74 (20.55)**	25.00 (22.44)[a]
Sensitivity to Smells	18.42 (30.15)	09.87 (20.66)	32.24 (23.69)[b]
Rash	06.58 (10.51)	21.05 (32.56)	16.45 (26.37)
Allergies	06.58 (20.14)	12.50 (22.82)	25.00 (30.33)[a]
Neuroendocrine	30.08 (21.76)	20.02 (18.27)	35.15 (19.04)[b]
Chills	31.58 (36.65)	18.42 (27.75)	34.21 (24.59)

Domain/Symptom	PASC (*N* = 19)		ME/CFS (*N* = 19)
	Initial	Current	
	M (*SD*)	*M* (*SD*)	*M* (*SD*)
Feeling hot/cold	38.82 (35.57)	29.61 (31.24)	51.97 (19.21)[b]
Night Sweats	25.66 (34.23)	18.42 (30.15)	30.26 (29.56)
Sweating Hands	12.50 (27.00)	11.18 (22.40)	27.63 (30.21)
Loss of Appetite	39.47 (30.69)	30.26 (32.63)	33.55 (22.07)
Low Temperature	16.45 (26.70)	13.16 (21.44)	28.29 (22.38)[b]
High Temperature	**46.05 (37.51)**	**19.08 (20.99)**	40.13 (29.04)[b]
Pain	31.16 (20.25)	26.20 (22.85)	35.53 (17.21)
Muscle Pain	45.39 (31.24)	43.42 (30.72)	58.55 (27.34)
Headaches	49.34 (32.93)	38.16 (26.18)	48.68 (28.84)
Eye Pain	**23.03 (31.25)**	**15.13 (27.19)**	28.29 (27.27)
Joint Pain	32.89 (39.79)	34.87 (40.31)	44.74 (34.44)
Stomach Pain	**50.66 (32.67)**	**32.89 (35.41)**	51.32 (31.43)
Chest Pain	21.71 (32.77)	22.37 (33.48)	34.87 (27.82)
Twitching	09.21 (24.24)	12.50 (20.83)	19.74 (28.66)
Upset Stomach	48.03 (30.97)	37.50 (34.86)	36.84 (21.44)
Tinnitus	07.89 (23.65)	10.53 (26.77)	17.76 (23.69)
Nausea	43.42 (34.70)	33.55 (36.10)	40.79 (25.29)
Vomiting	11.18 (25.99)	07.24 (15.20)	09.21 (17.10)
Orthostatic	29.61 (31.64)	22.24 (25.01)	30.59 (22.54)
Feeling Unsteady	26.97 (35.91)	23.68 (33.57)	32.89 (32.33)
Shortness of Breath	29.61 (39.13)	21.05 (31.75)	35.53 (25.77)
Dizziness	34.87 (35.74)	23.03 (33.40)	31.58 (24.07)
Irregular heartbeat	26.32 (30.30)	22.37 (27.82)	27.08 (27.54)
Weight Change	30.26 (38.49)	21.05 (34.62)	25.66 (31.03)
CDC	**21.62 (21.44)**	**10.50 (12.92)**	-
Dry Cough	**29.61 (38.24)**	**07.89 (23.65)**	-
Loss of Taste/Smell	**17.11 (31.24)**	**01.32 (05.74)**	-
Difficulty Breathing	22.37 (35.00)	13.82 (19.50)	-
Diarrhea	33.55 (36.57)	26.32 (35.08)	-
Nose Congestion	**25.66 (23.38)**	**12.50 (25.34)**	-
Loss of Hair	05.92 (20.57)	09.21 (16.05)	-
DSQ Total Scores	37.85 (20.04)	31.93 (20.44)	45.60 (14.49)[b]

Notes:

Bold numbers indicate significant differences between the two time points for participants with PASC.

[a] Significant differences between PASC and ME/CFS at initial stage.

[b] Significant differences between PASC and ME/CFS at current stage.

$p < .05$.

Table 3.

DPSQ change scores for parents reporting on pediatric participants with PASC during initial and current phases ($N = 19$)

Domain/Symptom	Change Score	Individuals whose symptoms improved over time	Individuals whose symptoms worsened over time	Individuals whose symptoms stayed the same over time
	M (*SD*)	*n*	*n*	*n*
Sleep	1.71 (28.47)	10	8	1
Unrefreshing Sleep	2.63 (30.21)	7	6	6
Needing to Nap	8.55 (22.07)	9	2	8
Difficulty Falling Asleep	−5.92 (36.17)	6	8	5
Difficulty Staying Asleep	1.97 (42.75)	8	8	3
Waking up Early	1.32 (45.81)	8	5	6
PEM	8.55 (33.59)	12	5	2
Heavy Feeling	−3.95 (32.29)	6	5	8
Mental Fatigue	5.92 (34.95)	8	4	7
Minimum Exercise	10.52 (33.40)	10	3	6
Feeling Drained	20.39 (39.35)	11	2	6
Soreness	9.87 (42.20)	10	4	5
Fatigue	8.55 (30.35)	10	4	5
Neurocognitive	0.68 (18.28)	9	7	3
Difficulty Remembering	−2.63 (20.23)	4	5	10
Difficulty Paying Attention	7.24 (27.10)	9	5	5
Trouble Forming Words	−2.63 (24.50)	6	6	7
Difficulty Understanding	3.29 (19.02)	6	2	11
Difficulty Focusing	4.61 (30.11)	8	2	9
Slowness of Thought	0.66 (22.23)	5	4	10
Absent Mindedness	−4.61 (22.13)	4	6	9
Loss of Train of Thought	1.97 (22.54)	4	4	11
Trouble with Math/Numbers[2]	−2.78 (25.92)	5	6	7
Immune	5.48 (20.71)	12	5	2
Sore Throat	13.82 (26.32)	10	4	5
Lymph Nodes	6.58 (26.47)	5	3	11
Fever	24.34 (31.03)	10	1	5
Sensitivity to Smells	8.55 (30.92)	5	2	12
Rash	−14.47 (33.92)	2	5	12
Allergies	−5.92 (26.14)	2	4	13
Neuroendocrine	10.06 (21.38)	12	5	2
Chills	13.16 (33.20)	8	2	9
Feeling hot/cold	9.21 (30.86)	6	5	8
Night Sweats	7.24 (46.64)	8	5	6
Sweating Hands	1.32 (21.61)	3	3	13

Domain/Symptom	Change Score	Individuals whose symptoms improved over time	Individuals whose symptoms worsened over time	Individuals whose symptoms stayed the same over time
	M (*SD*)	*n*	*n*	*n*
Loss of Appetite	9.21 (42.66)	8	4	7
Low Temperature	3.29 (17.60)	4	3	12
High Temperature	26.97 (35.91)	12	3	4
Pain	4.96 (15.26)	14	4	1
Muscle Pain	1.97 (35.66)	8	5	6
Headaches	11.18 (25.99)	10	2	6
Eye Pain	7.89 (16.25)	7	2	10
Joint Pain	−1.97 (30.97)	4	4	11
Stomach Pain	17.76 (27.42)	11	2	6
Chest Pain	−0.66 (32.13)	6	3	10
Twitching	−3.29 (19.02)	2	5	12
Upset Stomach	10.53 (26.77)	9	5	5
Tinnitus	−2.63 (14.18)	1	2	16
Nausea	9.87 (24.14)	9	2	8
Vomiting	3.95 (29.48)	4	3	12
Orthostatic	7.37 (26.13)	11	6	2
Feeling Unsteady	3.29 (28.52)	5	4	10
Shortness of Breath	8.55 (35.37)	6	3	10
Dizziness	11.84 (35.96)	9	3	7
Irregular heartbeat	3.95 (30.35)	5	4	10
Weight Change	9.21 (37.69)	8	3	8
CDC	11.12 (13.41)			
Dry Cough	21.71 (34.57)	9	1	9
Loss of Taste/Smell	15.79 (29.12)	6	0	13
Difficulty Breathing	8.55 (32.82)	5	3	11
Diarrhea	7.24 (22.17)	8	2	9
Nose Congestion	13.16 (18.39)	10	1	8
Loss of Hair	−3.29 (15.50)	1	4	14
DSQ Total Scores	5.92 (18.93)	15	4	0

Notes:

[1] Higher DPSQ scores indicate worse functioning

[2] Missing data for one participant