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COVID-19 affects match running performance in professional soccer players
El COVID-19 afecta el rendimiento de carrera de partido en jugadores de fútbol profesional
O COVID-19 afeta o desempenho de corrida de jogo em jogadores de futebol profissional

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Abstract. Objectives: To compare the match running performance of male soccer players in the Brazilian A series before and after being infected with COVID-19. Methods: The sample consisted of 20 professional soccer players from Rio de Janeiro-based teams during the 2020 and 2021 seasons, pre- and post-COVID-19 infection. Match running performance data were collected using a Global positioning system (GPS), and the analysis includes average data across 1 to 17 games pre-infection and 1 to 13 games post-infection per player. Results: COVID-19-infection induced an unclear effect on the total distance traveled during the match [SWC-Factor = -1.9, 90 % CL (-4.7; 0.9)], the number of sprints at speeds over 24 km/h [SWC-Factor = 1.1, 90 % CL (-1.7; 3.9)], maximum speed reached [SWC-Factor = 0.1, 90 % CL (-2.6; 2.9)], the number of decelerations [SWC-Factor = -2.2, 90 % CL (-5.0; 0.6)], explosive efforts [SWC-Factor = -2.4, 90 % CL (-5.1; 0.4)], distance traveled at speeds between 0 and 7 km/h [SWC-Factor = 2.4, 90 % CL (-0.4; 5.2)], and distance traveled at speeds between 7 and 14 km/h [SWC-Factor = -1.8, 90 % CL (-4.5; 1.0)]. However there was a moderate and significant decrease in distance covered during high-intensity running, defined as speeds greater than 20 km/h [SWC-Factor = -4.2, 90 % CL (-7.0; -1.5)], the number of accelerations greater than 3 m/s² [SWC-Factor = -3.6, 90 % CL (-6.4; -0.9)], and distance traveled at speeds between 14 and 20 km/h [SWC-Factor = -3.5, 90 % CL (-6.2; -0.7)]. The results also showed that COVID-19-infection led to a substantial decrease in minutes played during matches [SWC-Factor = -4.0, 90 % CL (-6.8; -1.3)], affecting the analysis of match variables' absolute values. Conclusion: The results suggest that players infected with COVID-19 experienced changes in match running performance, notably decreases in distance covered during high-intensity running and increases traveled at speeds between 0 and 7 km/h. Further analysis of other player populations (in other leagues) is necessary to verify these findings.
Keywords: Coronavirus, Physiology, Task Performance and Analysis, Match running, External Load.

Resumen. Objetivos: Comparar el rendimiento de carrera en partidos de futbolistas masculinos de la Serie A de Brasil antes y después de haber sido infectados con COVID-19. Métodos: La muestra consistió en 20 futbolistas profesionales de equipos de Río de Janeiro durante las temporadas 2020 y 2021, tanto antes como después de la infección por COVID-19. Los datos de rendimiento de carrera en partidos se recopilaron utilizando un sistema de posicionamiento global (GPS), y el análisis incluye datos promedio de 1 a 17 partidos antes de la infección y de 1 a 13 partidos después de la infección por jugador. Resultados: La infección por COVID-19 tuvo un efecto incierto en la distancia total recorrida durante los partidos [Factor SWC = -1,9, 90 % CL (-4,7; 0,9)], el número de sprints a velocidades superiores a 24 km/h [Factor SWC = 1,1, 90 % CL (-1,7; 3,9)], la velocidad máxima alcanzada [Factor SWC = 0,1, 90 % CL (-2,6; 2,9)], el número de desaceleraciones [Factor SWC = -2,2, 90 % CL (-5,0; 0,6)], los esfuerzos explosivos [Factor SWC = -2,4, 90 % CL (-5,1; 0,4)], la distancia recorrida a velocidades entre 0 y 7 km/h [Factor SWC = 2,4, 90 % CL (-0,4; 5,2)], y la distancia recorrida a velocidades entre 7 y 14 km/h [Factor SWC = -1,8, 90 % CL (-4,5; 1,0)]. Sin embargo, hubo una disminución moderada y significativa en la distancia recorrida durante la carrera de alta intensidad, definida como velocidades superiores a 20 km/h [Factor SWC = -4,2, 90 % CL (-7,0; -1,5)], el número de aceleraciones superiores a 3 m/s² [Factor SWC = -3,6, 90 % CL (-6,4; -0,9)], y la distancia recorrida a velocidades entre 14 y 20 km/h [Factor SWC = -3,5, 90 % CL (-6,2; -0,7)]. Los resultados también mostraron que la infección por COVID-19 provocó una disminución sustancial en los minutos jugados durante los partidos [Factor SWC = -4,0, 90 % CL (-6,8; -1,3)], lo que afectó el análisis de los valores absolutos relacionados con las variables del partido. Conclusión: Los resultados sugieren que los jugadores que se infectaron con COVID-19 experimentaron cambios en su rendimiento de carrera en partidos, particularmente disminuciones en la distancia recorrida durante la carrera de alta intensidad y aumentos en la distancia recorrida a velocidades entre 0 y 7 km/h. Es necesario realizar un análisis adicional en otras poblaciones de jugadores (en otras ligas) para verificar estos hallazgos.
Palabras clave: Coronavirus, Fisiología, Desempeño y análisis de tareas, Rendimiento en partidos, Carga externa.

Resumo. Objetivos: Comparar o desempenho de corrida em partidas de jogadores de futebol masculino da Série A do Brasil antes e depois de terem sido infectados pela COVID-19. Métodos: A amostra consistiu em 20 jogadores de futebol profissionais de equipes do Rio de Janeiro durante as temporadas de 2020 e 2021, tanto antes quanto depois da infecção por COVID-19. Os dados de desempenho de corrida em partidas foram coletados usando um sistema de posicionamento global (GPS), e a análise inclui dados médios de 1 a 17 partidas antes da infecção e de 1 a 13 partidas após a infecção por jogador. Resultados: A infecção por COVID-19 teve um efeito incerto na distância total percorrida durante as partidas [Fator SWC = -1,9, 90% CL (-4,7; 0,9)], no número de sprints a velocidades superiores a 24 km/h [Fator SWC = 1,1, 90% CL (-1,7; 3,9)], na velocidade máxima alcançada [Fator SWC = 0,1, 90% CL (-2,6; 2,9)], no número de desacelerações [Fator SWC = -2,2, 90% CL (-5,0; 0,6)], nos esforços explosivos [Fator SWC = -2,4, 90% CL (-5,1; 0,4)], na distância percorrida a velocidades entre 0 e 7 km/h [Fator SWC = 2,4, 90% CL (-0,4; 5,2)], e na distância percorrida a velocidades entre 7 e 14 km/h [Fator SWC = -1,8, 90% CL (-4,5; 1,0)]. No entanto, houve uma diminuição moderada e significativa na distância percorrida durante a corrida de alta intensidade, definida como velocidades superiores a 20 km/h [Fator SWC = -4,2, 90% CL (-7,0; -1,5)], no número de acelerações superiores a 3 m/s² [Fator SWC = -3,6, 90% CL (-6,4; -0,9)], e na distância percorrida a velocidades entre 14 e 20 km/h [Fator SWC = -3,5, 90% CL (-6,2; -0,7)]. Os resultados também mostraram que a infecção por COVID-19 provocou uma diminuição substancial nos minutos jogados durante as partidas [Fator SWC = -4,0, 90% CL (-6,8; -1,3)], o que afetou a análise dos valores absolutos relacionados às variáveis das partidas. Conclusão: Os resultados sugerem que os jogadores que foram infectados pela COVID-19 experimentaram mudanças em seu desempenho de corrida em partidas, particularmente diminuições na distância percorrida durante a corrida de alta intensidade e aumentos na distância percorrida a velocidades entre 0 e 7 km/h. É necessário realizar uma análise adicional em outras populações de jogadores (em outras ligas) para verificar esses achados.
Palavras-chave: Coronavírus, Fisiologia, Desempenho e Análise de Tarefas, Desempenho em Jogos, Carga Externa.

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Introduction

Due to the ongoing "Coronavirus Disease 2019" (COVID-19) pandemic, soccer players worldwide were required to remain confined in their homes under strict mandatory isolation by government regulations enforced in response to the outbreak (Jukić et al., 2020). This isolation led teams to implement remote training methods through their technical staff to preserve the physical condition of their players (Jukić et al., 2020; Sarto et al., 2020). Data were collected over time, and strategies were published on safely conducting training sessions and games using strict hygiene measures, undergoing regular PCR testing, and conducting systematic contact tracing after confirmed cases (Buldú et al., 2020; Meyer et al., 2021). However, even with strict protocol compliance, a 100% guarantee against infection cannot be ensured (Fernandez Ortega et al., 2024).

Contracting COVID-19 can result in various clinical symptoms that vary among individuals, ranging from mild to severe respiratory symptoms and acute respiratory distress syndrome. COVID-19 can also affect the cardiovascular system in some people (Cowan et al., 2018), with complications such as myocarditis (including fulminant cases), arrhythmias, and rapid-onset heart failure (Madjid et al., 2020). In some cases, cardiac involvement has even occurred in asymptomatic patients (Inciardi et al., 2020). Although athletes are generally healthy, without underlying comorbidities, and do not belong to high-risk groups, many of them—and even entire sports teams—have been affected by COVID-19 infections. This has necessitated the collection of evidence and the development of practical recommendations, including the publication of a guide with specific primary guidelines for returning infected athletes to play (Schellhorn et al., 2021).

Soccer is an intermittent sport that mixes technical and tactical skills with high-intensity actions such as sprinting, jumping, and changing direction, with short rest periods, covering between 9-14 km per game at different speed intensities (Dolci et al., 2020; Bangsbo et al., 2006). Several articles have been published on the effects of COVID-19 on athletes' well-being, physical performance, and pre- and post-quarantine movement patterns (Villaseca-Vicuña et al., 2021; Brito de Souza et al., 2021; García-Aliaga et al., 2021; Cohen et al., 2020; Freire et al., 2020). Some of the adverse effects identified include negative impacts on well-being, cardiovascular performance (Yo-Yo test), neuromuscular outcomes (countermovement jump variables), and match running performance. The latter is defined as an analysis of physical demands through the quantification of movement patterns during match play, often described by distance covered in different velocity zones and the number of explosive actions such as accelerations and decelerations (Villaseca-Vicuña et al., 2021; Brito de Souza et al., 2021; García-Aliaga et al., 2021; Cohen et al., 2020; Freire et al., 2020; Modric et al., 2023).

The urgency to clarify the progression of the disease and its potential long-term cardiorespiratory complications has been emphasized (Schellhorn et al., 2021; Dores & Cardim, 2020), which could be reflected in the running performance of players since there is a relationship between running capacity and cardiovascular performance (Aquino et al., 2020; Rampinini et al., 2007). Furthermore, match running performance has been associated with a match performance index involving several successful crosses, shots, and interceptions (Modric et al., 2019). A relationship with match results (win, loss, or draw) has also been reported (Nobari et al., 2021). Moreover, the distances covered at high intensity have been able to distinguish between Spanish first and second-division teams (Gomez-Piqueras et al., 2019). However, the impact of the COVID-19 quarantine period on these performance-related variables has yet to be extensively studied.

Collecting data and sharing information is crucial to helping athletes return safely after being confined at home (Impellizzeri et al., 2020). In particular, sharing information about infected athletes could be essential for coaches to individualize the training load for these players. Because of the above, this study aimed to compare the match running performance outcomes in a sample of male Brazilian soccer players in the Brasileirão Serie A league before and after being infected with COVID-19. We hypothesized that infected players would experience a decline in match running performance post-COVID-19 infection, primarily in high-intensity actions.

Methods

Study design

This is a comparative and descriptive applied research study using performance analysis to examine the effects of COVID-19 on running performance. The study is based on a thorough and randomized data collection using documentary analysis associated with COVID-19 infection, comparing pre- and post-infection Global Positioning System (GPS) parameters. During the COVID-19 pandemic, SARS-CoV-2 detection in professional Brazilian athletes was conducted weekly using nasopharyngeal swabs (Castro et al., 2020). Upon detecting the presence of the coronavirus, the respective athlete was isolated until they tested negative. After testing negative, the athlete returned to training and subsequently to competitive play. We used pre- and post-infection running data from championships for the same athletes who had moderate symptoms during infection (Tostmann et al., 2020) without requiring hospitalization. The investigation was conducted with soccer players from a first-division team in the Brazilian league, focusing on official matches in the Brasileirão Serie A championship, the City Cup (Carioca), the Brazil Cup, and the Libertadores Cup (international). A total of 305 samples

of athletes' GPS data were obtained during games before and after infection with COVID-19. The analysis includes average data across 1 to 17 games pre-infection and 1 to 13 games post-infection per player. This study describes performance data collected from GPS units (Catapult Innovations, Scoresby, Australia), with a sampling frequency of 5 Hz, tracking movement patterns common to professional soccer players and comparing players' performance during official games before and after COVID-19 infection (Jennings et al., 2010). All participants had undergone pre-season training and were in appropriate physical condition without injuries. This study was submitted to and approved by the Local Ethics Committee in Research (n. 13846919.8.0000.5257), following the rules of the National Health Council and the WMA Declaration of Helsinki.

Participants

The sample consisted of 305 randomized GPS data samples from 20 soccer players, including 4 central defenders, 5 lateral defenders, 6 midfielders, and 5 strikers (weight: 78.8±7.6 kg; height: 1.81±0.07 m; BMI: 23.8±1.2; fat mass: 11.7±3.7%) from professional soccer teams in Rio de Janeiro (Brazil League Serie A), assessed pre- and post-COVID-19 infection. All athletes received constant medical follow-ups.

The inclusion criteria for this study were meticulously outlined to ensure that the data collected were reliable and relevant to the research question concerning the impact of COVID-19 on the running performance of professional soccer players. The study targeted athletes who participated in approximately 85% of game time, ensuring that the GPS data collected represented significant in-game activity. This criterion was essential for accurately assessing the players' physical performance while minimizing variability that could arise from limited playing time.

The selection of athletes competing in national and international championships every week was strategic, aiming to capture performance data from high-level competitions where athletes are likely to exert maximum effort. Given the regularity and comparable intensity of the competitions involved, this approach also provided a consistent framework for comparing pre- and post-infection performance levels.

A critical aspect of the inclusion criteria was the confirmation of SARS-CoV-2 infection through nasopharyngeal swabs, paired with the presence of moderate symptoms such as anosmia, muscle aches, ocular pain, general malaise, headache, extreme tiredness, fever, common cold, sneezing, coughing, shortness of breath, runny nose, sore throat, nausea, or diarrhea. These symptoms indicate a COVID-19 infection significant enough to potentially impact physical performance without requiring hospitalization. This distinction was crucial in focusing the study on athletes who experienced typical symptoms that could affect their return to peak performance levels post-infection.

Exclusion criteria were equally important to maintain the integrity of the study. Participants with incomplete pre- or post-infection data were excluded to ensure the analysis was based on comprehensive and comparative datasets. Similarly, athletes who had been infected with COVID-19 but remained asymptomatic (Tostmann et al., 2020) were excluded, allowing the study to concentrate on the effects of the virus when it manifests physically, which could directly influence athletic performance. Additionally, by omitting games that went into extra time and substituted players and goalkeepers, the study aimed to standardize the conditions under which performance data were evaluated, thereby minimizing extraneous variables that could skew the results.

As indicated in Table 1, all participants in the sample were athletes who had been regularly training pre- and post-infection.

Table 1.
Microcycle: the week of training and game of soccer players at national and international levels during the collection data.

Moment/day	1st day	2nd day	3rd day	4th day	5th day	6th day	7th day
Morning	60 min Physical training	60 min Physical training	120 min Technical-tactical training or rest	rest	60 min Physical training	Rest	Rest
Afternoon	120 min Technical-tactical training	120 min Technical-tactical training	Technical-tactical training with similar game load or Game	120 min Technical-tactical training	120 min Technical-tactical training	Rest	Rest
Night	Rest	Rest	Rest	Rest	Rest	Game	Rest

All participants had previous experience with GPS equipment, professional soccer events, rules, and procedures used during the games. Following approval and with the institution's consent, the volunteers (age >18 years) were contacted by the researchers to be informed about the aims and procedures of the study and signed an informed consent form to participate in the data collection. No modifications were made to participants' training, nutritional, or hydration status, and they maintained a passive recovery period of 24 hours without training efforts between games.

SARS-CoV-2 detection with nasopharyngeal collection

The detailed description of the nasopharyngeal (NP) swabbing procedure for COVID-19 PCR testing highlights

the meticulous and standardized approach required for accurate sample collection. This method, which uses synthetic fiber swabs with thin plastic shafts, is widely employed for its effectiveness in reaching the nasopharynx, a key site for detecting SARS-CoV-2 viral load in infected individuals.

The Immunochromatographic assay technique, which utilizes a double antibody (sandwich) method enhanced with colloidal gold, allows for qualitatively determining the COVID-19 antigen. This approach underscores the advanced methodologies used to detect the presence of the virus, with a reported sensitivity of 70% and specificity of 97%, as specified by the COVID-19 Ag ECO Test (Castro et al., 2020). The precision in the swabbing technique, from the angle of insertion to the gentle rotation and removal of the swab, is critical in ensuring the reliability of test results.

The weekly testing protocol, conducted every Monday, underscores the rigorous monitoring athletes underwent during the study. This consistent testing regime promptly identified infections and played a crucial role in managing the spread of the virus within professional athletic environments. By adhering to such stringent procedures, the study aimed to mitigate the risk of COVID-19 transmission among participants while providing valuable data on the virus's impact on athletes' performance and well-being.

Match running performance variables

Performance analyses of the professional soccer players were monitored using a portable 5-Hz global positioning system (GPS) unit (Catapult®, Melbourne, AUS) during games (Abbott et al., 2018). The GPS unit was positioned via an elasticized shoulder harness to sit between the player's scapulae at the base of the cervical spine. The GPS unit was activated, and a GPS satellite lock was established for at least 15 minutes before the player took the field, per the manufacturer's recommendations (Abbott et al., 2018; Petersen et al., 2009; Pettersen et al., 2009a). The recorded information was downloaded after each session using Catapult Sprint software (Catapult Innovations®, Melbourne, AUS) for analysis. Once downloaded, the competition data were edited and split into two 45-minute halves (Abbott et al., 2018; Petersen et al., 2009; Pettersen et al., 2009a). The mean number of satellites and the horizontal dilution of position were recorded during data collection (Abbott et al., 2018; Petersen et al., 2009; Pettersen et al., 2009a). Variables are described in Table 2.

Table 2.
Description match running performance variables.

Variable	Description	Normalized by MIN
TD (m)	Total distance traveled during the match	yes
MIN (min)	Minutes played in the match	not
D0_7 (m)	Distance traveled at speeds between 0 and 7 km/h	yes
D7_14 (m)	Distance traveled at speeds between 7 and 14 km/h	yes
D14_20 (m)	Distance traveled at speeds between 14 and 20 km/h	yes
HIR (m)	Distance covered during high-intensity running (greater than 20 km/h)	yes
PD20 (%)	Percentage of distance traveled at speeds greater than 20 km/h	not
NS (count)	Number de sprint at speeds over 24 km/h	yes
MS (km/h)	Maximum speed reached	not
ACC (count)	Number of accelerations greater than 3 m/s	yes
DC (count)	Number of decelerations	yes
EE (count)	Explosive efforts, including accelerations, decelerations, and jumps over 30 cm	yes

Statistical analysis

Data in the text and figures are presented as means (±SD; 90% confidence limits, CL). Normality was verified using the Shapiro–Wilk test. We employed the Two-One-Sided-Tests (TOST) method because traditional statistical approaches often do not provide the magnitude of an effect, which is essential in understanding athletic performance alongside statistically significant results. The TOST approach aims to specify an inferior limit (IL) and an upper limit (UL), where observed results falling within this range are considered equivalent to the absence of a worthwhile effect. The null hypothesis in the TOST procedure is that there is a real effect at the IL or UL. The alternative hypothesis is that the effect falls within the equivalence bounds or that no effect is worth examining.

The observed data are compared against the lower and upper bounds in two one-sided tests. If the p-value for both tests indicates that the observed data are significant, assuming IL or UL is true, we can follow a Neyman–Pearson approach to statistical inference and reject effect sizes larger than the equivalence bounds. This approach maintains the long-term Type 1 error rate (i.e., 5%) (Lakens, 2017). The likelihood that changes in performance or physiological variables were substantial (i.e., greater than the smallest worthwhile change, SWC), similar to, or smaller than, another time point was calculated. SWC was calculated as 0.14 based on Cohen's dz principle for paired data (Lakens, 2017). The present research also used changes as a factor of variable-specific smallest worthwhile differences, where changes of 1×, 3×, 6×, and 10× SWC can be considered small, moderate, large, and very large, respectively (Buchheit, 2016). If the 90% CL overlapped with positive and negative values, the magnitude was deemed unclear; otherwise, the observed magnitude was reported. Statistical analysis was performed using the "TOSTER" package and the TOST paired function of the R software program. Statistical significance was set at $p < 0.05$.

Results

Table 3.
Descriptive statistic of running performance and differences pre versus post-infection in soccer players.

MV	Pre-infection	Post-infection	Mean	IL	UL	P
	M ±SD	M ±SD	diff.			
TD (m)	9534±890	9331±937	-203	-498	92	0.249
PD20 (%)	9.3 ±1.9	8.7 ±2.3	-0.58	-1.16	-0.01	0.096
NS (count)	50.3 ±15.6	51.8 ±15.5	1.6	-2.3	5.4	0.497
HIR (m)	909 ±241	827 ±255*	-81	-135	-28	0.016
MS (km/h)	29.8 ±2.1	29.8 ±2.0	0.05	-0.97	1.06	0.939
ACC (count)	86.6 ±14.2	80.1 ±13.7*	-6.5	-11.5	-1.6	0.034
DCC (count)	70.9 ±13.9	67.6 ±10.8	-3.3	-7.5	0.8	0.183
EE (count)	106.5 ±18.6	102.2 ±15.3	-4.3	-9.3	0.7	0.152
D0_7 (m)	3743 ±372	3838 ±268	95	-15	204	0.151
D7_14 (m)	3725 ±538	3587 ±637	-137	-354	79	0.286
D14_20 (m)	1467 ±335	1357 ±288*	-110	-197	-23	0.042
MIN (min)	94.9 ±3.7	92.5 ±3.9*	-2.4	-4.1	-0.8	0.020

MV: match variables; M: mean; SD: standard deviation; PC%: percent change; P: p value; mean diff: mean differences; IL: inferior limit; UL: upper limit; TD: total distance; RD: relative distance; PD20: percent of distance covered > 20km/h; NS: number of sprint; HIR: high-intensity running > 20km/h; MS: maximum speed; ACC: number of accelerations; DCC: number of decelerations; EE: number of explosive efforts; D0_7: distance between 0 and 7km/h; D7_14: distance between 7 and 14km/h; D14_20: distance between 14 and 20km/h; MIN: minutes of effort. * Significant difference vs. Pre-infection.

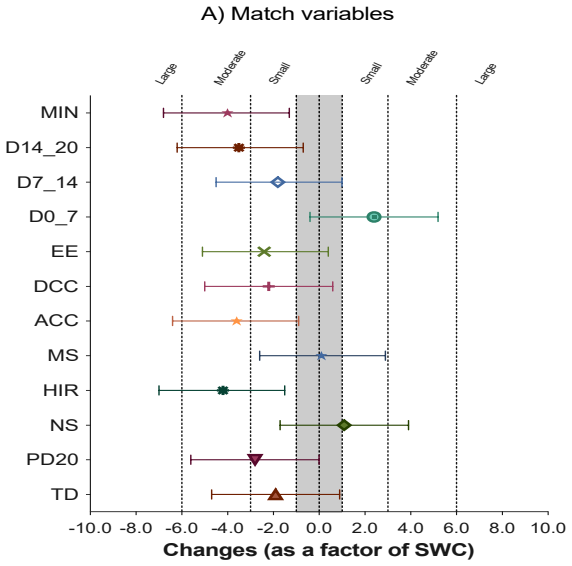

Figure 1. Standardized effects between periods with 90% confidence interval. SWC: smallest worthwhile change

Match variables

Table 3 and Figure 1A show that COVID-19 infection induced an unclear effect on TD (SWC-Factor = -1.9, 90% CL [-4.7; 0.9]), NS (SWC-Factor = 1.1, 90% CL [-1.7; 3.9]), MS (SWC-Factor = 0.1, 90% CL [-2.6; 2.9]), DCC (SWC-Factor = -2.2, 90% CL [-5.0; 0.6]), EE (SWC-Factor = -2.4, 90% CL [-5.1; 0.4]), D0_7 (SWC-Factor = 2.4, 90% CL [-0.4; 5.2]), and D7_14 (SWC-Factor = -1.8, 90% CL [-4.5; 1.0]). There was a moderate and significant decrease in HIR (SWC-Factor = -4.2, 90% CL [-7.0; -1.5]), ACC (SWC-Factor = -3.6, 90% CL [-6.4; -0.9]), and D14_20 (SWC-Factor = -3.5, 90% CL [-6.2; -0.7]), and a small but not significant decrease in PD20 (SWC-Factor = -2.8, 90% CL [-5.6; -0.04]). However, the results also showed that COVID-19 quarantine induced a substantial decrease in MIN (SWC-Factor = -4.0, 90% CL [-6.8; -1.3]), affecting the analysis of absolute values related to match variables.

Normalized match variables

Regarding normalized data, Table 4 and Figure 1B show that COVID-19 infection induced an unclear effect on TD (SWC-Factor = 0.3, 90% CL [-2.4; 3.1]), NS (SWC-Factor = 2.2, 90% CL [-0.6; 5.1]), ACC (SWC-Factor = -2.5, 90% CL [-5.2; 0.3]), DCC (SWC-Factor = -1.1, 90% CL [-3.8; 1.7]), EE (SWC-Factor = -0.9, 90% CL [-3.6; 1.7]), D7_14 (SWC-Factor = -0.6, 90% CL [-3.3; 2.2]), and D14_20 (SWC-Factor = -2.3, 90% CL [-5.0; 0.5]). There was a moderate but not significant decrease in HIR (SWC-Factor = -3.1, 90% CL [-5.8; -0.3]) and a moderate increase in D0_7 (SWC-Factor = 5.3, 90% CL [2.5; 8.1]).

Table 4.
Descriptive statistic of running performance and differences between moments on normalized data by minutes of effort of soccer players.

MV/minutes	Pre-infection	Post-infection	Mean	IL	UL	P
	M ±SD	M ±SD	diff.			
TD (m)	100.8±9.1	101.3±8.4	0.42	-2.88	3.72	0.830
NS (count)	0.5±0.2	0.6±0.2	0.03	-0.01	0.07	0.193
HIR (m)	9.6±2.5	9.0±2.7	-0.6	-1.2	-0.1	0.072
ACC (count)	0.9±0.2	0.9±0.1	-0.05	-0.10	0.01	0.134
DCC (count)	0.8±0.2	0.7±0.1	-0.02	-0.06	0.03	0.504
EE (count)	1.1±0.2	1.1±0.2	-0.02	-0.07	0.03	0.549
D0_7 (m)	39.5±3.8	41.5±2.4*	2.04	0.98	3.11	0.004
D7_14 (m)	39.3±5.6	38.8±6.5	-0.52	-3.06	2.02	0.729
D14_20 (m)	15.5±3.6	14.7±3.1	-0.81	-1.80	0.18	0.173

MV: match variables; M: mean; SD: standard deviation; P: p value; mean diff: mean differences; IL: inferior limit; UL: upper limit; NS: number of sprint; HIR: high-intensity running > 20km/h; ACC: number of accelerations; DCC: number of decelerations; EE: number of explosive efforts; D0_7: distance between 0 and 7km/h; D7_14: distance between 7 and 14km/h; D14_20: distance between 14 and 20km/h. * Significant difference vs. Pre-infection.

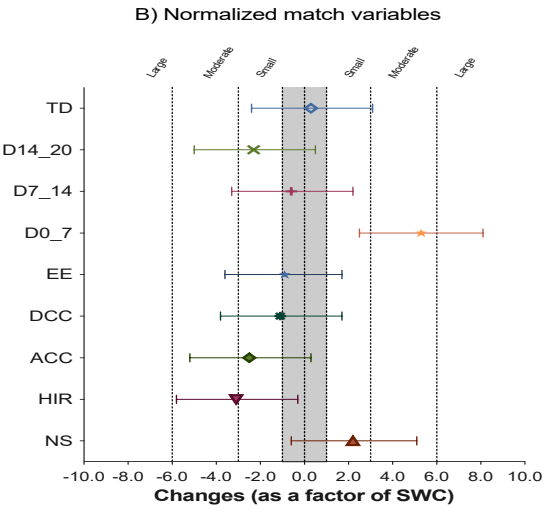

Figure 2. Standardized effects between periods with 90% confidence interval. SWC: smallest worthwhile change

Discussion

This study aimed to determine the changes in match running performance among professional Brazilian soccer players before and after COVID-19 infection. The main results indicate significant moderate decreases in High-Intensity Running (HIR), Accelerations (ACC), Minutes Played (MIN), and Distances covered at 14-20 km/h (D14_20). A significant moderate increase in the variables normalized by MIN was only found in Distances covered at 0-7 km/h (D0_7).

Clinical manifestations of COVID-19

The present data align with a recent study showing a high prevalence of COVID-19 infection in professional soccer teams in Qatar, Croatia, Denmark, and Germany (Mack et al., 2021; Pedersen et al., 2021; Schumacher et al., 2021). Several factors could explain performance outcome changes, including the potential clinical manifestations caused by COVID-19 infection (Schellhorn et al., 2021; Dores & Cardim, 2020). However, a cardiological medical evaluation, such as an electrocardiogram, was necessary to confirm this. These changes can be attributed to clinical manifestations and mandatory quarantines. The present data identified symptomatic and asymptomatic SARS-CoV-2 infections via PCR tests; however, only soccer players with symptoms were included in this study. Furthermore, during the research period, vaccination against COVID-19 was not mandatory for professional soccer players in Brazil. Athletes were not among the prioritized groups when the vaccination program began in January 2021. However, all professional players were immunized after May 2021.

Additionally, a significant outbreak of COVID-19 among the studied players occurred at the beginning of 2021, when the SARS-CoV-2 Alpha variant was the dominant strain circulating in Brazil. This variant is known to be more contagious than the original strain, and previous investigations regularly demonstrated earlier periods when other variants of the virus were circulating (Freire et al., 2020; Mack et al., 2021). This high virus transmissibility, coupled with the low adherence to control measures, both non-pharmaceutical and vaccination, likely contributed to this outcome (Savicevic et al., 2021).

Mandatory quarantines, isolation, and returning to play

The deterioration in athletic performance could also be due to mandatory quarantines, such as isolation for testing positive for COVID-19 (i.e., nasopharyngeal swabs). During the four-day quarantine period, soccer athletes in Brazil performed three to five sessions of 30 minutes of aerobic training at ~70% of maximal heart rate per week, measured by a frequency meter (H10, Polar, BRA), and four to six sessions of 60 minutes of technical-tactical training per week, as indicated by previous reports (Freire et al., 2020). Specific changes in the athlete's physical condition may have occurred depending on the characteristics of the training methods carried out at home (Grazioli et al., 2020; Rampinini et al., 2021; Kalinowski et al., 2021). Several studies have analyzed the changes due to national mandatory quarantines, and results suggest changes in the maintenance of physical fitness levels in both aerobic (Yo-Yo and Mognoni tests) and neuromuscular (jumps and sprints, among others) outcomes (Grazioli et al., 2020; Freire et al., 2020; Rampinini et al., 2021). Match running performance outcomes in La Liga (Spain) were reported pre- and post-quarantine during the 2019/2020 season (García-Aliaga et al., 2021), with the first 11 matches (2019) being compared to the post-quarantine matches (2020), finding decreases in the median and high-intensity outcomes (ES=0.77 and 1.13 respectively), as well as an increase in ACC and DCC normalized by time (ES=0.57 and 0.22). In another study (Brito de Souza et al., 2021), the 2018/2019 season was compared to the 2019-2020 season, revealing several differences in intensity and distances covered.

Quarantine periods following infection varied depending on public health regulations or medical staff guidance, and it was recommended not to perform intense physical activity during this period (Schellhorn et al., 2021). A study conducted in the Russian Premier League described that the cessation of training depended on the symptoms and their severity (Bezuglov et al., 2020). Several studies have examined detraining and retraining in soccer players, with varying results. A study on university soccer players showed that a one-week detraining period decreased values related to repeated sprint ability (RSA) but not in intermittent endurance capacity (IEC) (Joo, 2016). A study on semiprofessional soccer players in Korea showed that a two-week detraining period decreased RSA and IEC but not linear sprinting (5 and 10 meters) or agility. However, with a three-week retraining period, they could return to their baseline RSA and IEC levels (Joo, 2018). Another study on professional soccer players from the Greek Superleague found reductions in maximal oxygen consumption, squat jump, and countermovement jump and increases in linear sprinting (10 and 20 meters) after a six-week detraining period (Koundourakis et al., 2014). Another study analyzed two weeks of detraining in young and adult professional players, finding reductions in RSA but not in IEC in both groups (Rodríguez-Fernández et al., 2018). These findings could explain the reductions in HIR, as associations have been found between HIR and RSA (r=-0.6 [95% CI: -0.83; -0.18]) (Rampinini et al., 2007). On the other hand, the maintenance of sprinting ability and even improvements could explain the maintenance of MS in this case. Past protocols regarding return to play have been developed based on prior knowledge of SARS-CoV-2 infections that affect the cardiorespiratory system (Gomez-Piqueras et al., 2019; Joo, 2018). A recent study provided specific recommendations for this situation.

Still, these protocols were not entirely applicable in the present study due to the many unpredictable, specific, and contextual factors that impacted the time to return to play (Koundourakis et al., 2014). This occurred most often after the 12-day adaptation period, as demonstrated by previous authors (Savicevic et al., 2021), suggesting that soccer players required a certain number of days for team training and full adaptation (Sanmiguel-Rodríguez et al., 2024). Future studies could verify the time needed to return to full training after COVID-19 infection, considering vaccination for players competing at national and international levels (Schwellnus et al., 2021).

Similar studies

To our knowledge, only two studies have analyzed the effect of SARS-CoV-2 infection on soccer match running performance. The first study analyzed COVID-19 infection in Croatian first-division players, finding that infected players showed a decrease in post-infection ACC and DCC. Still, these actions matched those of a control (non-infected) group (Savicevic et al., 2021). This could be because the players were analyzed after a "return to play" period of 1 to 4 weeks, aligning with previous findings that basal levels of RSA and IEC can be reached in short training periods (Joo, 2018). Another descriptive study (case report) found that female players from a high school soccer team decreased their D14_20 and HIR distances after infection (difference = -10% to -35%), and their values were also lower than those of their non-infected counterparts (Wilson et al., 2022). These results are consistent with ours.

Effort time (match time)

Another factor that could explain the decrease in performance variables is the moderate reduction in MIN played by the athletes during the post-contamination period. These changes are inherent to the nature of soccer (Dolci et al., 2020), where match durations can vary. However, after normalizing the variables by MIN to eliminate its effect (Table 3 and Figure 1B), a significant increase was found in D0_7, corresponding to a speed below the first ventilatory threshold (Altmann et al., 2020; Pérez-Contreras et al., 2021). These changes suggest that players may have altered their movement patterns due to sub-optimal recovery periods during the matches, necessitating more activity at that intensity to allow for more recovery time.

Study limitations

All soccer players maintained continuous training during the 40-day isolation period between March and April 2020; however, there was no continuous monitoring of intensity and volume, and only remote supervision was possible. Previous research has indicated the effects of COVID-19-related restrictions and quarantine on cardiovascular performance and yo-yo test results in Brazilian professional soccer players, showing adverse impacts on relative distance, maximal speed, acceleration, deceleration, sprints, and high-intensity running distance (Freire et al., 2020). The present data avoided the initial moments after the COVID-19 quarantine, as they were collected during two periods: pre-COVID-19 infection (03.02.2020 to 11.03.2020) and two months after the end of the lockdown in Brazil when SARS-CoV-2 infections increased among soccer players (19.06.2020 to 03.03.2021). Consequently, the number of games analyzed per player varied, as participation depended exclusively on the coaching staff. Therefore, monitoring players' body composition during each match was impossible, which could also influence their physical performance (Pérez-Contreras et al., 2021; Villaseca-Vicuña et al., 2021). Finally, the GPS units' sampling frequency may have low validity and reliability in high-intensity and short-distance linear running (Scott et al., 2016). However, despite these limitations, the present data could contribute valuable insights to the field of soccer research.

Practical applications

Given the high intensity of the Brazilian soccer season, the condensed match calendar, and the fact that COVID-19 infections can remove professional players from team training for a certain period, practical measures are needed to continue protecting this population through both non-pharmaceutical interventions and vaccination to reduce SARS-CoV-2 infection rates. Moreover, based on the study's findings, coaches can implement specific training strategies for players infected with COVID-19 to optimize variables that may change over a prolonged period. Understanding that there may be acute changes (from one match to another) due to the multifactorial nature of soccer (tactical systems, playing positions, location, climate, among others) is crucial.

Conclusion

The results can conclude that COVID-19-infected players had changes in match running performance, mainly decreases in HIR and increases in D0_7. Nevertheless, the present study results emphasized that generalizations are adverse and that each infected athlete should be approached individually, using present information and previous knowledge on the topic as guidelines and not as strict directions. Further analysis of other player populations (other leagues) is required to carry out multifactorial comparisons regarding the impact of SARS-CoV-2 infection on soccer players.

References

Abbott, W., Brickley, G., & Smeeton, N. J. (2018). Positional difference in outputs and perception effort during soccer training

games and competition. *Journal of Strength and Conditioning Research*, 32(11), 3222–3231. https://doi.org/10.1519/JSC.0000000000002739

Altmann, S., Neumann, R., Woll, A., & Härtel, S. (2020). Endurance capacities in professional soccer players: Are performance profiles position specific? *Frontiers in Sports and Active Living*, 2(September), 579150. https://doi.org/10.3389/fspor.2020.579150

Aquino, R., Carling, C., Maia, J., Vieira, L. H. P., Wilson, R. S., Smith, N., et al. (2020). Relationships between running demands in soccer match-play, anthropometric, and physical fitness characteristics: A systematic review. *International Journal of Performance Analysis in Sport*, 20(3), 534–555. https://doi.org/10.1080/24748668.2020.1714309

Bangsbo, J., Mohr, M., & Krustrup, P. (2006). Physical and metabolic demands of training and match-play in the elite football player. *Journal of Sports Sciences*, 24(7), 665–674. https://doi.org/10.1080/02640410500482529

Bezuglov, E., Lazarev, A., Achkasov, E., Khaitin, V., Romanova, L., Butovskiy, M., et al. (2020). The incidence and severity of COVID-19 in adult professional soccer players. *medRxiv*. https://doi.org/10.1101/2020.10.27.20220400

Brito de Souza, D., López-Del Campo, R., Resta, R., Moreno-Perez, V., & Del Coso, J. (2021). Running patterns in LaLiga before and after suspension of the competition due to COVID-19. *Frontiers in Physiology*, 12(April), 1–7. https://doi.org/10.3389/fphys.2021.667731

Buchheit, M. (2016). The numbers will love you back in return—I promise. International *Journal of Sports Physiology and Performance*, 11(4), 551–554. https://doi.org/10.1123/ijspp.2015-0704

Buldú, J. M., Antequera, D. R., & Aguirre, J. (2020). The resumption of sports competitions after COVID-19 lockdown: The case of the Spanish football league. *Chaos, Solitons & Fractals*, 138. https://doi.org/10.1016/j.chaos.2020.110191

Castro, R., Luz, P. M., Wakimoto, M. D., Veloso, V. G., Grinsztejn, B., & Perazzo, H. (2020). COVID-19: A meta-analysis of diagnostic test accuracy of commercial assays registered in Brazil. *Brazilian Journal of Infectious Diseases*, 24(2), 180–187. https://doi.org/10.1016/j.bjid.2020.05.004

Cohen, D. D., Restrepo, A., Richter, C., Harry, J. R., Franchi, M. V., Restrepo, C., et al. (2020). Detraining of specific neuromuscular qualities in elite footballers during COVID-19 quarantine. *Science and Medicine in Football*, 00(00), 1–6. https://doi.org/10.1080/24733938.2020.1766665

Cowan, L. T., Lutsey, P. L., Pankow, J. S., Matsushita, K., Ishigami, J., & Lakshminarayan, K. (2018). Inpatient and outpatient infection as a trigger of cardiovascular disease: The ARIC study. *Journal of the American Heart Association*, 7(22). https://doi.org/10.1161/JAHA.118.009683

Dolci, F., Hart, N. H., Kilding, A. E., Chivers, P., Piggott, B., & Spiteri, T. (2020). Physical and energetic demand of soccer. *Strength and Conditioning Journal*, 42(3), 70–77. https://doi.org/10.1519/SSC.0000000000000518

Dores, H., & Cardim, N. (2020). Return to play after COVID-19: A sport cardiologist's view. *British Journal of Sports Medicine*, 54(19), 1132–1133. https://doi.org/10.1136/bjsports-2020-102482

Fernandez Ortega, J. A., Hoyos Cuartas, L. A., Reina Prieto, J., Guzmán Pinzón, N. P., & Becerra Patiño, B. A. (2024). Variación de la condición física e impacto de la COVID-19 en adultos jóvenes colombianos: Un estudio retrospectivo observacional de 11 años (Variation in physical fitness and the impact of COVID-19 in young Colombian adults: An 11-year observational retrospective study). *Retos*, 59, 381–390. https://doi.org/10.47197/retos.v59.107090

Freire, L. de A., Tannure, M., Sampaio, M., Slimani, M., Znazen, H., & Bragazzi, N. L., et al. (2020). COVID-19-related restrictions and quarantine COVID-19: Effects on cardiovascular and yo-yo test performance in professional soccer players. *Frontiers in Psychology*, 11(January), 1–8. https://doi.org/10.3389/fpsyg.2020.622872

García-Aliaga, A., Marquina, M., Cordón-Carmona, A., Sillero-Quintana, M., de la Rubia, A., & Román, I. R. (2021). Comparative analysis of soccer performance intensity of the pre–post-lockdown covid-19 in LaLigaTM. *International Journal of Environmental Research and Public Health*, 18(7). https://doi.org/10.3390/ijerph18073485

Gomez-Piqueras, P., Gonzalez-Villora, S., Castellano, J., & Teoldo, I. (2019). Relation between the physical demands and success in professional soccer players. *Journal of Human Sport and Exercise*, 14(1), 1–11. https://doi.org/10.14198/jhse.2019.141.01

Grazioli, R., Loturco, I., Baroni, B. M., Oliveira, G. S., Saciura, V., Vanoni, E., et al. (2020). Coronavirus disease-19 quarantine is more detrimental than traditional off-season on physical conditioning of professional soccer players. *Journal of Strength and Conditioning Research*, 34(12), 3316–3320. https://doi.org/10.1519/JSC.0000000000003802

Impellizzeri, F. M., Franchi, M. V., Sarto, F., Meyer, T., & Coutts, A. J. (2020). Sharing information is probably more helpful than providing generic training recommendations on return to play after COVID-19 home confinement. *Science and Medicine in Football*, 0(0), 1–2. https://doi.org/10.1080/24733938.2020.1757980

Inciardi, R. M., Lupi, L., Zaccone, G., Italia, L., Raffo, M., Tomasoni, D., et al. (2020). Cardiac involvement in a patient with coronavirus disease 2019 (COVID-19). *JAMA Cardiology*, 5(7), 819–824. https://doi.org/10.1001/jamacardio.2020.1096

Jennings, D., Cormack, S., Coutts, A. J., Boyd, L., & Aughey, R. J. (2010). Variability in load as measured by s-RPE and its association with player characteristics in elite Australian football. *International Journal of Sports Physiology and Performance*, 5(3), 328–341. https://doi.org/10.1123/ijspp.5.3.328

Joo, C. H. (2016). The effects of short-term detraining on exercise performance in soccer players. *Journal of Exercise Rehabilitation*, 12(1), 54–59. https://doi.org/10.12965/jer.1632598.299

Joo, C. H. (2018). The effects of short-term detraining and retraining on physical fitness in elite soccer players. *PLoS One*, 13(5), e0196212. https://doi.org/10.1371/journal.pone.0196212

Jukić, I., Calleja-González, J., Cos, F., Cuzzolin, F., Olmo, J., Terrados, N., et al. (2020). Strategies and solutions for team sports athletes in isolation due to COVID-19. *Sports*, 8(4), 56. https://doi.org/10.3390/sports8040056

Kalinowski, P., Myszkowski, J., & Marynowicz, J. (2021). Effect of online training during the COVID-19 quarantine on the aerobic capacity of youth soccer players. International *Journal of Environmental Research and Public Health*, 18(12), 6195.

https://doi.org/10.3390/ijerph18126195

Koundourakis, N. E., Androulakis, N. E., Malliaraki, N., Tsatsanis, C., Venihaki, M., & Margioris, A. N. (2014). Discrepancy between exercise performance, body composition, and sex steroid response after a six-week detraining period in professional soccer players. *PLoS One*, 9(2), e87803. https://doi.org/10.1371/journal.pone.0087803

Lakens, D. (2017). Equivalence tests: A practical primer for t tests, correlations, and meta-analyses. *Social Psychological and Personality Science*, 8(4), 355–362. https://doi.org/10.1177/1948550617697177

Mack, D., Gärtner, B. C., Rössler, A., Kimpel, J., Donde, K., Harzer, O., Krutsch, W., von Laer, D., & Meyer, T. (2021). Prevalence of SARS-CoV-2 IgG antibodies in a large prospective cohort study of elite football players in Germany (May–June 2020): Implications for a testing protocol in asymptomatic individuals and estimation of the rate of undetected cases. *Clinical Microbiology and Infection*, 27, e471–e473. https://doi.org/10.1016/j.cmi.2020.09.046

Madjid, M., Safavi-Naeini, P., Solomon, S. D., & Vardeny, O. (2020). Potential effects of coronaviruses on the cardiovascular system: A review. *JAMA Cardiology,* 5(7), 831–840. https://doi.org/10.1001/jamacardio.2020.1286

Meyer, T., Mack, D., Donde, K., Harzer, O., Krutsch, W., Rössler, A., et al. (2021). Successful return to professional men's football (soccer) competition after the COVID-19 shutdown: A cohort study in the German Bundesliga. *British Journal of Sports Medicine*, 55(1), 62–66. https://doi.org/10.1136/bjsports-2020-102596

Modric, T., Esco, M., Perkovic, S., Basic, Z., Versic, S., Morgans, R., & Sekulic, D. (2023). Artificial Turf Increases the Physical Demand of Soccer by Heightening Match Running Performance Compared with Natural Grass. *Journal of Strength and Conditioning Research*, 37(11), 2222–2228. https://doi.org/10.1519/JSC.0000000000004539

Modric, T., Versic, S., & Sekulic, D. (2020). Aerobic fitness and game performance indicators in professional football players; playing position specifics and associations. *Heliyon*, 6(11), e05304. https://doi.org/10.1016/j.heliyon.2020.e05304

Modric, T., Versic, S., Sekulic, D., & Liposek, S. (2019). Analysis of the association between running performance and game performance indicators in professional soccer players. *International Journal of Environmental Research and Public Health*, 16(20). https://doi.org/10.3390/ijerph16203986

Nobari, H., Oliveira, R., Brito, J. P., Pérez-gómez, J., Clemente, F. M., & Ardigò, L. P. (2021). Comparison of running distance variables and body load in competitions based on their results: A full-season study of professional soccer players. *International Journal of Environmental Research and Public Health*, 18(4), 1–11. https://doi.org/10.3390/ijerph18041548

Pedersen, L., Lindberg, J., Lind, R. R., & Rasmusen, H. (2021). Reopening elite sport during the COVID-19 pandemic: Experiences from a controlled return to elite football in Denmark. *Scandinavian Journal of Medicine &Science in Sports*, 31, 936–939. https://doi.org/10.1111/sms.13875

Pérez-Contreras, J., Merino-Muñoz, P., & Aedo-Muñoz, E. (2021). Vínculo entre composición corporal, sprint y salto vertical en futbolistas jóvenes de élite de Chile. MHSalud: *Revista en Ciencias del Movimiento Humano y Salud*, 18(2), 1–17. https://doi.org/10.15359/mhs.18-2-3

Petersen, C., Pyne, D. B., Portus, M. R., Karppinen, S., & Dawson, B. (2009). Variability in movement patterns during One Day Internationals by a cricket fast bowler. International *Journal of Sports Physiology and Performance,* 4(2), 278–281. https://doi.org/10.1123/ijspp.4.2.278

Petersen, C., Pyne, D., Portus, M., & Dawson, B. (2009a). Validity and reliability of GPS units to monitor cricket-specific movement patterns. *International Journal of Sports Physiology and Performance*, 4(3), 381–393. https://doi.org/10.1123/ijspp.4.3.381

Rampinini, E., Bishop, D., Marcora, S. M., Ferrari Bravo, D., Sassi, R., & Impellizzeri, F. M. (2007). Validity of simple field tests as indicators of match-related physical performance in top-level professional soccer players. *International Journal of Sports Medicine*, 28(3), 228–235. https://doi.org/10.1055/s-2006-924340

Rampinini, E., Bishop, D., Marcora, S. M., Ferrari Bravo, D., Sassi, R., & Impellizzeri, F. M. (2007). Validity of simple field tests as indicators of match-related physical performance in top-level professional soccer players. *International Journal of Sports Medicine*, 28(3), 228–235. https://doi.org/10.1055/s-2006-924340

Rampinini, E., Donghi, F., Martin, M., Bosio, A., Riggio, M., & Maffiuletti, N. A. (2021). Impact of COVID-19 lockdown on Serie A soccer players' physical qualities. *International Journal of Sports Medicine*, 42(10), 917-923. https://doi.org/10.1055/a-1345-0381

Rodríguez-Fernández, A., Sánchez-Sánchez, J., Ramirez-Campillo, R., Rodríguez-Marroyo, J. A., Villa Vicente, J. G., & Nakamura, F. Y. (2018). Effects of short-term in-season break detraining on repeated-sprint ability and intermittent endurance according to initial performance of soccer player. *PLoS One*, 13(8), e0201111. https://doi.org/10.1371/journal.pone.0201111

Sanmiguel-Rodríguez, A., García-Soidán , J. L., & Navarro-Patón , R. (2024). ¿La pandemia ha cambiado la metodología de entrenamiento del fútbol? (Has the pandemic changed soccer training methodologies?). *Retos*, 58, 753–759. https://doi.org/10.47197/retos.v58.107042

Sarto, F., Impellizzeri, F., Spörri, J., Olmo, J., Requena, B., Suarez, L., et al. (2020). Impact of potential physiological changes due to COVID-19 home confinement on athlete health protection in elite sports: A call for awareness in sports programming. *Institute of Physiology Department of Biomedical Sciences*, (0123456789), 1–6.

Savicevic, A. J., Nincevic, J., Versic, S., Cuschieri, S., Bandalovic, A., Turic, A., et al. (2021). Performance of professional soccer players before and after COVID-19 infection; observational study with an emphasis on graduated return to play. *International Journal of Environmental Research and Public Health*, 18(21), 11688. https://doi.org/10.3390/ijerph182111688

Schellhorn, P., Klingel, K., & Burgstahler, C. (2021). Return to sports after COVID-19 infection. *European Heart Journal*, 41(46), 4382–4384. https://doi.org/10.1093/eurheartj/ehaa448

Schumacher, Y. O., Tabben, M., Hassoun, K., Al Marwani, A., Al Hussein, I., Coyle, P., Abbassi, A. K., Ballan, H. T., Al-Kuwari, A., & Chamari, K. (2021). Resuming professional football

(soccer) during the COVID-19 pandemic in a country with high infection rates: A prospective cohort study. *British Journal of Sports Medicine*, 55, 1092–1098. https://doi.org/10.1136/bjsports-2020-103150

Schwellnus, M., Sewry, N., Snyders, C., Kaulback, K., Wood, P. S., Seocharan, I., Derman, W., Hull, J. H., Valtonen, M., Jordaan, E. (2021). Symptom cluster is associated with prolonged return-to-play in symptomatic athletes with acute respiratory illness (including COVID-19): A cross-sectional study—AWARE study I. *British Journal of Sports Medicine,* 55, 1144–1152. https://doi.org/10.1136/bjsports-2020-103714

Scott, M. T. U., Scott, T. J., & Kelly, V. G. (2016). The validity and reliability of global positioning systems in team sport: A brief review. *Journal of Strength and Conditioning Research,* 30(5), 1470–1490. https://doi.org/10.1519/JSC.0000000000001221

Tostmann, A., Bradley, J., Bousema, T., Yiek, W., Holwerda, M., Bleeker-Rovers, C., et al. (2020). Strong associations and moderate predictive value of early symptoms for SARS-CoV-2 test positivity among healthcare workers, the Netherlands, March 2020. *Eurosurveillance*, 25(23), 1. https://doi.org/10.2807/1560-7917.ES.2020.25.23.2000508

Villaseca-Vicuña, R., Molina-Sotomayor, E., Zabaloy, S., & Gonzalez-Jurado, J. A. (2021). Anthropometric profile and physical fitness performance comparison by game position in the Chile women's senior national football team. *Applied Sciences*, 11(5), 2190. https://doi.org/10.3390/app11052190

Villaseca-Vicuña, R., Pérez-Contreras, P., Merino-Muñoz, J., González-Jurado, J. A., & Aedo-Muñoz, E. (2021). Effects of the COVID-19 confinement measures on training loads and the degree of well-being of players from Chile women's national soccer team. *Revista de la Facultad de Medicina*, 69(1), 1–10. https://doi.org/10.15446/revfacmed.v69n1.81853

Wilson, A., Carlson, L. M., Norton, C., & Bruce, W. D. (2022). Decreases in performance observed after COVID-19 infection in high school female soccer players. *International Journal of Athletic Therapy & Training*. https://doi.org/10.1123/ijatt.2021-0103

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