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ORIGINAL ARTICLE

Did the quarantine period of covid-19 interfere with the physical demands of central referees and assistants in professional soccer in a high level competition in Brazil?

La période de quarantaine du covid-19 a-t-elle interféré avec les exigences physiques des arbitres centraux et auxiliaires du football professionnel dans une compétition de haut niveau au Brésil?

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SARS-CoV-2; Heart rate; Distance; Soccer performance; Detraining

Summary
Objective. — This study compares the performance demanded from central referees and soccer assistants during professional games before and after the quarantine of COVID-19 during the same competition.

Equipment and methods. — Ten central referees and 19 assistants were monitored. Using a watch with Global Positioning System technology and a heart rate monitor, data were obtained of the distance they moved and information on their heart rate. A game before the quarantine period was compared to a game played 128 days after the quarantine period. These participants represented all the referees who played at least one game in the pre- and post-quarantine period of the same high-level competition in Brazil.

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1. Introduction

The 2019 coronavirus pandemic (COVID-19) has affected the world sports scene, canceling and postponing competitions in several sports. This was also seen in soccer, where several competitions were postponed during the virus’s worldwide spread. During this period, the organizations responsible for world health requested that everyone remains in quarantine and social isolation to minimize the virus’s spread. Consequently, this alerted sports scientists that this quarantine period may have impacted the athletes’ performance for modality [1–4].

Through research, sports scientists have sought to understand the implications of the COVID-19 pandemic and periods of social isolation on variables that can directly affect athletes’ physical performance and the incidence of injuries [1–4]. A recent study investigating the effect of 63 days of quarantine on professional soccer athletes’ physical performance demonstrated a decrease in performance in countermovement jump and sprint times in 10 and 20 m, with no change in cardiorespiratory performance [4]. In contrast, a study of 14-year-old male soccer players indicated that a 2-month period affected aerobic performance in a Yo-Yo test, even with the high-intensity interval training performed at home during the isolation period [3].

The literature makes it clear that the quarantine period may have affected the neuromuscular performance of professional athletes and the aerobic fitness of young athletes, however studies devoted to assessing the effects of the quarantine of COVID-19 on the physical performance of central and assistant soccer referees were not found. This increased attention to soccer athletes in the resumption of competitions after the confinement period meant that the International Football Association included two extra substitutions in professional competitions [5,6]; however, no change in the referees’ routine was observed. We proposed a study examining the effect of the COVID-19 quarantine on central referees and assistants in the same competition. It can indicate what to do in periods when soccer matches are not refereed and whether individual training is sufficient to maintain physical demands, as in the traditional transition periods between seasons.

Thus, in order to give due attention to these professionals equally relevant to the sport, this study compared the physical demands of central referees and soccer assistants during professional games before and after the quarantine period of COVID-19. The hypothesis was that in the pre-quarantine period, the physical demands of central referees and assistants would be higher since the quarantine period required social isolation, adaptations in training routines, and a long period without refereeing a soccer game, which could reduce the performance of these professionals.

2. Methods

2.1. Subjects

Ten central referees (10 men) and 19 assistant referees (17 men and 2 women) participated in this study. The mean
and standard deviation of age, body mass, height, and experience of the central referees were 38.30 ± 4.16 years, 86.23 ± 5.42 kg, 182.50 ± 5.87 cm, and 15.50 ± 4.42 years, respectively. The assistant referees were 34.47 ± 5.20 years old, 79.52 ± 9.46 kg, 177.11 ± 5.51 cm, and 11.58 ± 3.70 years, respectively. The participants represented the entire population of central referees and assistants in the competition. All of them were from professional staff A in the state of Rio Grande do Sul in Brazil, belonging to the Soccer Federation of Rio Grande do Sul (FGF). The inclusion criteria for the present study were defined as: being released by the medical department of the FGF to perform the physical test and the games; being a central referee or assistant; and belonging to professional staff A in the FGF. The exclusion criterion was: not refereeing at least one game of the state championship of the first division in the pre- and post-quarantine of COVID-19. The Ethics Committee of the Federal University of Rio Grande do Sul approved this study (No. 002397/2020). The participants were informed about the study’s risks and benefits before any data collection and then signed an approved informed consent form by the institution. This study is in accordance with the World Medical Association’s Code of Ethics (Declaration of Helsinki), printed in the British Medical Journal (July 18, 1964).

2.2. Procedures

The central referees and assistants were monitored using a watch with global positioning system (GPS) technology and with a heart rate monitor in the first match refereed in a state championship of the Brazilian first division after the traditional transition period between competitive seasons (37 days; December 15, 2019, to January 22, 2020) and in the first game after the quarantine period caused by COVID-19 (128 days; March 15, 2020, to July 22, 2020). In both periods, central referees and assistants’ training was carried out through self-prescription, a common feature in Brazil, considering that there is no professionalization of arbitration in the country. In addition, during the quarantine period, the referees and assistants needed to adapt the training due to social isolation. A comparison was made of the demands of the first match refereed in the competition before and after the quarantine period to analyze the effect of the 128 days of isolation in relation to the 37-day period traditional off-season.

Anthropometric assessments were carried out in a session that occurred prior to starting the state championship at the School of Physical Education, Physiotherapy, and Dance at the Federal University of Rio Grande do Sul. Initially, the objectives of analyzing the demands of the central referees and assistants and the methodological procedures of the study were explained to the referees and the informed consent form was signed. As the demands were being assessed, it was possible to compare the pre- and post-quarantine periods. Then, body mass and height were measured for anthropometric assessment. Subsequently, the age and year of admission to the FGF by the referees were recorded to evaluate their experience. The researchers monitored the central referees and assistant referees for the matches in the first and second half of the first match refereed before and after the quarantine period in official matches of the first division of the state championship held during the study period. The distances covered, heart rate, and time in the championship games were evaluated using GPS equipment with a heart rate monitor (Garmin Forerunner 45/1 Hz) and subsequently processed by the researchers to obtain the study’s dependent variables. The central and auxiliary referees were asked about physical training during the quarantine period after the first game of the competition’s return (Fig. 1).

2.3. Anthropometric assessment

The referees’ body mass and height were measured on a digital scale, with a resolution of 100 g (G-TECH - Accumul Produtos Médico Hospitalares LTDA, Duque de Caxias, Brazil) and a stadiometer, with a resolution of 1 mm (Sanny, São Paulo, Brazil), respectively.

2.4. Time experience

The referees’ experience was obtained by subtracting the referee’s chronological age on the day of the first assessment by the date of entry into the FGF.

2.5. Games

Before starting the games, the researchers in charge handed the referees the GPS equipment with a heart rate monitor (Garmin Forerunner 45) positioned close to the referees’ wrist. The equipment has a sampling frequency of 1 Hz. A study sought to assess pulse heart rate monitor’s validity with 1 Hz measurements similar to the model used, finding associations in different exercise intensities [7]. The referees were instructed to turn on the equipment at the beginning of the first and second half of the game and turn off the equipment, saving the monitored data at the end of each game period. The first game of each referee and assistant referee was monitored before and after the quarantine.
period. The game time was monitored by the GPS timer. After finishing the games, the referees handed the GPS equipment with the heart rate monitor to the researchers for further processing and data analysis.

2.6. Data processing

The collected data were downloaded using the Garmin Connect platform (Copyright © 1996–2020 Garmin Ltd.). They were then organized in an Excel program routine (Microsoft, Washington, USA). To characterize the period of the analyzed game, the first half plus the second half of the game were considered, with the added times, the 15-minute interval between the first and second half was also disregarded. In monitoring the games, it was possible to obtain the average, maximum, and total values in the first and second game times of the distance covered and heart rate. The total time were analyzed with the addition time. In addition, the distance traveled was divided by time to obtain the normalized result.

2.7. Statistical analysis

Descriptive statistics with mean, standard deviation, and minimum and maximum values were used to present the results. The normality of the data was verified using the Shapiro–Wilk test. For comparisons between the variables measured in the pre- and post-quarantine games, the paired t-test was used when the data were parametric and the Wilcoxon test for non-parametric data (distance in the first half of the referees and assistant referees, and average heart rate in the first half). In addition, a confidence interval of 95% (95% CI) and percentage deltas were provided. The effect size measures were calculated using the "Cohen’s d" method, with the qualitative interpretation of these data: < 0.19 insignificant; 0.20–0.49 small; 0.50–0.79 average; 0.80–1.29 large; > 1.30 too large [8,9]. The level of significance was set at α = 0.05. These comparisons were made for the maximum and average values of heart rate and distance in games. For statistical analysis, SPSS version 22.0 (IBM, Chicago, USA) was used.

3. Results

All 29 study participants indicated that they underwent individual training in the quarantine period of COVID-19 in order to maintain physical fitness. The comparison data of the average, maximum, and total values of the central referees’ distance and heart rate in the games are shown in Table 1 and the assistant referees in Table 2.

The distance covered in the second half by the assistant referees showed a statistically significant difference, being greater in the post-quarantine period with an average effect size.

The average and individual values of the total distance covered, average heart rate, and total heart rate of the central referees and assistants are shown in Fig. 2.

The total time of the games was significantly higher in the post-quarantine moment for the central referees (pre: 96.60 ± 2.72; post: 99.50 ± 2.12; CI 95% = −4.57 to −1.23; Δ% = 3.00; P = 0.003; effect size = 1.19) and assistants (pre: 97.53 ± 2.63; post: 99.89 ± 2.68; CI 95% = −4.46 to −0.28; Δ% = 2.42; P = 0.029; effect size = 0.89). The total normalized distance covered showed no difference in the pre and post-quarantine periods for the central referees (P = 0.979) and assistants (P = 0.357).

| Table 1 | Comparison of average, maximum and total values of distance and heart rate in the games of the 10 central referees evaluated. |
|---------|--------------------------------------------------------------------------------------------------------------------------------
| Variables | Moment | Mean | SD | CI 95% | Δ % | P | Effect size |
|-----------|--------|------|----|--------|-----|---|-------------|
|           |        |      |    | Lower  | Upper |   | Numerical | Qualitative |
| Distance 1st half (km) | Pre    | 4.81 | ±0.36 | −0.35 | 0.22 | 1.31 | 0.508 | 0.14 | Insignificant |
|           | Post   | 4.88 | ±0.51 | −0.35 | 0.22 | 1.31 | 0.508 | 0.14 | Insignificant |
| Distance 2nd half (km) | Pre    | 4.83 | ±0.48 | −0.55 | 0.10 | 4.70 | 0.147 | 0.54 | Average |
|           | Post   | 5.06 | ±0.35 | −0.79 | 0.21 | 3.00 | 0.225 | 0.37 | Small |
| Total distance (km) | Pre    | 9.64 | ±0.81 | −0.79 | 0.21 | 3.00 | 0.225 | 0.37 | Small |
|           | Post   | 9.93 | ±0.76 | −0.79 | 0.21 | 3.00 | 0.225 | 0.37 | Small |
| Average HR 1st half (bpm) | Pre    | 139.70 | ±20.11 | −12.01 | 13.41 | −0.50 | 0.904 | −0.04 | Insignificant |
|           | Post   | 139.00 | ±16.49 | −12.01 | 13.41 | −0.50 | 0.904 | −0.04 | Insignificant |
| Average HR 2nd half (bpm) | Pre    | 139.30 | ±22.10 | −19.13 | 6.93 | 4.38 | 0.317 | 0.34 | Small |
|           | Post   | 145.40 | ±12.88 | −15.50 | 8.34 | 4.38 | 0.317 | 0.34 | Small |
| Total average HR (bpm) | Pre    | 139.50 | ±20.94 | −14.84 | 9.44 | 1.94 | 0.627 | 0.15 | Insignificant |
|           | Post   | 142.20 | ±14.07 | −14.84 | 9.44 | 1.94 | 0.627 | 0.15 | Insignificant |
| Maximum HR 1st half (bpm) | Pre    | 166.50 | ±19.57 | −10.14 | 12.14 | −0.60 | 0.844 | −0.06 | Insignificant |
|           | Post   | 165.50 | ±16.66 | −10.14 | 12.14 | −0.60 | 0.844 | −0.06 | Insignificant |
| Maximum HR 2nd half (bpm) | Pre    | 162.70 | ±21.28 | −22.43 | 5.63 | 5.16 | 0.209 | 0.49 | Small |
|           | Post   | 171.10 | ±11.99 | −22.43 | 5.63 | 5.16 | 0.209 | 0.49 | Small |
| Total maximum HR (bpm) | Pre    | 167.10 | ±19.20 | −16.93 | 5.93 | 3.29 | 0.305 | 0.35 | Small |
|           | Post   | 172.60 | ±11.13 | −16.93 | 5.93 | 3.29 | 0.305 | 0.35 | Small |

SD: standard deviation; CI: confidence interval; HR: heart rate; bpm: beats per minute; km: kilometers.


4. Discussion

The aim of the study was to compare the demands of central referees and assistant referees during professional games before and after the quarantine period of COVID-19 during the same competition. The results indicated that the total distance, average and maximum heart rate did not present significant differences between the pre- and post-quarantine moments of the central and assistant referees in the same competition, except for the distance covered by the assistant referees in the second half, which was significantly greater in the post-quarantine period. 

The hypothesis was that in the pre-quarantine period, the physical demands of the central referees and assistant referees were higher since the quarantine period required social isolation, adaptations in the training routines, and a long period without refereeing a football match, which could reduce the physical performance of these professionals. This hypothesis was not confirmed since most of the results did not show any significant difference. The results can be explained mainly by two factors. The first factor is related to the fact that the referees and assistants’ training is carried out individually and often with self-prescribed training. This is a characteristic often related to the negative factors of the activity not being professionalized in Brazil. However, this probably has allowed referees and assistants to maintain their performance in the quarantine period by maintaining their activities through self-training, as in the traditional transition period between competitive seasons.

In addition, the second factor is related to the demands of the games. A study with soccer athletes from the same competition showed decreased performance in the counter-movement jump and sprint times in 10 and 20 m, with no change in cardiorespiratory performance [4]. Knowing that the physical demands of the referees are related to the demands imposed by the players [10,11], one could also expect a decrease in the demands of the referees. However, as it was possible to add two additional substitutions of athletes during the game in the post-quarantine period [5,6], we suggest that this greater possibility of variation of athletes during the game has kept the demands of the referees or even increased, as seen from a distance run in the second half by the assistant referees and the observed time increase. Thus, the fact that athletes with lower performance are substituted in greater quantity, when compared to the three possible substitutions in the pre-quarantine period, can also explain the maintenance or increase in the demands of central referees and assistants in the post-quarantine period.

Since this quarantine period is abnormal in soccer routine, few studies have investigated the effects of this period on soccer athletes [2—4]. Also, no specific studies were found dealing with central referees and assistant referees. The discussion of studies about central referees and assistants can therefore only be based on research results conducted during normal times. This comparison is relevant for analyzing the level of physical demand required for the games evaluated in the present study. The studies in the literature present similar results for the demands of total distance covered. Values range from 9155 ± 70 to 12,956 ± 548 m for central referees [12—15] and from 5146.5 ± 544.75 to 5819 ± 381 m for assistant referees [12,16]. Regarding heart rate, the study by Castillo et al. [14] presented mean and maximum frequency values for central referees of 156.87 ± 11.06 and 183.04 ± 9.74 bpm, respectively, and for assistant referees 129.76 ± 15.61 and

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**Table 2**  Comparison of average, maximum and total values of distance and heart rate in the games of the 19 assistant referees evaluated.

| Variables                | Moment | Mean   | SD     | Cl 95% | Δ % | P     | Effect size |
|--------------------------|--------|--------|--------|--------|-----|-------|-------------|
|                          |        | Lower  | Upper  |        |     |       |             |
| Distance 1st half (km)   | Pre    | 2.38   | ±0.23  | −0.23  | 0.09| 2.90  | 0.369       | 0.28 Small |
|                          | Post   | 2.45   | ±0.25  | −0.09  | 0.20| 2.67  | 0.034*      | 0.74 Average|
| Distance 2nd half (km)   | Pre    | 2.41   | ±0.20  | −0.29  | −0.01| 6.27  | 0.034*      | 0.74 Average|
|                          | Post   | 2.56   | ±0.21  | −0.46  | 0.02| 4.59  | 0.068       | 0.64 Average|
| Total distance (km)      | Pre    | 4.79   | ±0.33  | −0.46  | 0.02| 4.59  | 0.068       | 0.64 Average|
|                          | Post   | 5.01   | ±0.36  | −0.46  | 0.02| 4.59  | 0.068       | 0.64 Average|
| Average HR 1st half (bpm)| Pre    | 119.95 | ±16.75 | −11.94| 7.41| 1.89  | 0.811       | 0.15 Insignificant|
|                          | Post   | 122.21 | ±13.12 | −8.49 | 6.60| 0.77  | 0.795       | 0.07 Insignificant|
| Average HR 2nd half (bpm)| Pre    | 123.21 | ±14.00 | −9.94 | 6.73| 1.32  | 0.691       | 0.12 Insignificant|
|                          | Post   | 124.16 | ±13.50 | −9.94 | 6.73| 1.32  | 0.691       | 0.12 Insignificant|
| Total average HR (bpm)   | Pre    | 121.58 | ±14.85 | −9.94 | 6.73| 1.32  | 0.691       | 0.12 Insignificant|
|                          | Post   | 123.18 | ±12.98 | −2.89 | 13.73| −3.47 | 0.187       | −0.42 Small |
| Maximum HR 1st half (bpm)| Pre    | 156.16 | ±12.27 | −4.91 | 15.54| −3.38 | 0.289       | −0.39 Small |
|                          | Post   | 150.74 | ±13.23 | −4.91 | 15.54| −3.38 | 0.289       | −0.39 Small |
| Maximum HR 2nd half (bpm)| Pre    | 157.16 | ±12.79 | −4.91 | 15.54| −3.38 | 0.289       | −0.39 Small |
|                          | Post   | 151.84 | ±14.24 | −4.91 | 15.54| −3.38 | 0.289       | −0.39 Small |
| Total maximum HR (bpm)   | Pre    | 156.79 | ±10.49 | −3.45 | 12.50| −2.85 | 0.248       | −0.36 Small |
|                          | Post   | 154.26 | ±14.50 | −3.45 | 12.50| −2.85 | 0.248       | −0.36 Small |

SD: standard deviation; CI: confidence interval; HR: heart rate; bpm: beats per minute; km: kilometers.

* Statistically significant difference between the test and the game, \( P < 0.05 \).
166.11 ± 13.65 bpm, respectively. The similarity between the results of other studies reinforces the quality of the sample evaluated, indicating that, even if a single game per referee was evaluated in the pre-quarantine period and one game in the post-quarantine period, the demands were in accordance with the standard behavior found in the literature in traditional periods of playing games in the modality.

The present study has the limitation of not having controlled the training performed by central referees and assistants in the traditional transition period between seasons and quarantine, not allowing to identify what was done to maintain performance in the traditional transition period between seasons and in the social isolation caused by the 128-day quarantine. In addition, evaluations of the neuromuscular profile and acceleration of referees and assistants were not carried out, which could allow a more specific analysis of the performance of strength and power. However, to the best of our knowledge, this is the first study to demonstrate that central referees and assistants’ demands were not affected by the quarantine period compared to a traditional period of transition between seasons in the same competition. This important finding makes it possible to infer that the physical performance maintenance demands of for the referees’ can be performed only with individual training without the need to referee games in the preparatory period before the competition.

5. Conclusions

In conclusion, the central referees and assistants’ demands were not affected after the 128-day quarantine period compared to the traditional transition period between the 37-day seasons. In addition, there was an increase in the total distance assistants had moved in the second half after the period of social isolation. Finally, the current study suggests that the maintenance of physical performance for the demands of central referees and assistants in Brazil can be performed only with individual training without the need to referee games in the preparatory period before the competition. However, we warn that the increase in the number of substitutions may require greater care in the prescription of referee training, if this temporary change in the game’s rules remains and physical demands increase.

Disclosure of interest

The authors declare that they have no competing interest.
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