

COVID-19 Testing and Preventive Behaviours During The Pandemic's Onset: A Cross-sectional Study

Testagem para COVID-19 e Comportamentos Preventivos no Início da Pandemia: Estudo Transversal

RESUMO

Objetivo: Este estudo teve como objetivo analisar a exposição ao SARS-CoV-2 e o engajamento em práticas preventivas no início da pandemia de COVID-19. **Método:** Foi realizado um inquérito transversal de base populacional (Testar para Cuidar) em São Carlos, SP, Brasil, com amostragem aleatória estratificada por setores censitários. Um adulto por domicílio participou de entrevistas e testagem sorológica (anticorpos IgG anti-SARS-CoV-2-S1). As entrevistas abordaram dados demográficos, fatores socioeconômicos e epidemiológicos, comorbidades, sintomas gripais recentes e adesão a práticas de higiene e distanciamento social. **Resultados:** Participaram 3.921 indivíduos. A maioria (91,6%) relatou redução da mobilidade. Menor adesão esteve associada a idade jovem, sexo masculino, presença de crianças em idade escolar e ausência de benefícios sociais. O uso de máscaras foi elevado (97,1%), porém menor entre homens. Um terço apresentou sintomas gripais; 1,1% foi hospitalizado. A soroprevalência foi de 1,74% e associou-se ao sexo masculino, ausência de consumo de álcool e sintomas prévios. **Conclusão:** Compreender barreiras ao comportamento preventivo é essencial para orientar estratégias de saúde pública.

DESCRIPTORIOS: COVID-19; Estudo transversal; Comportamento de risco à saúde; Controle de doenças transmissíveis

ABSTRACT

Objective: This study aimed to analyze individual exposure to SARS-CoV-2 and engagement in preventive practices at the onset of the COVID-19 pandemic. **Method:** A population-based cross-sectional survey (Test to Care) was conducted in São Carlos, SP, Brazil, using stratified random sampling by census sectors. One adult per household was interviewed and tested for anti-SARS-CoV-2-S1 IgG antibodies. Data included demographics, comorbidities, recent symptoms, and adherence to hygiene and social distancing measures. **Results:** Among 3,921 participants, 91.6% reported reduced mobility. Lower adherence was associated with younger age, male sex, marital union, inhaled drug use, school-aged children at home, and lack of social benefits. Mask use was high (97.1%) but less frequent among men. One-third had flu-like symptoms; 1.1% were hospitalized. Seroprevalence was 1.74%, associated with male sex, absence of alcohol use, and previous symptoms. Case clusters were concentrated in low-income areas. **Conclusion:** Understanding barriers to preventive behavior is essential for guiding public health strategies and reducing vulnerabilities to respiratory infections.

DESCRIPTORS: COVID-19, cross-sectional study, health risk behaviour, communicable disease control

RESUMEN

Objetivo: Analizar las características y distribución de individuos según su exposición al SARS-CoV-2 y adopción de medidas preventivas. **Método:** Estudio transversal y poblacional realizado al inicio de la pandemia en São Carlos (SP, Brasil), a partir de la encuesta seroepidemiológica Prueba para Cuidar. Se seleccionó un adulto por domicilio mediante muestreo aleatorio por sectores censales. Se aplicaron entrevistas y pruebas serológicas (anticuerpos IgG anti-SARS-CoV-2-S1), abarcando datos demográficos, condiciones socioeconómicas, comorbilidades, síntomas recientes y conductas preventivas. **Resultados:** Participaron 3.921 personas. El 91,6% reportó alguna reducción de movilidad. Menor adherencia se asoció a edad joven, sexo masculino, convivencia con niños en edad escolar, y falta de beneficios

sociales. El 97,1% refería uso de mascarilla, menos frecuente entre hombres. Un tercio presentó síntomas gripales; 1,1% fue hospitalizado. La seroprevalencia fue de 1,74%, asociada a sexo masculino, abstinencia alcohólica y síntomas previos. Zonas de bajos ingresos presentaron mayor densidad de casos.

Conclusión: Comprender los factores asociados a la baja adherencia a medidas preventivas ayuda a orientar estrategias de salud pública.

DESCRIPTORES: COVID-19; Estudio transversal; Conducta de riesgo para la salud; Control de enfermedades transmisibles

RECEIVED: 03/19/2025 APPROVED: 04/05/2025

How to cite this article: Santos SS, Zenatti CT, Anibal FF, Mestre CAA, Junior AC, Oishi J. COVID-19 Testing and Preventive Behaviours During The Pandemic's Onset: A Cross-sectional Study. *Saúde Coletiva (Edição Brasileira)* [Internet]. 2025 [acesso ano mês dia];15(97):16392-16415. Disponível em: DOI: 10.36489/saudecoletiva.2025v15i97p16392-16415

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INTRODUCTION

The COVID-19 pandemic had required changes in population lifestyle, including social isolation, social distancing, and routine use of masks^(1,2), with health, educational, social and economic impacts beyond the disease's own morbidity and lethality⁽³⁻⁶⁾. Implementing combination of multiple behavioural non-pharmaceutical interventions is effective for preventing or reducing transmission of COVID-19. However, the behavioural changes should consider the capability, opportunity, and motivation of the adopters. They must be acceptable, practical, effective,

accessible and promote equity⁽⁷⁾

Once recognizing the role of preventive health behaviours in controlling the spread of COVID-19, it becomes important to recognize the factors associated with behavioural engagement with safe practices and risk of infection. The spatial variation of compliance to COVID-19 containment policies can be associated to the presence of social vulnerabilities as living in densely populated areas and socially deprived neighbourhoods, with a higher number of people per household, lower incomes and higher levels of poverty^(8,9). The degree of containment imposed for controlling the disease has been associated with

increases in economic and food insecurity, poverty-related stress, declines in female mental health, and increase in domestic violence^(10,11)

This study aimed at evaluating the prevalence and geographical distribution of IgG anti-SARS-CoV-2 antibodies in adult individuals in the city of São Carlos, SP, Brazil, in the beginning of COVID-19 pandemic, before the implementation of the covid-19 vaccination campaign. The study also sought to better understand individual and collective factors associated with engagement or not in recommended COVID-19 preventive behaviours.

METHOD

“Test to Care” was a Cross-Sectional Study of SARS-CoV-2 antibody prevalence in probabilistic sample of the adult urban population of the municipality of São Carlos, central region of the state of São Paulo (22° 09', 21° 35' S and 48° 05', 47° 43' W), with a local population of 251,983 inhabitants (July 2019)(12) The study was approved by the Human Research Ethics Committee (HREC) of the Irmandade da Santa Casa de Misericórdia de São Carlos (CAAE: 31620420.0.0000.8148), with the consent and participation of the São Carlos Department of Health.

In April 2020, the study design was finalized, and partnerships were established to support logistics, interviews, sample collection, immunoassays, and sponsorship. By May 2020, a recombinant immunoenzymatic assay for detecting IgG against SARS-CoV-2 was selected, meeting both technical and cost criteria. Simultaneously, a volunteer team consisting of nine doctors, six nurses, 44 medical students, four nursing students, three students from other health fields, and private laboratory collection teams was assembled and trained to administer informed consent, conduct interviews, and collect and store blood samples.

Initially, a sample of the population of São Carlos was estimated to represent the census sectors of the municipality. The families were selected by a random sampling plan, stratified by region of the city, using the 2010 urban Instituto Brasileiro de Geografia e Estatística (IBGE) census sectors⁽¹³⁾ Some census sectors considered rural in 2010, but which were urbanized at the time of the project, were included in the research (Eduardo Abdelnur and Samambaia districts).

The study took place during the first wave of the coronavirus disease 2019 (COVID-19) pandemic in Brazil.

During the months of June and July 2020, between 1200 and 1400 home addresses were randomly chosen per weekend every two weeks (STATISTICA V10, Statsoft inc. Tulsa. USA).

The residences were drawn according to the numbering of buildings on each street, to guarantee maximum representativeness and accuracy of estimates. In each house, one adult resident was invited to attend an interview and testing unit. If there was interest in participating, he received a password to access the unit. If there was no one in the target house on the day of the visit, it was replaced by the first house to the left of the interviewer positioned with his back to the target house on the same side of the street.

The interview and collection of peripheral blood samples for serological tests were carried out in testing units established in schools, churches, basic health units and hospitals. Once in the unit, adults (≥ 18 years old) who had been living in São Carlos for at least 14 days and signed the Informed Consent Term were included in the study.

All volunteers received protective kits containing identified gowns, face shields, surgical masks, and N95 respirators. The teams, accompanied by the municipal guard for protection, were dispatched in groups to different areas of the city, including socially disadvantaged neighbourhoods.

Study data were collected and managed using REDCap electronic data capture tools hosted at Centro de Pesquisas em Óptica e Fotônica do Instituto de Física de São Carlos (IFSC-USP)⁽¹⁴⁾. The interview data were collected directly into the RedCap® program on the interviewer mobile phone, and included demographic aspects, address, habits, comorbidities, epidemiological and socioeconomic aspects, adherence to hygiene and social isolation practices, and recent history of flu-like illness or of serious

acute respiratory syndrome (SARS).

All workstations had posters, materials for blood collection (butterfly needle, vacuum collection tubes, collection holders, cotton, blood stop bandages, tourniquets, boxes suitable for the disposal of sharps, and alcohol 70° liquid and gel). Peripheral blood samples were collected in vacuum tubes that were transported every 2-3 hours to the laboratory, where they were immediately centrifuged and stored refrigerated (4-8°C).

The serum was utilized in a SARS-CoV-2 IgG enzyme-linked immunosorbent assay directed against the S1 domain of viral spike protein (Euroimmun®). The optical density was detected at 450 nm and calculated a ratio of the reading of each sample to the reading of the calibrator, included in the kit, for each sample (OD ratio). The final interpretation of positivity was determined by ratio from the threshold value of 0.8^(15,16)

Descriptive statistics were performed, followed by univariate and multivariate analysis by multiple logistic regression of factors associated with compliance to covid-19 prevention practices and with SARS-CoV-2 IgG seropositivity, in the Epi Info 7 Program.

Categorical variables were grouped in a dichotomous manner based on subgroups similarity by contingency table analysis. Missing interview data were excluded from the analysis. In the same way, individuals in whom blood collection was not possible or with insufficient blood sample were excluded from the serological analysis. Variables that showed p values less than 0.15 in univariate analysis were considered for inclusion in the model. A backward elimination was used to successively remove factors with the largest p-value until all variables in the model had a p-value less than 0.05.

The results were made available on the city hall's website (<http://te>

starparacuidar.saocarlos.sp.gov.br/), where each participant had access to their result through their personal data (name, ID and birthdate). A telephone centre was made available for doubts ("Alô HU"), and if there was a request from the participant or symptoms, a medical appointment was scheduled.

The georeferencing of residential addresses was carried out by capturing latitude and longitude coordinates using the Google Maps online platform (WGS 84). A cartographic base in vector format (shape) of the 2010

census sectors of São Carlos were obtained from the IBGE website (www.ibge.gov.br). The study project was produced using the coordinate reference system Universal Transverse Mercator System 23S, SIRGAS 2000 datum. The spatial analysis of the data was made using QGIS version 3.4 program. To reduce variance instability and spurious outliers arising from differences in population size, the possibility of Empirical Bayes Smoothing was evaluated in the Geda program.

RESULTS

Between June and July, 2020, a total of 3937 individuals attended the testing units, 16 did not meet the inclusion criteria for the study (one declined to consent, two were under 18 years of age, and 13 were not living for at least 14 days in São Carlos). Thus, 3,921 individuals took part of the study, which corresponds to about a 70% participation rate⁽¹⁷⁾ The Figure 1 shows the thematic map of the distribution of participants in the municipality of São Carlos.

FIGURE 1 – Thematic Map of the Distribution of Participants in the "Test to Care" Study of the Municipality of São Carlos, São Paulo, Brazil, 2020



Study participants' characteristics are detailed in Table 1. The mean age was 54 years, 55.6% were female, 73.1% were white, and 63% were married. As for economic activity, 63,6% worked in formal employment, received retirement payments or social welfare pensions, and 37.7% had lost income due to the pandemic. As for urban density, 61.1% lived in three or more persons per household, and 46.7% had contact with a school-age

child at home. Comorbidities were reported by 58.7% of patients. Previous or current alcohol use was reported by 60.8% of participants; tobacco, by 38.3%, and inhaled drugs by 6.4%. Regarding social isolation, most people reported some degree of mobility reduction (91.6%), and 55.5% warned that they only left the house for essential activities. The main reasons for leaving home were the need for work and shopping for supplies.

The vast majority use face masks regularly (97.1%), and the main difficulties related to their use were nasal discomfort and forgetting to put them on. As for the previous history, 35.6% of the participants had presented flu symptoms in the first months of 2020, and 1.1% were hospitalized for this reason. Missing data rate was less than 1% for all variables.

TABLE 1 – Characteristics of participants in the “TEST TO CARE” Program, São Carlos, São Paulo, Brazil, 2020.

Characteristic		
Age, mean (SD) years	50.4	(15.2)
Sex female, n (%)	2179	(55.6)
Color, n (%)		
White	2859	(73.1)
Brown	718	(18.4)
Black	257	(6.6)
Yellow	56	(1.4)
Indigenous	8	(0.2)
Ignored	14	(0.4)
Marital status, n (%)		
Married or stable union	2471	(63.0)
Single	819	(20.9)
Divorced/separated	331	(8.4)
Widowed	299	(7.3)
Ignored	1	(0.0)
Occupational Classification, n (%)		
Retired or receiving benefits	686	(17.5)
Administrative careers	482	(12.3)
Sales workers	319	(8.1)
Education professional	290	(7.4)
Healthcare professional	230	(5.9)
Cleaning and maintenance occupations	160	(4.1)
Student	141	(3.6)
Unemployed	129	(3.3)
Construction occupations	113	(2.9)
Transportation occupations	103	(2.6)
Personal Appearance Workers	81	(2.1)
Food Preparation and Serving occupations	61	(1.6)
Protective Services	26	(0.7)
Others	1100	(28.1)

Comorbidities, n (%)	2392	(61.0)
Obesity	337	(8.6)
Cardiovascular	1399	(35.7)
Endocrinological	798	(20.4)
Respiratory	547	(14.0)
Gastrointestinal	426	(10.9)
Immunological	278	(7.1)
Neurologic	173	(4.4)
Renal	78	(2.0)
Habits, n (%)		
Current or previous alcohol consumption	2384	(60.8)
Current or previous or current tobacco use	1500	(38.3)
Current or previous inhaled drugs use	229	(5.9)
Number of persons per private household, n (%)		
One	341	(8.7)
Two	1184	(30.2)
Three	1068	(27.4)
Four	851	(21.7)
Five	304	(7.8)
More than five	173	(4.4)
Home contact with school-age children, n/ total (%)	1831/3919	(46.7)
Family income, n (%)		
Formal employment	1356	(34.6)
Informal employment	964	(24.6)
Pension/ allowance	1138	(29.0)
No income	462	(11.8)
Total	3920	(100)
Pandemic family income, n (%)		
Increased	121	(3.1)
Equal	2008	(51.2)
Reduced	1478	(37.7)
No income	312	(8.0)
Social isolation, n (%)		
Leaving home only for essential activities	2177	(55.5)
Leaving the house much less frequently	1098	(28.0)
Leaving the house a little less often	316	(8.1)
Leaving the house as frequently as before	330	(8.4)
Total	2921	(100)
Face masks wearing, n (%)		
Always	3804	(97.1)
Sometimes	92	(2.4)
Never	21	(0.5)
Total	3917	(100)

Mild or moderate respiratory illness, n (%)		
Yes	1382	(35.3)
No	2538	(64.7)
Severe respiratory disease, n (%)		
Yes	44	(1.1)
No	2538	(98.9)
IgG Against SARS-CoV-2, n (%)		
Reactive	68	(1.7)
Nonreactive	3832	(98.3)
Total	3921	100

In the univariate analysis, the factors associated with compliance to mobility reduction were older age (OR = 1.0264), female sex (OR = 2.0443), white colour-race (OR = 1.2955), not being married/stable union (OR = 1.5468), having comorbidity (OR = 1.4877), living with up to three persons per household (OR = 1.6172), and earning any type of pension or allowance (OR = 4.1464). Factors associated with lower adherence to mobility reduction

were history of alcohol consumption (OR = 0.6520), inhaled drugs use (OR 0.4486), and having home contact with school-age children (OR = 0.5194) (eTable 1 in the Supplemental Material). After the multivariate analysis, the factors that remained significantly associated with compliance to mobility reduction were older age (OR = 1.0128), female sex (OR = 1.8587), not being married/stable union (OR = 1.3709), and earning any type of pension or allowance (OR

= 2.9230). Factors that remained associated with lower adherence to mobility reduction were history of inhaled drugs use (OR = 0.6398), and having home contact with school-age children (OR = 0.6764) (Table 2). The only factor associated with adherence to masks use was female male sex (OR = 2.5089) (eTable 2 in the Supplemental Material), since the variable comorbidity was excluded in the multivariate analysis.

TABLE 2 – Multivariate analysis of factors associated with compliance to mobility reduction, São Carlos, São Paulo, Brazil, 2020.

Variable	p	OR*	95%CI**	
Age, per year	0.0129	1.0128	1.0028	1.0229
Female sex	0.0000	1.8587	1.4631	2.3612
Not Married/ stable union	0.0236	1.3709	1.0432	1.8015
History of inhaled drug use	0.0275	0.6398	0.4301	0.9518
Home contact with school-age children	0.0019	0.6764	0.5284	0.8659
Earning pension or allowance	0.0000	2.9230	1.9402	4.4037

*Odds Ratio. **Confidence Interval.

Of the total number of participants, 3900 collected a blood sample for serological analysis, and the presence of IgG antibodies against SARS-CoV-2 was detected in 68 participants (1.74%). The prevalence of antibodies increased in the last weekend of the study, being 1.62% from June 13th to 14th; 1.63% from June 27th to 28th; 0.68% from July 11th to 12th, and 2.72%

from July 25th to 26th, 2020.

In the univariate analysis, previous flu-like symptoms or severe acute respiratory syndrome were associated with anti-SARS-CoV-2 IgG seropositivity (OR = 2.2264 and OR = 4.2632, respectively) (eTable 3 in the Supplemental Material). In the multivariate analysis, although reduction in mobility and mask use were initially included in the model, only previous flu-like symptoms

remained positively and significantly associated with seropositivity (OR = 2.3229). Female sex and a history of alcohol consumption were associated with lower seropositivity rates, with OR = 0.5557 and OR = 0.5454, respectively (Table 3).

TABLE 3 – Multivariate analysis of factors associated with anti-SARS-CoV-2 IgG seropositivity, São Carlos, São Paulo, Brazil, 2020.

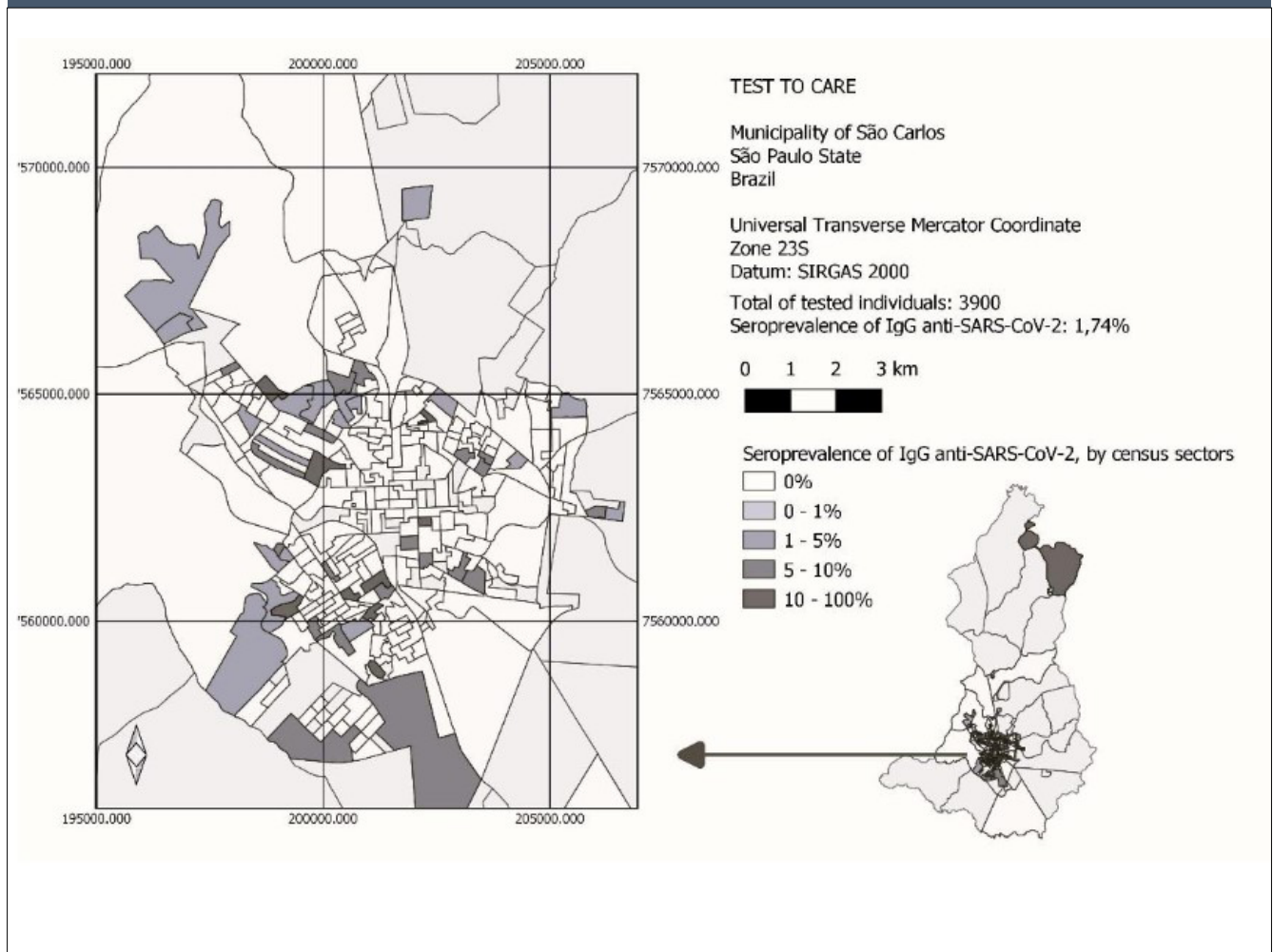
Variable	p	OR*	95%CI**	
Female sex	0.0207	0.5557	0.3378	0.9140
History of alcohol consumption	0.0165	0.5454	0.3323	0.8953
Previous flu-like symptoms	0.0006	2.3229	1.4325	3.7667

*Odds Ratio. **Confidence Interval.

As for the spatial distribution, there was a higher density of positive cases in the census sectors of the northwest and south of the city, predominantly low-income regions, as shown in Figure 2. Cases with positive serology were detected in 50 of the 263 census sectors, with 30 sectors present

ing 5% or more of positive cases. In the extreme north of the municipality, there is an area with low population density and a high positivity rate (Santa Eudóxia District), surrounded by a rural area. It was not possible to smooth the rate because there was no surrounding population (zero elements). This isolated region/neighborhood cannot

be included in the integrated analysis due to its lack of geographical continuity, as this would force the statistical and spatial models to generate artificial values that do not reflect reality.

FIGURE 2 – Thematic Map of the Percentage of Individuals with IgG Positive for SARS-CoV-2 by São Carlos Census Sectors in the “Test to Care” Study, São Paulo, Brazil, 2020.

DISCUSSION

The COVID-19 pandemic brought a constant concern from government health authorities with the population's compliance to some practices considered associated with a lower risk of transmission of the disease, particularly before the advent of preventive vaccines. Despite widespread vaccination, non-pharmacological measures remain crucial for controlling transmission, as high incidence rates persist even in areas with substantial vaccination coverage⁽¹⁸⁾ In this sense, the reduction of social mobility and the use of masks are practices considered safe⁽¹⁹⁻²¹⁾ The higher or lower rate of adherence to these practices may have had an impact on controlling the pandemic, but it may also have caused social disruption^(22,23) Therefore, understanding the factors that corroborate the greater or lesser adherence to these practices could help us to better understand the social dynamics of the epidemic and what strategies could be used to help the population protect itself in similar risk situations. The population's difficulties in adhering to these practices can also serve as a trigger for the development of safer alternatives to protect the population, with less social and/or economic impact.

In the present study, the main factors associated with lower compliance to mobility reduction were younger age, being male, being married/stable union, using inhaled drugs, having contact with school-age children, and not receiving any type of pension or allowance. This suggests that low-income men, who are beginning their productive activities, lack financial stability, and bear the responsibility of supporting their families, may be particularly vulnerable to respiratory viruses, even under conditions of restricted mobility. This finding aligns with results from nationwide online surveys⁽²⁴⁾ They may have less access to masks, soap, and clean water, they may lack social distan-

cing on public transport and they often live in overcrowded, poorly ventilated, and sometimes dirty homes^(21,25) Even in the case of health care workers, previous studies have found that there are demographic and socioeconomic determinants of exposure to SARS-CoV-2, with higher prevalence of specific antibodies in non-whites individuals, with lower education and income, and who use public transport to get to work⁽²⁶⁻²⁸⁾ COVID-19 pandemic stress was also associated with substantial increase in use and abuse of alcohol and illicit drugs, reduced physical distancing, and increased social interaction^(29,30)

Consistent use of masks can reduce the risk of COVID-19 regardless of vaccination status⁽³¹⁾ Despite this, we observed that men also need more convincing encouragement to use masks. For them, their use demands high response costs in terms of money, time and additional preparation. They are less psychologically motivated to protect themselves as they tend to underestimate health risks, just as they are more likely to perceive the use of face masks as shameful, unpleasant, stigmatizing, and threatening to their masculine image⁽³²⁾ The higher rate of male seropositivity found in the study is compatible with this situation in which men are especially vulnerable.

The study drew attention to the lack of association between mobility, mask use and seropositivity. There is evidence that changing mobility patterns is not always associated with a greater risk of COVID-19, particularly when there is a high prevalence of facial covering⁽³³⁾ as found in the present study.

Although the association between history of alcohol consumption and anti-SARS-CoV-2 IgG seropositivity may be spurious, drinking during self-isolation is predominant⁽³⁴⁾ and this could perhaps explain the association between alcohol intake and lower seropositivity.

The low prevalence of antibodies against SARS-CoV-2 at the time of the

campaign in São Carlos showed that the population had not been exposed to the virus until then and was totally vulnerable to infection, which required constant efforts to be followed to avoid the explosive increase in the number of cases. With the subsequent increase in the number of cases of COVID-19, the city instituted more restrictive measures and educational campaigns with guidance on hygienic measures and distribution of masks in the most affected neighbourhoods. In addition, the municipality started the vaccination campaign against covid-19 on January 21st 2021. Even so, from March 18th 2020 until March 3rd 2023, São Carlos had 36,161 cases of covid-19 and 639 deaths, corresponding to 254 cases per 100,000 inhabitants.

A potential limitation of this study is the possibility of information bias, as adherence to preventive behaviours was self-reported. Additionally, conflicting guidance within the country regarding appropriate COVID-19 prevention measures may have influenced participants' responses⁽²⁴⁾

This study underscores the need for strategies to protect vulnerable populations from COVID-19 and future respiratory disease outbreaks, emphasizing the importance of addressing practical needs beyond cognitive beliefs. While the study identifies this broader context, potential measures to achieve these goals may include workplace distancing, free face coverings on public transport, access to hygiene facilities, universal healthcare, financial support, and essentials like food, housing, water, and sanitation. Additionally, promoting family-friendly policies, such as affordable and high-quality childcare, could further support these efforts^(25,35)

ACKNOWLEDGEMENTS:

&“TESTAR PARA CUIDAR” [TEST TO CARE TEAM]: A) Irmandade Santa Casa de São Carlos: Antônio Valério Morillas Júnior and Roberto Muniz Junior – administrative and

financial support; Carolina Toniolo Zenatti – administrative support, logistics and interviews; Olga Maria Picolo Vela – nutritional support; Daniele de Cassia Gigante Rodrigues, Amanda de Assunção Lino, Luiz Carlos Silva, Beatriz de Menezes Dobbert, Vanessa Madrid, Guilherme Henrique Martins de Souza, Letícia Caroline Miranda – interviews and blood sample collections; Grupo de voluntárias: Nilcemar Morillas, Mariangela Pucci and Team - production of homemade mask gifts; B) Secretaria da Saúde de São Carlos: Vigilância Epidemiológica: Crislaine Aparecida Antonio Mestre, Lindiamara Talita Soares, Kátia Regina Spiller, Camila Félix Francisco, Tamyris Targas Mota Caiero - Logistics; Centro de Atendimento de Infecções Crônicas: Daniela Falcão, Cintia Ruggiero – blood sample collections; Family Health Unit: Cecília Malvezi, Denise Gili – interviews and blood sample collections; Transport: Osmar Freire, Gilmar Freire, Denis, Ivan, Leandro Tassim Luciano, Marcio Giovannini, Rodrigo Fioravante De Simone; City Guard - security; Information Technology: Anderson Luiz Escarabelo; C) Army reserve training: Warrant Officer Clodan Maurício Ferreira; D) UNIMED São Carlos: Ivan Linjardi – administrative and financial support; E) UNILAB: Natalia Sardella & Team – blood sample collection; F) Universidade Federal de São Carlos: a) Department of Medicine: Sigrid De Sousa dos Santos, Cecilia Malvezzi, Aline Apis, Andréia Agraso Gusmão, Camila Marino Sorgi, Daniel de Azevedo Iriarte, Eder José Franco, Flavia Marcos de Angeli, Gabriel Rodrigues Carrijo, Getúlio Pinheiro Lopes Ferraz, Giovana Kharfan de Lima, Jhon Anderson B. Agudelo, Klaus Werner Wende, Leonardo Marcos Fausto Costa, Luciana França da Silva, Luiza Ferreira Lopes, Malu Oliveira da Cunha, Mayra de Fátima Martins de Oliveira, Meire Savino da Costa Bettoni Moreira, Priscila Alves dos Santos, Priscila Merlotti Mayor, Rafaela Catelan Martins Pereira, Ro-

drigo Alexandre Cerqueira da Silva, Tiago Vitor Ramalho, Aline Augusto de Carvalho, Amanda Rodrigues Vale, Amanda Soares Sousa, Ana Beatriz Lima e Silva, Ana Luiza Carvalho Sartoreli, Aurora Gameiro, Beatriz Brecht Albertini, Daniel Basile, Roseane Rigo, Beatriz Brecht Albertini, Beatriz Carvalho de Jesus, Beatriz Gabrielle Ishikawa Ducci, Camila Monteiro Faria Araújo, Érica Letícia Ângelo Liberato, Felipe Defina Sicchieri, Gabriele Alves de Morais, Glielmo Slywitch Filho, Gustavo Luis de Oliveira, João Marques Batista Júnior, João Paulo Borges Bispo, Laís Prandine Tofanelli, Letícia Bassani Maida, Luccas Cavalcanti Garcia, Maria Beatriz Frigo Cortez, Mariela Lara Fernandes Bonizio, Monise Siquette, Nathalia Fahl Cicotti, Natália Menegassi Pedrini, Nicoly Stefani Sevalho Carlucci, Pedro Issa Martinho Araujo, Samira Saad Guarda, Thamires Rosa dos Santos, Valeska Cristina Torcia, Vinícius Magagnini Fernandes Gazzali, Willians Victor da Silva Cardoso – administrative support, logistics, interviews and blood sample collections; b) Department of Biotechnology: Marcella Rosa Leão da Costa - interviews; c) Department of Special Education: Carmen Silvia Kapp Guerreiro, Fabiana da Conceição – interviews; d) Nursing Department: Alyne Martins Toledo, Andressa Rueda de Oliveira, Antonio Perez David Ferrari Neto, Beatriz Caroline de Arruda Andrade, Bruna Caroline Gorla, Maria Paula Guerreiro, Suzana Maria Nery Carraschi - interviews and sample blood collection; e) Department of Physiotherapy: Rafaela Veiga Oliveira – interviews; f) Department of Electrical Engineering: Felipe Akira Kimura Gama - logistical support; g) Production Engineering Department: Pedro Vitor de Azevedo Sanches – logistical support; h) Department of Gerontology: Larissa Cayla Cesario – interviews; i) Hospital Universitário da UFSCar: Valeiria Gabassa, Regina Ferreira Cardoso, Ana Cláudia Casarin, Barbara Martins

Lima, Regina Ferreira Cardoso, Sueli Dos Santos, Simone Candido Pereira, Denise Tavares de Luna Mariano - (tec enferm) – administrative support, interviews and blood sample collections; G) STATSOL SOLUCOES ESTATISTICAS E PESQUISA DE MERCADO LTDA: Jorge Oishi; Reginaldo Aparecido Coelho; Jorge Camargo Oishi - Probability sampling of residential addresses; H) Centro Universitário Central Paulista (UNICEP): Ademilda Gonçalves, Camila Nogueira Zafalon, Camila Lucia Muniz, Camila Arioli, Jessica Nascimento Coelho, Luiz Carlos Silva – Interviews and blood sample collections; I) Universidade Federal de Alenas (UNIFAL): Erika Cristina Napolitano Giuliano - interviews; J) Universidade Federal de Alagoas (UFAL): Marcella Bruno Terruggi – logistical support and interviews; K) FACERES: Amanda de Macedo Ferreira Machado, Angela Baggio Maria, Fernanda Carrocini Capelim, Helena Rohden Serafim, Natalia Lois Gonçalves – interviews; L) UNOESTE: Bianca Villanova – interviews; M) Faculdade de Medicina de São José do Rio Preto (FAMERP): Gabrielle Marques Batista – interviews; N) Centro Universitário São Camilo: Bruna Lindoso Correia; O) Universidade do Estado de Minas Gerais: Larissa Romanello – interviews; P) Universidade de São Paulo: Caio César La-Cava Gonçalves Bernardo – logistic support; Q) Volunteer professionals: Daiany Silva Souza – interviews.

FUNDING

This work was supported by public and private health institutions in the municipality of São Carlos: Irmandade Santa Casa de Misericórdia de São Carlos, São Carlos Municipal Health Department; Universidade Federal de São Carlos (UFSCar); UNIMED São Carlos; Hospital Universitário da UFSCar; Health Insurance São Francisco; Centro de Diagnóstico e Pesquisa em Biologia Molecular Ivo Ricci; STATSOL Soluções Estatísticas e Pesquisa de

Mercado; Clara Resorts and Dr. Tips.

Human Research Ethics Com-mittee (HREC) of the Irmandade da Santa Casa de Misericórdia de São Carlos (CAAE: 31620420.0.0000.8148), with

the consent and participation of the São Carlos Department of Health.

STUDY REGISTRATION:

The study was approved by the

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