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Authors' affiliation:
[1]Universidad de Costa Rica, Escuela de Biología, San José, Costa Rica. fabiana.rey@ucr.ac.cr
0009-0009-2991-5750
[2]Universidad de Costa Rica, Escuela de Biología, San José, Costa Rica. adriana.rojasbermudez@ucr.ac.cr
0009-0008-3379-5934
[3]Universidad de Costa Rica, Escuela de Biología, San José, Costa Rica. sofía.solanoperez@ucr.ac.cr
0009-0009-9666-6264
[4]Clínica Bíblica, Laboratorio de Diagnóstico Molecular, San José, Costa Rica. kgutierrez@clinicabiblica.com
0009-0006-1948-9047.
[5] Universidad de Costa Rica, Centro de Investigación en Biología Celular y Molecular, San José, Costa Rica. gabriela.chavarriasoley@ucr.ac.cr
0000-0002-7153-4072
[6]Autora correspondiente: Universidad de Costa Rica, Centro de Investigación en Biología Celular y Molecular, San José, Costa Rica. henriette.raventos@ucr.ac.cr
0000-0001-9423-8308

Abbreviations:
COVID o COVID-19; Infectious disease caused by the SARS-CoV-2 coronavirus
LC; Long COVI
LR; Likelihood ratio
SARS-CoV-2; Severe Acute Respiratory Syndrome Coronavirus 2

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Conflict of Interest
The authors have no conflicts of interest.

Human Resources: Faculty, technical staff, and students from the University of Costa Rica: Collaboration on fieldwork activities, including participant recruitment, survey administration, and the collection of biological samples.

✉ henriette.raventos@ucr.ac.cr

Original (translation)

Clinical and Sociodemographic Characterization of Long COVID-19 in Costa Rica

Fabiana Rey-Cuadra[1], Adriana Rojas-Bermúdez[2], Sofía Solano-Pérez[3], Karla Sofía Gutiérrez-González[4], Gabriela Chavarría-Soley[5], Henriette Raventós[6]

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Abstract

Aim: to describe the clinical and sociodemographic profile of adults in Costa Rica who contracted Severe Acute Respiratory Syndrome Coronavirus type 2 and experienced symptoms for three months or longer after the acute phase of infection—classified as long COVID—and to compare them with adults without persistent symptoms, in order to identify factors linked to symptom persistence.

Methods: We carried out a retrospective descriptive study of Costa Rican adults recruited between January and October 2022. Eligibility required a laboratory-confirmed infection by Severe Acute Respiratory Syndrome Coronavirus type 2 at least three months before enrolment, documented by polymerase chain reaction, rapid antigen assay, or antibody-based test. Participants with compatible symptoms and an epidemiological link but no prior confirmation underwent serological testing for antibodies. An online questionnaire gathered demographic data, medical history, vaccination status, and symptoms. Based on these data, participants were classified as (1) individuals with symptoms lasting three months or longer (long COVID, strict phenotype) or (2) controls without prolonged symptoms; those reporting only nonspecific symptoms were excluded.

Results: among 448 participants, 193 met criteria for the strict long COVID phenotype, 198 served as controls, and 57 were excluded as indeterminate. The cohort was predominantly female (61.1 %) and younger than forty years (73.9 %). Most had a single documented infection (67.3 %), and 56.5 % reported acute-phase symptoms that limited daily activities. Complete vaccination was recorded in 91 %. The likelihood of long COVID was higher in females (probability ratio = 2.33; p value less than 0.001), in adults forty years or older (probability ratio = 1.82; p value = 0.039), in those whose acute symptoms restricted daily activities (probability ratio = 2.09; p value = 0.002), and in participants with mental-health disorders (probability ratio = 1.87; p value = 0.018). No associations emerged with vaccination status, smoking, alcohol use, physical activity, or number of comorbidities. Fifty-seven percent of long COVID cases reported poorer health than before the infection.

Conclusion: these findings align with international reports and underscore the need for prospective studies—particularly those stratified by sex—to clarify the long-term consequences of long COVID. They also highlight the urgency of comprehensive health policies to mitigate its impact on quality of life. This study provides the first snapshot of long COVID in Costa Rica and lays groundwork for future research on post-viral syndromes in this population.

Keywords: coronavirus infections, risk factors, demography, signs and symptoms.

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In May 2023, the World Health Organization lifted the declaration of a public health emergency of international concern for the infectious disease caused by SARS-CoV-2, known as COVID or COVID-19.[1] (World Health Organization. Statement on the fifteenth meeting of the IHR (2005) Emergency Committee on the COVID-19 pandemic. Geneva: WHO; 2023. [accessed 08/22/2023]. Available at: https://www.who.int/news/item/05-05-2023-statement-on-the-fifteenth-meeting-of-the-international-health-regulations-(2005)-emergency-committee-regarding-the-coronavirus-disease-(covid-19)-pandemic). However, many physical and mental sequelae following recovery from acute infection require further study.[2,3]

Currently, more than 775 million cases of COVID-19 have been reported worldwide, and it is estimated that 10-30% of those infected continue to experience symptoms months after the initial infection.[4,5] (World Health Organization. WHO COVID-19 dashboard. Geneva: WHO; 2024. [accessed 06/17/2024]. Available at: https://data.who.int/dashboards/covid19/cases). When symptoms persist beyond 3 months and cannot be explained by an alternative diagnosis, the condition is referred to as long COVID (LC).[6–8] (World Health Organization. A clinical case definition of post-COVID-19 condition by a Delphi consensus. Geneva: WHO; 2021. [accessed 10/06/2021]. Available at: https://www.who.int/publications-detail-redirect/WHO-2019-nCoV-Post_COVID-19_condition-Clinical_case_definition-2021.1)

LC encompasses one or more of 200 clinical manifestations[9], which may be the same as or different from those experienced during the acute phase and may evolve in various ways over time. (World Health Organization. A clinical case definition of post-COVID-19 condition by a Delphi consensus. Geneva: WHO; 2021. [accessed 10/06/2021]. Available at: https://www.who.int/publications-detail-redirect/WHO-2019-nCoV-Post_COVID-19_condition-Clinical_case_definition-2021.1)(Centers for Disease Control and Prevention. Post-COVID conditions. Atlanta: CDC; 2024. [accessed 06/18/2024]. Available at: https://www.cdc.gov/coronavirus/2019-ncov/long-term-effects/index.html). Among the most common symptoms are brain fog, fatigue, post-exertional malaise, cough, shortness of breath, headache, and anosmia/hyposmia and/or ageusia/hypoesthesia[10] (National Center for Biotechnology Information. Postacute coronavirus (COVID-19) syndrome. Treasure Island (FL): StatPearls Publishing; 2024. [accessed 04/23/2024]. Available at: https://www.ncbi.nlm.nih.gov/books/NBK570608/). The pathophysiology of LC manifestations is associated with tissue damage[11], chronic inflammation due to dysregulation of the immune response[12], reactivation of latent viruses, tissues acting as a residual reservoir for SARS-CoV-2, and other mechanisms currently under investigation.[4,13-15]

The most commonly reported risk factors for LC in the international literature are related to preexisting conditions, the severity of SARS-CoV-2 infection during the acute phase[16-20], female gender[19-27], smoking[28,29], and vaccination[26,30]. Some studies show a higher prevalence of LC among people aged 35 to 64.[23,26,29,31–34] Additionally, socioeconomic characteristics also play an important role, as groups with lower socioeconomic status have a higher risk of developing LC.[25,26,35-39] However, it is important to note that socially disadvantaged communities are underrepresented in research studies for various reasons, such as limited access to medical care and local resources.[40]

The diversity of LC presentations and triggers complicates our understanding of this condition, affects diagnostic capabilities and clinical management, and places an additional economic burden on health care systems and on affected individuals with resulting disabilities.[41,42] Therefore, efforts have been made to identify groups of patients with similar clinical presentations of LC, referred to as "LC phenotypes."[43–47] This allows for better monitoring and a more targeted therapeutic approach. Furthermore, it facilitates an understanding of the disease's inherent pathophysiological mechanisms.[48]

The objective of this study is to describe a sample of individuals in Costa Rica with symptoms persisting for at least 3 months following the acute phase of COVID-19. By comparing them with individuals who did not report prolonged clinical manifestations potentially related to SARS-CoV-2 infection, we also describe certain clinical and sociodemographic conditions and characteristics associated with persistent symptoms. This is the first report of Long COVID in the Costa Rican population.

Methods

The project was approved by the Ethical-Scientific Committee of the University of Costa Rica and complied with all international ethical guidelines for research involving human subjects.

Study Design. A retrospective, descriptive study was conducted to examine the clinical, sociodemographic, and genotypic characteristics of a group of Costa Ricans with a confirmed diagnosis of COVID-19. In this first article, only the clinical and sociodemographic results were presented.

Study Population. The sample included individuals recruited between January and October 2022, primarily from the Central Valley, who met the following inclusion criteria: 1) being Costa Rican, 2) being of legal age, and 3) having had at least one SARS-CoV-2 infection three months or more prior to recruitment, confirmed by polymerase chain reaction (PCR) or rapid diagnostic tests. For participants who did not meet the third criterion but were suspected of having the infection

based on symptoms and contact with a confirmed case, the diagnosis was confirmed via an antibody test.

Processing and analysis of biological samples. After signing the informed consent form, blood was drawn via peripheral venipuncture at the Molecular Human Genetics Laboratory of the School of Biology (University of Costa Rica) and at the Hospital Clínica Bíblica, into two tubes: one containing ethylenediaminetetraacetic acid for deoxyribonucleic acid extraction, and the other containing a coagulation activator plus a separating gel for serological confirmation of SARS-CoV-2 infection. To this end, the tubes were centrifuged, the serum was collected, and a double-antigen sandwich electrochemiluminescence immunoassay using Elecsys Anti SARS-CoV-2 was performed to detect total antibodies against the SARS-CoV-2 spike protein on the cobas 6000 platform (Roche Diagnostics).

Questionnaire. Using the information available at the time of the study regarding the presentation of COVID-19 and LC, a group of experts designed an online questionnaire that included: age, sex, occupation, place of residence, vaccination status (doses, vaccine type, vaccination dates), medical conditions and treatment prior to the first COVID-19 diagnosis, physical activity, smoking, and alcohol consumption prior to COVID-19 infection, dates of infection, tests used for diagnosis, and clinical manifestations (see the questionnaire in APPENDIX 1). The clinical manifestations that participants experienced during the acute episode(s) (if they had more than one episode) and the symptoms of LC they experienced before or during the 3 months prior to, and even at the time of, recruitment were recorded.

Definition of Long COVID. To define LC, participants were classified into two groups: 1) those who reported symptoms that persisted for 3 months or more after the acute episode and were not present beforehand; and 2) those who did not present any symptoms 3 months after contracting COVID (control group). Within the first LC group, two subcategories were defined: (a) broad phenotype, where the sole criterion was the presence of any symptom or symptoms 3 months after the acute episode; and (b) the strict phenotype, which included only those individuals who reported one or more of the most characteristic symptoms of long COVID, namely dyspnea, fatigue, post-exertional malaise, brain fog, and persistent changes in taste or smell. Because the first group included individuals with one or more highly nonspecific symptoms common in the general population, such as headache, we decided to classify them as doubtful cases and excluded them from the analysis in this article. Consequently, LC included only individuals with the strict phenotype. The control group consisted of individuals without any prolonged symptoms.

Definition of categories:

- Broad-spectrum long COVID: Presence of any symptom 3 months or more after the acute episode of COVID-19 that was not present prior to that episode.
- Strict long COVID: Presence of at least one of the most characteristic symptoms of long COVID, namely, shortness of breath, fatigue, post-exertional malaise, brain fog, and persistent changes in taste or smell, 3 months or more after the acute episode of COVID-19 and not present prior to that episode.
- Non-smoker: Has never smoked regularly.
- Former smoker: Used to smoke but has quit.
- Smoker: Smokes occasionally or frequently.
- Does not consume alcohol: Has never consumed alcoholic beverages.
- Sporadic alcohol consumption: Consumes alcoholic beverages once a month or less.
- Regular alcohol consumption: Consumes alcohol at least 2–4 times a month.
- Little exercise: Engages only in activities that do not require physical exertion.
- Moderate exercise: Engages in regular physical activity several days a week.
- Regular exercise: Engages in endurance sports for several hours a week or daily at a competitive level.
- Insufficient income: They do not have enough to make ends meet and have difficulty or great difficulty saving.
- Sufficient income: They have just enough to make ends meet without great difficulty, or they have enough to live comfortably and can save.
- 1 infection: An individual who was infected with the COVID-19 virus on a single occasion.
- 2 infections: An individual who was infected with the COVID-19 virus on two occasions.
- 3 infections: An individual who was infected with the COVID-19 virus on three occasions.
- Asymptomatic or mild symptoms during the acute phase: An individual who has no symptoms or has symptoms that did not interfere with daily activities.
- Moderate or severe symptoms during the acute phase: An individual who is at home and has difficulty performing daily activities and/or required hospitalization.

- Incomplete vaccination series: An individual who received fewer than three doses of the COVID-19 vaccine.
- Complete vaccination series: An individual who received three doses of the COVID-19 vaccine.
- Complete vaccination series plus booster: An individual who received three doses of the COVID-19 vaccine and subsequently one or more booster doses.
- No comorbidities: An individual who has no other diseases or conditions in addition to COVID-19.
- 1 to 2 comorbidities: An individual who has one to two diseases or conditions in addition to COVID-19.
- 3 or more comorbidities: An individual with three or more diseases or conditions in addition to COVID-19.
- Type of comorbidity: Name of the disease or condition in addition to COVID-19 diagnosed in an individual.

Statistical analysis. The questionnaire data were coded and classified into the categories defined in the box. Descriptive statistics were performed; R version 4.4.2 was used to calculate the chi-square test of independence, and a logistic regression analysis was also conducted (with long COVID-19 as the dependent variable and sociodemographic information, severity during the acute phase, vaccination status, number of infections, and presence of comorbidities as independent variables).

Results

A total of 526 participants were recruited, of whom 60 were excluded due to negative antibody test results and 18 for failing to complete the questionnaire. Of the remaining 448 participants, 193 were classified as having the strict LC phenotype, 198 as not having LC (control group), and 57 were excluded from the preliminary analysis because they fell into the "doubtful cases" category according to the previously established definition. The demographic and socioeconomic characteristics of the 391 participants analyzed are presented in Table 1, while the clinical characteristics are shown in Table 2.

Table 1. Demographic and socioeconomic characteristics of a Costa Rican cohort and their distribution based on the presence or absence of persistent COVID-19 three months after the acute episode of COVID-19

Characteristics		LC N=193	Control N=198	Total N=391
Age	<40	131 (67,9%)	158 (79,8%)	289 (73,9%)
	⩾40	59 (30,6%)	38 (19,2%)	97 (24,8%)
	No response	3 (1,5%))	2 (1%)	5 (1,3%)
Sex	Female	136 (70,5%)	103 (52%)	239 (61,1%)
	Male	56 (29%)	95 (48%)	151 (38,6%)
	No response	1 (0,5%)	0	1 (0,3%)
Smoking[1]	Non-smoker	148 (76,7%)	167 (84,3%)	315 (80,6%)
	Former smoker	20 (10,3%)	13 (6,6%)	33 (8,4%)
	Smoker	25 (13%)	18 (9,1%)	43 (11%)
Alcohol consumption[2]	Never	37 (19,2%)	39 (19.7%)	76 (19,4%)
	Occasional consumption	77 (39,9%)	81 (40,9%)	158(40,4%)
	Regular consumption	79 (40,9%)	78 (39,4%)	157(40,2%)
Physical activity[3]	Low	69 (35,7%)	60 (30,3%)	129 (33%)
	Moderate	72 (37,3%)	76 (38,4%)	148 (37,8%)
	Consistent	52 (27,0%)	62 (31,3%)	114 (29,2%)
Economic income[4]	Insufficient	34 (17,6%)	30 (15,2%)	64 (16,4%)
	Sufficient	159 (82,4%)	168 (84,8%)	327 (83,6%)

1: non-smoker (has never smoked regularly), former smoker (used to smoke but has quit), smoker (smokes occasionally or frequently).
2: never (does not consume alcoholic beverages), occasional consumption (consumes alcoholic beverages once a month or less), regular consumption (consumes alcoholic beverages at least 2–4 times a month).
3: low (performs physically undemanding tasks), moderate (regular physical activity several days a week), consistent (endurance sports for several hours a week or daily at a competitive level).
4: insufficient (does not earn enough to make ends meet and experiences difficulties or significant difficulties), sufficient (earns just enough without significant difficulties or can make ends meet and save).

Table 2. Clinical characteristics of the Costa Rican sample studied and their distribution based on the presence or absence of long COVID-19 three months after the acute episode of COVID-19

Characteristics		LC N=193	Control N=198	Total N=391
No. of infections	One time	111 (57.5%)	152 (76.8%)	263 (67.3%)
	Two times	64 (33.2%)	38 (19.2%)	102 (26.1%)
	Three times	18 (9.3%)	8 (4%)	26 (6.6%)
Severity during the acute phase[1]	Asymptomatic or mild	62 (32.1%)	103 (52%)	165 (42.2%)
	Moderate or severe	129 (66.9%)	92 (46.5%)	221 (56.5%)
	No response	2 (1%)	3 (1.5%)	5 (1.3%)
Vaccination[2]	Schedule I	4 (2.1%)	3 (1.5%)	7 (1.8%)
	Schedule C	16 (8.3%)	12 (6.1%)	28 (7.2%)
	Schedule C+R	173 (89.6%)	183 (92.4%)	356 (91.0%)
No. of comorbidities	No comorbidities	73 (37.8%)	106 (53.5%)	179 (45.8%)
	1 to 2 comorbidities	92 (47.7%)	77 (38.9%)	169 (43.2%)
	3 or more comorbidities	28 (14.5%)	15 (7.6%)	43 (11%)
Type of comorbidity	Diabetes (type I or II only; gestational diabetes not included)	7 (3.6%)	4 (2.0%)	11 (2.8%)
	Coronary artery disease or heart attack (myocardial infarction)	3 (1.6%)	0	3 (0.8%)
	Hypertension (high blood pressure)	28 (14.5%)	12 (6.1%)	40 (10.2%)
	Overweight	38 (19.7%)	35 (17.7%)	73 (18.7%)
	Obesity	11 (5.7%)	7 (3.5%)	18 (4.6%)
	Stroke	1 (0.5%)	0	1 (0.1%)
	Blood clots in the legs and/or lungs	3 (1.6%)	0	3 (0.8%)
	Kidney disease requiring dialysis	0	0	0
	Chronic hepatitis B or C, or other chronic liver disease	1 (0.5%)	0	1 (0.1%)
	Anemia	4 (2.1%)	1 (0.5%)	5 (1.3%)
	Asthma	32 (16.6%)	29 (14.6%)	61 (15.6%)
	Other lung disease such as COPD, chronic bronchitis, or emphysema	5 (2.6%)	3 (1.5%)	8 (2.0%)
	Cancer	2 (1.0%)	1 (0.5%)	3 (0.8%)
	Brain or nervous system disorder (e.g., dementia, Parkinson's disease)	0	1 (0.5%)	1 (0.1%)
	HIV	3 (1.6%)	0	3 (0.8%)
	Arthritis	3 (1.6%)	2 (1.0%)	5 (1.3%)
	Tuberculosis	0	0	0
	Other condition causing a weakened immune system	14 (7.3%)	6 (3.0%)	20 (5.1%)
	Mental health problems (depression, anxiety, other disorders)	68 (35.2%)	40 (20.2%)	108 (27.6%)

1: Asymptomatic/mild (asymptomatic or at home with mild symptoms), moderate/severe (at home with difficulty performing daily activities and/or hospitalized).
2: Schedule I (incomplete), Schedule C (complete), Schedule C + R (complete and booster).

Table 3. Prediction of the risk of long COVID in the Costa Rican population using logistic regression						
Variables	**β**	**SE**	**z**	***p***	**PR**	**95% CI**
Constant	-0,79	0,65	1,23	0,220	0,45	0.13 - 1.61
Age ⩾ 40 years	0,6	0,29	2,06	0,039	1,82	1.03 - 3.22
Male sex	-0,85	0,24	3,51	<.001	0,43	0.27 - 0.69
COVID-19 ×3	1,11	0,49	2,25	0,024	3,05	1.16 - 8.03
COVID-19 ×2	0,8	0,27	3,01	0,003	2,23	1.32 - 3.75
Relevant severity	0,74	0,23	3,14	0,002	2,09	1.32 - 3.31
Vaccination	0,04	0,16	0,24	0,812	1,04	0.75 - 1.43
Former smoker	0,18	0,46	0,39	0,693	1,2	0.49 - 2.94
Smoker	0,46	0,39	1,19	0,234	1,58	0.74 - 3.37
Occasional alcohol consumptionl	-0,1	0,31	0,33	0,744	0,9	0.49 - 1.67
Regular alcohol consumption	0	0,32	0	1	1	0.53 - 1.89
Moderate physical activity	-0,12	0,27	0,42	0,672	0,89	0.52 - 1.52
Consistent physical activity	-0,26	0,3	0,89	0,372	0,77	0.43 - 1.37
Insufficient income	0,15	0,32	0,49	0,624	1,17	0.63 - 2.17
Pre-existing comorbidities prior to COVID						
Diabetes	0,62	0,7	0,88	0,377	1,86	0.47 - 7.42
Hypertension	0,75	0,46	1,63	0,103	2,11	0.86 - 5.19
Overweight	-0,63	0,34	1,86	0,063	0,53	0.28 - 1.04
Obesity	0,01	0,57	0,02	0,985	1,01	0.33 - 3.11
Anemia	1,47	1,23	1,19	0,233	4,35	0.39 - 48.74
Asthma	0,14	0,32	0,44	0,659	1,15	0.62 - 2.14
Pulmonary condition	0,22	0,81	0,28	0,782	1,25	0.25 - 6.15
Arthritis	-0,87	1,12	0,77	0,439	0,42	0.05 - 3.8
Weakened immune system	0,28	0,59	0,47	0,64	1,32	0.41 - 4.22
Mental health problems	0,63	0,27	2,36	0,018	1,87	1.11 - 3.15

β = Beta coefficient; SE = Standard error; z = z-statistic; p = p-value; OR = Odds ratio; CI = Confidence interval.

Below are some relevant descriptive results. 73.9% of the participants were under 40 years of age, and 61.1% were female. 67.3% reported having had a single SARS-CoV-2 infection. Regarding the severity of acute symptoms during the infection, 56.5% indicated that their symptoms prevented them from continuing their daily activities, while 42.2% reported no such impacts. 14.1% required hospitalization. 91.0% had completed the full vaccination series, including a booster shot. Regarding health habits, 80.6% did not smoke, 40.4% consumed alcohol sporadically, 40.2% did so regularly, and 37.8% engaged in moderate physical activity. 83.6% reported having sufficient income.

Among those classified as having LC, 71% were female and 29% were male. 47.7% had between one and two comorbidities. The most common comorbidities were mental health problems (35.2%), being overweight (19.7%), asthma (16.6%), and hypertension (14.5%).

Figure 1 shows the statistically significant associations with LC. Among these, women are more likely to have LC than men, with an odds ratio (OR) of 2.33 ($p < 0.001$). People over the age of 40 also showed a higher risk (PR = 1.82; $p = 0.039$). Those who reported acute symptoms that interfered with their daily activities were twice as likely to develop LC compared to those who had no symptoms or only mild symptoms (PR = 2.09; $p = 0.002$). Among comorbidities, mental health problems increased the risk of LC (RR = 1.87; $p = 0.018$).

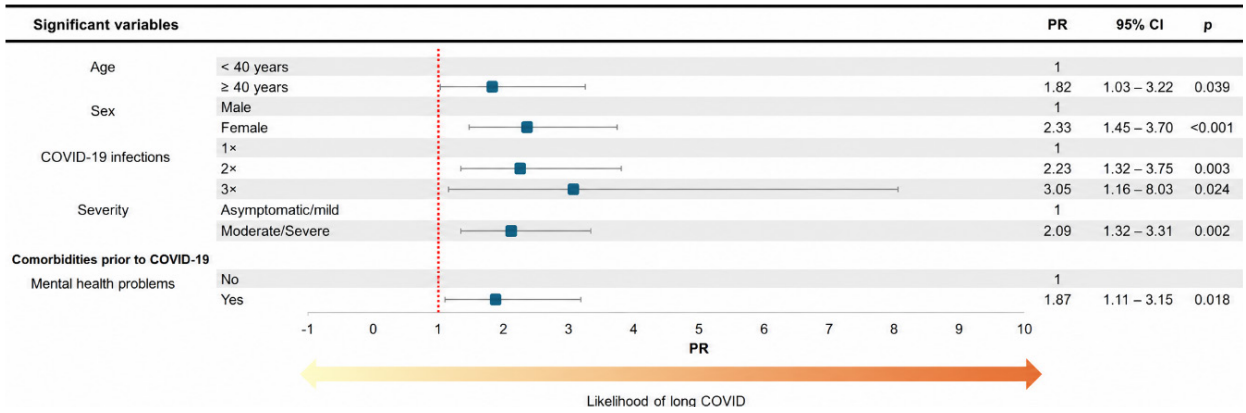

Figure 1. Variables associated with long COVID in a Costa Rican cohort. OR = odds ratio; CI = confidence interval; p = p-value; 1X = infected with COVID-19 once, 2X = infected with COVID-19 twice, 3X = infected with COVID-19 three times.

The number of infections was also associated with an increased risk: individuals with two infections were more than twice as likely to develop LC (RR = 2.23; p = 0.003), and those with three infections had a threefold higher risk (RR = 3.05; p = 0.024), compared with those who were infected only once. No statistically significant association was observed between unvaccinated status and the risk of LC (Figure 2). Nor were significant associations identified with other factors such as smoking, alcohol consumption, frequency of physical activity, or the number of comorbidities (Figure 2).

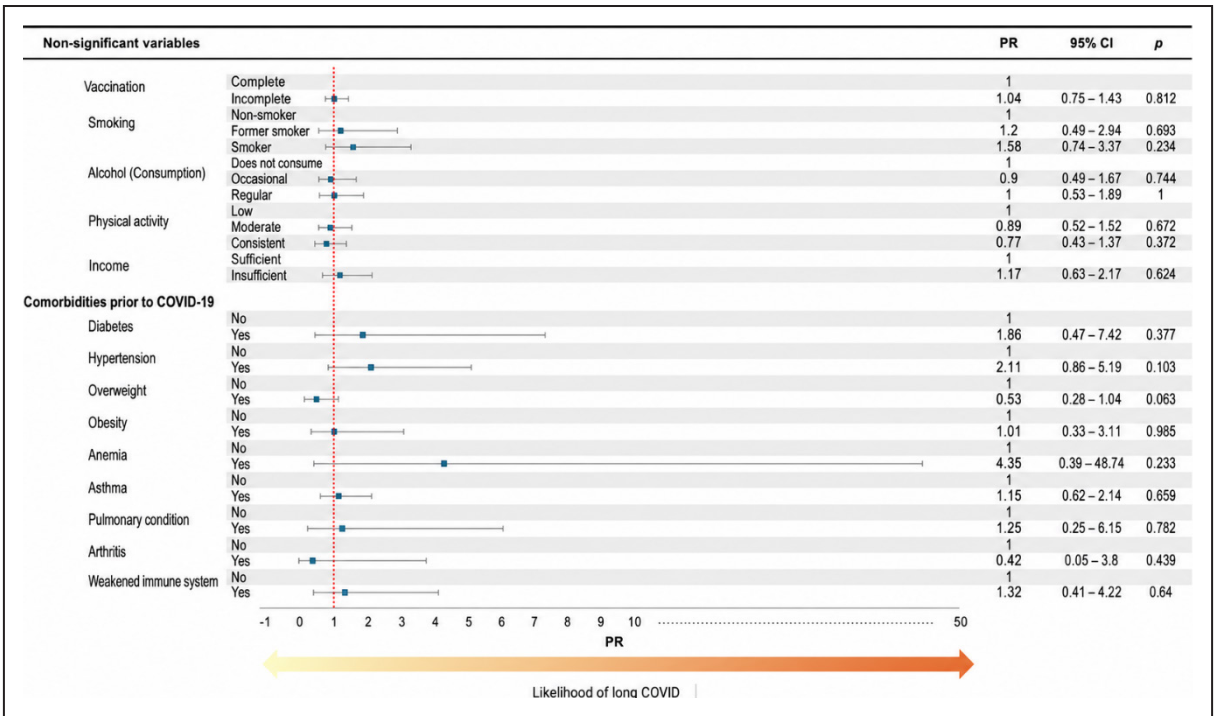

Figure 2. Variables not associated with long COVID in a Costa Rican cohort. OR = Odds ratio; CI = Confidence interval; *p* = p-value.

Figure 3 shows the self-reported health status of people with LC before and after acute infection. Fifty-seven percent reported a deterioration in health following infection. In the group without LC, 16% reported a worsening in their health. The association between LC and worsening health was statistically significant (X^2 = 73.35; g.l. = 2; p < 2.2×10^{-16}).

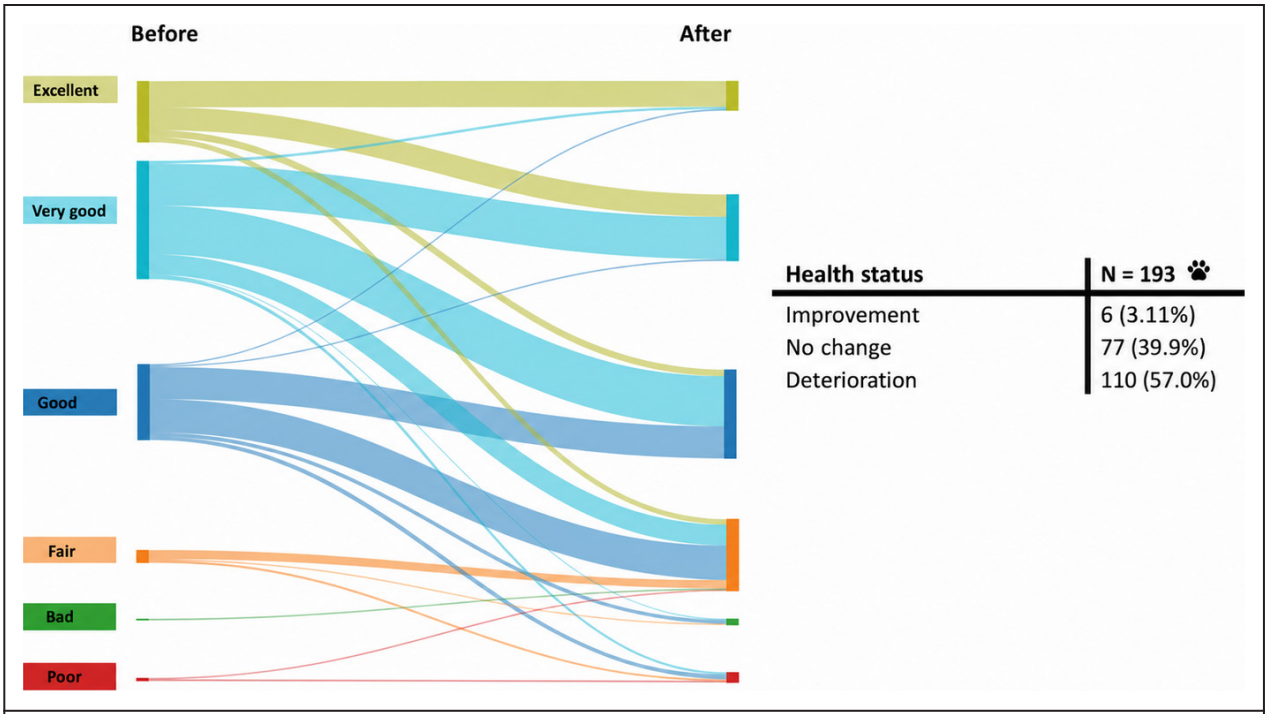

Figure 3. Self-reported health status among individuals diagnosed with long COVID in Costa Rica, before and after the acute episode of COVID-19.

Discussion

The results of this study suggest that certain demographic and clinical factors, such as age, sex, severity of acute illness, number of reinfections, and history of mental health conditions, are associated with a higher likelihood of developing LC in the Costa Rican population, as has been reported in other studies.[49–52] Specifically, a higher risk of LC was observed in individuals over 40 years of age, even though the sample consisted primarily of young adults. This finding is consistent with previous studies that have identified a relationship between advanced age and a higher prevalence of LC.[15,25,33,34,50,51] This relation could be explained by immunosenescence associated with aging, which promotes greater virus-induced inflammation and favors the development of comorbidities, thereby increasing older adults' susceptibility to developing this condition.[53]

Furthermore, the higher incidence of LC among women is consistent with studies that point to immunological and hormonal differences as possible explanations.[23,54,55] It is believed that differences in immunological correlates between men and women may be related to how each sex's immune system responds to infection, influenced by hormonal and genetic factors.[56,57] This pattern highlights the need to include a sex-specific approach in research on post-infectious syndromes, such as LC.

Another relevant finding is the association between the severity of symptoms in the acute phase and the subsequent development of LC, suggesting that the initial intensity of the infection may directly influence the duration and persistence of its long-term effects, reinforcing the hypothesis that a more intense initial response may predispose individuals to lasting effects.[23,45,58] However, unlike what has been observed in other studies[58–62], variables such as smoking, physical activity, or vaccination did not show significant associations. This discrepancy could be explained by the small size of the corresponding subgroups (for example, only 11% were smokers and 7% were unvaccinated), which limits the statistical power to detect differences.

With regard to mental health, the association between preexisting disorders and a higher likelihood of developing persistent symptoms is confirmed.[63-65] Individuals experiencing depression, anxiety, stress, worry, or loneliness prior to infection have a higher risk of exhibiting persistent COVID-19 symptoms.[63,64] Furthermore, an association has been identified between preexisting mental health disorders and the persistence of symptoms not only in the context of COVID-19 but also in other infectious diseases.[65] Furthermore, a correlation was identified between the number of infections and the presence of persistent symptoms, suggesting a possible cumulative effect of the virus.[17,18,66] However, findings on this topic vary depending on the population

studied. While some studies suggest a protective effect of immunity acquired through vaccination or prior infection[30,67], others, such as the present study, indicate that each new infection may increase the risk of persistent symptoms, albeit of lesser severity.[68]

A particularly noteworthy aspect is the perception of health among those with long COVID, where more than half reported perceiving a deterioration in their health, compared to 16% in the group without long-term symptoms. This difference reflects not only physical deterioration but also an impact on emotional and functional well-being. Previous studies have documented that long COVID compromises quality of life in multiple dimensions, affecting the physical, neurocognitive, and neuropsychiatric abilities necessary to perform daily activities.[69,70,71] These findings reinforce the urgency of health policies that prioritize a multidisciplinary approach, tailored to the specific needs of this population.[70]

Among the study's limitations are the inherent barriers of retrospective studies that rely on participants' memories.[72] Since this was a self-administered questionnaire, it is possible that some questions were interpreted differently by participants, introducing variability that may affect the generalizability of the results. Despite this, this study represents a valuable contribution by offering the first detailed analysis of LC in Costa Rica. Furthermore, it helps identify trends that could guide the development of public health policies and improve medical care. These findings highlight the importance of continuing to investigate LC through prospective studies to better understand its long-term impact and thereby contribute to the well-being of our population. Furthermore, understanding LC in a local context provides insights for addressing other post-viral syndromes, whose repercussions on public health may be equally significant.

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Declaration of Contribution by Each Author

Fabiana Rey-Cuadra and Adriana Rojas-Bermúdez, both first authors, contributed equally to the analysis of data (C), the drafting and preparation of tables and figures (D), and the approval of the final version (G). Adriana Rojas-Bermúdez also participated in data collection and blood sampling (B). Sofía Solano-Pérez, the second author, contributed to data analysis (C), writing (D), and approval of the final version (G). Karla Sofía Gutierrez-González participated in the planning (A), recruitment, and serological diagnostic confirmation (B), as well as in the approval of the final version (G). Gabriela Chavarría-Soley and Henriette Raventós contributed equally as senior researchers. Both planned and drafted the project and the instrument (A), assisted in the collection and categorization of data (B), participated in the data analysis, including the definition of categories (C), and participated in the drafting (D), critical review (F), and approval of the final version (G).

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