CLINICAL RESEARCH STUDY

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A Cross-Sectional Study of Symptom Prevalence, Frequency, Severity, and Impact of Long-COVID in Scotland: Part I

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ABSTRACT

BACKGROUND: Commonly reported symptoms of long COVID may have different patterns of prevalence and presentation across different countries. While some limited data have been reported for the United Kingdom, national specificity for Scotland is less clear. We present a cross-sectional survey to examine the symptom prevalence, frequency, and severity of long COVID for people living with the condition in Scotland.

METHODS: An online survey was created in the English language and was available between April 21, 2022 and August 5, 2022. Participants were included if they were ≥18 years old, living in Scotland, and had self-diagnosed or confirmed long COVID; and excluded if they were hospitalized during their initial infection. Within this article we quantify symptom prevalence, frequency, severity, and duration.

RESULTS: Participants (n = 253) reported the most prevalent long-COVID symptoms to be post-exertional malaise (95%), fatigue/tiredness (85%), and cognitive impairment (68%). Fatigue/tiredness, problems with activities of daily living (ADL), and general pain were most frequently occurring, while sleep difficulties, problems with ADL, and nausea were the most severe. Scottish Index of Multiple Deprivation associated with symptom number, severity, and frequency, whereas vaccine status, age, sex, and smoking status had limited or no association.

CONCLUSIONS: These findings outline the challenges faced for those living with long COVID and highlight the need for longitudinal research to ascertain a better understanding of the condition and its longer-term societal impact.

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INTRODUCTION

Long COVID has been defined as symptoms that develop or continue weeks or months after acute SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2) infection, and that persist for more than 12 weeks without an alternative explanation.[1] It is part of a group of conditions known as post-acute infection syndromes (PAISs), characterized by a failure to recover from an infectious agent, including bacteria, viruses, and parasites. As a result, these conditions often cause commonly overlapping symptoms such as poor functional status, exertion intolerance, debilitating fatigue, and sleep quality disturbances.[2] With the sheer scale of the COVID-19 pandemic since its first detection in December 2019, long COVID has been recognized as having a significant impact for the global population not previously noticed in other PAISs.[2]

CLINICAL SIGNIFICANCE

- The most prevalent long-COVID symptoms in Scotland are post-exertional malaise, fatigue, cognitive impairment, breathlessness, headache, and sleep difficulties.
- Sleep difficulties, problems with activities of daily living, nausea, and post-exertional malaise were reported as most severe.
- Those living in more deprived areas were likely to report a greater number of symptoms, severity, and frequency of some symptoms.
- Vaccine status, age, sex, and smoking status had limited or no effect on symptoms.

The most commonly reported symptoms of long COVID are fatigue, shortness of breath, and cognitive impairment, or 'brain fog'.[3] However, there are more than 100 different symptoms that have so far been reported in the literature, with heterogeneity in reported symptom prevalence within different geographical locations.[3] For example, at 60 days post-infection, fatigue and dyspnea have been reported to have a prevalence of 87% and 71%, respectively, across the Netherlands and Belgium;[4] 55% and 45%, respectively, in New Jersey;[5] and 53% and 43%, respectively, in Italy.[6] While research has been conducted to establish symptom prevalence across the whole of the United Kingdom,[7] there remains limited understanding of the nature and consequences of long COVID for specific geographical regions and countries, including Scotland. Scotland has some of the worst health inequalities in western and central Europe,[8] and has the highest incidence of alcohol- and drug-related deaths,[9] prevalence of cardiovascular disease, stroke, cancer,[10] and multiple sclerosis,[11] compared with other UK nations. Higher prevalence of health problems within the nation of Scotland may influence symptom data, and therefore, it is important to characterize long COVID specific to this nation.

At the time of writing, the Office for National Statistics in the United Kingdom has estimated that around 1.9 million people in the United Kingdom are living with long COVID, of which 172,000 reside in Scotland.[12] The result of this is over 3% of the estimated Scottish population[13] living with additional health needs. Within this paper we map out the prevalence, frequency, and severity of long-COVID symptoms experienced by those living in this UK nation.

METHODS

Study Design

This cross-sectional observational study was funded through the Chief Scientist Office funding call for Scottish-led research on long-term effects of COVID-19 infection (COV/LTE/20/08). All respondents gave digital informed consent prior to participating in an online survey consisting of questions about their experience of long COVID. Survey responses contained no personally identifiable information. Ethical approval was granted by the School of Health and Life Sciences Ethics Committee at the University of the West of Scotland ethical review committee (ethics number 14019).

An online survey was created in the English language and embedded to our project-specific website: UWS Long Covid (uws-projects.co.uk). Survey questions were curated based on symptoms in our previously reported scoping review of the literature[3] and the impact of these symptoms. Included were questions about participant demographics, symptom prevalence, frequency, severity, and duration, and impact of long COVID on work, study, and caring duties, as well as ratings of current emotional well-being. To ensure understanding, questions containing medical jargon where accompanied with a description in plain language.

The survey was launched on April 21, 2022 and advertised directly to relevant patient support groups and on social media platforms, Twitter, and Facebook. Data used in this study were collected from April 21 through August 5, 2022.

Participant Demographics and Study Population

Respondents reported their age, sex, ethnicity, vaccination status, underlying health conditions, smoking status, type of home, marriage status, household income, and postal code. Scottish Index of Multiple Deprivation (SIMD) was determined by postal code using the website: https://simd.scot/#/simd2020/BTTTFTT/9/-4.0000/55.9000/. From this, 5 categories were created, with quintile 1 representing the most deprived areas (low SIMD) to quintile 5, representing the least deprived areas (high SIMD).

Participants were included if they were ≥18 years old, living in Scotland (determined by their postal code), and had either self-diagnosed or confirmed long COVID, regardless of presence of SARS-Cov-2 testing at the time of initial suspected infection. Individuals were excluded from

participation if they were hospitalized during their initial infection. Analysis was limited to respondents with illness lasting at least 4 weeks and symptom onset from December 2019 onward.

Study Outcomes

This study quantified symptom prevalence, frequency, severity, duration, and ratings of current emotional well-being. Data on the impact of long COVID on work, study, and caring duties were also collected and are reported in Part 2.[14]

Symptom Number and Prevalence

Thirty-six symptoms[3] were investigated by identifying their presence or absence at the current time of survey completion. For each respondent, a total number of symptoms reported was calculating a mean ± SD to the nearest whole number. Additionally, prevalence was calculated for each symptom by dividing the number of those who reported experiencing the symptom by the total number of survey respondents.

Symptom Frequency and Severity

Respondents rated the frequency (more than once per day, every day, every week, more than once per week) and severity (mild, moderate, severe, very severe) for each of the symptoms experienced. Frequency and severity responses were reported as percentages of the total number of those experiencing the symptom of interest.

Duration and Improvement Rating of Long COVID

The duration of long COVID was calculated based on the reported date of starting to experience long COVID to the date the survey was completed. Participants were asked to grade whether they were still experiencing the worst symptoms of long COVID at the time of survey completion or whether they have had some level of recovery. For those who answered that they had now seen a recovery, they were asked to grade the level of recovery on a 10-point Likert scale.

Statistical Analysis

Data were analyzed using Jamovi version 2.3.12 (The jamovi project [2023], jamovi [Version 2.3]; retrieved from https://www.jamovi.org) and GraphPad Prism version 9 (GraphPad Software, Boston, Mass). Shapiro-Wilks tests were performed to determine normality of data distribution. All data were determined to be normally distributed. *t* Tests and analyses of variance (ANOVAs) were performed to determine between-group differences for sex and smoking status. Correlation coefficients were determined using Spearman rho, Mann-Whitney *U*, and Kruskal-Wallis tests to determine associations of long-COVID symptoms with demographics, including vaccination status, SIMD, and age. All statistical tests where $P \leq .05$ have been reported; tests where $P > .05$ have been reported where this information is pertinent. Data are presented as mean ± standard deviation.

RESULTS

Between April 2022 and August 2022, a total of 253 respondents with a median illness duration of 25.6 ± 15.6 months completed the survey. Of all respondents, 55.9% answered "Yes" to being tested at the time of infection; 77.2% of respondents were female, 21.1% male, 0.4% non-binary, and 1.3% preferred not to say. Details of participant demographics can be found in the Table.

Number of Symptoms

Mean combined number of symptoms reported was 13 ± 7. The number of symptoms reported was not different between males (12.65 ± 6.66) and females (13.04 ± 6.52) ($P = .71$). ANOVA showed that respondents from the highest SIMD areas (lowest quintile) were more likely to report a higher number of symptoms (average reported symptom number: 15.81 ± 4.97, 13.73 ± 7.10, 10.9 ± 6.61, 10.93 ± 4.92, 11.82 ± 6.77 for SIMD 1, 2, 3, 4, 5, respectively, $P = .031$ for SIMD group 1 vs SIMD group 4; all other pairwise comparisons were nonsignificant, $P > .05$). ANOVAs also revealed that a greater number of symptoms were reported by smokers vs nonsmokers (20.25 ± 6.85 vs 11.75 ± 6.43; $P = .028$) and smokers vs those who used to smoke (20.25 ± 6.85 vs 11.97 ± 6.69; $P = .044$). Independent *t* tests showed a greater number of symptoms reported in those with existing conditions vs those without existing conditions (14.9 ± 6.27 vs 12.08 ± 6.43; $P = .002$). Pearson's correlation revealed that the duration of long COVID was associated with fewer number of symptoms reported ($r = -0.1865$, $P = .003$). Pearson's correlation analyses showed that age did not correlate with number of symptoms reported ($P = .26$). ANOVA revealed no difference between vaccination status and symptom number ($P = .64$).

Symptom Prevalence

The most prevalent symptoms were post-exertional malaise (PEM; 95.26%, n = 239), fatigue/tiredness (84.58%, n = 212), and cognitive impairment (68.38%; n = 172 Figure 1). PEM was defined as being disproportionately tired after small amounts of activity. For those reporting PEM, 8.9 ± 18.5 hours was the average reported recovery duration after being active, with 16.7% (n = 40) meeting the myalgic encephalomyelitis/chronic fatigue syndrome (ME/CFS) PEM criteria of ≥14 hours recovery duration.[15] Chi-squared analysis revealed that PEM prevalence was similar in females vs males (94.57% vs 95.32%, $P = .723$). The prevalence of general fatigue/tiredness (ie, unrelated to any preceding activity) was higher in females vs males

Table Participant Demographics

	Combined	Males	Females
Ethnicity (%)			
White British	90.4	95	90.8
White Irish	2.2		2.4
Any other white background	5.2	5	3.6
Chinese	0.4		1.3
Asian/British Asian — Indian	0.4		1.3
Asian/British Asian — Pakistani	0.4		0.6
Mixed — white and black	0.4		
African	0.4		
Other	0.4		
Age (years; mean ± SD; range)	47.4 ± 11.3 (22-72)	47.9 ± 8.9 (35-70)	46.2 ± 11.4 (22-72)
BMI (kg/m^2; mean ± SD)	29.7 ± 17.4	27.7 ± 4.5	29.9 ± 10.4
Smoking status (%)			
Nonsmoker	78.3	65	85.3
Smoker	1.8	5	1.3
Former smoker	19.9	30	13.3
Average household income (£; mean ± SD)	46,919 ± 27,303	44,310 ± 25,434	45,091 ± 26,555
Previous diagnosis of physical or mental health condition (%)	27.4	21.7	29
Living with number of adults (%)			
0 adults	3.2	2.2	4.2
1 adult	21.7	19.57	20.66
2 adults	60.5	69.57	57.75
3 adults	8.3	4.35	7.51
4 adults	5.5	4.35	7.51
5 adults	0.8	0	0.47
Type of home (%)			
Semi-detached	62.1	52.17	62.44
Detached	16.5	15.22	14.08
Flat	16.5	21.74	13.15
Terraced house	4.5	8.70	3.76
Marriage status (%)			
Living together but not married or in a civil partnership	13.8	6.5	15
Married	93.1	95.6	91.1
Single (never married or never registered a same-sex civil partnership)	19.0	15.2	21.1
Widowed or surviving partner from same-sex civil partnership	1.2	2.2	0
Divorced or formally in a same-sex civil partnership which is now legally dissolved	5.5	0	6.1
In a registered same-sex civil partnership	0.4	2.1	0
Separated but still legally married or still legally in a same-sex civil partnership	1.6	6.5	1.9
Underlying health conditions (%)			
Yes	27.4	21.7	29.1
Asthma	17.4	15.22	14.08
Breathing problems or other lung conditions	4.2	2.17	2.82
Diabetes	4.7	4.35	3.29
Heart Disease	4.8	6.5	2.82
Hepatitis	0.5	0	0.47
Hypertension	10.8	8.7	7.51
Other	14.7	23.9	16.43
Vaccination status (%)			
Yes — 2 doses plus booster	50.2	63.04	38.50
Yes — 3 doses	22.5	6.52	24.41
Yes — 3 doses plus booster	4.3	0	5.63
Yes — Can't remember date of vaccination(s)	10	15.2	8.45
Yes — 2 doses	6.5	9.57	4.72
No	4.8	2.17	3.76
Yes — 1 dose	1.7	2.17	0.94

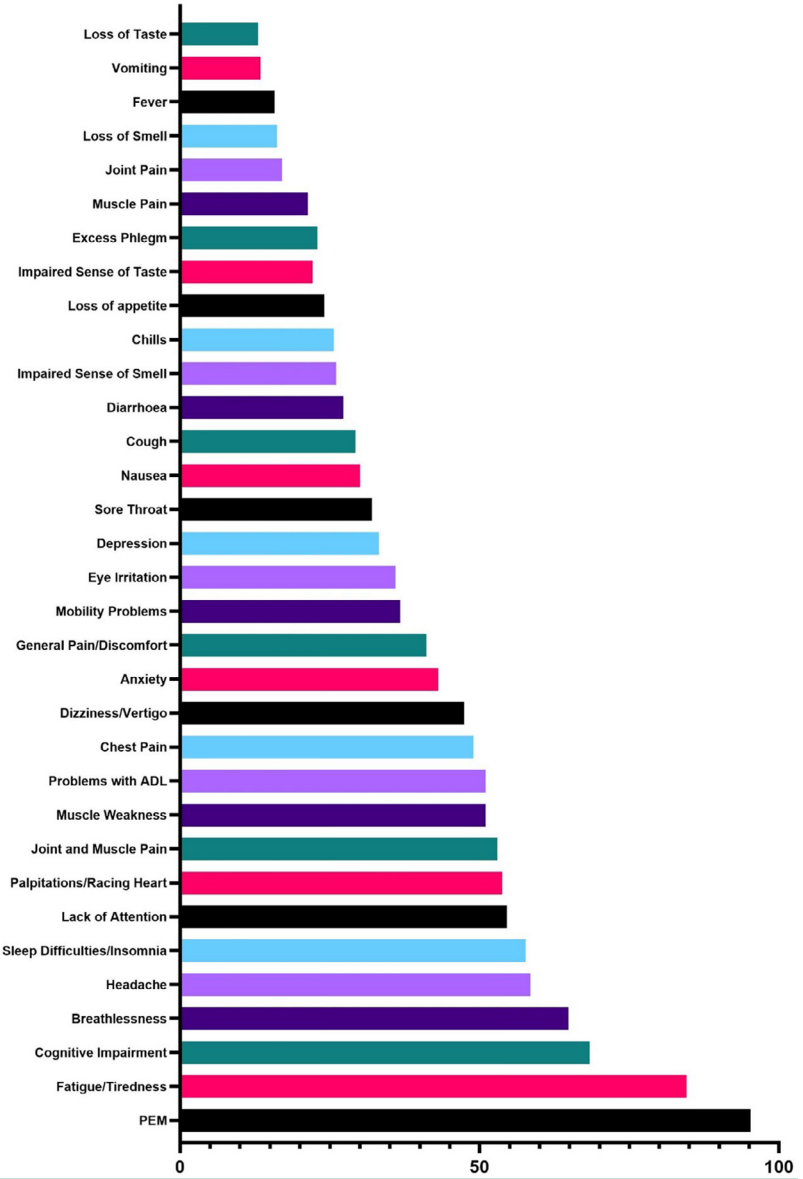

Figure 1 Percentage prevalence of symptoms in 253 respondents. ADL = Activities of Daily Living; PEM = post-exertional malaise.

(94.58% vs 85.42%, $P = .013$). Similarly, the prevalence of cognitive impairment was higher in females than males, but this did not reach significance (77.34% vs 68.75%, $P = .211$).

Symptom Frequency and Severity

The most frequently occurring symptoms were fatigue/tiredness, problems with activities of daily living, general pain, mobility problems, and PEM; with 65.8%, 55.9%, 50%, 49.3%, and 48.1%, respectively, reporting these symptoms as being constantly present (Figure 2A). Notably, Spearman rho revealed that the duration of long COVID was associated with more frequent muscle and joint pain ($P = .008$). Vaccination status was negatively associated with the frequency of runny nose ($r = -0.44$, $P = .009$), sore throat ($r = -0.2191$, $P = .032$), dizziness/vertigo ($r = -0.234$, $P = .04$), and eye irritation ($r = -0.3406$, $P = .006$). Higher deprivation (lower SIMD quintile) was associated with more frequent cough (Spearman rho = −0.23, $P = .0289$), general pain/discomfort (Spearman rho = −0.28, $P = .0001$), and muscle weakness (Spearman rho = −0.05, $P = .009$).

The most severe symptoms reported were sleep difficulties, problems with activities of daily living, nausea, and PEM, with 37.3%, 33.3%, 31.6%, and 31.0%, respectively, reporting the symptom as highly debilitating (Figure 2B). Greater duration of long COVID was associated with more severe muscle and joint pain ($P = .011$), chest pain ($P = .0002$), and mobility impairment ($P = .002$). Furthermore, more severe chest pain was reported in those with more vaccinations ($r = 0.52$, $P = .0009$); this was the only

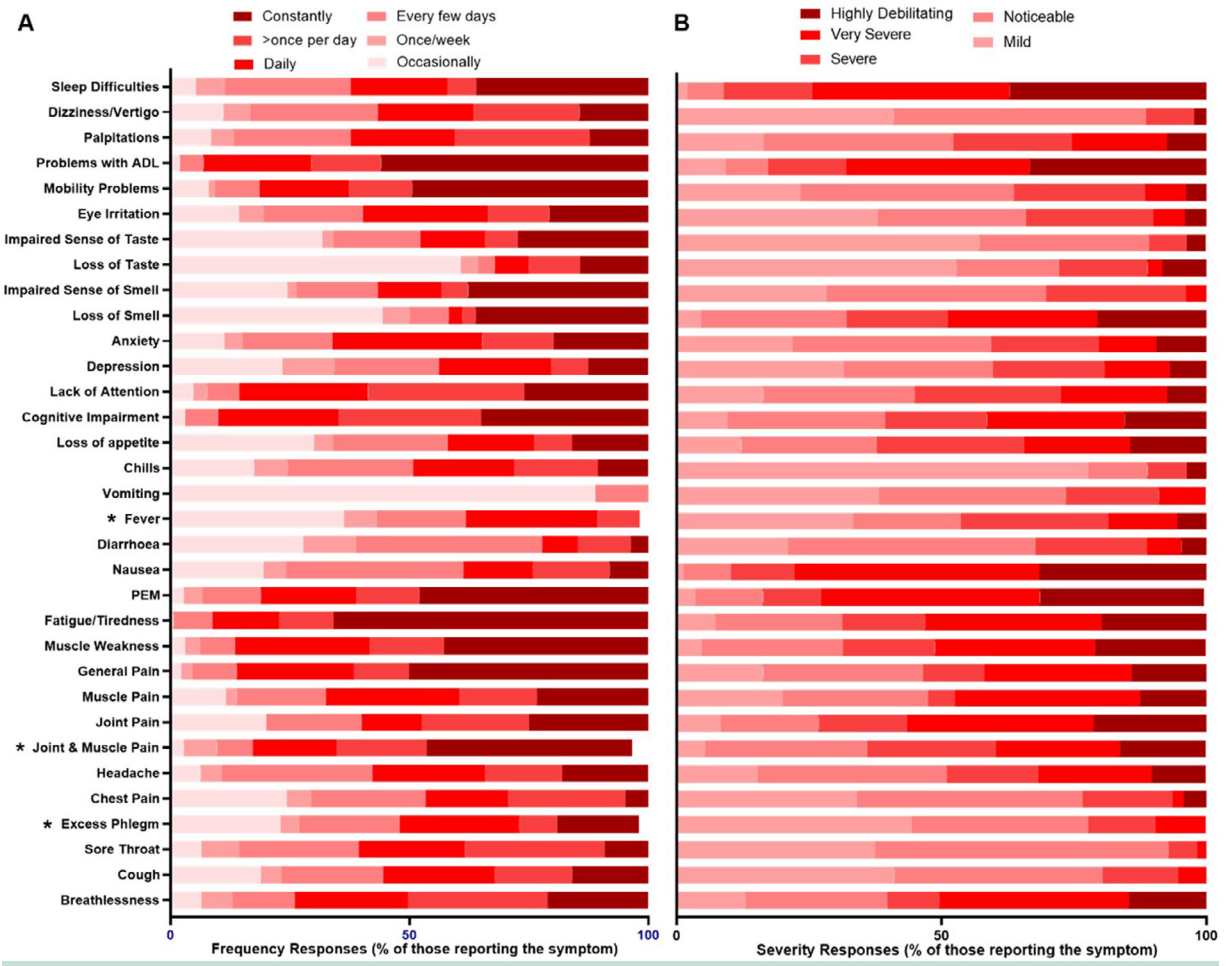

Figure 2 Symptom frequency (**A**) and severity (**B**) as a percentage of those reporting the symptom. ADL = activities of daily living; PEM = post-exertional malaise. *Missing responses for frequency data.

association between vaccination status and the severity of symptoms reported. Higher deprivation (lower SIMD quintile) was associated with more severe breathlessness (Spearman rho = −0.23, P = .012) and dizziness (Spearman rho = −0.24, P = .04).

Regarding the changeable nature of the severity of long COVID, 53.8% of respondents reported that they were still experiencing the worst long COVID at the time of survey completion, with 24.4% reporting that long COVID was at its worst ≥6 months prior and 22.8% reporting that long COVID was at its worst <6 months prior. Of those surveyed, 94.2% suffer from symptom relapses.

DISCUSSION

This study investigated the frequency, severity, and impact of symptoms experienced by those with long COVID residing in Scotland. The individuals responding to this survey were not hospitalized with initial COVID-19 acute infection. It is important to characterize symptoms in these individuals, as the lack of formal records (eg, hospital records) means they are often omitted from studies[6,16] despite accounting for the majority of sufferers (>50,000 hospitalizations vs 2.1 million reported positive cases in Scotland[17]).

For people in Scotland, long COVID remains a multifactorial condition with a wide range of symptoms, and, in line with other studies, the most prevalent is fatigue. However, people with long COVID in our study also report a significant amount of chronic pain, which is most severe in those who have had the condition the longest.

Prevalence

Fatigue was reported by 84.6% of participants within this study, which is greater than the pooled data from systematic reviews investigating symptoms of long COVID, found to be 32% (95% confidence interval [CI], 27-37),[18] 58% (95% CI, 42-73),[19] and 31% (95% CI 23.91-39.03).[20] Muscle weakness was reported by 51% of participants in the current study. This is supported by a recent review,[21] which reported weakness to be prevalent in 41% (95% CI, 25.43-59.01) of participants within the pooled literature. PEM was reported in 95.3% of participants. While PEM has not yet been sufficiently reported to include within review literature,[22] our study's findings closely match the findings of a

Canadian observational study investigating chronic fatigue and PEM in participants (n = 211) living with long COVID.[23] Twomey et al[23] found that 94.8% of participants scored above the threshold of 1 of the first 5 items of the 10-item DePaul Symptom Questionnaire−Post-Exertional Malaise (DSQ-PEM); however, only 58.7% met the full threshold used to qualify individuals for ME/CFS. This indicates the greater depth of research required to determine the true extent of PEM in people living with long COVID, and what proportion experience PEM to an extent similar to those living with ME/CFS. The current study adds new insights that for the 95.3% of respondents reporting PEM, only 16.7% met the MECFS PEM criteria of ≥14 hours recovery duration.[15]

Chronic pain was a commonly reported symptom, including joint pain (16.9%) and muscle pain (21.3%). This confirms the broader findings of a systematic review investigating prevalence of long-COVID-19 symptoms,[24] reporting prevalence of 25% (95% CI, 13-37) for muscle pain and 20% (95% CI, 13-27) for joint pain. General pain, reported in 41.1% of participants within the current study, is also comparable with that of the findings of a systematic review investigating qualify of life in post-acute COVID-19 syndrome.[25] Malik et al[25] found pain and discomfort to be reported in 41.5% (95% CI, 28-55) of cohorts in the published literature. Findings of our investigation differed considerably from that of wider research for headache symptoms (58.5%); far more prevalent than values reported in systematic reviews by both Aiyegbusi et al[24] (18%; 95% CI, 9-27) and Malik et al[25] (21%; 95% CI, 3-47). It is unclear why this may be so concentrated among the current cohort and, as such, further research is required to understand the pathology of COVID-19.

Breathlessness was reported by 64.8% of participants, which is greater than the findings of the broader review literature, who reported shortness of breath to affect 32% (95% CI, 18-47); 39.5% (95% CI, 20-60),[25] and 43%[26] of pooled data from previous reviews. Palpitations were reported by 53.8% of participants within the current study, which is similar to the pooled prevalence of 58% reported in a review of the link between long COVID and cardiovascular autonomic dysfunction,[26] although far beyond the range reported in another review article[24] of <6% of the pooled data. Chest pain was reported by 49% of participants, which is greater than the pooled prevalence of 30%,[26] 15% (95% CI, 9-20),[24] and 10% (95% CI, 5-16)[25] reported within the review literature.

Cognitive impairment was reported by 68.38%. Although not specifically reported within the review literature available to the authors, another study (n = 2526) with the majority of participants residing in the United Kingdom (79.9%)[27] reported cognitive dysfunction in 69.2% of participants with long COVID; comparable with the findings of this study. Sleep difficulties were reported by 57.7% of participants, which is comparable with, though slightly higher than, the findings of one review[25] that reported sleep disturbances in 47% (95% CI, 7-89) of pooled participants.

Duration of Long COVID

There was an inverse relationship between the duration of long COVID and the number of symptoms reported. This suggests that the early phase of long COVID might include a greater number of symptoms, which may underpin the breadth of symptoms previously reported.[3] However, as the condition proceeds, the reported symptoms appear to concentrate on a smaller number, with fatigue and pain being among the most prevalent. Important, however, is that the increased duration of long COVID is also associated with increased severity of fatigue, general pain, and muscle and joint pain. Therefore, it appears that those people who have experienced long COVID the longest tend to have a smaller number of more severe symptoms.

Frequency and Severity

One aim of this study was to ascertain some measure of symptom load. We asked respondents to report not only what symptoms they experienced but also how often (ie, days per week) and how severe they felt the symptoms were, as it is clear that symptom load varies, both within and among people with long COVID.[3] We chose to separate out severity and frequency, as symptom equivalence is difficult to quantify. For example, it is not clear if we should consider a modest headache that occurs daily as an equivalent symptom to a headache that occurs only rarely but is debilitatingly severe. As such, attempts to simplify frequency and severity data with a global score would be arbitrary and obscure important information, and so we reported frequency and severity data separately.

The most frequently occurring symptoms were reported to be fatigue/tiredness, problems with activities of daily living, general pain, mobility problems, and PEM, with 65.8%, 55.9%, 50%, 49.3%, and 48.1%, respectively, reporting these symptoms as being constantly present. Comparison with previous work is difficult because most studies have reported the prevalence but not the frequency of the symptoms, so additional questions determining how often these symptoms are experienced help to highlight the impact that these symptoms are having on people's lives. One UK study used similar time periods on which to ask about symptom frequency;[27] however, these results encompass overall long-COVID symptoms and do not detail specific symptoms that may occur more frequently than others.

The most severe symptoms reported are sleep difficulties, problems with activities of daily living, nausea, and PEM, with 30%-40% of participants reporting the symptom as highly debilitating. This differs somewhat with the findings of another UK-based questionnaire study (n = 812), which found the most common symptoms reported as severe to be fatigue (55.3%), brain fog (30.7%), myalgia (24.1%), shortness of breath (21.9%), and insomnia (21.1%).[28] The study scored severity using a visual analogue scale (mild score = 1-4, moderate score = 5-7, and severe score 8-10). It is unclear as to why the results would be different between this study and the current study;

however, individual symptom severity is rarely reported within the long-COVID literature, and to the authors' knowledge, is the first study to do so for data obtained in Scotland. This information should provide some guidance for future research and health care settings to deploy and develop counteractive interventions against the most debilitating symptoms identified.

The nature of long COVID is that the symptoms fluctuate in nature and severity.[27,29] In the current study, 94% of respondents reported suffering from symptom relapses. This is similar to another study at 7 months post-COVID, with 85.9% of participants experiencing relapses, primarily triggered by exercise, physical or mental activity, and stress.[29] The current study did not explore the potential causes for relapse in symptoms, and this should be explored in future studies.

Respondents reported high levels of negative emotions, including anger, sadness, and anxiety. This highlights the detrimental impact on the well-being and quality of life of those suffering from long COVID and provides advocacy for these individuals. This is important to emphasize the case for long COVID to have more funding for research and to improve and develop health care initiatives throughout Scotland to help treat people suffering from the condition.

Vaccine Status

While vaccine status was found to have a minor negative association with the frequency of runny nose, sore throat, dizziness and vertigo, and eye irritation, it broadly wasn't associated with number, severity or frequency of symptoms, respondents' mood (see Part 2), or impact on their work or study. This is supported by the findings of another study, which found vaccine administration to have no effect on long-COVID symptom improvement.[30] However, another study investigating the effects of vaccine administration on long-COVID symptoms[28] found an improvement in most self-reported symptoms after participants had received a vaccine dose. Without knowing how severe this study's participants' long-COVID symptoms would have been in the absence of their vaccine, firm conclusions cannot be drawn, and clarity on the etiology of long COVID and the effects of vaccination on symptoms is needed.

Age

No significant correlations were found in relation to age. This contradicts the findings of an app-based observation study of 4128 participants that found a significant positive correlation between age and duration of long COVID in participants aged >70 years.[31] However, few participants within our study were over the age of 65 years. This may have been due to the use of an online survey as a barrier, however, similar barriers would have faced participants from Sudre et al (2021).[31]

Sex

There were a greater number of female participants in this study (77% female to 21% male, 0.4% non-binary, 1.3% prefer not to say), reflecting, albeit to a greater degree than some of the literature, the increased prevalence of long-COVID among women over a population.[32] Sex differences were of proportional impact, however, were only found in differences for fatigue and tiredness (94.58% vs 85.42%) and cognitive impairment (77.34% vs 68.75%); both were more prevalent in women. These findings have been supported by a review of sex differences in long-COVID symptoms.[32]

SIMD

We found that respondents from more deprived areas (lower SIMD quintile) were significantly more likely to report a higher number of symptoms than those from higher SIMDs. Furthermore, lower SIMD was associated with more frequent cough, general pain/discomfort, and muscle weakness; as well as more severe breathlessness and dizziness. To the best of our knowledge, this is the first study to state these findings, however, it does follow similar trends with regards to likelihood of contracting COVID-19[33] and the impact of socioeconomic factors on health outcomes after COVID-19 infection.[34] As such, these findings stress a need to ensure that burden of cost for support while living with long COVID should be distributed fairly to ensure minimal compounding of factors limiting society's most vulnerable members.

Smoking Status

We found that a significantly greater number of symptoms were reported by smokers vs nonsmokers and smokers vs those who used to smoke, but this was the only significant association found between long-COVID symptoms and smoking status. This is the only study known to the authors to report smoking status effect on isolated symptoms, with the exception of one study that found smoking to have no effect on cough being reported as a primary symptom for hospitalization.[35] While studies found smoking to be associated with increased risk of reporting long-COVID symptoms ≥12 weeks after infection,[36,37] the evidence that smoking has significant effect on the impact of long COVID itself has been lacking and requires further research to draw firmer conclusions.

Limitations

Limitations of this study focus on the self-report nature of the survey. This is discussed in detail in Part 2: A Cross-Sectional Study of Symptom Prevalence, Frequency, Severity, and Impact of Long-COVID in Scotland.

CONCLUSION

The results of this study show that the most prevalent long-COVID symptoms in Scotland are PEM, fatigue and tiredness, cognitive impairment, breathlessness, headache, and sleep difficulties. Fatigue and tiredness, problems with

activities of daily living, general pain, mobility problems, and PEM occurred more frequently, while sleep difficulties, problems with activities of daily living, nausea, and PEM were the most severely reported. Those living in a lower SIMD-rated postal code were likely to report a greater number of symptoms, severity, and frequency of some symptoms. Vaccine status, age, sex, and smoking status had limited or no effect on symptoms.

This information elucidates a picture of the challenges faced specifically for those living with long COVID in Scotland. Findings from this study may aid physicians, health care practitioners, and policy-makers to better understand the prevalence, frequency, and severity of symptoms of long COVID. This is the first study to quantify individual symptoms in Scotland and, in conjunction with Part 2, demonstrates the large impact symptoms have on affected persons' ability to work and perform daily tasks. Given the heterogeneity of long COVID, further depth of multidisciplinary research will be necessary to understand the pathophysiology of the disease and develop effective treatments and services to support those developing and continuing to live with long COVID in the future.

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