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Original Article

Lessons learned from the COVID-19 pandemic: implications for semi-professional soccer clubs after the crisis- a team study.

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Abstract
In 2019-2020 and 2020-2021, the COVID-19 pandemic led to unexpected behavioral restrictions, allowing only the individual training of the athletes. The purpose of the present study was to record the effects of a home-based training program on physical performance at a semi-professional level, after the Covid-19 confinement, in terms of external load. Twenty soccer players from one semi-professional team participated in this study. The data was collected by GPS devices, with an accelerometer and gyroscope, and a sampling rate 10Hz. The external load is evaluated by the total distance, the high-intensity runs, the sprint distance as well as the number of accelerations and decelerations. Three matches before and twelve games after the lockdown were analyzed and compared. During the confinement period, the players performed 5-6 training sessions per week. This period lasted over 4 four months. The training sessions were monitored by a free smartphone application. Similarly, the players communicated with the technical staff with a free internet application. The results showed significant increases ($p < 0.05$) in the total distance covered during the matches after the intervention. No significant increase in high-intensity runs and the number of accelerations were found ($p > 0.05$). The present data suggest that an intervention monitored by a free application could improve athletic performance at the semi-professional level, even after long-term abstinence from team training such as quarantine or off-season periods. These data might provide affordable solutions to the semi-professional soccer teams, which could be used during the off-season period leading to reduce detraining effects and higher performance in the forthcoming championship.
Keywords: social confinement, soccer, external load, Global Positioning System, intervention, free applications

Introduction

In 2019-2020 and 2020-2021, the COVID-19 pandemic led to countries' lockdowns where both the general population and athletes were exposed to unexpected behavioral restrictions. Preventive instructions to reduce possible infections included social distancing and the avoidance of social congregation. Strict home confinement and diminished access to training facilities, due to this pandemic, also resulted in a shutdown of the activities in all sports (De Souza et al., 2021; Sampson et al., 2021). Elite sports championships and major international events have been postponed. Thus, the main concept of the fitness and the medical staff was the possible detraining effects of this prolonged period, especially since the total duration was unknown, and the safe return to the game of the footballers (Seshadri et al., 2021). It is noteworthy that the amateur athletes and semi-professional teams faced greater problems since their championships were either postponed for the whole year or continued with several special restrictions.

In soccer teams, the effects of lockdown, due to longer periods of detraining and the increased loading of the players with the accumulated games after quarantine were very difficult to be managed. Indeed, a previous study, proposed that COVID-19 quarantine caused greater impairments in physical performance compared with the off-season training of soccer players (Grazioli et al., 2020). The diminished football-specific training resulted in a significant drop in their performance in both professional and non-professional footballers (Seshadri et al., 2021) leading to an increased injury risk (Sarto et al., 2020). It is previously established that aerobic capacity is related to the high intensity runs during a soccer match (Radziminski et al., 2021), with a short term (5 weeks) of detraining to decrease more than 10% the aerobic capacity (Chatzinikolaou et al., 2018). It is noteworthy that the lockdown lasted more than every other previous restriction in sports underpinning the importance of home-based training programs to retain athletes' performance.

Despite the period of restrictions and the limited access of the players at the fields due to the COVID-19 outbreak varied among the countries, most professional cases lasted similar or longer than the soccer off-season

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period (De Souza et al., 2020). Thus, it was of great interest whether the professional clubs could retain their running performance after the quarantine period. Interestingly, the teams from Bundesliga were found to keep their running characteristics after a 63-day lockdown (Radziminski et al., 2021). In contrast, the 81-day lockdown period was found to affect the high intensity running in Polish teams (Radziminski et al., 2021). It is possible that the longer lockdown period in Poland compared to this in Germany, as well as the training protocols followed by each team, to be responsible for these differences. It has been proposed that the greater number of fouls after the lockdown period in Bundesliga possibly due to the higher and more aggressive willingness to play as well as the increased level of strength caused by home-based strength training during the restriction period (Metelski & Kornakov, 2021). In contrast, data from Seria A have shown that aerobic fitness was improved while muscular performance decreased possibly reflecting a different orientation of the training program during the lockdown (Rampinini et al., 2021). Nevertheless, the importance of strategies, such as organized strength and endurance training protocols, was also confirmed by the data in Spanish Liga. It has been showed that the teams that retain or increase their physical performance and mainly the high-intensity actions improved their final position at the end of the championship (Raya-gonzález et al., 2022). On the contrary, the teams that showed decreases in several parameters of the external load during the matches got worse in the championship ranking. Although there are limited data, for the semi-professional level, regarding the matches' external load after the lockdown, the aforementioned results underline the importance of organized training strategies during special occasions such as quarantine or long-term off-season periods.

Several recommendations or/ and guidance have been proposed for both individual and team sports to handle the prolonged period of limited access in the training facilities (Aspetar Orthopedic and Sports Medicine Hospital, 2020; Azevedo et al., 2021). It is previously suggested the importance of a home-based program to maintain neuromuscular capacity in both professional and non-professional soccer players due to the adapted restrictions' guidance (Mohr et al., 2022). Previous study showed that a customized training program during COVID-19 lockdown led to maintenance of important parameters of the athletic performance in female soccer players (Pedersen et al., 2021). Similarly, it is underpinned the importance of organized strength training program to maintain the strength levels of lower limbs (Scoz et al., 2022). They concluded that the monitoring of the training session is a crucial factor for the success of the program. Video calls or the use of wearable technology during training sessions were the most common monitoring strategies adopted by the teams (Kalinowski et al., 2021). These strategies were found to increase athletes' commitment to the training procedure due to performance recordings (Laranjo et al., 2021). Nevertheless, it was of great importance to provide sufficient stimulus to maintain the aerobic capacity and muscle power due to a well-planned home-based program with suitable monitoring by the team staff.

A considerable amount of research has investigated the aforementioned constraints regarding their possible effects on elite soccer players' performance. However, these results could not completely be transferred to semi-professional players and it remains unclear if the same strategies could be applied to maintain their performance and if it is possible to extrapolate similar data in normal periods. Thus, the purpose of the present study was to investigate the effects of a home-based program on the external load of a semi-professional team, following the Covid-19 confinement.

Methods

All data obtained during the competitive season 2020-2021. The external load was recorded from three matches before and twelve after the Covid-19 restrictions using a Global Positioning System (see below). The present team started the pre-season period on the 3rd of August, while the official starting date of the championship was moved three weeks later due to the National Federation of Greece's instructions. The official games started on the 10th of October, and the team was put in quarantine after the second fixed match ten days later because of three positive PCR tests. Moreover, the whole championship was put on hold due to the increased number of COVID-19 outbreaks. Team training and training in athletic facilities were restricted. Athletes could perform only personal training either indoors or outdoors near their homes. According to the instructions of the national federation of Greece, the whole teams' training was allowed after four months and two weeks. A four-weeks retraining period was given before the restart of the championship. In the first two weeks, the training sessions consisted of subgroups of eight players whereas in the two weeks, team's training all the players trained together. In the first two-week sessions, light soccer training was performed to enter soccer-specific training. Some subgroup tactical exercises, either for defensive or attacking behavior, were also included. In the third and fourth weeks, all the players resumed the team training sessions with tactical exercises and friendly matches taking place. The third division championship resumed on 11 April 2021, and the teams played the remaining games of the 1st round since the league completed only games of one round.

Participants

All the participants (n=20, age: 28.6± 8.3 years, weight: 80.71± 6.7 Kgr, height: 178.7 ± 7.6 cm) were players from the same team who participated in the third national division of Greece (1st region). From the 20 players (20 devices) started before the Covid-19 confinement, 18 remained at the club after the quarantine

period. All the players were familiar with the standard monitoring procedure of the team. The club and the players were informed about the purpose of the study and provide a written consent to allow the use of the data.

Measurements

The external load of the match was monitored by GPS unit (GPS LagalaColli, SPINItalia, Roma, Italy) with a sample 10 Hz rate of recoding. These devices have already been investigated for metrics and were found to be appropriately reliable and valid in sports settings (Johnston et al., 2014; Modric et al., 2019). The GPS unit was placed on the upper back between the shoulder blades in a vest for all players. Each player received the same sensor during the matches to reduce measurement error (Jennings et al., 2010). The external measurements consisted of the parameter of total distance covered (m); distance in high-intensity running (19.8- 25.2 km/h); distance in sprint running (25.2 km/h); number of high-intensity accelerations (> 3 m/s^2), and number of high-intensity decelerations (> –3 m/s^2) (Ravé et al., 2020).

Intervention program

The intervention program started almost three weeks after the first positive PCR tests (Table 1). Right after the end of the quarantine period (14 days at that time), all the infected players examined by the medical staff of the club or a personal doctor. Each player started the training program when the staff ensured that no infection remains were evident. In the first two weeks, all the participants performed light aerobic training to enter the intervention program and body weight strength training. The intervention period finally was more than four months (four months and two weeks). The distribution of training sessions over the quarantine period is found in Table 1. The training contents depended on the period of time, the instructions of the National Federation of Soccer in Greece, the possible date of retaining as well as the weather conditions. The weekly training program consisted of five or six training sessions and it was publicized to the players with the Viber application (Rakuten Viber). The training sessions was monitoring by the SportTracker application. This application was found to be accurate in earlier study (Bauer, 2013). The collected data from every training session were sent back to the technical staff by the Viber app and analyzed. Moreover, the strength and neuromuscular training sessions were conducted during video calls with the Cisco Webex application.

Statistical analysis

The descriptive statistics were presented as the means ± standard deviations. A one-way ANOVA test was performed to compare the effect of time (before and after quarantine) on total distance, Vel max, HIR distance, Spr distance, N acc, and N dec, using SPSS statistical software (v.28.0, SPSS Inc., Chicago, USA). Statistical significance was accepted at a p-value < 0.05.

Table 1. Training intervention of the studied team during the Covid-19 confinement (MIC: Microcycle, BW/Str Tr: Body weinght strength training, CSt Tr: Core stability training, Aer Tr: Aerobic training, An Tr: Anaerobic training, Neuro/Plyo Tr: Neuromuscular/ Plyometric training, CP Tr: Complex power training)

Mesocycle 1	1st SESSION	2nd SESSION	3rd SESSION	4th SESSION	5th SESSION
MIC 1st	BW/StrTr-CSt Tr	Aer Tr	Neur/Plyo Tr	Aer Tr	
MIC 2nd	Aer Tr	BW/StrTr-CSt	Neur/Plyo Tr	BW/StrTr-CSt - Aer Tr	Aer Tr
MIC 3rd	Neur/Plyo Tr	Aer Tr	Aer Tr	BW/StrTr-CSt – Aer Tr	Aer Tr
MIC 4th	Neur/Plyo Tr	Aer Tr	Neur/Plyo Tr	BW/StrTr-CSt - Aer Tr	Aer Tr
Mesocycle 2					
MIC 1st	Neuro/Plyo Tr - AnTr	Aer Tr	BW/StrTr-CSt–An Tr	Aer Tr	BW/StrTr-CSt – An Tr
MIC 2nd	BW/StrTr-CSt – An Tr	An Tr	Aer Tr	BW/StrTr-CSt – An Tr	AvA+Aer Tr
MIC 3rd	BW/StrTr-CSt – An Tr	Aer Tr	Aer Tr- An Tr	BW/StrTr-CSt – An Tr	Aer Tr
MIC 4th	Plyo Tr- BW/StrTr	An Tr	Aer Tr	BW/StrTr-CSt – An Tr	Aer Tr
Mesocycle 3					
MIC 1st	BW/Str Tr +Aer Tr	Plyo Tr- An Tr	Aer Tr	CP Tr- AnA Tr	Aer Tr
MIC 2nd	BW/Str Tr -Aer Tr	Plyo Tr- An Tr	BW/Str Tr –Aer Tr	Aer Tr	An Tr
MIC 3rd	BW/Str Tr –Aer Tr	An Tr	Aer Tr	An Tr	
MIC 4th	BW/Str Tr -Aer Tr	Neuro/Plyo Tr - AnTr	Aer Tr	Neuro/Plyo Tr – AnTr	BW/Str Tr –Aer Tr
Mesocycle 4					
MIC 1st	BW/Str Tr –Aer Tr	Plyo Tr- An Tr	Aer Tr	CP Tr- An Tr	An Tr
MIC 2nd	BW/Str Tr –Aer Tr	Plyo Tr- An Tr	BW/Str Tr –Aer Tr	Aer Tr	An Tr
MIC 3rd	BW/Str Tr –Aer Tr	An Tr	Aer Tr	An Tr	
MIC 4th	BW/Str Tr –Aer Tr	Neuro/Plyo Tr – An Tr	Aer Tr	Neuro/Plyo Tr – An Tr	BW/Str Tr –Aer Tr
Mesocycle 5					
MIC 1st	BW/Str Tr –Aer Tr	Aer Tr	Plyo Tr- An Tr	Aer Tr- An Tr	Aer Tr
MIC 2nd	BW/Str Tr –Aer Tr	Plyo Tr- An Tr		Aer Tr- An Tr	An Tr
MIC 3rd	Aer Tr		Subgroups training		
MIC 4th					

Results

There was a significant difference in the scores for total distance (F (1,13) =15.337, p=.002). The mean values (±SD) are presented in Table 1. There was no statistically significant difference between before and after quarantine time in HIR distance (F(1,13) =.657, p=.432), Spr distance (F (1,13) =.026, p=.875), N Sprints>7m (F (1,13) =.001, p=.972), N acc (F (1,13) =.776, p=.394), N dec (F (1,13) =930, p=.930). Since the assumption of homogeneity of variance was not met for Vel max we used the obtained Welch's adjusted F (1,13) =1.589, p=.542 resulting no significant difference.

Table 2. Mean values of total distance covered, the maximum velocity, the distance of high intensity running, distance of sprint, number sprints over 7m, number of accelerations and decelerations.* Significantly different from pre-Covid-19 values

	Pre Covid-19	Post Covid-19
N Matches	3	12
Total distance (m)	97366.3± 8236.3	108552.9± 3287.6 *
Vel max (km/h)	29.2± 2.1	28.3± 0.8
HIR distance (m)	5051.2± 520.7	5309.8± 489.4
Spr distance (m)	916.7± 232.3	896.3± 190.1
N Sprints>7m	92± 19.3	92.3± 13.2
N acc	84.7± 9.3	93.4± 16.3
N dec	41.3± 8.4	41.9± 10.3

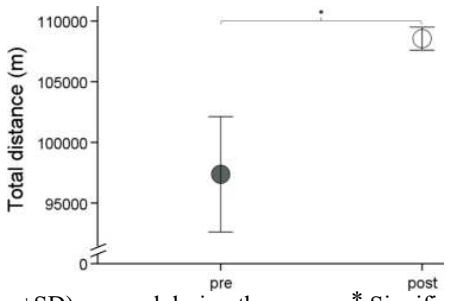

Figure 1. Total distance (mean±SD) covered during the games .* Significantly different from Pre-Covid values

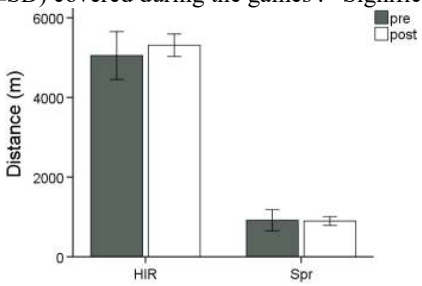

Figure 2. Covered distances (mean ± SD) of high intensity and sprints runs during the games

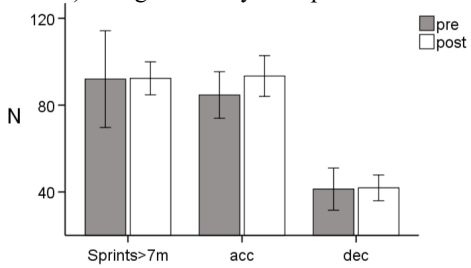

Figure 3. Number (mean ± SD) of sprints > 7 m, accelerations and decelarations during the games

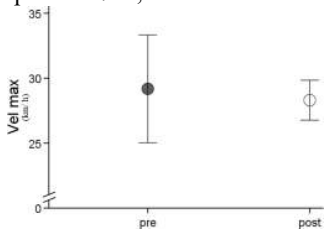

Figure 4. Maximum velocity (mean± SD) during the matches

Discussion

The main purpose of this study was to record the effects of an intervention program on a semi-professional team's performance, considering the external load of the match. Although there are data about the effects of Covid-19 confinement and the consequences on match performance, this is the first attempt to record and examined these effects on a semi-professional level in reference to the external load. The main finding of this study was that an organized, monitored home-based program could maintain or even improve some parameters of the external load at a semi-professional level. Additionally, our results demonstrated that parameters dependent on neuromuscular performance remain unchanged after the quarantine period, concluding that an intervention could be helpful in a long-term off-season period.

Interestingly, improvements in TD were found in the present study. The present result clarifies that increases in the different parameters of athletic performance are possible due to a well-designed training intervention. These results support previous reports which demonstrated similar running patterns between the seasons of 2018-2019 and 2019-2020 in La Liga (Brito de Souza et al., 2021) or the improvements in aerobic capacity in Serie A (Rampinini et al., 2021). Similarly, the German teams in Bundesliga did not affect by the 63-day lockdown, suggesting that these teams used this period as an opportunity window to improve overall performance (Radziminski et al., 2021). Contrary to our results and the previous reports, recent studies revealed that the Spanish teams decreased their performance after Covid-19 confinement in terms of external load, at least for the first eight games after the retaining (García-Aliaga et al., 2021; Raya-gonzález et al., 2022). Several factors could be responsible for these differences, such as the long individual training with the absence or the limited friendly match during the short preparatory period and the fact that the games played without audiences. The team from the present study focused on team training when this was allowed with four friendly matches to be arranged (Raya-gonzález et al., 2022). The importance of the match's number in the athletic form is previously described, showing that the Spanish team needed more than eight matches to reach the same level of performance after the Covid-19 confinement (De Souza et al., 2020). The individual training lasted more than four months, leading to an increase in overall fitness. Thus, a specific stimulus is needed to transform general fitness into soccer-specific performance. The number of friendly matches possibly leads to these soccer-specific adaptations (García-Aliaga et al., 2022). Additionally, the preparatory period after the restrictions consisted of only soccer exercises with technical-tactical and specific conditioning orientation. Given the above, our results emphasized the importance of an organized intervention program during pandemic confinement or even during a long off-season period to maintain the overall performance of semi-professional soccer players. The benefits of an efficient intervention would be apparent during the sequential period of specific training.

Another interesting finding of the present study was that both high intensity and the strength demanded actions remained at the same level after the lockdown. As previously proposed that lower limb strength and explosive actions are affected more, due to Covid-19 confinement (Guerrero-Calderón & Rodriguez, 2021). The interaction between the high-intensity actions and the match results has been previously established (Raya-gonzález et al., 2022). Our finding support previous reports showing that it is possible to maintain the TD and HIR distance after the Covid-19 lockdown due to intervention programs (Radziminski et al., 2021). Additively, a previous study revealed the importance of maintaining the ability of HIR actions which leads to an improved ranking after the confinement (Raya-gonzález et al., 2022). They found that the improved ranking teams were those with the smaller reduction in HIR actions. In contrast with our results, a previous study has also shown that the clubs of the Polish championship failed to reach the pre-Covid-19 values due to the stricter and longer duration of restrictions (Radziminski et al., 2021). Since the confinement in the present study lasted more than four months (greater than in Ekstraklasa), an important question related to this finding is the following: "what are the reasons leading to increased HIR actions (non-significant) after the particular training program?". Firstly, it should be mentioned that a preparatory period of four weeks was given in the third Greek national championship. As every team could organize this period at will, the present club performed four friendly matches to increase the soccer-specific load and get into the optimal shape (Raya-gonzález et al., 2022). Secondly, when the subgroup training sessions were allowed, every part of the session consisted of exercises with the ball to increase the specific load. In the sense of a limited number of players and the consequent relatively small place per player during exercises, a customized interval program was included to reach greater velocities with longer distances(Nevado-Garrosa et al., 2021). Last but not least, despite the decreased training volume which is evident during confinement, the training intensity could increase due to the absence of the weekly match (Rampinini et al., 2021). Furthermore, the use of high-intensity training could provoke a significant increase in the aerobic capacity of the soccer player, while the submaximal exercises or the limited use of conditioning exercises because of the technical and/ or tactical needs during the competitive period might influence negatively (Laursen & Jenkins, 2002). The novel finding of the present research was that the confinement period should be used as an opportunity window to increase high-intensity running actions since the training intensity could be increased without the limitations of the "following match" during the competitive period.

Regarding the number of accelerations and decelerations, our findings have shown an insignificant increase for the accelerations while the decelerations were almost the same. Although previous studies indicated

that home-based training programs could be inefficient to maintain lower limb anaerobic power (Rampinini et al., 2021) , the efficiency of the present intervention might be a result of the increased volume of plyometric training during lockdown (Wang & Zhang, 2016). Moreover, in the context of the limited number of players participating during the training session after the lockdown, there was an increase in the use of small-space tasks leading to specific actions such as accelerations and decelerations. Thus, training with a small number of players in small places might result in an improved ability to accelerate and decelerate repeatedly (Rebelo et al., 2016). Reinforcing the previous, the increased volume of plyometric training during the Covid-19 confinement and the soccer-specific adaptations of the small-sided game with a small number of players during the preparatory period would result in increased and maintained the number of accelerations and decelerations respectively.

Although this is the first study to be conducted at a semi-professional level after confinement regarding the external load, some limitations must be considered. Firstly, there was a significant change in the number of substitutions from 3 to 5. This change possibly affected the number of high-intensity actions, sprints, acceleration, and deceleration (Padrón-Cabo et al., 2018). In contrast to the above parameters, the total distance could not be affected so much showing such an increase. Secondly, two players of the squat left the club right after the Covid-19 lockdown. The players that took their GPS transmitters were also players of the team before the confinement, but an inter-individual variability during the game is possible. Thirdly, the match's external load depends also on several factors such as tactical formation, weather conditions, and game variables. Our data demonstrated that the total distance covered presented the minimum value when the team was ahead of three nil. Thus, a possible effect of the match variables on game's the external load could not be excluded. Finally, only one semi-professional team was recruited in the present study (the only one had in possession GPS), thus the extrapolation of the present results for teams of different status requires caution.

Conclusion

Despite the confinement due to Covid-19 has passed, the results of the present study provide further information about the soccer periodization and the off-season period. The semi-professional teams have more than three months off from the pitches and team training. Thus, the present data constitute a management proposal for the long-term off periods. The above results suggest that a well-designed home-based intervention program could increase or maintain athletic performance, specifically regarding the external load, after a long-term confinement (or just a long-term detraining period). Similar training programs could increase players' total distance suggesting a better aerobic capacity. The adaptations will permit the training staff to include specific training exercises earlier during the pre-season period. Consequently, the specific training load would increase, leading to an increased distance of high-speed runs and sprints. Therefore, the soccer teams and their staff should create an intervention strategy for both a possible lockdown and/ or a long-term off-season period. Additively, from a practical point of view, the apps used in this study are free on the Internet and they could be proposed as an affordable solution for semi-professional soccer teams, to monitor the training process and communicate the data, leading to a higher level of performance at the start of the preparatory period. A similar training program, monitored by the technical staff, could be applied to the off-season period to provide further information about their effect on different periods of the season (eg. off-season period) and/or different sports. Such a use could be beneficial for both technical staff and the players.

Conflict of interest declaration

The authors report there are no competing interests to declare

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