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Repercussions of the COVID-19 pandemic on athletes: a cross-sectional study

AUTHORS: Lucas R Lopes[1,2], Vitor AR Miranda[3], Rodrigo A Goes[3], Gabriel GA Souza[3], Giuliana R Souza[1], Jessica CS Rocha[1,3], Victor RA Cossich[3,4], Jamila A Perini[1,2,3]

[1] Laboratório de Pesquisa de Ciências Farmacêuticas, Centro Universitário Estadual da Zona Oeste (UEZO), Rio de Janeiro, Brazil
[2] Programa de Pós-graduação em Saúde Pública e Meio Ambiente, Escola Nacional de Saúde Pública, Fundação Oswaldo Cruz (Fiocruz), Rio de Janeiro, Brazil
[3] Divisão de Pesquisa, Instituto Nacional de Traumatologia e Ortopedia (INTO), Rio de Janeiro, Brazil
[4] Laboratório de Biomecânica, Escola de Educação Física e Esportes (EEFD), Universidade Federal do Rio de Janeiro (UFRJ), Rio de Janeiro, RJ – Brazil

ABSTRACT: The COVID-19 pandemic has presented significant challenges and implications for the sports community. Thus, this study aimed to describe the prevalence of COVID-19 in Brazilian athletes and identify the epidemiological, clinical, athletic, life and health factors associated with the disease in these individuals. A cross-sectional study was performed involving 414 athletes from 22 different sports using an online questionnaire from August to November 2020. The association between the athletes' characteristics and COVID-19 was evaluated using a logistic regression model. The prevalence of COVID-19 was 8.5%, although only 40% of athletes reported having been tested. Being under 27 years of age (3-fold), having children (~5-fold), having a teammate test positive for COVID-19 (2.5-fold), and smoking (14-fold) were associated with a possible higher risk of disease. Almost 20% of athletes self-reported musculoskeletal injuries during the period of the pandemic that was studied. Athletes with a university education ($P = 0.02$), a profession other than sports ($P < 0.001$), those from a low-income family ($P = 0.01$), and public health system users ($P = 0.04$) were significantly less frequently tested for COVID-19, whereas international competitors, athletes who received a wage, and athletes who had a teammate who tested positive for COVID-19 were 2-, 3-, and 15-fold more likely to be tested for COVID-19, respectively. Approximately 26% of the athletes who tested negative or were untested reported more than three characteristic COVID-19 symptoms, and 11% of athletes who tested positive for COVID-19 were asymptomatic. The identification of modifiable (have children, smoking, and teammates positively tested) and non-modifiable (age under 27 years) factors related to COVID-19 in athletes can contribute to implementing surveillance programmes to decrease the incidence of COVID-19 in athletes and its negative impacts in sports.

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Corresponding author:
Jamila Alessandra Perini
Research Division, Instituto Nacional de Traumatologia e Ortopedia, Avenida Brasil 500 zip code 20940-070
Rio de Janeiro, RJ, Brazil
E-mail: jamilaperini@yahoo.com.br, japerini@into.saude.gov.br

ORCID:
Lucas Rafael Lopes
0000-0003-0488-0730

Vitor Almeida Ribeiro de Miranda
0000-0003-0241-5237

Rodrigo Araújo Goes
0000-0002-1209-4425

Gabriel Garcez de Araujo Souza
0000-0002-1732-1092

Giuliana Rodrigues de Souza
0000-0002-4266-672X

Jessica Christinny Santos Rocha
0000-0002-7638-1407

Victor Rodrigues Amaral Cossich
0000-0002-3984-6121

Jamila Alessandra Perini
0000-0002-7683-0698

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INTRODUCTION

The coronavirus disease 2019 (COVID-19) pandemic, which has posed a great public health threat, astonished the world in 2020, as a total of 120,390,929 people have been infected and 2,663,741 people have died worldwide (update on March 16, 2021) [1]. COVID-19 is caused by SARS-CoV-2, a pathogen that primarily targets the human respiratory system, and is transmitted through contact with contaminated surfaces or airborne droplets released from infected individuals when they cough, sneeze, or speak [2]. Moreover, individuals can unknowingly host and spread the virus during the incubation period [3]. The most common symptoms of COVID-19 infection are fever, dry cough, myalgia, and fatigue. Other symptoms include headache, sore throat, diarrhoea, dyspnoea, body aches and pains, conjunctivitis, loss of taste/smell, skin rashes, and discolouration of the fingers or toes [4]. In more severe cases, acute respiratory distress syndrome and acute multiorgan injury can occur [5].

The World Health Organization (WHO) declared the COVID-19 outbreak a public health emergency in January 30, 2020, which encouraged a sense of urgency in seeking effective interventions to diminish the spread of the virus [6], such as social distancing, frequent hand washing, and continuous use of facemasks [7]. Although quarantine periods and total lockdowns were used as common measures in several countries, each nation faced different and specific problems in fighting against the virus. Specifically, Brazil – a developing country with continental dimensions – was one of the most affected countries, with an official number of cases of 7,619,200 and

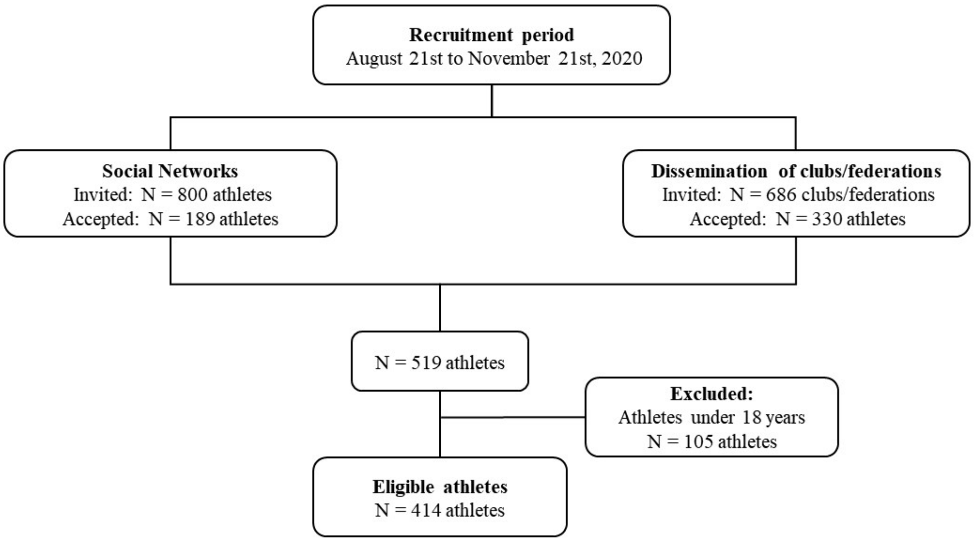

FIG. 1. Flowchart of the study population.

193,875 confirmed deaths in 2020 [8]. These numbers place Brazil 3rd in deaths, just behind the United States of America (USA) and India [1].

In addition to having impacts on the general population, the COVID-19 pandemic has also had a tremendous negative effect on sports [9, 10]. As a direct impact of social distancing, several major competitions were cancelled or postponed – such as national and international championships, including the Tokyo 2020 Olympics and Paralympics Summer Games – to reduce viral spread amongst spectators and athletes [11–13]. Athletic training routines were affected and to maintain physical fitness, athletes needed to move towards a home-based exercise protocol, which may have resulted in detraining as a consequence of insufficient and/or inappropriate stimuli, consequently leading to performance impairment and increasing orthopaedic injury risk [9, 14].

Although severe COVID-19 is more common in patients with coexisting comorbidities such as diabetes, hypertension, obesity, and cardiovascular disease [15], athletes – who have excellent fitness and are theoretically in good health – are not spared by the disease [16]. In fact, high-load training (intensity × volume) can expose athletes to the overtraining syndrome [17] and transitory immune depression produced by exercise [18]. Both could increase the infection potential of microorganisms [19, 20], with a special concern for upper respiratory tract infections [21]. Moreover, even recovered patients could present long-term symptoms and/or disease complications associated with the cardiorespiratory system [22].

To provide the best and a safe return to sports, medical and sporting professionals (e.g., physicians, physical therapists, and coaches) must understand the impact of the pandemic on athletes. Thus, this study aimed to describe epidemiological and athletic profiles, life and health habits, and clinical conditions to determine the prevalence of COVID-19 in Brazilian athletes and factors associated with disease in these individuals.

MATERIALS AND METHODS

Population and study design

This study was a cross-sectional observation of the repercussions of the COVID-19 pandemic on athletes that aimed to identify sociodemographic, economic, and sporting factors associated with COVID-19 diagnosis. The availability of specific diagnostic testing in the studied population was also investigated. The athletes were mainly invited to participate via laboratory social networks (Instagram: @Lapesf.uezo and Facebook: *Pesquisa COVID-19 e atletas*). Additional invitations were sent by e-mail, texting, or phone calls when appropriate and possible. The inclusion criteria were Brazilian athletes of any sport modality, and the exclusion criteria were athletes under 18 years old. Sociodemographic profiles, sport and training characteristics, life and health habits, and COVID-19 data were obtained using an online questionnaire from August to November 2020. The study flowchart is shown in Figure 1. The study was approved by the Human Ethics Committee of the *Escola Nacional de Saúde Pública Sergio Arouca – Fundação Oswaldo* (#4.180.668), and all the participants provided written consent.

Questionnaire

The online questionnaire was previously validated by a multi-professional expert panel including sports doctors, a sport scientist, and an epidemiologist. The questionnaire was divided into four sections implemented and delivered using the Google Forms platform (Google Inc., Mountain View, California, USA). The total response time was approximately 10 minutes, and the athlete could only progress to a new section if he/she had answered all the questions in the previous section. The first section was dedicated to sociodemographic characteristics, such as age, sex, blood type, ethnicity, marital status (single, married/common law marriage or divorced), number of children, housing type, number of residents in the housing, level of schooling (middle school, high school, or university education), and family income. Ethnicity was reported according to the Brazilian official census classification scheme (*Instituto Brasileiro de Geografia e Estatística* – IBGE), which uses only a few pre-established skin colour categories based on self-classification: white, intermediate, black, yellow, or indigenous [23]. The second section was about sports and training characteristics, such as competition level, sport modality, adapted sport (for parathletes), wage as an athlete, profession other than sports,

TABLE 1. Description of the sociodemographic, sport, training, lifestyle and COVID-19 characteristics in study population (N = 414).

Variables	N (%)	Variables	N (%)
Sociodemographic characteristics		**COVID-19 health issues**	
Age ≥ 27 years old[a]	194 (47)	Diagnosis	167 (40)
Male sex	246 (59)	Positive test results for the athlete	35 (8.5)
Blood group A[b]	139 (34)	Test performed by the team	108 (26)
White ethnicity	209 (50)	Teammate test positive	183 (44)
Single marital status	307 (74)	Family member test positive	298 (72)
Having children	100 (24)	Someone close died by COVID-19	106 (26)
Apartment housing	248 (60)	Characteristic symptoms of COVID-19	233 (56)
Living with more people	366 (88)	≤ 3 symptoms[d]	111 (48)
University education	314 (76)	> 3 symptoms[d]	122 (52)
Family income < R$10.000	318 (77)	Suspected COVID-19 medical care[e]	15 (9.7)
(U$1991.16)		Use of medication for COVID-19[f]	26 (18)
Sports and training characteristics		Hospitalization for COVID-19[g]	2 (1.4)
Federated athletes	328 (84)	**Repercussion of COVID-19**	
Collective sports	280 (68)	Change in financial income	267 (64)
Parathletes	19 (4.6)	Contract suspended or changed	54 (13)
Wage as an athlete	126 (30)	Adapted home training	295 (71)
Profession other than sports	284 (69)	MSK injuries during the pandemic	81 (20)
Sponsorship	49 (9.4)	Joint injury	34 (8.2)
Weekly training > 15 hours[a]	145 (35)	Muscle injury	52 (13)
Weekly training break	171 (41)	Tendinopathy	14 (3.4)
Life and health habits			
Nutritional follow-up	280 (68)		
Supplement usage	245 (59)		
Alcohol consumption	208 (50)		
Smoking	26 (6.3)		
Private health plans	241 (58)		
Use of public health services	194 (47)		
Chronic disease[c]	45 (11)		

MSK is musculoskeletal. [a]The variables were categorized by percentile according to the distribution among the athletes recruited. [b]Blood group A was according to the presence or absence of the Rh antigen/Rh factor. [c]The chronic diseases reported were cardiovascular (arterial hypertension, stroke), hepatic, metabolic (diabetes, hypercholesterolemia), renal, respiratory (asthma, chronic obstructive pulmonary disease, rhinitis, sinusitis) diseases, anxiety, atopic dermatites, glaucoma, herpetiform dermatites, hyperthyroidism, prostatic hyperplasia and sickle cell trait. [d]Frequency calculated according to 233 athletes who showed COVID-19 symptoms.[e]Frequency calculated according to information obtained from 155 suspected athletes of COVID-19. [f]Frequency calculated according to information obtained from 147 suspected athletes of COVID-19. [g]Frequency calculated according to information obtained from 144 suspected athletes of COVID-19.

sponsorship, weekly training hours (number of weekly training periods and duration in hours of each training period), and weekly training break. The third section was about life and health habits and asked about nutritional follow-up and supplement usage, alcohol consumption, smoking, private health plans, the use of public health services, and the presence of chronic disease (cardiovascular, hepatic, metabolic, renal, respiratory or others). Finally, the fourth and last section inquired about COVID-19 health issues (diagnosis, positive test results for the athlete, positive test results for a teammate or family member, characteristic symptoms, and medical care) and the repercussions of socioeconomic changes and episodes of musculoskeletal injuries during the pandemic.

Statistical analysis

The sample size was calculated using Epi Info 7, version 7.1.3. (http://wwwn.cdc.gov/epiinfo/html/downloads.htm), assuming a power of 0.8 and 5% type I error. The data distribution was verified by the Shapiro-Wilk test. Continuous variables were reported as mean ± standard deviation (SD). However, according to their distribution and clinical significance, for the analysis, continuous variables (age and weekly training hours) were divided into percentiles. Categorical data were shown in proportions and differences using the chi-squared (χ^2) statistic test or Fisher's exact test, when applicable.

The frequency of positive COVID-19 tests among the tested athletes and the prevalence of COVID-19 were calculated as the total number of affected athletes divided by the total number of recruited athletes, both monthly and for the cumulative period. The positive ratio for tested athletes was obtained both monthly and cumulative frequencies and analysed by either the chi-squared (χ^2) statistic test or Fisher's exact test.

Multivariable logistic regression analyses were performed to identify possible sociodemographic, sports, training, and lifestyle factors associated with COVID-19 prevalence and diagnostic testing, which was estimated by the odds ratio (OR) with a 95% confidence interval (95%CI). Univariate characteristics with biological importance or p-value less than 0.25 were included in the multivariable logistic regression analysis. The difference was statistically significant when the p-value was less than or equal to 0.05. All analyses were performed using IBM SPSS 20.0 Statistics for Windows (SPSS Inc., Chicago, IL, USA).

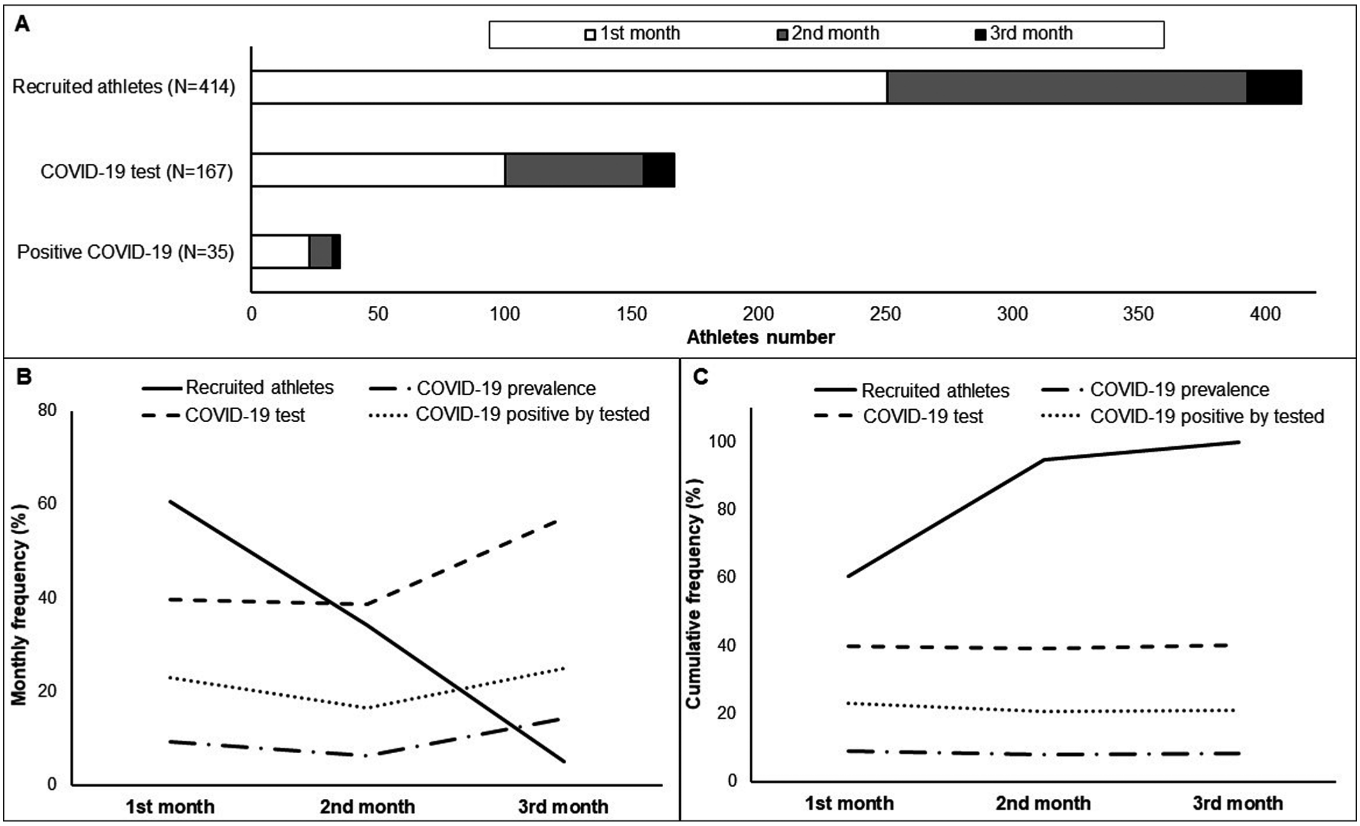

FIG. 2. Distribution of the tested athletes and frequency of positive tests for COVID-19 according to recruitment month: 1st month corresponds to the period from 08/21/2020 to 09/20/2020, 2nd from 09/21/2020 to 10/20/2020 and 3rd from 10/21/2020 to 11/21/2020. **(A)** Total athletes recruited per month. **(B)** Frequency and ratio between positive tests for COVID-19 by tested athletes according to recruitment months. **(C)** Frequency and ratio between positive tests for COVID-19 by tested athletes in the total study period.

RESULTS

A total of 414 subjects were eligible for inclusion (age: 28.4 ± 9.3 years) (Figure 1). Half of these athletes (n = 207) reported having competed internationally. The sports modalities of the athletes comprised 18% rugby (n = 73), 17% combat sports (n = 69), 16% handball (n = 65), 8.5% basketball (n = 35), 6.8% football (n = 28), 5.3% soccer (n = 22), 4.6% volleyball (n = 19), 4.3% water polo (n = 18), 4.1% athletics (n = 17), 2.7% canoeing (n = 11), 2.4% marathon (n = 10), 2.4% synchronized swimming (n = 10), 1.9% swimming (n = 8), 1.7% cycling (n = 7), 1.5% tennis (n = 6), 1.5% hockey (n = 6), 1.2% CrossFit (n = 5), 1.2% and others (n = 5). Table 1 displays the sociodemographic, sport, training, lifestyle, and COVID-19 characteristics of the studied population.

Approximately 60% (n = 251) of the athletes answered the questionnaire from August 21st to September 20th, 2020, and the next largest portions of the sample were 34% (n = 142) who answered the questionnaire from September 21st to October 20th and 6% (n = 21) from October 21st to November 21st. Among the athletes, 40% (n = 167) were tested for COVID-19 (Figure 2A). Although the frequency of positive COVID-19 tests was higher in the third month than in the previous periods (about 20%), there was no significant difference between the COVID-19 prevalence and the ratio of positive COVID-19 tests in athletes tested monthly (Figure 2B). In addition, the cumulative frequency of tested athletes and COVID-19 prevalence remained similar throughout the study (about 40% and 9%, respectively); and approximately 21% of the tested athletes were positive for COVID-19 throughout the entire recruitment period (Figure 2C).

Table 2 shows the multivariate logistic regression model used to identify the factors associated with COVID-19 in the athletes. The variables age (*P* = 0.55), sex (*P* = 0.52), sport modality (*P* = 0.83), having children (*P* = 0.05), wage as an athlete (*P* = 0.10), smoking status (*P* = 0.007), and having a teammate test positive for COVID-19 (*P* = 0.04) were inserted in the logistic regression model according to the biological importance (age, sex, and sport modality) or univariate statistical significance level. After multivariate analysis, age over 27 years was found to be negatively associated with COVID-19, while having children, smoking, and having a teammate positive for COVID-19 were factors associated with a potential risk of the disease in athletes (model 1). The multivariate analysis

TABLE 2. Multivariate analysis of characteristics athletes COVID-19 tested (N and %).

Model 1[b]	COVID-19 (-) (N = 132)	COVID-19 (+) (N = 35)	P-value[a]	Crude OR (CI 95%)	Adjusted OR (CI 95%)
Age ≥ 27 years old[d]	64 (48)	15 (43)	0.55	0.8 (0.4–1.7)	0.3 (0.1–0.9)
Having children	25 (19)	12 (34)	0.05	2.2 (1.0–5.1)	4.9 (1.5–16.1)
Smoking	1 (0.8)	3 (8.6)	0.007	12.3 (1.2–122.0)	14.2 (1.2–167.0)
Teammate test positive	69 (52)	25 (71)	0.04	2.3 (1.0–5.1)	2.5 (1.0–5.9)
Model 2[c]	**Untested (N = 247)**	**Tested (N = 167)**	**P-value[a]**	**Crude OR (CI 95%)**	**Adjusted OR (CI 95%)**
Apartment housing	136 (55)	112 (67)	0.01	1.7 (1.1–2.6)	1.7 (1.1–2.5)
University education	197 (80)	117 (70)	0.02	0.6 (0.4–1.0)	0.5 (0.3–0.9)
Family income[e]	200 (81)	118 (71)	0.01	0.6 (0.4–0.9)	0.5 (0.3–0.9)
Wage as athlete	48 (19)	78 (47)	< 0.001	3.6 (2.3–5.6)	3.8 (2.3–6.0)
Profession other than sports[f]	189 (76)	95 (60)	< 0.001	0.4 (0.3–0.6)	0.3 (0.2–0.5)
International competition	104 (42)	103 (62)	< 0.001	2.2 (1.5–3.3)	2.2 (1.4–3.3)
Training > 15 hours[d,g]	66 (27)	79 (47)	< 0.001	2.5 (1.6–3.7)	2.5 (1.6–3.8)
Smoking	21 (8.5)	5 (3.0)	0.02	0.3 (0.1–0.9)	0.3 (0.1–0.8)
Use of public health services	126 (51)	68 (41)	0.04	0.7 (0.4–1.0)	0.6 (0.4–1.0)
Test performed by the team	20 (8.1)	88 (53)	< 0.001	12.6 (7.3–21.9)	15.2 (8.3–27.7)
Teammate test positive	89 (36)	94 (56)	< 0.001	2.3 (1.5–3.4)	2.3 (1.6–3.5)
> 3 symptoms[h]	64 (47)	58 (60)	0.04	1.7 (1.0–3.0)	1.7 (1.0–3.0)

OR is Odds ratio, CI is confidence interval. [a]*P*-value ≤ 0.05 was obtained through the Chi-squared Test (Pearson p-value). [b]OR adjusted by age, sex, sport group, having children, wage as athlete, smoking and teammate test positive. [c]OR adjusted by age, having children, smoking and teammate test positive. [d]The variables were categorized by percentile according to the distribution among the athletes recruited. [e]Family income corresponds to the athletes who monthly live on less than R$ 10,000 (U$ 1991,16). [f]Athletes with a parallel profession to sport. [g]Weekly training hours. [h]Frequency calculated according to information obtained from 233 athletes with characteristic symptoms of the COVID-19.

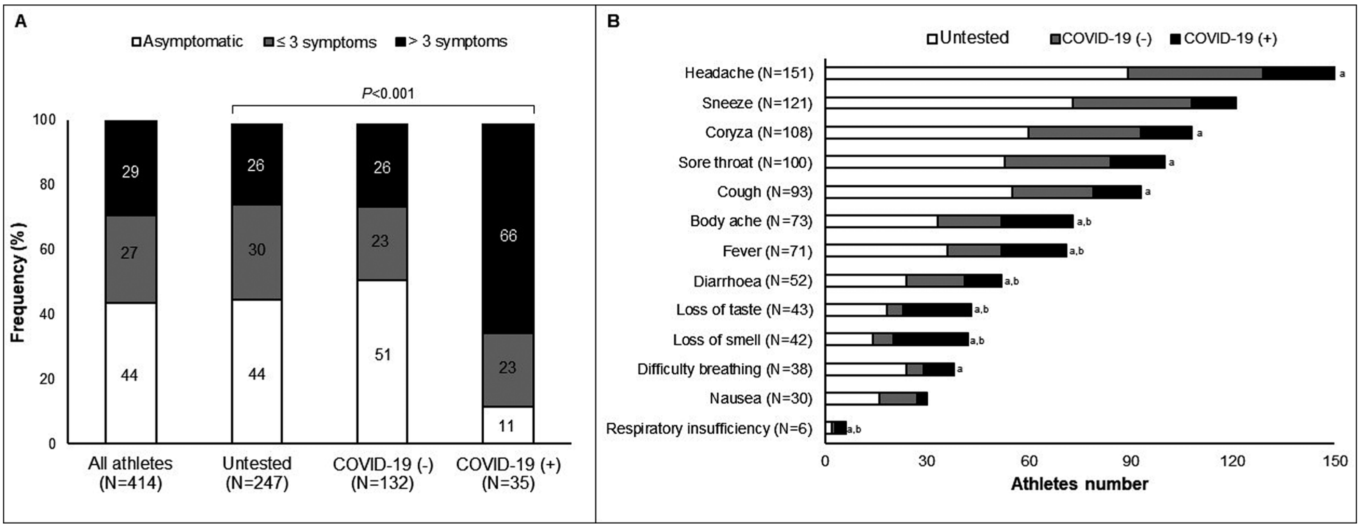

FIG. 3. Characteristic symptoms of COVID-19 in the study population. **(A)** Frequency of asymptomatic and symptomatic among untested athletes, those who tested negative, and those who tested positive for COVID-19. **(B)** Distribution of the main characteristic symptoms of COVID-19 between the groups (athletes who tested positive, those who tested negative and athletes who tested positive and untested athletes). [a]*P*-value ≤ 0.05 was obtained through the chi-squared test (Pearson p-value) comparing the athletes who tested positive versus who tested negative. [b]*P*-value ≤ 0.05 was obtained through the chi-squared test (Pearson p-value) comparing the athletes who tested positive versus untested athletes.

comparing athletes tested for COVID-19 and those not tested (about 60%) (model 2) was adjusted by factors associated with disease in the present study (age, children, smoking, and teammate tested positive for COVID-19). Athletes with a university education, with a profession other than sports, and public health users were tested less frequently than athletes who competed internationally, trained for more than 15 hours weekly, and received a wage as an athlete (Table 2).

Regarding COVID-19 symptoms, 26% (n = 99) of athletes who tested negative or were untested reported having more than 3 symptoms characteristic of COVID-19 during the pandemic, and ~11% (n = 4) of athletes who tested positive for COVID-19 were asymptomatic (Figure 3A). The distribution of characteristic symptoms of COVID-19 among untested athletes, those who tested negative, and those who tested positive is shown in Figure 3B. Sneezing and nausea were the only symptoms that showed no significant difference between athletes who tested positive versus those who tested negative, and athletes who tested positive and untested athletes.

DISCUSSION

This study examined the repercussions of the COVID-19 pandemic on the epidemiological and sporting profiles, life and health habits, and clinical characteristics of Brazilian athletes. Although the high number of COVID-19 cases among athletes itself indicates the requirement of a better understanding of the prevalence, associated factors, and behaviour of SARS-CoV-2 infection [14, 24], few studies have focused on this subject [25–27], and highly variable results have been reported. For example, the prevalence of COVID-19 was observed to be 2% in a prospective study of 812 professional soccer players and 372 staff members from the German Bundesliga [25]. However, 23% of Italian soccer players reported testing positive by RT-qPCR assay [26]. In addition, 60% of athletes on an Italian soccer team had anti-SARS-CoV-2 IgG class antibodies, although 33% of those athletes were asymptomatic [27]. Here, the prevalence of COVID-19 was 8.5% in the studied population, and the hospitalization rate was ~1%. Thus, we cannot make a direct comparison of our results with those of previous reports.

The WHO recommended a return-to-play framework during the pandemic, which included general hygiene and training environment sanitation procedures, and established that the triage and referral of COVID-19 cases are the responsibility of the teams [28]. In the case of a positive test, asymptomatic teammates and technical staff should also be tested. In Brazil, the medical guidelines for preventing COVID-19 during the national soccer championship demanded RT-qPCR testing of athletes and coaching staff before games, and advised that only asymptomatic players who tested negative be allowed to play in matches [29]. However, the economic heterogeneity among teams and athletes implies that some have less access to testing [11]. In line with this, athletes who had a teammate who tested positive for COVID-19 were 2-fold more likely to be tested and had a 2.5-fold greater chance of having the disease. In addition, an athlete had a greater chance (15-fold) of being tested when the test was administered by their team. However, only 40% of our athletes reported being tested for COVID-19, and only 26% were tested by their team. Undoubtedly, the lack of a gold standard molecular test (i.e., RT-qPCR) implies that case numbers [30] and the real disease prevalence were underestimated. In addition, 56% of our subjects reported some characteristic symptoms of COVID-19, although they were not diagnosed. This observation is of great concern because although the subjects were symptomatic, they could not be properly diagnosed due to the lack of testing. It must be highlighted that in Brazil, less than 7% of the entire population had been tested before October 2020 [30], which may have been an effect of both the high test cost and the country's decision to test only hospitalized patients due to wealth politics [31].

Although few studies have reported on COVID-19 symptoms in athletes, our observation agrees with Gervasi et al., who reported that 67% of professional soccer players on the same team reported mild symptoms, such as fever, ageusia, asthenia, anosmia, cough, arthromyalgia, sore throat, headache, and nocturnal dyspnoea [27]. It has been suggested that despite their excellent fitness and theoretically good health, athletes can be prone to viral infection of the upper respiratory tract [21]. In the present study, 9.2% of subjects reported respiratory distress, and only 1.4% were hospitalized. This observation, together with the report of a thirty eight-year-old Italian male athlete who needed to be attended by an intensive care unit for respiratory failure just four days after the onset of COVID-19 symptoms, shows that physically active subjects can also have serious disease complications [32].

While the consequences of SARS-CoV-2 infection may vary between symptomatic and asymptomatic athletes, professional football players manifested fever, dry cough, malaise, and dyspnoea immediately after an official match [32], and even recovered patients could present long-term symptoms [22]. The high frequency of COVID-19 symptoms reported by the untested athletes (55%) and athletes who tested negative (50%) in the present study, combined with previous observations, indicates that periodic triage and testing are necessary to maintain the health of athletes and mitigate the spread of the virus in sports-related environments [14].

When athletes were exposed to lockdown and social distancing during the pandemic, they needed to adapt their training routines to home-based exercise protocols [9]. This requirement forced a change in routines associated with musculoskeletal injuries and/or performance-related goal breaks [14, 33]. In this study, athletes who trained for more than 15 hours weekly had a 2-fold greater chance of being tested for COVID-19. During the pandemic, before November 2020, 71% of athletes reported moving towards a home-based protocol, and 20% reported an orthopaedic injury (e.g., joint, muscular, or tendon). Recently, a cross-sectional observational study involving 627 Brazilian athletes observed a prevalence of 76% of musculoskeletal injuries throughout sporting life [34]. However, it was not possible to compare injury occurrence with changes in training during the COVID-19 pandemic.

In addition to the physical and health problems directly related to COVID-19, the cancellation and postponement of regular competitions produced socioeconomic side effects. Approximately 65% of athletes reported a reduction in financial income, and 13% had a contract cancelled or changed, which is extremely relevant not just to the athletes but also to their families. The absence of games drastically decreases teams' revenues, affecting their ability to pay employees' salaries. This problem was not restricted to Brazilian teams; for example, major national leagues in the USA, e.g., basketball, hockey, baseball and soccer, also faced serious financial issues [35]. The sport financial crisis followed both the crises in both the world and Brazil in 2020, during which the national gross domestic product (GDP) growth rate decreased. In line with this, participants who received wages as athletes were more frequently tested, while athletes with monthly family incomes less than two thousand dollars and a profession other than sports were less frequently tested. This difference, perhaps, can be explained by the return-to-sport testing policy imposed by local leagues, which required employed athletes to be tested by the teams (employers) [29]. On the other hand, unemployed and/or athletes with lower salaries probably could not pay for COVID-19 tests.

Viral spread and infection are complex and multivariate problems. In the present study, the subjects who were under 27 years old (3-fold), subjects who had children (~5-fold), subjects who had a teammate tested positive for COVID-19 (2.5-fold), and subjects who smoked (14-fold) had a higher risk of COVID-19. Advanced age and the presence of comorbidities have been identified as risk factors for COVID-19 severity and death [36, 37], but athletes are younger and have a lower risk of serious disease outcomes. However, it should be noted that this study was based on a self-reported online questionnaire, and it was not possible to report the occurrence of death among the athletes. Our results corroborate previous observations that social aspects, such as education, having children, and place of residence, increase the risk of community transmission [38, 39]. In addition, it is well known that smoking impairs the immune system and increases the risk of respiratory tract infections [40]. A total of 9% of COVID-19 patients with severe complications were exposed to smoke (current and ex-smokers), and the lethality rate among current smokers was 38% [41]. According to a meta-analysis by Pantavanich and Glantz, patients with a history of smoking were 1.5 times more likely to have severe COVID-19 than non-smokers [42].

The present observations are helpful for aiding sport medicine providers in understanding the impact of the pandemic on socioeconomic and clinical factors in the athletic community. The current study has several strengths and limitations that should be considered. The risk of recall bias should not be discounted because all results were obtained from online self-reported questionnaires. In addition, this is a cross-sectional study, and we were not able to estimate the exact month in which the athlete was infected and could not examine the causality of the associations. This study was able to identify outcomes likely specific to the situation in Brazil and may not translate directly to other countries. However, a strength of the present study is that the total sample size was adequate to detect significance with 80% statistical power. In addition, the online form was a feasible choice of data collection, especially because it provided a good and self-explanatory user interface (i.e., the element is widely used across web-based applications and well known by the users, facilitating answering), allowed only single responses (provided by an e-mail control system), and created an automatic database (i.e., the answers were directly transferred to an online spreadsheet as structured data, allowing typing and conference errors to be avoided).

CONCLUSIONS

Although we observed that disease prevalence was lower in athletes, the COVID-19 pandemic had a deep effect on athletes' lives, especially on training routines and financial resources (i.e., wages or loss of sponsorship). We suggest that efforts be made to continue the process of triage and that testing should be a priority. These measures should at least mitigate new cases of COVID-19 amongst teammates, which is witnessed by the higher percentage of untested symptomatic athletes. Parents, smokers, and athletes younger than 27 years should pay extra attention to public health safety measures (general hygiene, face masking, and social distancing) given their higher probability of infection. We consider that the identification of modifiable (have children, smoking and teammates positively tested) and non-modifiable (age under 27 years) factors can contribute to implementing surveillance programmes to decrease disease incidence in athletes and the negative impacts of COVID-19 on sport.

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Conflict of interest declaration

No potential conflict of interest was reported by the authors.

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