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# Long COVID in the population of COVID-19 hospitalized patients discharged from SUS' hospitals in Rio de Janeiro City, Brazil: a patient-engaged cohort survey study

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## Abstract

**Background** Long COVID (LC) is a global health concern, affecting millions and placing significant strain on healthcare systems. However, there is a notable lack of LC research in low- and middle-income countries, particularly in the global south. This study aims to fill this gap by focusing on Brazil, a country with an emerging LC literature but limited population estimates due to sampling constraints. Our unique focus is to estimate the prevalence of persistent symptoms and LC self-reported diagnosis among COVID-19 patients hospitalized in Rio de Janeiro City public hospitals. We also aim to identify factors associated with the LC measures and most frequent symptoms, providing valuable insights for healthcare systems and policymakers.

**Methods** We designed a comprehensive, patient-engaged cohort survey study to assess LC symptoms and administered it to a probability sample of adults six to 24 months post-discharge from public hospitals in Rio de Janeiro City. LC was measured as (i) at least one persistent symptom or (ii) self-reported LC. Among the symptoms, we considered post-exertional malaise, which is frequently neglected in LC studies. Additionally, we applied an adaptation of the DePaul Symptom Questionnaire to account not only for the presence but also the frequency of symptom occurrence. We estimate the prevalence of symptoms and use logistic regression models to identify associations between LC and the most frequent LC symptoms and independent variables, assessing demographic, socioeconomic, lifestyle, and clinical characteristics, vaccination, and severity of acute disease.

**Results** Results indicate the predominant study's focus on low-income and highly vulnerable people, with an elevated prevalence of comorbidities before LC. In the study population of 11,328 persons, 71.3% (95%CI 66.3; 76.2) reported frequently experiencing at least one persistent symptom, and 39.3% (95%CI 34.2; 44.4) self-reported having LC. The most frequent symptoms were fatigue, post-exertional malaise, joint pain, sleep disturbance, and cognitive

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impairment, and symptoms were consistently more likely to occur among women. Age was non-linearly related to LC, and comorbidities before COVID-19 hospitalization were positively associated with LC symptoms.

**Conclusions** Evidence is provided for the LC burden among COVID-19 hospitalized patients even 24 months post-discharge. LC accessible and appropriate healthcare is fundamental.

**Keywords** Long COVID, Post COVID condition, Prevalence, Symptoms, Survey, Patient-engaged research

## Background

The World Health Organization (WHO) estimates that 10–20% of people with COVID-19 infection develop persistent or new symptoms after the acute phase, frequently referred to as long COVID (LC), which may affect daily personal and work activities for months and years [1, 2]. Over 200 LC symptoms have been identified [1], with post-exertional malaise (PEM), breathlessness, cognitive dysfunction (such as "brain fog"), sleep disturbance, muscular and joint pains, and cardiovascular conditions frequently experienced [3–7]. Although the WHO has declared that COVID-19 no longer presents a global health emergency, the global prevalence of LC continues to rise as people are reinfected, and many people who developed the condition earlier in the pandemic continue to struggle with symptoms. Thus, LC continues to exert pressing demands on health systems worldwide – pressures which vary according to health system structure, social and economic resources patterning, COVID-19 infection and vaccination rates, and LC prevalence, among other factors.

A meta-analysis of 1,289,044 participants who had COVID-19 from 11 countries found that 41.7% had at least one unresolved symptom, and 14.1% could not return to work two years after COVID-19 infection [6]. For some individuals, symptoms were continually present, while others experienced relapsing and remitting ones. Individuals who were older, females, with higher body mass index (BMI), pre-existing comorbidities (arterial hypertension, diabetes, asthma, chronic obstructive pulmonary disease, heart disease, and chronic liver disease), more severe disease or intense inflammatory process in the COVID-19 acute phase, and used of corticoid therapy were found to increase the risk of LC [6]. Other reviews have found that LC is more common among hospitalized than non-hospitalized patients, although LC often develops among non-hospitalized individuals (which also greatly depends on healthcare access) [8]. Studies have also identified socioeconomic/financial insecurity effects on LC risk [9, 10]. Symptom prevalence estimates vary broadly depending on time and method of assessment, among other factors [3].

In Brazil, LC has been studied amongst different populations of patients, including those who receive care in the universal and public Unified Health System (SUS) [11–18]. These studies have indicated a higher prevalence of the condition than global estimates, which decreases with time since onset. Estimates among Brazilian hospitalised patients ranged from 61% [11] to 87.4% six months post-discharge [13] and 67.5% 12 months post-discharge [13]. As with LC studies in high-income countries, these studies have overlooked important symptoms reported by patient groups, such as PEM and menstrual dysregulation.

Despite the growing literature on LC prevalence in Brazil, most studies were built on convenience samples (e.g., single-center studies [11, 12], online self-administered questionnaires [17, 18]). Additionally, active patient participation in generating evidence is largely absent in Brazilian studies, limiting the applicability of research results to inform high-quality, person-centered healthcare for people living with this condition.

This study is part of an international, interdisciplinary, and patient-engaged collaboration aimed at building evidence concerning prevalence, impacts, and healthcare utilization amongst people with LC to inform and improve LC public healthcare in Rio de Janeiro City, the second-largest in Brazil. The city registered high rates of COVID-19 infection [19] and is marked by substantial income inequality, complex social and political currents, and supported by a public healthcare and welfare system. Such a focus is specifically valuable given the dearth of LC research in low- and middle-income countries, especially in the global south. It is also important to note the low awareness of LC among both patients and providers within Brazil, which can constrain access to formal diagnoses and care services [20].

This paper aims to estimate the prevalence of persistent symptoms and LC self-reported diagnosis six to 24 months after discharge from COVID-19 hospitalization and identify factors associated with symptom occurrence.

## Methods

Below, we present the methodological procedures adopted in the study. Further details are provided in the study protocol [21] and an article that describes the survey conception [22].

### Study design and population

We developed a cohort survey study with patients aged at least 18 years who were discharged from SUS hospitals following acute COVID-19 infection (confirmed with

PCR test or clinical diagnosis) from December 2020 to November 2022. The study population was stratified into four discharge cohorts: those recruited and surveyed at six, 12, 18, and 24 months post-discharge. Although a second round of interviews was conducted with some participants approximately six months after the initial interview, this work is based solely on data from the first interview, performed immediately after recruitment.

### Sampling plan

We employed a two-step probability sample, selecting hospitals (with probability proportional to size – PPS) and individuals (with simple inverse sampling).

In the first stage, 16 hospitals were included: 10 from the municipality, two from the state, two from the federal Government, and two from universities. As usual in PPS selection, the largest-sized hospitals were included with certainty in the sample and became a selection stratum. In these cases, the patients were the primary selection units.

The patients were selected using a simple inverse sample procedure from a non-anonymized Influenza Epidemiological Surveillance Information System database (*Sistema de Informação da Vigilância Epidemiológica da Gripe* – SIVEP-Gripe) within each selected hospital and the four discharge strata [23–25]. Patients were sorted in a random order and then searched sequentially within each cohort.

The total sample size was defined as 484 patients and calculated to estimate a minimum proportion of 3% ($P_{min}$=0.03), with a relative error of no more than 0.5% at a significance level of 5%, which implies that this proportion will have a 95% confidence interval ranging from 1.5 to 4.5%. It was allocated among the hospitals proportionally to their size (i.e., the number of surviving patients), ensuring a minimum of five patients per hospital. The hospital patient sample size was then allocated among its four cohorts proportionally to the number of survivors in each cohort.

### Data collection

We recruited participants from November 2022 to August 2023. Recruitment was conducted via telephone, with the patients randomly selected. In the event of the selected patients' death or difficulties participating, we invited people close to them (e.g., spouse/widow, daughter/son, or caregiver) who could answer the questions on their behalf.

Participants were recruited using the available SIVEP-Gripe contact information. The selected patients (or their proxies) were informed about the nature and objectives of the research and invited to participate after clarifying expectations. Further research information was sent to potential study participants via email or WhatsApp. Consent to participate was obtained verbally and audio-recorded.

Surveys were conducted via interviews to reduce literacy and technology barriers, allowing participants to elaborate more easily on their experiences. Interviews were scheduled at the respondents' convenience and held by telephone or video. To accommodate participants' needs, such as symptom management, we offered to split interviews into two stages.

A qualified team, including senior researchers and master's and doctoral students, was involved in data collection. Through training and periodic meetings, the team worked toward alignment and consistency in the questionnaire application.

### Measures

We used a patient-engaged approach to design a structured survey to assess LC symptoms and associated factors [21, 22]. The survey questionnaire is presented as Supplementary material 1. We measured LC in two ways: first, if patients report at least one persistent symptom, and second, if patients self-report LC.

We surveyed 29 symptoms associated with LC, aggregated into nine groups [26, 27]: (i) general symptoms (fever; fatigue – too much tiredness even after slight efforts; PEM – worsening of symptoms after previously tolerated physical or mental effort/activity); (ii) cardiovascular symptoms (chest pain/chest tightness; fast beating or pounding heart – palpitations); (iii) respiratory symptoms (difficulty breathing or shortness of breath – breathlessness; cough); (iv) neurologic symptoms (cognitive impairment – difficulty thinking and processing information, trouble with concentration, memory, or finding the right word to say, "brain fog" and feeling like your head is fuzzy; headaches or migraines; sleep disturbance – difficulty falling or staying asleep, need more sleep than usual; numbness or tingling in parts of the body; dizziness or lightheaded; delirium, mental confusion, delirium, awareness reduction and hallucination; difficulty walking or moving about; problems with vision such as fuzzy vision, floaters, or light sensitivity); (v) gastrointestinal symptoms (abdominal pain, nausea and vomiting, diarrhea; weight loss and reduced appetite – not being hungry) (vi) musculoskeletal symptoms (joint pain; muscle pain); (vii) ear, nose and throat symptoms (tinnitus; earache; sore throat; loss of taste and/or smell; stuffed-up or congested nose); (viii) dermatological symptoms (skin rash; hair loss); and (ix) psychiatric symptoms (little interest or pleasure in doing things; not being able to stop or control worrying, feeling nervous, anxious or on edge; repeated, disturbing, and unwanted memories of your COVID experience; feeling very upset or having strong physical reaction to when something reminded you of your COVID experience, herein

described as post-traumatic stress disorder (PTSD) symptoms. Unlike similar studies in Brazil, we included a measure of PEM, and we asked about the impact of menstruation on symptoms, informed by the expertise of the team's patient-researchers in emerging patient-led findings in a fast-paced research landscape. We included lay terms or explanations for all symptoms; for some items, such as PEM, where the medical label may not be well known, we used a short lay definition instead of the term itself. For participants who menstruated and reported the presence of symptoms, we asked whether symptoms worsened right before or during the menstrual period.

Considering an adaptation of the DePaul Symptom Questionnaire [28], for all symptoms, participants could indicate whether they used to experience them before COVID-19 and the frequency and intensity had not changed; they had never experienced them since getting COVID-19; they had experienced them after COVID-19 but not anymore; or they were still experiencing them a little of the time; or most or all the time.

We asked participants whether they thought they had LC (henceforth self-reported LC) and gave the following response options: never had LC, had LC but not anymore, have LC, or unsure.

We also asked participants to self-report:

- Demographic variables: age; gender (cisgender woman, cisgender man, transgender woman, transgender man, non-binary, other gender identities not listed); race (white, black, *pardo* (mixed race), yellow, Indigenous); marital status (single, married or with a partner, separated/divorced, widow); schooling (no school, middle school uncompleted, middle school, graduated high school or equivalent, bachelor's degree, post-graduate degree);
- Socioeconomic variables: household income and the number of home residents, and employment status (unpaid domestic/caregiving worker, paid domestic/caregiving worker, private sector employee, public sector employee, self-employed, informal worker, student, retired/receiving pension, unemployed);
- Lifestyle variables: smoking (smoker, former smoker, not smoker); and physical activity;
- Clinical variables: comorbidities before COVID-19, COVID-19 reinfections;
- COVID-19 vaccination status (not vaccinated, only one dose (AstraZeneca, Pfizer, Sinovac), two doses (AstraZeneca, Pfizer, Sinovac), or one dose Janssen, one booster, two boosters) at COVID-19 hospitalization and interview.

Participants (or their proxies) could not answer or declare they did not know how to answer the questions. Two variables indicating intensive care unit (ICU) admission and ventilatory support use during hospitalization were obtained from SIVEP-Gripe.

### Analyses

Descriptive statistics of the sample and the population were obtained, and for population estimates, the 95% confidence intervals were also registered.

We measured the prevalence of symptoms in two ways: symptoms were classified as "frequently occurring" if they were reported "most of the time" or "all of the time", and were classified as "present" if they were reported with any frequency other than "never" or "before but not anymore". We considered how these prevalences and the distribution of the number of symptoms differed between all participants and those with self-reported LC. Additionally, we described the prevalence of symptoms by cohort. Given that this paper focuses on prevalence, we do not report here findings for symptoms previously experienced but not currently experienced by participants.

We fit seven logistic regression models to explain the variation in the likelihood of reporting: having at least one frequently occurring symptom, having each of the five most observed symptoms in the population as frequently occurring, and self-reporting LC. The inclusion of potential explanatory variables accounted for hypotheses based on LC knowledge built, which indicates the increase of LC risk in the female sex, among socioeconomically vulnerable individuals, among those with comorbidities before COVID-19, those with more severe acute COVID-19, and those with reinfections. Vaccination was expected to have a protective effect, and age was expected to have a linear or non-linear effect on LC risk. Not smoking and regular physical activity before COVID-19 were expected to be protective, considering the idea that a good lifestyle prevents diseases. We also tested the effect of the number of LC-associated symptoms reported on the likelihood of self-reporting LC. In all models, variables' categories were tested individually and eventually collapsed, considering the results obtained in the modeling process. We applied a significance level of $\alpha = 0.05$.

All analyses were developed using the SAS® statistical package, version 9.4. In all analyses oriented towards producing population estimates, we accounted for the sample design variables (selection strata, primary sampling units, and sample weights) employing SAS complex survey procedures "surveyfreq", "surveymeans", and "surveylogistic".

## Results

### Sample and population

Figure 1 shows a flowchart for contact attempts with randomly ordered potential participants in the study recruitment process. We began with a list of 2,978 patients,

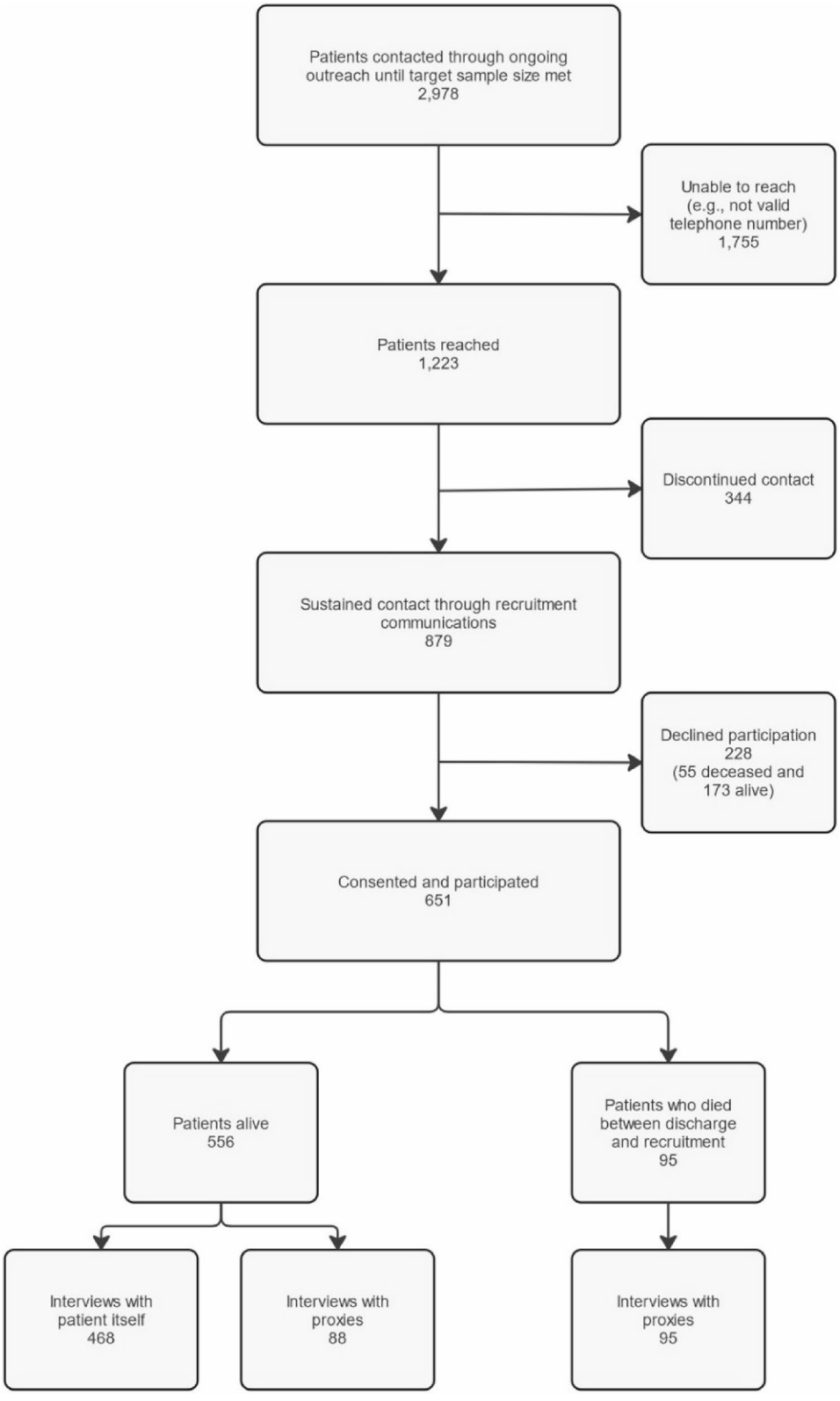


**Fig. 1** Flowchart concerning contact attempts in the recruitment process for the study

reaching only 1,223, primarily due to incorrect telephone numbers, no longer valid, or the registered contact belonging to someone not close to the patient who could not pass the study information on to her/him. The study sample finished with 651 individuals. Among them, 95 had died between hospitalization discharge and the study recruitment/interview.

For all participants, at least six months had passed since discharge; therefore, symptoms reported were persistent after six months or more.

Accounting for sample weights, the sample of 651 individuals corresponded to 12,936 persons discharged from hospitalizations for COVID-19 in public hospitals in Rio de Janeiro from December 2020 to November 2022, unequally distributed among the four cohorts. Excluding patients who died between discharge and the study's recruitment, the sample of 556 individuals alive at the interview corresponded to an estimated population of 11,328 persons, which is the focus of this article. Among the 556 individuals, 84% answered the survey themselves.

Table 1 presents the baseline sample and population characteristics regarding sociodemographics, lifestyle, health status, COVID-19 vaccination, and hospitalization variables. The results indicate a predominant focus on low-income and highly vulnerable individuals. It is estimated that 43.1% of the participants did not complete high school. Before hospitalization, about 1/3 of the population was estimated to have a monthly per capita family income of less than 1,000 reais (approximately 185 US dollars), with nearly 20.0% in poverty. More than ¾ of the population was estimated to have at least one pre-existing comorbidity at COVID-19 hospitalization, with the four most frequent being arterial hypertension (51.6%; 95%CI 46.3; 56.9), obesity (25.7%; 95%CI 20.7; 30.7), diabetes (24.5%; 95%CI 20.2; 28.8), and heart disease (13.2%; 95%CI 9.1; 17.4). Regarding vaccination, 60.3% (95%CI 55.4; 65.1) of the individuals in the population were not immunized against COVID-19 at hospitalization, while 81.9% had received at least one booster at the time of the interview, in addition to other 11.5% vaccination completed.

#### LC symptoms

About 71.3% (95%CI 66.3; 76.2) of the population were estimated to report at least one frequently occurring LC symptom, while 91.1% (95%CI 87.9; 94.4) had at least one present LC symptom. Additionally, 39.3% (95%CI 34.2; 44.4) of people were estimated to self-report LC.

Table 2 shows the prevalence of symptoms and symptom groups, considering only frequently occurring symptoms and present symptoms in the surviving population ($N = 11,328$) and the self-reported LC population ($n = 4,450$).

The most observed frequently occurring symptoms reported (prevalence ≥ 25.0%) in the whole population and the population of self-reported LC were, respectively: fatigue (34.0%; 57.0%), PEM (32.3%; 55.6%), joint pain (30.1%; 51.6%), sleep disturbance (28.4%; 48.1%), cognitive impairment (27.5%; 47.6%), numbness (27.4%; 43.6%), feeling anxious (27.3%; 47.1%), and little interest/feeling down (25.3%; 50.1%). Amongst those who self-reported LC, the list also included muscle pain (40.4%), problems of vision (31.7%), difficulty walking or moving about (30.6%), and breathlessness (25.6%). No individual cardiovascular, gastrointestinal, ear-nose-throat, or dermatologic symptoms reached a prevalence ≥ 25.0% in either population. Accounting for present symptoms, the prevalence estimates increase substantially, but the frequency ranking of symptoms stays approximately the same. Additional information comparing the estimates of Table 2 between those who self-reported and did not self-report LC, and providing the prevalence of the symptoms among those who said they did not think they had LC and those who were unsure, is available in Supplementary material 2.

In the menstruating population ($N = 2,232$), it was estimated that 25.3% (95%CI 15.8; 34.8) experienced worsening symptoms right before or during the menstrual period, increasing to 38.1% (95%CI 22.1; 54.0) amongst the subset who self-reported LC ($N = 1,150$).

Although the sample was not designed for specific inferences by cohorts, and the sampling of individuals discharged six- and 12-months prior was lower than in the other cohorts (reflected in large confidence intervals), we show in Fig. 2 the prevalence estimates for the most observed self-reported frequent symptoms in the four cohorts and provide more detailed information on symptom prevalence by cohorts in Supplementary material 3. Fatigue and PEM, followed by joint pain, consistently appeared among the four most frequent symptoms in all cohorts. The prevalence of self-reported LC was somewhat reduced from approximately 44.5% at six and 12 months post-discharge to around 39.0% at 18 and 24 months.

Table 3 shows the distribution of the number of frequently occurring symptoms and present symptoms in the population and among those who self-reported LC, showing that the inclusion of symptoms regardless of frequency makes the estimates much higher. Supplementary material 4 extends Table 3 to include statistics for those who did not think they had LC or were unsure.

#### Logistic regression models

Table 4 presents the final logistic regression models for explaining the variation in the seven selected dependent variables: reporting at least one frequently occurring symptom, reporting as frequently occurring each

**Table 1** Characteristics of the sample ($n=556$) and estimated for the study population alive at interview ($N=11,328$)

| Variable | Sample ($n=556$) | | Population alive at interview ($N=11,328$) | | |
|---|---|---|---|---|---|
| | ***n*** | **%** | ***N*** | **%** | **95% CI** |
| Age at hospital admission | | | | | |
| 18–29 | 22 | 4.0 | 583 | 5.1 | 2.7; 7.6 |
| 30–39 | 49 | 8.8 | 1,489 | 13.1 | 8.7; 17.5 |
| 40–49 | 100 | 18.0 | 2,168 | 19.1 | 14.8; 23.5 |
| 50–59 | 142 | 25.5 | 2,681 | 23.7 | 19.3; 28.1 |
| 60–69 | 124 | 22.3 | 2,306 | 20.4 | 16.3; 24.4 |
| 70–79 | 77 | 13.9 | 1,460 | 12.9 | 8.7; 17.0 |
| 80+ | 42 | 7.6 | 641 | 5.7 | 3.5; 7.9 |
| Gender | | | | | |
| Cis woman | 265 | 47.7 | 5,187 | 45.8 | 40.3; 51.3 |
| Cis man | 288 | 51.8 | 6,082 | 53.7 | 48.2; 59.2 |
| Trans female or trans male or other Gender variant | 0 | 0.0 | - | - | - |
| Not listed | 1 | 0.2 | 14 | 0.1 | 0.0; 0.4 |
| Preferred not to answer | 2 | 0.4 | 45 | 0.4 | 0.0; 1.1 |
| Race/ethnicity | | | | | |
| White | 210 | 37.8 | 3,989 | 35.2 | 30.0; 40.4 |
| Black | 83 | 14.9 | 1,670 | 14.7 | 11.1; 18.4 |
| Pardo (mixed race) | 253 | 45.5 | 5,406 | 47.7 | 42.3; 53.1 |
| Asian | 4 | 0.7 | 73 | 0.6 | 0.0; 1.5 |
| Indigenous | 2 | 0.5 | 103 | 0.9 | 0.7; 1.2 |
| Preferred not to answer | 4 | 0.7 | 87 | 0.8 | 0.0; 1.7 |
| Marital status | | | | | |
| Single | 106 | 19.1 | 2,485 | 21.9 | 17.2; 26.6 |
| Married/Civil partnership | 305 | 54.9 | 6,244 | 55.1 | 49.8; 60.5 |
| Separated/Divorced | 66 | 11.9 | 1,309 | 11.6 | 8.3; 14.8 |
| Widow | 77 | 13.9 | 1,244 | 11.0 | 7.7; 14.3 |
| Unknown | 2 | 0.4 | 46 | 0.4 | 0.0; 1.0 |
| Education | | | | | |
| No school | 24 | 4.3 | 388 | 3.4 | 1.6; 5.2 |
| Middle school uncompleted | 137 | 24.6 | 2,885 | 25.5 | 20.5; 30.4 |
| Middle school | 101 | 18.2 | 1,613 | 14.2 | 10.9; 17.6 |
| Graduated High School or equivalent | 230 | 41.4 | 5,058 | 44.7 | 39.3; 50.1 |
| Bachelor's degree | 50 | 9.0 | 1,109 | 9.8 | 6.1; 13.4 |
| Postgraduate degree | 7 | 1.3 | 161 | 1.4 | 0.1; 2.8 |
| Unknown | 7 | 1.3 | 114 | 1.0 | 0.1; 1.9 |
| Occupation before COVID-19 hospitalization* | | | | | |
| UNPAID Domestic/caregiving worker | 37 | 6.7 | 853 | 7.5 | 4.5; 10.5 |
| PAID Domestic/caregiving worker | 23 | 4.1 | 433 | 3.8 | 2.0; 5.6 |
| Private sector employee | 117 | 21.0 | 2,800 | 24.7 | 19.8; 29.6 |
| Public sector employee | 16 | 2.9 | 405 | 3.6 | 1.8; 5.3 |
| Self-employee | 147 | 26.4 | 2,986 | 26.4 | 21.6; 31.1 |
| Informal worker | 13 | 2.3 | 200 | 1.8 | 0.7; 2.9 |
| Student | 1 | 0.2 | 24 | 0.2 | 0.0; 0.6 |
| Retired/Receiving a pension | 169 | 30.4 | 2,926 | 25.8 | 20.9; 30.8 |
| Unemployed | 33 | 5.9 | 701 | 6.2 | 3.6; 8.8 |
| Per capita family income (R$) before COVID-19 hospitalization* | | | | | |
| < 200 | 8 | 1.4 | 143 | 1.3 | 0.3; 2.2 |
| 200–637 | 103 | 18.5 | 2,110 | 18.6 | 14.4; 22.8 |
| 638–999 | 77 | 13.9 | 1,514 | 13.4 | 9.7; 17.1 |
| 1000–1499 | 123 | 22.1 | 2,577 | 22.8 | 18.2; 27.3 |
| 1500–1999 | 57 | 10.3 | 1,430 | 12.6 | 8.9; 16.3 |

**Table 1** (continued)

| Variable | Sample (*n* = 556) | | Population alive at interview (*N* = 11,328) | | |
|---|---|---|---|---|---|
| | *n* | % | *N* | % | 95% CI |
| 2000–2999 | 70 | 12.6 | 1,496 | 13.2 | 9.5; 16.9 |
| ≥ 3000 | 29 | 5.2 | 604 | 5.3 | 2.7; 8.0 |
| Not informed | 89 | 16.0 | 1,453 | 12.8 | 9.8; 15.8 |
| Tobacco smoking | | | | | |
| Smoker | 25 | 4.5 | 579 | 5.1 | 2.7; 7.5 |
| Former smoker | 143 | 25.7 | 2,252 | 19.9 | 16.2; 23.6 |
| Not smoker | 386 | 69.4 | 8,447 | 74.6 | 70.3; 78.8 |
| Preferred not to answer | 2 | 0.4 | 50 | 0.4 | 0.0; 1.1 |
| Physical Activity | | | | | |
| Yes | 235 | 42.3 | 5,012 | 44.2 | 38.9; 49.6 |
| No | 320 | 57.6 | 6,278 | 55.4 | 50.1; 60.7 |
| Unknown | 1 | 0.2 | 38 | 0.3 | 0.0; 1.0 |
| COVID-19 vaccination status before hospitalization | | | | | |
| Not vaccinated | 305 | 54.9 | 6,829 | 60.3 | 55.4; 65.1 |
| Only one dose (AstraZeneca, Pfizer, Sinovac) | 77 | 13.9 | 1,432 | 12.6 | 9.5; 15.8 |
| Two doses (AstraZeneca, Pfizer, Sinovac) or one dose Janssen | 66 | 11.9 | 996 | 8.8 | 5.9; 11.6 |
| 1 Booster | 31 | 5.6 | 584 | 5.2 | 2.5; 7.8 |
| 2 Boosters or more | 63 | 11.3 | 1,240 | 10.9 | 7.6; 14.3 |
| Preferred not to answer | 2 | 0.5 | 43 | 0.4 | 0.0; 1.0 |
| Unknown | 12 | 2.2 | 204 | 1.8 | 0.6; 3.0 |
| Comorbidities previous to COVID-19 | | | | | |
| Arterial hypertension | 300 | 53.96 | 5,847 | 51.6 | 46.3; 56.9 |
| Asplenia (absence of spleen) | 3 | 0.54 | 28 | 0.2 | 0.0; 0.5 |
| Asthma/bronchitis | 46 | 8.27 | 872 | 7.7 | 4.8; 10.6 |
| Cancer | 33 | 5.94 | 499 | 4.4 | 2.2; 6.6 |
| Chronic liver disease | 23 | 4.14 | 412 | 3.6 | 1.3; 6.0 |
| Diabetes | 140 | 25.18 | 2,779 | 24.5 | 20.2; 28.8 |
| Heart disease | 82 | 14.75 | 1,499 | 13.2 | 9.1; 17.4 |
| Hematological disease | 13 | 2.34 | 287 | 2.5 | 0.8; 4.2 |
| Immunodepression/immunodeficiency | 23 | 4.14 | 531 | 4.7 | 2.2; 7.1 |
| Kidney disease | 49 | 8.81 | 794 | 7.0 | 4.7; 9.4 |
| Mental health conditions | 57 | 10.25 | 1,142 | 10.1 | 6.9; 13.3 |
| Neurologic disease (epilepsy, migraine, etc.) | 58 | 10.43 | 1,236 | 10.9 | 7.6; 14.2 |
| Obesity | 123 | 22.12 | 2,912 | 25.7 | 20.7; 30.7 |
| Osteoporosis | 25 | 4.50 | 311 | 2.7 | 1.3; 4.2 |
| Pulmonary disease (COPD, emphysema) | 34 | 6.12 | 535 | 4.7 | 2.8; 6.7 |
| Rheumatologic disease | 48 | 8.63 | 899 | 7.9 | 5.2; 10.6 |
| Sequelae of other viral infections | 52 | 9.35 | 1,033 | 9.1 | 5.9; 12.3 |
| Tuberculosis | 8 | 1.44 | 136 | 1.2 | 0.2; 2.2 |
| Number of comorbidities | | | | | |
| 0 | 116 | 20.9 | 2,560 | 22.6 | 18.0; 27.2 |
| 1 | 149 | 26.8 | 3,029 | 26.7 | 22.1; 31.3 |
| 2 | 120 | 21.6 | 2,509 | 22.2 | 17.9; 26.4 |
| 3 | 84 | 15.1 | 1,602 | 14.1 | 10.5; 17.8 |
| 4 | 46 | 8.3 | 893 | 7.9 | 5.1; 10.7 |
| ≥5 | 41 | 7.4 | 733 | 6.5 | 3.7; 9.3 |
| ICU use during COVID-19 hospitalization | | | | | |
| Yes | 127 | 22.8 | 3,529 | 31.2 | 25.7; 36.6 |
| No | 422 | 75.9 | 7,707 | 68.0 | 62.6; 73.5 |
| Unknown | 7 | 1.3 | 92 | 0.8 | 0.1; 1.5 |
| Ventilatory support use during COVID-19 hospitalization | | | | | |

**Table 1** (continued)

| Variable | Sample (*n* = 556) | | Population alive at interview (*N* = 11,328) | | |
|---|---|---|---|---|---|
| | *n* | % | *N* | % | 95% CI |
| Yes, invasive | 21 | 3.8 | 585 | 5.2 | 2.3; 8.1 |
| Yes, non-invasive | 441 | 79.3 | 8,982 | 79.3 | 74.7; 83.9 |
| No | 81 | 14.6 | 1,539 | 13.6 | 9.4; 17.8 |
| Unknown | 13 | 2.3 | 222 | 1.9 | 0.8; 3.1 |
| COVID-19 vaccination status at interview | | | | | |
| Not vaccinated | 14 | 2.5 | 313 | 2.8 | 1.1; 4.4 |
| Only one dose (AstraZeneca, Pfizer, Sinovac) | 11 | 2.0 | 274 | 2.4 | 1.3; 3.6 |
| Two doses (AstraZeneca, Pfizer, Sinovac) or one dose Janssen | 61 | 11.0 | 1305 | 11.5 | 7.7; 15.3 |
| 1 Booster | 79 | 14.2 | 1774 | 15.7 | 11.4; 19.9 |
| 2 Boosters other | 386 | 69.4 | 7493 | 66,2 | 60,8; 71,5 |
| Preferred not to answer | 4 | 0.7 | 134 | 1,2 | 0; 2.8 |
| Unknown | 1 | 0.2 | 35 | 0,3 | 0; 0,9 |
| Reinfection | | | | | |
| No | 481 | 86.5 | 9916 | 87.5 | 84.0; 91.1 |
| Yes | 75 | 13.5 | 1411 | 12,5 | 8.9; 16.0 |

of the five most observed symptoms (fatigue, PEM, joint pain, sleep disturbance, cognitive impairment), and self-reported LC.

These results show a positive association between identifying as a ciswoman and reporting at least one frequently occurring LC symptom and frequent fatigue, PEM, joint pain, sleep disturbance, and cognitive impairment. For example, the odds of reporting frequently experiencing PEM among cis women were 3.20 (95%CI 2.07; 5.21) times as much as that among cis men (the other answers were residual in the sample). Interestingly, there was no significant difference between cis women and cis men in the odds of self-reporting LC. Our sample did not allow for inferences about transgender women, transgender men, or other gender identities.

Age was neither a statistically significant predictor of the likelihood of at least one frequently occurring LC symptom reporting, nor of frequently occurring cognitive impairment reporting, nor of self-reporting LC. However, age was associated with the odds of frequently occurring fatigue, PEM, and joint pain reporting, with individuals in the 30–39, 40–49, and 50–59 age groups, respectively, at higher risk.

We did not find significant effects of race and socioeconomic variables on the dependent variables considered, except for a higher risk among Black individuals of reporting frequent sleep disturbance. Exploring the effects of individuals' occupations indicated confounding aspects with the age variable, which led to their exclusion from the models.

Having comorbidities prior to COVID-19 hospitalization was shown to be positively associated with the risk of LC, as measured by the dependent variables selected (Table 4): heart disease, diabetes, asthma/bronchitis, chronic liver disease, immunodepression/immunodeficiency, and pulmonary disease. Specifically, heart disease and cancer were associated with lower odds of LC self-reporting, even though those who self-reported LC and had pre-existing heart disease or cancer reported, on average, 6.2 (95%CI 5.2; 7.2) and 5.9 (95%CI 4.0; 7.7) symptoms, respectively. The findings suggest that the knowledge of having heart disease or cancer may discourage/prevent people from attributing these symptoms to LC.

The number of LC symptoms reported, the number of comorbidities prior to hospitalization, and the use of ventilatory support during COVID-19 hospitalization were positively associated with LC self-reporting. Ventilatory support during COVID-19 hospitalization was associated with increased odds of frequently occurring cognitive impairment reporting.

Lifestyle variables or reinfections were not associated with the seven LC outcomes studied. Regarding COVID-19 vaccination, we were not able to identify any protective effect of it before COVID-19 hospitalization, but we did identify a protective effect of being fully vaccinated (i.e., having received the primary series of doses programmed according to the type of vaccine employed) or having received at least one booster dose at the time of the interview.

The model's c-statistic indicated overall moderate model accuracy, varying from 0.62 to 0.82.

## Discussion

The results of this study highlighted the high burden of symptoms associated with LC. We discuss this study's key contributions in estimating the prevalence of LC symptoms, identifying factors associated with their

**Table 2** Frequently occurring symptoms and present symptoms reporting among participants alive and who self-reported long COVID

| Symptoms | Frequently occurring symptom reporting | | | | Present symptom reporting | | | |
|---|---|---|---|---|---|---|---|---|
| | Participants alive (*N* = 11,328) | | Self-reported Long COVID (*N* = 4,450) | | Participants alive (*N* = 11,328) | | Self-reported Long COVID (*N* = 4,450) | |
| | % | 95% CI | % | 95% CI | % | 95% CI | % | 95% CI |
| General symptoms | 40.9 | 35.6; 46.2 | 67.1 | 59.4; 74.8 | 68.1 | 62.8; 73.4 | 85.0 | 79.3 90.6 |
| Fever | 0.3 | 0.0; 0.9 | 0.8 | 0.0; 2.4 | 5.9 | 3.5; 8.2 | 10.8 | 5.6; 15.9 |
| Fatigue | 34.0 | 28.9; 39.1 | 57.0 | 48.7; 65.2 | 63.1 | 57.7; 68.6 | 80.5 | 74.1; 86.9 |
| Post-exertional malaise | 32.3 | 27.3; 37.3 | 55.6 | 47.2; 64.09 | 50.4 | 44.7; 68.1 | 68.1 | 60.4; 75.7 |
| Cardiovascular symptoms | 12.6 | 9.3; 16.0 | 24.1 | 17.2; 31.0 | 44.2 | 38.9; 49.6 | 63.0 | 55.1; 70.9 |
| Chest pain/chest tightness | 9.8 | 6.7; 12.8 | 18.6 | 12.3; 24.9 | 29.7 | 24.6; 34.8 | 40.2 | 31.9; 48.4 |
| Palpitations | 8.6 | 5.8; 11.3 | 17.2 | 11.1; 23.2 | 32.1 | 27.2; 36.9 | 53.0 | 44.9; 61.1 |
| Respiratory symptoms | 18.2 | 14.3; 22.0 | 30.0 | 22.9; 37.1 | 52.4 | 46.9; 57.8 | 69.5 | 62.0; 76.9 |
| Breathlessness | 13.2 | 9.9; 16.6 | 25.6 | 18.8; 32.5 | 41.1 | 35.8; 46.4 | 59.6 | 51.7; 67.4 |
| Cough | 9.9 | 6.8; 12.9 | 15.5 | 10.1; 20.9 | 29.5 | 24.5; 34.5 | 41.0 | 32.8; 49.3 |
| Neurologic symptoms | 56.9 | 51.4; 62.3 | 80.3 | 72.6; 87.9 | 81.7 | 77.5; 86.0 | 96.2 | 93.1; 99.3 |
| Cognitive impairment | 27.5 | 22.7; 32.3 | 47.6 | 39.2; 56.1 | 54.8 | 49.4; 60.2 | 77.2 | 70.4; 84.1 |
| Headaches or migraines | 10.6 | 7.4; 13.7 | 17.1 | 11.2; 23.1 | 30.9 | 26.0; 35.8 | 48.3 | 39.9; 56.7 |
| Sleep alteration | 28.4 | 23.8; 33.0 | 48.1 | 39.98; 56.3 | 42.3 | 37.0; 47.5 | 65.0 | 57.0; 73.0 |
| Numbness | 27.4 | 22.0; 32.7 | 43.6 | 35.2; 52.0 | 50.0 | 44.4; 55.6 | 71.0 | 63.7; 78.3 |
| Dizziness | 10.6 | 7.3; 13.9 | 19.3 | 13.0; 25.6 | 40.9 | 35.6; 46.2 | 59.8 | 51.6; 67.9 |
| Distortion of reality | 1.9 | 0.4; 3.4 | 4.3 | 0.6; 8.0 | 12.3 | 8.8; 15.7 | 23.5 | 16.0; 30.9 |
| Difficulty walking or moving about | 16.7 | 13.0; 20.4 | 30.6 | 23.3; 38.0 | 31.5 | 26.7; 36.2 | 49.0 | 40.6; 57.3 |
| Problems with vision | 19.2 | 15.1; 23.2 | 31.7 | 23.9; 39.4 | 32.4 | 27.6; 37.2 | 53.6 | 45.2; 61.9 |
| Gastrointestinal symptoms | 13.9 | 10.3; 17.5 | 23.5 | 16.5; 30.4 | 31.5 | 26.3; 36.7 | 45.3 | 37.0; 53.6 |
| Abd. pain, nausea, vomiting, diarrhea | 8.1 | 5.2; 11.1 | 14.8 | 9.0; 20.6 | 21.8 | 17.6; 25.9 | 34.0 | 26.0; 41.9 |
| Weight loss/reduced appetite | 7.2 | 4.8; 9.7 | 12.3 | 7.0; 17.5 | 16.1 | 12.2; 20.0 | 22.1 | 15.3; 28.9 |
| Musculoskeletal symptoms | 33.2 | 28.1; 30.3 | 56.3 | 47.9; 64.8 | 51.5 | 46.3; 56.7 | 70.5 | 62.4; 78.7 |
| Joint pain | 30.1 | 25.1; 35.0 | 51.6 | 43.1; 60.1 | 46.6 | 41.4; 51.8 | 66.2 | 57.9; 74.5 |
| Muscle pain | 22.7 | 18.3; 27.1 | 40.4 | 32.3; 48.6 | 37.0 | 31.9; 42.2 | 57.0 | 48.5; 65.4 |
| Ear-nose-throat symptoms | 20.3 | 16.1; 24.4 | 37.2 | 29.3; 45.2 | 49.3 | 44.1; 54.6 | 73.4 | 66.2; 80.6 |
| Tinnitus | 5.1 | 3.2; 6.9 | 9.8 | 5.6; 14.0 | 20.4 | 16.4; 24.5 | 32.0 | 24.2; 39.8 |
| Earache | 1.0 | 0.0; 2.2 | 2.2 | 0.0; 5.1 | 7.7 | 4.9; 10.5 | 12.5 | 7.0; 18.1 |
| Sore throat | 2.6 | 1.3; 3.9 | 4.8 | 2.0; 7.7 | 14.4 | 10.1; 18.7 | 20.5 | 14.2; 26.8 |
| Loss of taste and/or smell | 9.1 | 6.2; 12.0 | 19.1 | 13.0; 25.3 | 15.8 | 11.8; 19.8 | 28.8 | 20.9; 36.8 |
| Stuffed-up or congested nose | 9.5 | 6.7; 12.3 | 15.1 | 9.9; 20.4 | 23.8 | 19.1; 28.5 | 34.1 | 27.0; 41.4 |
| Dermatological symptoms | 16.1 | 12.4; 19.7 | 27.0 | 20.1; 33.9 | 28.1 | 22.9; 33.2 | 37.2 | 29.3; 45.1 |
| Skin rash | 2.5 | 0.9; 4.1 | 4.2 | 1.0; 7.4 | 6.4 | 4.0; 8.8 | 9.7 | 5.3; 14.1 |
| Hair loss | 14.2 | 10.7; 17.7 | 24.1 | 17.6; 30.7 | 24.0 | 18.9; 29.0 | 32.3 | 24.7; 39.9 |
| Psychiatric symptoms | 39.5 | 34.5; 44.4 | 66.3 | 58.4; 74.1 | 66.0 | 60.9; 71.2 | 89.8 | 84.8; 94.8 |
| Little interest, feeling down | 25.3 | 21.0; 29.7 | 50.1 | 41.8; 58.3 | 48.1 | 42.5; 53.6 | 76.3 | 69.4; 83.3 |
| Symptoms of anxiety | 27.3 | 22.6; 32.0 | 47.1 | 38.6; 55.7 | 50.5 | 45.0; 56.1 | 73.9 | 66.9; 80.9 |
| Symptoms of PTSD | 14.9 | 11.0; 18.7 | 24.9 | 17.8; 32.1 | 34.0 | 29.0; 38.9 | 48.3 | 39.8; 56.8 |

reporting, and considering the implications for effectively responding to the demands of LC and ensuring appropriate, person-centred care.

Furthermore, the study is based on data from a probability sample of a large urban city, focusing on a population that is mainly reliant on the public health system, the Unified Health System (SUS), with a significant part facing high socioeconomic vulnerability, as the results indicate.

Studies of LC prevalence use diverse definitions of LC, likely contributing to the widely varying prevalence estimates. Features that make estimating prevalence challenging include a large number of potential symptoms, an episodic pattern with fluctuations in the presence and

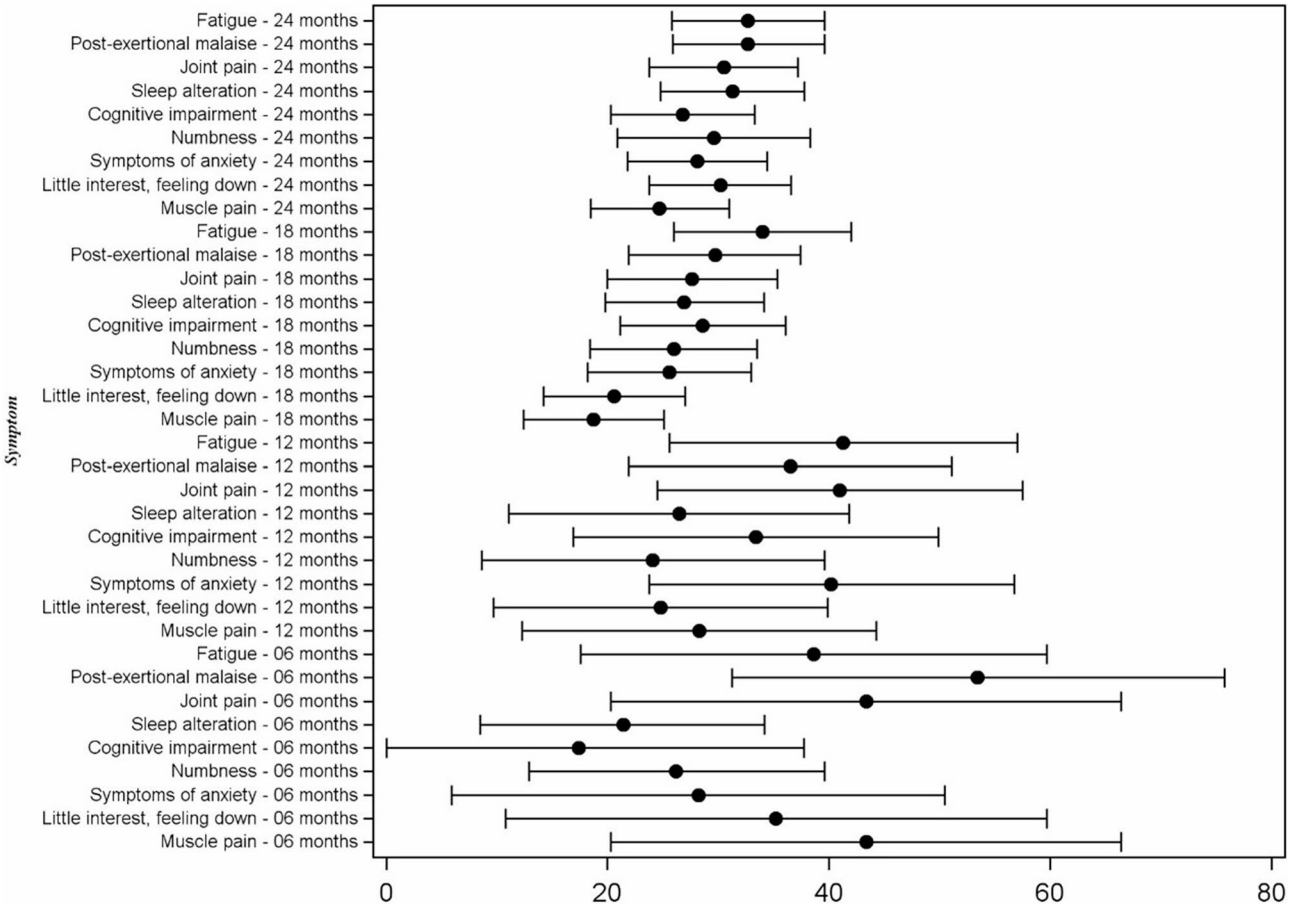


**Fig. 2** Estimates for the main frequently occurring symptoms reported in the study cohorts

**Table 3** Distribution of the number of frequently occurring and present symptoms reported

| Statistics | | Frequently occurring symptoms | | Present symptoms | |
|---|---|---|---|---|---|
| | | All Participants (*N* = 11,328) | Self-reported Long COVID (*N* = 4,450) | All Participants (*N* = 11,328) | Self-reported Long COVID (*N* = 4,450) |
| Minimum | | 0.0 | 0.0 | 0.0 | 0.0 |
| Max | | 22.0 | 22.0 | 27.0 | 27.0 |
| Mean | Estimate | 4.3 | 7.6 | 9.2 | 13.6 |
| | Std. error | 0.3 | 0.4 | 0.4 | 0.5 |
| | 95% CI | 3.9; 4.8 | 6.9; 8.3 | 8.6; 9.8 | 12.8; 14.4 |
| Q1 | Estimate | 0.0 | 2.9 | 3.0 | 8.3 |
| | Std. error | 0.1 | 0.5 | 0.4 | 0.7 |
| | 95% CI | 0.0; 0.2 | 1.9; 3.9 | 2.2; 3.7 | 7.0; 9.7 |
| Median | Estimate | 2.0 | 6.4 | 7.9 | 12.7 |
| | Std. error | 0.3 | 0.4 | 0.6 | 0.6 |
| | 95% CI | 1.5; 2.5 | 5.5; 7.2 | 6.8; 9.0 | 11.5; 13.9 |
| Q3 | Estimate | 6.5 | 10.4 | 13.1 | 17.8 |
| | Std. error | 0.4 | 0.6 | 0.6 | 0.8 |
| | 95% CI | 5.8; 7.3 | 9.3; 11.5 | 11.9; 14.4 | 16.1; 19.4 |

intensity of symptoms over time, and a widespread lack of access to clinical diagnoses or tests.

Some studies have considered at least one persistent symptom as a criterion for LC [8, 13, 29, 30]. On this basis, our study points to a prevalence of 71.3% for at least one frequently occurring symptom and 91.1% for at least one present symptom. These estimates are relatively high compared to other studies of hospitalized

**Table 4** Logistic regression models for LC measures and the main frequently occurring symptoms

| | At least one frequently occurring symptom | Frequent Fatigue | Frequent Post-Exertional Malaise | Frequent Joint Pain | Frequent Sleep Disorder | Frequent Cognitive Impairment | Self-reported long COVID |
|---|---|---|---|---|---|---|---|
| | OR(95% CI) | | | | | | |
| Age at COVID-19 hospitalization admission (ref.: 60 + years + omitted categories in the model) | | | | | | | |
| 18–29 | - | - | - | 0.21*(0.06; 0.72) | 0.17*(0.04; 0.76) | - | - |
| 30–39 | - | 2.35*(1.00; 5.55) | 1.49(0.70; 3.14) | 1.49(1.65; 29.32) | | - | - |
| 40–49 | - | 1.56(0.82; 3.0) | 2.00*(1.04; 3.88) | 1.20(0.59; 2.42) | | - | - |
| 50–59 | - | 1.59(0.89; 2.83) | 1.48(0.82; 2.66) | 1.69°(0.94; 3.02) | | - | - |
| Gender – Cis woman (ref.: Other) | 3.48****(1.95; 6.21) | 2.61****(1.63; 4.16) | 3.20****(2.01; 5.10) | 3.08****(1.86; 5.11) | 2.13**(1.32; 3.45) | 2.07**(1.29; 3.34) | - |
| Race/color – Black (ref.: Other) | - | - | - | - | 2.86***(1.53; 5.34) | - | - |
| Number of comorbidities | - | - | - | - | - | - | 1.42***(1.18; 1.71) |
| Comorbidities before COVID-19 | | | | | | | |
| Asthma/bronchitis (Yes vs. No) | - | - | - | 2.57*(1.16; 5.69) | - | - | - |
| Cancer (Yes vs. No) | - | - | - | - | - | - | 0.03***(0.01; 0.19) |
| Chronic liver disease (Yes vs. No) | - | - | 6.09**(1.75; 21.24) | - | - | - | - |
| Diabetes (Yes vs. No) | 1.98°(0.95; 4.11) | 1.81*(1.03; 3.20) | 2.06*(1.17; 3.63) | - | - | 1.72°(0.99; 3.00) | - |
| Heart disease (Yes vs. No) | 3.77*(1.24; 11.49) | 2.44**(1.25; 4.76) | 2.56**(1.32; 4.98) | 1.95°(0.97; 3.90) | 1.80°(0.97; 3.33) | - | 0.36*(0.15; 0.84) |
| Immunodepression/immunodeficiency (Yes vs. No) | 23.85**(2.92; 194.51) | - | - | - | - | - | - |
| Pulmonary disease (Yes vs. No) | 3.79*(1.17; 12.33) | - | - | - | - | - | - |
| Number of post-COVID symptoms | - | - | - | - | - | - | 1.38****(1.29; 1.48) |
| Ventilatory support use during COVID-19 hospitalization (Yes vs. No/Unknown) | - | - | - | - | - | 2.60*(1.21; 5.61) | 2.39*(1.19; 4.79) |
| COVID-19 vaccination status at interview (reference: unvaccinated or incomplete) | | | | | | | |
| Complete/Full | - | - | - | 0.39°(0.14; 1.08) | 0.17**(0.06; 0.54) | - | - |
| Booster | - | - | - | 0.47°(0.20; 1.09) | 0.23**(0.09; 0.58) | - | - |
| **C Statistic** | **0.70** | **0.64** | **0.65** | **0.67** | **0.62** | **0.63** | **0.82** |

°$0.05 < p \leq 0.10$; *$0.01 < p \leq 0.05$; **$0.001 < p \leq 0.01$; ***$0.0001 < p \leq 0.001$; ****$p \leq 0.0001$

populations, which generally do not differentiate between frequent and present symptoms [6–8]. A meta-analysis of European, Asian, and American studies reported that 54% of the hospitalized population for acute COVID-19 experienced at least one symptom after discharge [8].

Considering results from studies with hospitalized patients methodologically comparable in Latin America, the estimates in this study are not discrepant from those obtained in other studies in Brazil, such as the 84.0% prevalence at a median of 138 days after disease onset in patients discharged between July 2020 and March 2021, in Minas Gerais [29], and the 87.4% and 67.5% prevalences at six and 12 months post-discharge in patients discharged between October 2021 and March 2022, in Mato Grosso [13]. However, we underline that this study encompasses a larger period for the occurrence of acute

COVID-19 and a longer follow-up, highlighting a high LC prevalence even two years after discharge. In contrast, the estimates provided here are significantly higher than the 47.0% prevalence estimate at six months after discharge in patients discharged between March 2020 and September 2021 in Santander, Colombia [30].

One factor influencing prevalence is the level of pre-existing comorbidity in the population of people hospitalized in SUS for COVID-19, also considering that it's a relatively older population (almost 40% were over 60 years old when hospitalized). Secondly, approximately 75% of the population assisted by SUS likely includes a higher proportion of the most socially vulnerable individuals within the Brazilian population [31]. The rates of pre-existing chronic comorbidities found are similar to those reported for the elderly in a national household survey [32] and sound consistent, considering that younger adults hospitalized for COVID-19 were more likely to have comorbidities than those in the general population.

Given the challenges and lack of consensus on measuring LC, we used patients' self-reports of LC as one measure. We found that self-reported LC is consistently associated with a higher prevalence and number of LC symptoms, bolstering its validity as a useful measure. Conversely, however, many patients reporting one or several symptoms of LC did not self-report having LC, which, at least partially, may reflect very low levels of awareness among healthcare providers and the general population. While this situation continues, we argue that using a combination of methods – both self-reported LC and reporting of symptoms – remains necessary. At the same time, given the variability in estimates and measurement practices, guidance on standardized measures and reporting requirements is urgently needed to yield comparable and reliable prevalence estimates.

There is an urgent need for healthcare providers and the public to be educated on the condition. As diagnosis and awareness levels increase, we might expect changing patterns in responses to outcome measures, with, for example, patients becoming increasingly likely to self-report LC and less widely understood symptoms such as PEM. Understanding these changing levels of awareness will inform interpretation of reported prevalence estimates.

In common with other studies, including some in Latin America, fatigue was the most prevalent symptom [6–8, 11, 13, 14, 29, 33, 34], with frequent occurrence reporting of 34.0% in the population and 63.1% among those self-reporting LC. Also noteworthy, with prevalence levels above 25%, were joint pain, sleep disturbance, cognitive impairment, numbness, feeling anxious, and little interest/feeling down, as found elsewhere [6–8, 11, 13, 14, 29, 34].

Making a more novel contribution, this study also assessed the prevalence of PEM, which has yet to receive attention in Brazil and is only rarely investigated in global LC prevalence studies. We found a population estimate of PEM of 32.0%, and among those with LC self-report, 55.6%, which is remarkably similar to studies of PEM among LC patients in other countries [35].

The reporting of a high prevalence of disabling symptoms such as fatigue, PEM, and pain – and the lack of attention given to PEM – may suggest specific challenges for people living with LC, such as mobility issues in accessing healthcare services and difficulties in performing work-related tasks and accessing social rights for disability benefits.

Another novel contribution is the finding that 25.3% of menstruating people and 38.1% of those who self-report having LC experience worsened symptoms during menstruation. Given the magnitude of these impacts, we recommend incorporating measures of PEM and menstruation impacts in future LC studies.

Regarding the factors associated with having LC, our study corroborates trends in the international literature. From the logistic regressions, we underscore the consistently higher risk for cis women compared to cis men. The association of female sex with the high likelihood of LC has been described by several studies [6, 7, 11, 12, 17, 30, 36, 37].

Despite significant differences in symptom burden between men and women, we did not observe the same pattern in self-reported LC. Possible explanations for this may include gendered differences in how individuals tolerate symptoms or attribute them to specific causes [38]; it could also be related to limited public awareness of LC in the Brazilian context [39].

Regarding the age effect, this study's findings corroborate the idea of a nonlinear effect [40], in contrast to greater risk among older individuals [6, 7]. As people within a working age range (e.g., 30–39) are affected, we raise concerns about LC impacting the workforce and individuals' socioeconomic status [2].

In contrast to other studies [9, 10, 13], this work did not identify an association between income and LC. The question about income was the most sensitive and generated the highest number of non-answers in the research, which were treated as a category itself. The predominance of socially vulnerable individuals may have masked the study's capacity to capture differences detected by other studies. Additionally, it is important to underline how socioeconomic conditions, specifically income, affect access to the necessary care and the possibility of mitigating the condition's impacts on people's work, social life, and quality of life.

Vaccination significantly reduced hospitalizations due to COVID-19 in Brazil [31], which in turn influenced

the difficulty of recruiting patients from the end of 2021 (cohorts of six and 12 months) in this study. Our sample included a high proportion of unvaccinated people at the COVID-19 hospitalization, and we did not observe an effect of the variable on LC risk. Interestingly, even modestly, results suggest that vaccination post-hospital discharge may ameliorate LC symptoms, as found by other researchers [41].

This study confirms the association of LC symptoms with pre-existing comorbidities, as indicated by other studies [6, 8, 17, 36]. The association between joint pain and asthma/bronchitis may seem surprising, but it is supported by studies linking osteoarthritis and asthma, which affect each other through several mechanisms, including inflammatory pathogenesis [42, 43]. The findings suggest that these conditions serve as important risk factors, warranting the implementation of special protocols post-hospital discharge to flag these patients and refer them for targeted screening and monitoring.

LC self-reporting was found to be credible in light of the consistency of the results. We should underline the importance of healthcare providers considering LC self-perception, regardless of patients' gender, to increase person-centred care. Self-perceived health has been considered a valid indicator of morbidity, quality of life, reduced functionality, and a predictor of mortality.

Although we evaluate that the study has robust and consistent results, we should highlight some limitations. The inclusion of only hospitalized patients, though justified by the availability of records for sample design, incurs higher estimates of symptoms than in the general population with COVID-19. The prevalence of LC is likely to be higher among hospitalized than non-hospitalized patients. Still, international studies find that among the population of people with LC, far more have *not* been hospitalized than hospitalized, indicating that the LC burden amongst previously hospitalized patients is only the tip of the iceberg. Data from the FAIR Health's repository of 78,252 patients diagnosed with LC indicated that 81.6% of females had not had a COVID-19 hospitalization compared to 67.5% of males [40].

The non-participation of a large proportion of patients who could not be contacted or declined may have biased the results, with more vulnerable groups, such as homeless people, more likely to be excluded, but also the risk of those with more severe or persistent symptoms being more inclined to respond to the survey, leading to an overestimation of the prevalence of symptoms. Nonetheless, in addition to meeting sampling design requirements, our approach successfully included the population of SUS users, with limited but some diversity in terms of education, income, race, and geography (including residents of vulnerable areas with high violence rates) [22]. Small numbers in our sample did not allow us to make inferences about some subgroups of the population, such as Transgender individuals or Indigenous, which does not mean that they have not been affected or are not likely to have a higher risk of LC.

The limited numbers in the six- and 12-month cohorts reduced the representation of fully vaccinated people in the sample and hindered exploring differences across the cohorts.

We should also underline that we did not account for possible effects of post-hospitalization care on the presence of symptoms or the perception of LC in the study population. We did not measure the participants' post-hospitalization physical activity and were therefore unable to consider its effect on the relationship between PEM and LC.

Finally, we cannot disregard the potential for symptom self-reporting bias, and the more critical fact that when patients were unable to participate in the interview, we allowed their caregivers to participate on their behalf to maximize inclusiveness. Carers' answers may lack information or accuracy.

## Conclusions

The results of this study shed light on LC in a significant urban center in Latin America with over 6 million inhabitants, marked by high social vulnerability and socioeconomic inequities. Considerable representation of the population affected by these inequities is included. This study contributes to the understanding of LC in a Latin American metropolis and highlights a pressing need to ensure appropriate and accessible healthcare for LC.

### Abbreviations

| | |
|---|---|
| BMI | Body mass index |
| CI | Confidence interval |
| LC | Long COVID |
| PEM | Post–exertional malaise |
| SUS | [Brazilian] Unified Health System |
| WHO | World Health Organization |

## Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12879-025-11615-w.

Supplementary Material 1.

Supplementary Material 2.

Supplementary Material 3.

Supplementary Material 4.

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### Clinical trial number

Not applicable.

**Authors' contributions**
MCP – conceptualisation, data curation, formal analysis, funding acquisition, investigation, methodology, project administration, supervision, writing – original draft, and writing – review & editing; SMLL – conceptualisation, formal analysis, funding acquisition, investigation, methodology, writing – original draft, and writing – review & editing; CCE – conceptualisation, formal analysis, writing – original draft, and writing – review & editing; MM – conceptualisation, writing – original draft, and writing – review & editing; MTLV – methodology, writing – original draft, and writing – review & editing; BNC – conceptualisation, funding acquisition, methodology, writing – original draft, and writing – review & editing; MB – data curation, investigation, writing – original draft, and writing – review & editing; NPB – investigation, writing – original draft, and writing – review & editing; GG – investigation, writing – original draft, and writing – review & editing; BSR – investigation, writing – original draft, and writing – review & editing; DF – investigation, writing – original draft, and writing – review & editing; MC – investigation, writing – original draft, and writing – review & editing; ES – conceptualisation, writing – original draft, and writing – review & editing; LS – conceptualisation, writing – original draft, and writing – review & editing; SS – conceptualisation, funding acquisition, writing – original draft, and writing – review & editing; FC – conceptualisation, writing – original draft, and writing – review & editing; ELA – conceptualisation, funding acquisition, methodology, project administration, supervision, writing – original draft, and writing – review & editing.

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**Data availability**
The datasets generated and employed in the current study have not been made publicly available due to analyses still in progress. However, they may be obtained from the corresponding author upon reasonable request.

## Declarations

**Ethics approval and consent to participate**
This study followed Resolution n°. 466, issued by the Brazilian National Health Council on December 12, 2012, which draws upon the Declaration of Helsinki as one of its foundational references and seeks to protect the dignity, rights, safety, and well-being of research participants, upholding principles of autonomy, non-maleficence, beneficence, and justice. The project was submitted to and approved by the Research Ethics Committees of ENSP/Fiocruz (CAAE 57680922.3.0000.5240), the Rio de Janeiro Municipal Health Secretariat/RJ (CAAE 57680922.3.3001.5279), and one of the participating hospitals (CAAE 57680922.3.3003.5257), as required by its Direction. Given the international collaboration and funding, it was also submitted and approved by the National Research Ethics Commission (CONEP) (CAAE 57680922.3.0000.5240). All participants provided verbal informed consent.

**Consent for publication**
Consent for publication.

**Competing interests**
The authors declare no competing interests.

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