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Post-COVID-19 functional status in socioeconomically vulnerable neighborhoods attended in primary health care in two Brazilian cities: a cross-sectional study

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Abstract

Background The prolonged effects of COVID-19 present social costs and pose challenges to public health infrastructure, necessitating the implementation of public policies for comprehensive post-COVID-19 care.

Objective This study aimed to assess post-COVID functional status and associated sociodemographic factors and health inequalities among residents of socioeconomically vulnerable neighborhoods who attended primary health care in two Brazilian cities.

Methods A cross-sectional study was conducted from July 2022 to July 2023 in Salvador and Rio de Janeiro. We included participants who sought COVID-19 tests in primary health care services, had previously contracted COVID-19, and completed the post-COVID-19 functional status scale. Post-COVID syndrome was classified as none, negligible/slight, or moderate/severe. Sociodemographic characteristics, health conditions, and access to health services were analyzed as explanatory variables. Descriptive and bivariate analyses were performed. Using multinomial logistic regression, we estimated the adjusted odds ratios (aORs) and their 95% confidence intervals (95%CIs).

Results Among the 3,067 participants, the overall prevalence of post-COVID functional limitations status was 34.6% (26.7% and 7.9% reporting negligible/slight and moderate/severe, respectively). The following variables were associated with moderate/severe functional status: living in households with fewer rooms (aOR = 1.66, 95%CI: 1.23–2.24), female gender (aOR = 1.57, 95%CI: 1.14–2.16), older age (aOR = 1.02, 95%CI: 1.01–1.03), self-reported diabetes mellitus (aOR = 1.78, 95%CI: 1.17–2.69), respiratory diseases (aOR = 2.59, 95%CI: 1.56–4.29), having contracted COVID-19 two or more times (aOR = 1.57, 95%CI: 1.15–2.14), not having had a medical appointment in the last 12 months

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(aOR = 1.70, 95%CI: 1.24–2.33), difficulty accessing COVID-19 testing (aOR = 1.63, 95%CI: 1.05–2.52), and experience discrimination in health services (aOR = 2.85, 95%CI: 1.87–4.35).

Conclusions Our findings indicate varying degrees of post-COVID functional limitation status among residents of socioeconomically vulnerable neighborhoods who have recovered from COVID-19. People who live in homes with fewer rooms, are female, older, have pre-existing diabetes or respiratory diseases, have been reinfected with COVID-19, have difficulty accessing COVID-19 testing and those who experienced discrimination in health services are at higher chance of developing post-COVID syndrome.

Keywords Post-Acute COVID-19 syndrome, COVID-19, Vulnerable populations, Primary health care, Cross-Sectional studies

Introduction

Long COVID-19, post-COVID-19 condition, or post-COVID-19 syndrome is one of the long-lasting consequences of the COVID-19 (C19) pandemic and presents major challenges to public health. It occurs due to the persistence or onset of symptoms after resolution of acute infection by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2). Generally, it reduces the functional capacity to perform activities of daily living and/or social interaction [1, 2]. The symptoms associated with post-COVID-19 syndrome can involve multiple organ systems, leading to physical, mental, emotional, and neurological effects, with varying degrees of symptom intensity, ranging from mild to debilitating [2, 3].

Global estimates indicate that 10 to 20% of people who have already had C19 may develop post-COVID syndrome [2]. Studies on this subject have revealed that the estimated prevalence ranges from 30 to 70% in different countries worldwide [4, 5], varying according to the context and methodological differences, such as the period of analysis and the study population. Several strategies have been used to investigate post-COVID syndrome. The Post-COVID-19 Functional Status (PCFS) scale has been successfully used to measure the impact of symptoms on the functional status of individuals after C19, with good construct validity [6]. This scale has proven to be a valuable tool to be used as a patient-reported outcome measure for determining the post-COVID functional status after hospital discharge due to C19 in Brazil [7, 8], France [9], and Spain [10], and in non-critically ill patients in Nepal [5], and Egypt [11], and might indicate post-COVID-19 syndrome. Its use for individuals with less severe disease can contribute to the identification of those at high risk of developing post-COVID syndrome and to direct follow-up procedures with a multidisciplinary approach to primary health care (PHC) in community settings. This study aimed to assess post-COVID functional status and associated sociodemographic factors and health inequalities among residents of socioeconomically vulnerable neighborhoods who attended primary healthcare in two Brazilian cities.

Methods

Study design and population

This study represents a segment of the cross-sectional component of the TQT-C19 project: " Testing, isolation, quarantine, and telemonitoring strategy of C19 in Primary Health Care", with participants from two vulnerable communities in Brazil: the Cabula-Beirú neighborhood in Salvador, Bahia State, and the Manguinhos neighborhood in Rio de Janeiro, Rio de Janeiro State [12]. These populations are marked by social vulnerabilities, reflected in precarious infrastructure, problems with public safety and unequal access to basic services, such as health, education and sanitation [13, 14]. These locations were chosen for the investigation due to the precarious sociodemographic conditions of the population, similarly to several other peripheral regions in Brazil. In addition, both regions are covered by PHC and have residents from different social strata [13, 14].

Study participants were encouraged to undergo C-19 testing and participate in the research through various strategies, including the internet and online social media, community radio stations, podcasts, community health workers' recruitment, school health programs, mobilization of religious institutions and mobilization of civil society organizations. Individuals aged 12 years or older were invited to complete to a structured questionnaire, and children under 12 years of age had their questions answered by parents or guardians. Primary health care providers telemonitored individuals who tested positive using telephone contact or text messages sent by cell phone applications. Those with comorbidities were contacted every 24 h, and those without comorbidities were contacted every 48 h. Follow-ups were conducted until the end of isolation or quarantine. Further details and supplementary materials can be found in Magno et al. [12].

Data collection and ethical issues

The data were collected between July 2022 and July 2023. The sample used was non-probabilistic, for convenience, and consisted of primary health care users, residing in the communities. Individuals from the two communities

that searched PHC services, and presented symptoms associated with C-19 that have appeared 3 to 7 days after onset or havd close contact with a confirmed case of C-19 (symptomatic or asymptomatic) were eligible to participate in TQT-C19 study.

Initially, the health provider or a research assistant presented the research objectives, procedures, and consent forms to the participants. All individuals aged 18 years or older, who were invited to participate, signed written informed consent (WIC) forms. Children and adolescents under 18 years old participated of the research with the authorization of their parents or guardians. Only swabs were collected from children under 12 years of age, and parents or guardians answered the research questionnaire. Adolescents aged 12–17 signed assent forms, had swabs collected, and answered the research questionnaire.

Posteriorly, C19 testing was performed by a health provider, and a sociobehavioral questionnaire was applied while the result was awaiting, respecting all biosafety and ethical procedures. The questionnaire, developed for this study and published previously [12], was composed of the following blocks: (1) sociodemographic and housing data; (2) history of comorbidities; (3) access to and use of health services; (4) history of infection and previous tests for C19; (5) vaccination history; (6) behaviors, attitudes, and practices of C19 prevention and self-medication, perception of severity, and risk of C19 infection; and (7) acceptability, feasibility, and use of the self-test. For this analysis, we evaluated the available data of 3,064 participants who reported having C19 previously and responded who to the PCFS scale.

Study variables

The outcome variable was the post-COVID functional status constructed from the PCFS scale, which was originally developed in English in 2020 [15], validated in 2021 [6], and validated in Brazilian Portuguese at the same year [8]. We used the following question from the scale "Did you have any limitations after C19 infection?". This question offered five grading options: grade 0 - no functional limitations (no symptoms, pain, depression, or anxiety after healing); grade 1 - negligible functional limitations (I can perform all daily tasks/activities at home or work despite some symptoms, pain, depression, or anxiety); grade 2 - slight functional limitations (I can perform daily tasks/activities at home or work at a lower intensity or occasionally avoid due to symptoms, pain, depression, or anxiety); grade 3 - moderate functional limitations (some daily tasks/activities at home or work have been reduced considerably due to symptoms, pain, depression, or anxiety); and grade 4 - severe functional limitations (I need assistance with activities of daily living (ADL) due to symptoms, pain, depression or anxiety. I need the attention of caregivers). Post-COVID-19 functional status was recategorized as: None; Negligible/Slight; or Moderate/Severe.

The explanatory variables were defined after a literature review: number of dwellers per household (up to 3, 4 and more); number of rooms in the household (up to 5, 6 and more); sex assigned at birth (male, female); race/color (non black, black); age (in years), schooling (higher education or college, high school, primary school); current smoking (no, yes); self-reported diagnosis in life of: obesity (no, yes), heart disease or hypertension (no, yes), diabetes mellitus (no, yes); respiratory diseases, for example: asthma, pulmonary emphysema, tuberculosis, etc. (no, yes); other morbidities (no, yes)– for this variable, we considered self-reported cancer under current treatment, hematological, chronic kidney, chromosomal, hepatic, autoimmune disease, and immunodeficiencies; number of C19 episodes (1, 2 and more); access to health services (exclusively by SUS - Brazilian National Health System [*Sistema Único de Saúde* in Portuguese], health insurance or private provider, both ways); medical consultation in the last 12 months (no, yes); difficulty in accessing C19 testing (no, yes); discrimination in health services (no, yes)– for this variable, we considered the self-report of discrimination at any time in life due to race, sexual orientation, low income or other reason.

Data analysis

Descriptive statistics were estimated for all study variables: categorical variables were described using frequency, relative frequency (%) and 95% confidence interval (95%CI), the numerical variable age was described by frequency, median (Med) and interquartile range (IQR). The associations between the study variables and PCFS were measured by the prevalence (P) in bivariate using the chi-square test, and for the numerical variable age, bivariate analysis used the non-parametric statistical Kruskal-Wallis test. Multivariate analysis estimating adjusted odds ratios (aORs) and 95% confidence intervals (95%CIs), using multinomial logistic regression. The multivariate analysis included in the initial model variables with a significance lower than 20% in the bivariate analysis and only those with a p-value lower than 5%, at least in one of the categories of the outcome, remained in the final model. The Akaike criterion was used to compare the models, and the Hosmer-Lemeshow test was used to evaluate the adequacy of the final model. Multicollinearity was assessed by variance inflation factor (VIF) and tolerance (1/VIF). All analyses were conducted using Stata 16.1 software.

Results

The TQT-C19 Project recruited 12,883 individuals, of which 7,941 (61.6%) answered the socio-behavioral questionnaire. Of these, 3,064 participants had a previous C19 diagnosis: 34.6% had post-COVID functional syndrome after SARS-CoV-2 infection, 26.7% had negligible or slight limitations (17.8% negligible and 8.9% slight) and 7.9% had moderate or severe limitations (6.3% moderate and 1.6% severe) (Table 1).

Most participants lived in households with up to 3 dwellers (68.2%) and up to 5 rooms (61.8%). More than half of them were female (70.3%), black (80.7%), and 40 and 59 yo (40.9%), had a higher education or more (33.5%), and high school (47.8%) and some were smokers currently (7.7%). Among the morbidities investigated, 4.4% of the participants reported obesity, 23.5% heart disease or hypertension, 9.3% diabetes mellitus, 4.8% respiratory diseases, 2.7% other morbidities, and 23.6% had 2 or more previous C19 episodes. Most accessed health services were exclusively through SUS (61.6%), 19.8% reported not having had a medical appointment in the last 12 months, 8.6% had difficulty accessing C19 testing, and 6.5% had experienced discrimination in health services. The median age was 40.4 years old, with an interquartile range from 30.4 to 51.3 (Table 1).

Bivariate analysis revealed a significantly greater prevalence of post-COVID syndrome among participants who lived in households with fewer rooms, were female, had self-reported obesity, heart disease or hypertension, diabetes mellitus, respiratory diseases, and other morbidities, 2 or more C19 episodes, who did not have a medical appointment in the last 12 months, who had difficulty accessing testing for C19, and who suffered discrimination in health services. Older age also significatively increased the severity of post-COVID syndrome (Table 2).

Multivariate analysis revealed that the highest odds of negligible and slight limitations were associated with the female sex (aOR = 1.35, 95%CI: 1.12–1.63), older age (aOR = 1.01, 95%CI: 1.01–1.02), self-reported diabetes mellitus (aOR = 1.35, 95%CI: 1.01–1.81), respiratory diseases (aOR = 1.74, 95%CI: 1.01–1.81), and other morbidities (aOR = 1.74, 95%CI: 1.20–2.52), having had two or more times COVID-19 episodes (aOR = 1.78, 95%CI: 1.11–2.87) and having difficulty accessing COVID-19 testing (aOR = 1.67, 95%CI: 1.26–2.21) (Table 3).

The factors associated with higher odds of moderate and severe post-COVID syndrome were living in households with fewer rooms (aOR = 1.57, 95%CI: 1.14–2.16), female sex (aOR = 1.53, 95%CI: 1.11–2.11), older age (aOR = 1.02, 95%CI: 1.01–1.03), self-report of diabetes mellitus (aOR = 1.78, 95%CI: 1.17–2.69), respiratory diseases (aOR = 2.59, 95%CI: 1.56–4.29), having had two or more C19 episodes (aOR = 1.57, 95%CI: 1.15–2.14), not having had a medical appointment in the last 12 months (aOR = 1.70, 95%CI: 1.24–2.33), having difficulty accessing C19 testing (aOR = 1.63, 95%CI: 1.05–2.52) and having experienced discrimination in health services (aOR = 2.85, 95%CI: 1.87–4.35) (Table 3).

The collinearity assessment showed an average VIF of 1.03, ranging from 1.01 to 1.11, and tolerance ranging from 0.9011 (for the variable age) to 0.9933, thus, there is no evidence of multicollinearity.

Discussion

The prevalence of post-COVID functional limitations in this study was lower than that observed in other studies in Brazil [4, 7] and other countries [5, 6, 10, 11]. Individuals living in households with fewer rooms, female sex assigned at birth, older age, who reported morbidities (i.e., diabetes mellitus, respiratory diseases, and others), who had two or more C19 infections, who had not a medical appointment in the last 12 months, who had difficulty accessing C19 testing, and who experienced discrimination in health services were associated with greater odds of post-COVID functional limitations.

Our study investigated post-COVID-19 functional status at the community level in people who sought to be tested for C19 in PHC units, regardless of previous hospitalization for C19. The prevalence differed from that reported in the studies by Battistela et al. [4] and Leite et al. [7] conducted in Brazil with the same scale, with previously hospitalized participants. The prevalences of any post-COVID functional limitations identified by these authors were 70.9% from 3 to 11 months after discharge, and 73.0% at hospital discharge, respectively. Our values were also lower than those identified in other Brazilian studies that used different instruments to investigate the persistence of post-COVID symptoms, in hospitalized participants (87.4%) [16] and regardless of hospitalization status (77.4%) [17]. The differences observed can be explained by the origin of the investigated population samples and the instrument used to diagnose the syndrome. The prevalence may have been lower in the present study because it investigated people who lived in neighborhoods with socioeconomic vulnerability but in areas covered by PHC. More severe cases of the disease, which require hospitalization, may increase the occurrence of post-COVID syndrome. Our findings were consistent with a community-based study conducted in England [3], in which the prevalence of symptoms ranged from 21.6 to 37.0%, depending on the time elapsed after acute C19 infection, despite the use of a different instrument to investigate the persistence of post-COVID-19 symptoms. In this study, the variable time was not measured, and as post-COVID syndrome may present a reduction in symptoms over time, this may reflect a lower prevalence.

Table 1 Characteristics of the study population ($n = 3,064$). TQT-C19 project, 2022–2023

Variables	*n*	%	95%CI[a]
Post-COVID Functional Status			
None	2,005	65.4	63.7–67.1
Negligible/Slight	817	26.7	25.1–28.3
Moderate/Severe	242	7,9	7.0-8.9
Number of household dwellers			
4 and more	974	31.8	30.2–33.5
Up to 3	2,090	68.2	66.5–69.8
Number of rooms in the household			
6 and more	1,170	38.2	36.5–39.9
Up to 5	1,894	61.8	60.1–63.5
Sex			
Male	910	29.7	28.1–31.3
Female	2,154	70.3	68.7–71.9
Race/Color			
Non-black	591	19.3	17.9–20.7
Black	2,473	80.7	79.3–82.1
Schooling			
Higher education or college	1,026	33.5	31.8–35.2
High school	1,464	47.8	46.0-49.5
Primary school	574	18.7	17.4–20.1
Current smoking			
No	2,829	92.3	91.3–93.2
Yes	235	7.7	6.8–8.7
Self-reported obesity			
No	2,928	95.6	94.8–96.2
Yes	136	4.4	3.8–5.2
Self-reported heart disease or hypertension			
No	2,345	76.5	75.0–78.0
Yes	719	23.5	22.0–25.0
Self-reported diabetes mellitus			
No	2,780	90.7	89.6–91.7
Yes	284	9.3	8.3–10.3
Self-reported respiratory diseases			
No	2,918	95.2	94.4–95.9
Yes	146	4.8	4.1–5.6
Other self-reported morbidities			
No	2,980	97.3	96.6–97.8
Yes	84	2.7	2.2–3.4
Number of C19 episodes			
1	2,340	76.4	74.8–77.8
2 and more	724	23.6	22.2–25.2
Access to health services			
Exclusively by SUS	1,889	61.6	59.9–63.4
Health insurance or private provider	434	14.2	13.0-15.4
Both ways	741	24.2	22.7–25.7
Medical consultation in the last 12 months			
Yes	2,459	80.2	78.8–81.6
No	605	19.8	18.4–21.2
Difficulty in accessing C19 testing			
No	2,802	91.4	90.4–92.4
Yes	262	8.6	7.6–9.6
Discrimination in health services			
No	2,865	93.5	92.6–94.3

Table 1 (continued)

Variables	*n*	%	95%CI[a]
Yes	199	6.5	5.7–7.4
Numerical Variable	**n**	**Med[b]**	**IQR[c]**
Age (in years)	3.064	40.4	30.4–51.3

Legend: [a]95%CI– 95% confidence interval, [b]Med - Median, [c]IQR– Interquartile range

Considering the severity of the limitation, most individuals had negligible or slight limitations; nevertheless, 7.9% reported moderate or severe limitations. Continuity of care for people who have developed post-COVID-19 limitations is necessary to prevent the worsening of some pre-existing conditions, new health problems, or the development of permanent sequelae [18]. Recently, initiatives have emerged in Brazil to develop lines of care to guide the diagnosis, treatment, and follow-up of patients with long-term C19. Resolution Nº. 719/2023 of the National Health Council, proposes the strengthening PHC, including of integrative and complementary practices, and providing adequate care protocols to ensure the education of health professionals and proper information for the population [19]. It also proposes establishing psychosocial support initiatives for individuals with sequelae due to C19, considering age and territorial aspects [19]. In addition to strengthening PHC, the importance of integrating with other points of the health network necessary for post-COVID-19 care is highlighted, in compliance with PHC attributes of care coordination and comprehensiveness.

Social inequalities in health can affect the risk of developing long COVID-19. Living in households with fewer rooms increased the chance of moderate to severe limitations by 66%. In this work, this variable works as a proxy for the individual's economic level or social class. Poor housing conditions hinder home isolation and increase the risk of SARS-Cov-2 infection [20]. Whitaker et al. observed an association between greater economic vulnerability and the occurrence of the syndrome [3]. In addition, inadequate rest in the first two weeks of the acute phase of the disease and lower income were associated with severe functional impact and the persistence of multisystem symptoms [21]. Thus, to ensure equity and comprehensiveness of care, it is essential to identify people in conditions of greater social vulnerability.

The chance of post-COVID syndrome was greater in women in all severity categories, which is in line with the findings of other studies [17, 22, 23]. Researchers have reported this association with the persistence of psycho-emotional symptoms, a greater chance of multiple post-COVID-19 symptoms [17, 23], and the presence of continuous multisystem symptoms, which are mainly linked to impairment in self-care [21, 24]. Gender-related health inequalities, however, have been widely discussed, including for long COVID [24]. Cohen and van der Meulen Rodger [24] revealed that women have greater odds of developing long-term C19 than men, a difference that is exacerbated by lower educational levels. As this research took place in more socially vulnerable communities, this was also an observed issue.

Older age increases the chance of post-COVID syndrome, each additional year of age increases the chance of this outcome in 1% for negligible or slight functional limitations and in 2% of moderate and severe limitations. Several studies have shown that long-term COVID is more prevalent in older people [16, 23], which is justified by physiological changes during the aging process. However, it is noteworthy that the persistence of symptoms in young individuals has repercussions for loss of quality of life and higher costs of long-term health care [25]. Among those who are economically active, it also leads to difficulty returning to work activities [23, 25, 26] and absenteeism [26].

Our findings indicate that the presence of some pre-existing comorbidities, especially diabetes mellitus and respiratory disease, increases the chance of functional limitations. These health conditions have been associated not only with a greater chance of long-term C19 [16, 17, 23] but also with ongoing multisystem symptoms [21] and functional limitations [11]. The persistence of symptoms may be due to organ damage, persistence of chronic inflammation, immune response, and complications related to comorbidities before C19 infection [27].

C19 reinfection was associated with a greater chance of poorer post-COVID functional status. Bowe et al. [28], in a study in the United States, reported that reinfection increased the risk of death, hospitalization, and chronic health problems. Considering that C19 has become endemic and that the threat of recontamination by new variants remains latent [29], we emphasize the need for public health strategies that reduce the risk of reinfections. Initially, it is essential to provide continuous immunization aimed at additional protection from severe outcomes among individuals with previous SARS-CoV-2 infection [30] and post-COVID syndrome [17]. In addition, health education policies aimed at health professionals and the community must be implemented to provide qualified care, especially among those with a greater chance of long COVID-19 [18].

Both not having a medical appointment in the last 12 months and difficulty accessing C19 testing were associated with a greater chance of post-COVID functional

Table 2 Bivariate analysis between selected variables and the post-COVID functional limitations. TQT-C19 project, 2022–2023

Variables	Post-COVID Functional Status						*p* Value
	None		Negligible/ Slight		Moderate/ Severe		
	n	*P*(%)[a]	*n*	*P*(%)[a]	*n*	*P*(%)[a]	
Number of household dwellers							0.230
4 and more	622	63.9	279	28.6	73	7.5	
Up to 3	1,383	66.2	538	25.7	169	8.1	
Number of rooms in the household							0.003
6 and more	798	68.2	302	25.8	70	6.0	
Up to 5	1,207	63.7	515	27.2	172	9.1	
Sex							< 0.001
Male	643	70.7	211	23.2	56	6.1	
Female	1,362	63.2	606	28.1	186	8.7	
Race/Color							0.259
Non-black	393	66.5	161	27.2	37	6.3	
Black	1,612	65.2	656	26.5	205	8.3	
Schooling							0.077
Higher education or college	693	67.6	267	26.0	66	6.4	
High school	926	63.3	409	27.9	129	8.8	
Primary school	386	67.2	141	24.6	47	8.2	
Current smoking							0.486
No	1,859	65.7	750	26.5	220	7.8	
Yes	146	62.1	67	28.5	22	9.4	
Self-reported obesity							0.011
No	1,932	66.0	770	26.3	226	7.7	
Yes	73	53.7	47	34.6	16	11.7	
Self-reported heart disease or hypertension							0.001
No	1,562	66.6	621	26.5	162	6.9	
Yes	443	61.6	196	27.3	80	11.1	
Self-reported diabetes mellitus							< 0.001
No	1,849	66.5	727	26.2	204	7.3	
Yes	156	54.9	90	31.7	38	11.4	
Self-reported respiratory diseases							< 0.001
No	1,934	66.3	765	26.2	219	7.5	
Yes	71	48.6	52	35.6	23	15.8	
Other self-reported morbidities							0.004
No	1,964	65.9	785	26.3	231	7.8	
Yes	41	48.8	32	38.1	11	13.1	
Number of C19 episodes							< 0.001
1	1,585	67.7	583	24.9	172	7.4	
2 and more	420	58.0	234	32.3	70	9.7	
How to access health services							0.145
Exclusively by SUS	1,218	64.5	512	27.1	159	8.4	
Health insurance or private provider	294	67.7	102	23.5	38	8.8	
Both ways	493	66.5	203	27.4	45	6.1	
Medical consultation in the last 12 months							0.014
Yes	1,625	66.1	657	26.7	177	7.2	
No	380	62.8	160	26.5	65	10.7	
Difficulty in accessing C19 testing							< 0.001
No	1,867	66.6	723	25.8	212	7.6	
Yes	138	52.7	94	35.9	30	11.4	
Discrimination in health services							< 0.001
No	1,902	66.4	757	26.4	206	7.2	
Yes	103	51.8	60	30.1	36	18.1	

Table 2 (continued)

Variables	Post-COVID Functional Status						*p* Value
	None		Negligible/ Slight		Moderate/ Severe		
	n	*P*(%)[a]	*n*	*P*(%)[a]	*n*	*P*(%)[a]	
Numerical Variable	**n**	**Med[b]**	**N**	**Med[b]**	**n**	**Med[b]**	***p*Value[c]**
Age (in years)	2.005	39.4	817	41.8	242	45.1	< 0.001

Legend: [a]P– Prevalence, [b]Med– Median, [c]*p* Value determined by Kruskal-Wallis test

limitations. Both indicators reflect barriers to accessing and using of health services for diagnosis and longitudinal care [18], even for study participants living in PHC-covered areas. The importance of a widespread network of services that enables a broad range of services, including testing for C19 and other diseases, is highlighted. Establishing access barriers can lead to worsening of people's health conditions and increased virus spread. Access to and quality of services should be prioritized in a public health system, such as the Brazilian National United Health, considering the challenges posed by long COVID-19. This issue needs to include social minorities as well. In this study, perceived discrimination, whether in the context of race, sexual orientation, social class or any other reason, increased the chance of moderate to severe post-COVID functional limitations, with an odds ratio of 2.79. According to Cohen and van der Meulen Rodgers [24], the impact of long COVID-19 on historically marginalized populations, both economically and socially, can be well evidenced. Structural racism and discrimination are systemic barriers that affect the health of this population, due to complex interactions with other social determinants of health [24].

Some limitations of this study are that the data were self-reported and subject to recall, information, non-response and social desirability biases. This may result in inaccurate data, overestimation of limitations and affect the representativeness of the results. The PCFS was measured by self-report, however, based on a previously validated scale. The data were collected at different time intervals concerning SARS-CoV-2 infection, which influences the severity of long COVID-19, and the evaluation and interpretation of the associations between these effects and C19 infection. Within the period studied, genetic mutations in the SARS-CoV-2 virus can also lead to changes in symptomatology and possibly to differences in the persistence of the post-COVID-19 symptoms.

Our choice of using odds ratio as a measure of effect may have overestimated the outcome for Negligible/ Slight functional limitations, since it had a high prevalence. Furthermore, the use of a non-probabilistic sample among primary health care users may have introduced a selection bias, restricting the possibilities of generalizing the results to other populations.

Conclusions

A poorer post-COVID functional status implies a reduced ability to self-care, and social, family, and health costs. Our findings revealed that COVID-19 survivors have varying degrees of functional limitations. The factors of living in a household with fewer rooms, female sex, older age, presence of pre-existing diseases, C19 reinfection, difficulty of accessing, and discrimination in health services are associated with increased chances of post-COVID functional limitations in residents of socioeconomically vulnerable neighborhoods in Brazil. The PCFS scale is useful for identifying people with worse functional performance in the community. In Brazil, it is necessary to develop health policies that can guarantee access to immunization services and actions, especially within the scope of the SUS. The proposals elaborated at the 17th National Health Conference [19] pave the way for the implementation of comprehensive care for individuals with sequelae due to C19.

Table 3 Crude and adjusted odds ratios between selected variables and post-COVID functional limitations. TQT-C19 project, 2022–2023

Variables	Negligible/Slight		Moderate/Severe		Negligible/Slight		Moderate/Severe	
	OR[a]	95%CI[c]	OR[a]	95%CI[c]	aOR[b]	95%CI[c]	aOR[b]	95%CI[c]
Number of household dwellers								
4 and more	1.00		1.00					
Up to 3	1.15	0.97–1.37	0.96	0.72–1.28				
Number of rooms in the household								
6 and more	1.00		1.00		1.00		1.00	
Up to 5	1.13	0.95–1.33	1.62	1.21–2.17	1.14	0.96–1.35	1.66	1.23–2.24
Sex								
Male	1.00		1.00		1.00		1.00	
Female	1.36	1.13–1.63	1.57	1.15–2.14	1.35	1.12–1.63	1.57	1.14–2.16
Race/Color								
Non-black	1.00		1.00					
Black	0.99	0.81–1.22	1.35	0.94–1.95				
Age	1.01	1.01–1.02	1.02	1.01–1.03	1.01	1.01–1.02	1.02	1.01–1.03
Schooling								
Higher education or college	1.00		1.00					
High school	1.15	0.95–1.38	1.46	1.07-2.00				
Primary school	0.95	0.75–1.20	1.28	0.86–1.90				
Current smoking								
No	1.00		1.00					
Yes	1.14	0.84–1.54	1.27	0.80–2.04				
Self-reported obesity								
No	1.00		1.00					
Yes	1.61	1.11–2.35	1.87	1.07–3.27				
Self-reported heart disease or high hypertension								
No	1.00		1.00					
Yes	1.11	0.92–1.35	1.74	1.31–2.32				
Self-reported diabetes mellitus								
No	1.00		1.00		1.00		1.00	
Yes	1.47	1.12–1.93	2.21	1.50–3.24	1.35	1.01–1.81	1.78	1.17–2.69
Self-reported respiratory diseases								
No	1.00		1.00		1.00		1.00	
Yes	1.85	1.28–2.67	2.86	1.75–4.67	1.74	1.20–2.52	2.59	1.56–4.29
Other self-reported morbidities								
No	1.00		1.00		1.00		1.00	
Yes	1.95	1.22–3.12	2.28	1.16–4.50	1.78	1.11–2.87	1.89	0.94–3.80
Number of C19 episodes								
1	1.00		1.00		1.00		1.00	
2 and more	1.51	1.26–1.82	1.54	1.14–2.07	1.56	1.29–1.88	1.57	1.15–2.14
How to access health services								
Exclusively by SUS	1.00		1.00					
Health insurance or private provider	0.82	0.64–1.06	0.99	0.68–1.44				
Both ways	0.98	0.81–1.19	0.70	0.49–0.99				
Medical consultation in the last 12 months								
Yes	1.00		1.00		1.00		1.00	
No	1.04	0.85–1.28	1.57	1.16–2.13	1.08	0.88–1.34	1.70	1.24–2.33
Difficulty in accessing C19 testing								
No	1.00		1.00		1.00		1.00	
Yes	1.76	1.33–2.32	1.91	1.26–2.91	1.67	1.26–2.21	1.63	1.05–2.52
Discrimination in health services								
No	1.00		1.00		1.00		1.00	
Yes	1.46	1.05–2.03	3.23	2.15–4.84	1.29	0.92–1.80	2.85	1.87–4.35

Legend: [a]OR - Odds Ratio; [b]aOR - Adjusted Odds Ratio; [c]95%CI – 95% confidence interval

Abbreviations

95%CI	95% confidence interval
ADL	Activities of Daily Living
aOR	Adjusted odds ratio
C19	Coronavirus Disease 2019
COVID-19	Coronavirus Disease 2019
OR	Odds ratio
PCFS	Post-COVID-19 Functional Status Scale
PHC	Primary Health Care
SARS-CoV-2	Severe acute respiratory syndrome coronavirus 2
SUS	Brazilian National United Health [Sistema Único de Saúde in Portuguese
TQT-C19	Testing, isolation, quarantine, and telemonitoring strategies for COVID-19 in primary health care
WHO	World Health Organization
WIC	Written informed consent

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Author contributions
DSM was involved in the study conceptualization, writing the original draft, data analysis, reviewing and editing the contributions to the manuscript. GA was involved in writing the original draft, reviewing and editing the contributions to the manuscript. FS was involved in the methodology, data collection and reviewing the manuscript. LM was involved in the conceptualization and methodology of the study, as well as in the data collection and reviewing of the final version of the manuscript. TRAR was involved in the study conceptualization, methodology, data collection and reviewing the manuscript. TST was involved in the methodology of the study and reviewing the manuscript. VGV was involved in fundraising and in the methodology of the study. DC was involved in the methodology of the study and reviewing the manuscript. ID was involved in the study conceptualization, methodology, fundraising and review. All authors read and approved the final manuscript.

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Data availability
The datasets generated and/or analyzed during the current study are private due to other analyses that are still being carried out but are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate
The research was conducted under the guidelines of the Resolution of the Brazilian Research Ethics Committee (numbers 466/2012 and 510/2016). The protocol was approved by the Research Ethics Committees of the World Health Organization (WHO) (identification protocol under numbers CERC.0128 A and CERC.0128B) and by the local Brazilian Institutional Research Ethics Committees (identification protocol in Salvador - ISC/UFBA: nº 53844121.4.1001.5030; and in Rio de Janeiro - INI/Fiocruz: nº 53844121.4.3001.5240, ENSP/Fiocruz: nº 53844121.4.3001.5240, and SMS/RJ: nº 53844121.4.3002.5279). All individuals invited to participate received a verbal explanation of the study, its goals, and its methods, and were invited to sign written informed consent (WIC) forms. These forms described the research objectives, the potential risks and benefits of participating, and their voluntary nature. WIC forms were obtained from all participants aged 18 years or older. Children and adolescents under 18 years of age participated only with the authorization of their parents or guardians. Adolescents aged 12–17 also signed assent forms.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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