





# High SARS-CoV-2 infection rate after resuming professional football in São Paulo, Brazil

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## ABSTRACT

**Objective** To examine the SARS-CoV-2 infection rate in a cohort of 6500 professional athletes and staff during the 2020 football (soccer) season in São Paulo, Brazil.

**Methods** This retrospective cohort study included 4269 players (87% male, age: 21.7±4.2 years) and 2231 staff (87% male, age: 42.6±11.9 years) from 122 teams (women: n=16) involved in eight leagues (women: n=2), which took place in São Paulo, Brazil. Between 4 July 2020 and 21 December 2020, swab samples were collected weekly (n=29 507) and tested for SARS-CoV-2 via reverse transcription-PCR by an accredited laboratory commissioned by the São Paulo Football Federation. We contacted the medical staff of each team with positive cases to collect information on disease severity.

**Results** Among 662 PCR-confirmed cases, 501 were athletes and 161 were staff. The new infection rate was 11.7% and 7.2% for athletes and staff, respectively. Athletes were more susceptible to infection than staff (OR: 1.71, 95% CI: 1.42, 2.06, p<0.001), although with lower chance for moderate to severe disease (OR: 0.06, 95% CI: 0.01, 0.54, p=0.012). Six teams had ≥20 individuals testing positive for SARS-CoV-2, whereas 19 teams had ≥10 confirmed cases. Twenty-five mass outbreaks were identified (≥5 infections within a team in a 2-week period). The prevalence of SARS-CoV-2 infection was similar in athletes and staff as the general population in São Paulo.

**Conclusion** Despite weekly testing and other preventive measures, we found a high SARS-CoV-2 infection rate in athletes and staff after resuming football, which coincides with the high prevalence of infection in the community during the same period. These data may assist policy-makers and sports federations for determining if and when it is safe to resume competitions.

## INTRODUCTION

Brazil continues to be severely affected by the COVID-19 pandemic, accounting for approximately 13% of deaths worldwide by June 2021 (>500 000 reported deaths).<sup>1</sup> São Paulo, the country's largest metropolis with a population of over 44 million people, recorded over 3.55 million PCR-confirmed COVID-19 cases,<sup>2</sup> corresponding to approximately one-fifth of Brazilian cases.

In March 2020, social distancing measures were implemented by São Paulo authorities, which included the suspension of football (soccer) competitions. By 31 May 2020, 514 200 COVID-19 cases, resulting in 29 314 deaths, had been reported

in 75.3% (4196 of 5570) of municipalities across all five administrative regions of Brazil.<sup>3</sup> The case reproduction number ( $R_t$ ) was estimated to be 3.1 (95% Bayesian credible interval=2.4 to 5.5), with credible intervals being comparable with those of the worst-hit countries.<sup>3</sup> Successive nationwide seroprevalence surveys conducted from 14–21 May 2020 to 4–7 June 2020 confirmed a rapid increase in SARS-CoV-2 antibody prevalence from 1.9% (95% CI 1.7% to 2.1%) to 3.1% (95% CI 2.8% to 3.4%).<sup>4</sup>

Even though Brazil was clearly experiencing one of the world's most rapidly growing COVID-19 epidemics,<sup>3,4</sup> resumption of football activities occurred on June 14, when the  $R_t$  in São Paulo was 1.01. The  $R_t$  rose to 1.6 by early December,<sup>5,6</sup> suggesting that the epidemic was not contained. While there have been a few reports on the successful return-to-play of football in countries experiencing different rates of transmissibility,<sup>7–9</sup> the risk of COVID-19 exposure to competitors and staff of football clubs during a largely unmitigated epidemic, such as that affecting Brazil, remains unknown.

This study reports on the SARS-CoV-2 infection rate in a cohort of 6500 professional athletes and staff during the 2020 football season in São Paulo, Brazil.

## METHODS

### Study design and participants

The São Paulo Football Federation (SPFF) protocol for reopening football involved repeated reverse transcriptase (RT)-PCR testing, temperature checks, social distancing, wearing a mask outside training and matches, strict hygiene and limited number of staff in the stadium. Athletes and staff were tested on a weekly basis. Each club's responsible medic was obliged to submit confirmation of the negative test, or in the case of a positive test evidence that the 10-day quarantine had been completed, to the SPFF medical committee at least 24 hours before the match. Only players and staff who had confirmation of alignment with these procedures were permitted to participate. Immediate isolation of positive cases and tracing of close contacts were also recommended, although the latter was not effectively adopted.

In this retrospective cohort study, swab samples collected once-a-week, between 4 July 2020 and 21 December 2020, were sent to an accredited laboratory commissioned by SPFF, which provided its SARS-CoV-2 RT-PCR database (n=29 507) for



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**Table 1** Participants' characteristics

Characteristics	Total (n=6500)	Athletes (n=4269)	Staff (n=2231)*
Age, n (%)			
14–18	886 (13.6)	886 (20.8)	–
19–25	2885 (44.4)	2769 (64.9)	116 (5.2)
26–30	648 (10.0)	384 (9.0)	264 (11.8)
31–35	516 (7.9)	190 (4.5)	326 (14.6)
36–45	746 (11.5)	40 (0.9)	706 (31.6)
>45	818 (12.6)	–	818 (36.7)
Sex, n (%)			
Male	5650 (86.9)	3713 (87.0)	1937 (86.8)
Female	850 (13.1)	556 (13.0)	294 (13.2)
Disease severity†, n (%)			
Mild	576 (99.0)	439 (99.8)	137 (96.6)
Moderate	5 (0.9)	1 (0.2)	4 (2.7)
Severe/critical	1 (0.1)	0 (0.0)	1 (0.7)

\*One missing data for age.

†According to WHO-COVID-19 Clinical management: living guidance, 25 January 2021. Out of 122 teams' medical staff, six could not be contacted and twelve did not know or refused to inform about disease severity.

analysis. The RT-PCR assays were performed using Cobas SARS-CoV-2-RT-PCR Kit (Roche Molecular Systems, Branchburg, USA) and Xpert Xpress SARS-CoV-2-RT-PCR Kit (Cepheid, Sunnyvale, USA). For athletes and staff, we report the infection rate, defined as the proportion of at least one positive test divided by the number of individuals tested. We contacted the medical staff of the teams to collect information on disease severity for positive cases.

## Patient and public involvement

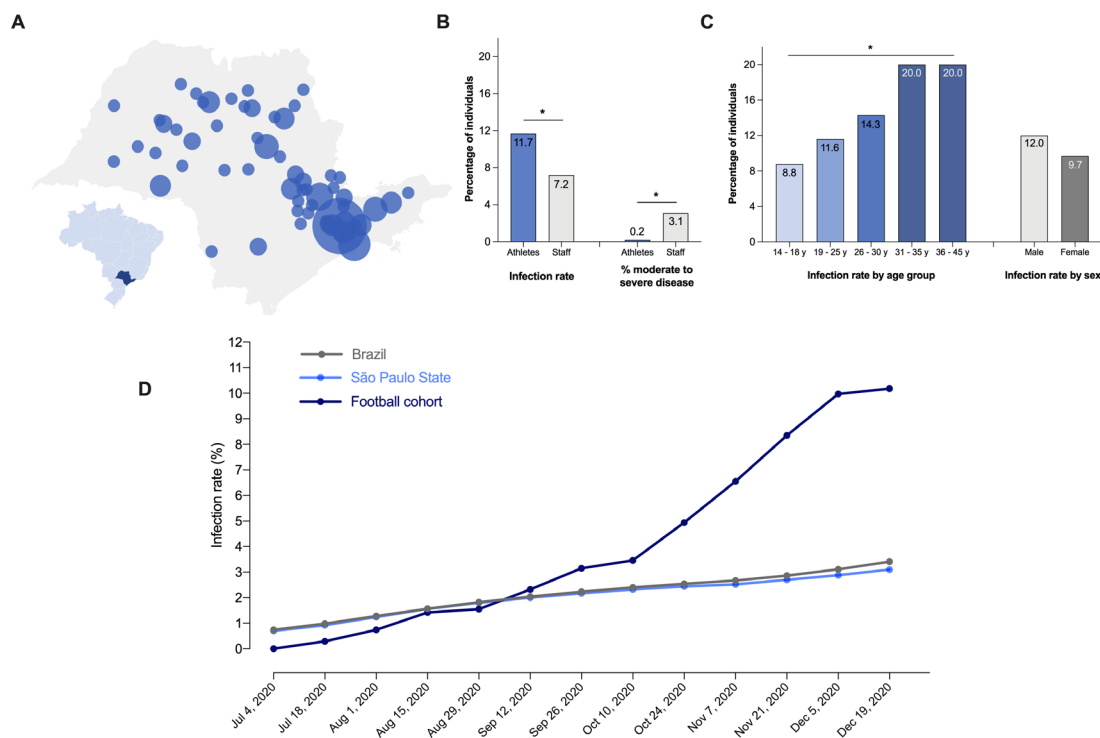
Patients and the public were not involved in the design or conduct of this study.

## Statistical analysis

Using logistic regression models, we tested whether the odds of infection and the incidence of moderate to severe disease were different between athletes versus staff. Also, we performed a post hoc comparison for the odds of infection (player plus staff) between teams from São Paulo city versus those outside the city. Among athletes, we tested whether age and sex had an influence on the odds of infection. Data are expressed as mean±SD and OR and 95%CI. Significance level was set at  $p=0.05$ . Statistical analyses were performed in SAS (V.9.4 for Windows; SAS Institute).

## RESULTS

The study included 4269 players (87% male, mean (SD) age:  $21.7\pm 4.2$  years) and 2231 staff (87% male, age:  $42.6\pm 11.9$  years) from 122 teams (women:  $n=16$ ) involved in 8 leagues (women:  $n=2$ ) organised by SPFF (table 1; figure 1A). The mean number of individuals per team was  $53.3\pm 19.8$ . There were 19 teams located in São Paulo city, with the remainder being spread over 62 other cities within São Paulo state. Teams were involved in eight leagues: Under-20, Under-23, São Paulo Cup, São Paulo Championship (Divisions I, II and III), Women's São Paulo Championship and Women's Under-17. The number of tests per team was  $241.9\pm 120.9$ , and tests per person was  $4.5\pm 3.1$ . The number of tests per team varied according to the length of the league; the number of leagues in which each team was involved; and the team's success rate (which determined



**Figure 1** SARS-CoV-2 infection rate after resuming football in São Paulo, Brazil. (A) distribution of teams across São Paulo state ( $n=122$ ), with larger circles representing a higher number of teams in the same city (range: 1–19). (B) infection rate in athletes and staff and the percentage of individuals that presented with moderate to severe COVID-19. (C) Infection rate in athletes by age and sex. \* $P<0.05$ , calculated by logistic regression models. (D) infection rate (considering PCR-confirmed cases) in Brazil,<sup>19</sup> São Paulo state<sup>2</sup> and the football cohort. note: the actual number of cases is likely underestimated in Brazil and São Paulo, as indicated by the high positivity rate<sup>2</sup> (which suggests an insufficient number of tests<sup>20</sup>) and the high seroprevalence of SARS-CoV-2 antibodies in the population.<sup>10</sup>

how long they remained in any given league). In total, 29 507 tests were performed with a positivity rate of 2.11% and 2.78% for players and staff, respectively. PCR-confirmed cases totalled 662, of which 501 were athletes and 161 were staff; the infection rate was 11.7% and 7.2%, respectively (figure 1B).

Athletes were more susceptible to infection than staff (OR: 1.71, 95% CI: 1.42, 2.06,  $p < 0.001$ ), although with a lower chance for moderate to severe disease (OR: 0.06, 95% CI: 0.01 to 0.54,  $p = 0.012$ ) (figure 1B). Only one athlete experienced moderate COVID-19 (a 23-year-old male), whereas four staff had moderate disease (3 males; age:  $55.3 \pm 9.7$ ) and one died (a 56-year-old male). The odds of infection did not significantly differ between teams from São Paulo city versus those outside the city (OR: 0.87, 95% CI: 0.69 to 1.10,  $p = 0.253$ ). Among players, the odds of infection increased according to age (OR: 1.05, 95% CI: 1.03 to 1.07,  $p < 0.001$ ) but did not differ between sexes (OR: 1.27, 95% CI: 0.95 to 1.71,  $p = 0.113$ ) (figure 1C).

Six teams had  $\geq 20$  individuals testing positive for SARS-CoV-2 (equivalent to  $46.7\% \pm 10.9\%$  of the individuals per team), whereas 19 teams had  $\geq 10$  confirmed cases ( $27.7\% \pm 15.4\%$ ). The worst-hit team had 37 cases (45.7%), 32 of whom tested positive within an approximately 5-week period. Twenty-five mass outbreaks (defined as  $\geq 5$  infections within a single team in a 2-week period) were identified.

During the study period, the infection rate in São Paulo, based on PCR-confirmed cases, varied from 0.7% to 3.1% (figure 1D).<sup>2</sup> However, these numbers are very likely underestimated, as indicated by the high positivity rate (28.4%)<sup>2</sup> and the high seroprevalence of SARS-CoV-2 antibodies in the population<sup>10</sup> (see the Discussion section).

## DISCUSSION

To our knowledge, the elevated SARS-CoV-2 infection rate during the 2020 football season in São Paulo is the highest among sport leagues around the world.<sup>7–9 11</sup> In fact, the average infection rate in players (11.7%) was within the range of worldwide seroprevalence observed in high-risk healthcare workers (9.9%–24.4%),<sup>12</sup> but lower than that seen in a citywide seroprevalence survey conducted in São Paulo from 14 January 2021 to 23 January 2021 (26.2%–33.5%),<sup>10</sup> when Brazil was already facing a severe second wave. Although successful returns to football competition have been seen in countries showing different rates of community transmission,<sup>7–9</sup> the current data cast doubt on the safety of reopening during a largely unmitigated epidemic, such as in Brazil.

Players and staff train and travel together which increases the chance of spread within a club if a player or staff member acquires an infection. This is evident from the numerous mass outbreaks that occurred throughout the season, which contrasts with the absence of signs of a chain of infection in less affected leagues.<sup>7–9</sup> Athletes were more likely to become infected than staff, but very often experienced a mild disease (500/501; 99.8%), confirming

previous observations.<sup>7–9</sup> Notwithstanding, the high rates of infections in athletes should not be overlooked as potential long-term complications (eg, ‘long-Covid’) in this population are not yet fully understood, with preliminary findings being controversial.<sup>13–15</sup> The current data also indicate that staff members may be at greater risk for more severe disease outcomes, perhaps because they are older, and most likely have more comorbid medical conditions and are less fit than athletes. This finding, however, requires further confirmation in a larger cohort with moderate-to-severe cases and proper control for confounding variables (eg, pre-existing chronic diseases and lifestyle).

Another interesting finding was that age was associated with increased odds of infection among athletes, varying from  $\sim 9\%$  in those aged 14–18 years to  $\sim 20\%$  in those aged  $\geq 31$  years. One possible explanation is that younger players are more commonly accommodated in club houses, which possibly restricts their circulation and social interaction, potentially preventing infections. In fact, as within-match transmission has been deemed unlikely,<sup>11 16</sup> positive cases in contact sports are most likely associated with intensive social interactions, frequent travel, and community transmission. Although adherence to common prevention strategies (ie, social distancing, mask wearing, hand hygiene) was not monitored in this study, low compliance may partially explain the high infection rates observed among players. With only weekly testing required, a point of concern is that infected athletes could be potential vectors of transmission. Unfortunately, contact tracing of infected individuals to interrupt chains of transmission was also not adopted by the clubs (and in a more generalised context, by Brazilian authorities overall,<sup>17</sup> hampering estimates of secondary infection rates).

## Limitations

A limitation of this study is that teams were allowed to test more often for SARS-CoV-2 at their own discretion in independent laboratories, which could have led to an underestimation of infections in this report. Furthermore, comparisons between reopened football leagues worldwide are limited by a wide range of lengths of the season ( $\sim 24$  weeks in Brazil as opposed to 9–11 weeks in other countries<sup>7–9</sup> and epidemic scenarios when competitions were resumed ( $R = 1.13$  in Brazil as opposed to  $R_t = 0.74$ – $0.94$  in other countries.<sup>7–9</sup> However, the substantial number of positive cases and mass outbreaks reported herein is unique (table 2), suggesting that in countries with a high prevalence of COVID-19 infections, reopening sport without robust attention to risk mitigation and resources for contact tracing and more frequent testing, increases in transmissions among players and staff are likely.

## CONCLUSION

We found high rates of SARS-CoV-2 infections after reopening football, which coincides with the high community

**Table 2** Comparisons between leagues across countries for SARS-CoV-2 infections among athletes following resumption of football

Country	$R_t^*$	Testing length (weeks)	Positivity rate (%)	Infected/tested athletes†	Infections per week per 1000 athletes	Infection rate (%)	Mass outbreaks‡
Brazil	1.13	22	2.11	501/4269	5.3	11.7	25
Denmark (2)	0.73	11	0.06	4/748	0.5	0.5	0
Qatar (3)	0.94	9	0.59	36§ / 549	4.8	4.4	0
Germany (4)	0.74	8	N/A	8¶ / 1079	0.9	0.7	0

\*Case reproduction number at the time of reopening football.<sup>20 21</sup>

†PCR-confirmed cases.

‡Defined as  $\geq 5$  infections within a team in a 2-week period.

§12 positive cases were identified at a quarantine period preceding competition.

¶All positive cases were identified 2–5 days before the onset of regular team training.

NA, not available.

transmissibility during the same period. These findings may assist policymakers and sports federations for determining if and when it is safe to resume training and competitions. During an unmitigated epidemic, stricter protocols (eg, adoption of biosecure ‘bubbles’, contact tracing and more frequent testing) appear to be necessary to effectively prevent sport-related outbreaks and potential community disease spread. As of June 2021, even without employing such strategies, football remains open in Brazil with national and international competitions, despite the current surge of cases and deaths and the emergence of variants of concern.<sup>18</sup>

### What are the findings?

- ▶ High rates of COVID-19 infections were seen in a cohort of 6500 athletes and staff after resuming football (soccer) in São Paulo, Brazil.
- ▶ PCR-confirmed cases totalled 662. Infection rates for athletes and staff were 11.7% and 7.2%, respectively. Staff were more susceptible to more severe disease.
- ▶ Six teams had  $\geq 20$  individuals testing positive for SARS-CoV-2, whereas 19 teams had  $\geq 10$  confirmed cases. The worst-hit team had 37 cases, 32 of whom confirmed within an approximately 5-week period.

### How might it impact on clinical practice in the future?

- ▶ The current data cast doubt on the safety of reopening sport competitions during a largely unmitigated epidemic, such as in Brazil.
- ▶ In countries severely hit by COVID-19, the resumption of sport likely requires stricter protocols (eg, adoption of biosecure ‘bubbles’, contact tracing and more frequent testing) to effectively prevent outbreaks and potential disease spread within a team. Without these measures, the postponement of sport should be considered in communities with a high prevalence of COVID-19 infections.

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