RICYDE. Revista Internacional de Ciencias del Deporte
doi: 10.5232/ricyde
Rev. Int. cienc. deporte

RICYDE. Revista Internacional de Ciencias del Deporte
Volume XVIII - Year XVIII
Pages: 29-42 - ISSN: 1885-3137
Issue 67 - January 2022

https://doi.org/10.5232/ricyde2022.06703

Mandatory lockdown impaired performance in professional football players
El confinamiento obligatorio afectó al rendimiento de jugadores de fútbol profesional

Ivan Peña-González[1]; Alejandro Javaloyes[1]; Fidel Agulló[2]; Manuel Sempere[2]; Aitor Soler[2], & Manuel Moya-Ramón[1]

1. Sports Research Centre (Department of Sport Sciences), Miguel Hernández University, Elche, Spain.
2. Department of Physical Performance, Elche C. F. SAD, Elche, Spain.

Abstract

COVID-19 caused a total halt in sport competition during 2020. The purpose of this study was to analyse the changes between pre- and post-lockdown competitive periods in the players' workload variables in competition. Seventeen professional football players were monitored using a WIMU PRO® inertial device throughout the 2019-20 season. Anthropometric and physical fitness were assessed with the aim to relate possible associations between these characteristics and the workload changes in the pre- and post-lockdown periods. During the lockdown, players carried out an 8-week guided self-training. There was a general decrement in the players' physical workload demands in competition, and the parameters related to high-intensity actions as accelerations and decelerations (-8.96% [ES: 0.64] and -11.04% [ES: 0.77] respectively; p < .05), Ind HSR (-35.57% [ES: 0.92]; p = .002), HMLD (-8.58% [ES: 0.66]; p = .016), PLOAD (-7.03% [ES: 0.54]; p = .047) and Vmax (-3.80% [ES: 0.65]; p = .016) can be highlighted. The results showed high negative correlations between match workload variables prior to the lockdown and the percentage of change in these variables after the lockdown period. Individual percentages of change showed high variability in players' changes. Individual self-training programs should be reviewed to minimize the impact of a "detraining" period in players' physical performance during possible new lockdown periods.

Keywords: COVID-19; Detraining; Team sports; Fitness testing.

Resumen

El COVID-19 causó un parón total en las competiciones deportivas durante 2020. El objetivo de este estudio fue analizar los cambios en las variables de carga de trabajo en competición entre los periodos competitivos pre- y post-confinamiento. Diecisiete jugadores de fútbol profesional fueron monitorizados usando el dispositivo inercial WIMU PRO® durante la temporada 2019-20. Se registraron los valores antropométricos y de rendimiento físico con el objetivo de buscar posibles asociaciones entre esas características y cambios en las variables de carga de trabajo en los periodos pre- y post-confinamiento. Durante el confinamiento, los jugadores realizaron un auto-entrenamiento guiado de 8-semanas. Se encontró un descenso generalizado en la carga de trabajo de los jugadores en competición y en los parámetros relacionados con las acciones a alta intensidad como aceleraciones y deceleraciones (-8.96% [ES: 0.64] y -11.04% [ES: 0.77] respectivamente; p < .05), HSR Ind (-35.57% [ES: 0.92]; p = .002), HMLD (-8.58% [ES: 0.66]; p = .016), PLOAD (-7.03% [ES: 0.54]; p = .047) y Vmax (-3.80% [ES: 0.65]; p = .016). Los resultados mostraron altas correlaciones negativas entre porcentajes alcanzados por las variables según la carga de trabajo en partidos antes-después del confinamiento. Los porcentajes de cambio individual mostraron una alta variabilidad entre jugadores. Los programas de auto-entrenamiento realizados individualmente durante el confinamiento deberían ser revisados para minimizar el impacto de un periodo de desentrenamiento en el rendimiento físico de los jugadores durante un posible nuevo periodo de confinamiento.

Palabras claves: COVID-19; Desentrenamiento; Deportes colectivos; Evaluación física.

Correspondence/correspondencia: Alejandro Javaloyes
Sports Research Centre (Department of Sport Sciences), Miguel Hernández University, Elche, Spain.
Email: ajavaloyes@umh.es

Received: October 10, 2021; Accepted: Dicember 19, 2021

Introduction

The COVID-19 global pandemic caused a complete or partial halt in the elite sport calendar during 2020 (Borges do Nascimento et al., 2020; Di Gennaro et al., 2020). In an attempt to reduce the socio-economic and health consequences of this virus, the most affected countries such as Italy, Spain, or Great Britain applied mandatory lockdown strategies that forced people to remain at home and as a consequence, elite athletes were forced to reduce their training frequency (Sarto et al., 2020). A reduction of training may cause some level of detraining that could impair performance and increase the injury risk (Impellizzeri et al., 2020; Seshadri et al., 2021). This is based on the principle of reversibility, as training adaptations are transitory and an insufficient or unspecific stimulus could produce short and long-term levels of loss of training-induced adaptations (Mujika & Padilla, 2001). Although this population shows fewer decay rates in fitness and performance due to detraining than moderate or untrained individuals (Fleck, 1994; Neufer et al., 1987), short (< 4 weeks) (Mujika & Padilla, 2000b) and long-term (> 4 weeks) (Mujika & Padilla, 2000a) detraining effects lead to different changes that directly influence the performance of highly trained individuals.

Although the effects of detraining are widely described in the literature, the positive or negative adaptations as a consequence of an unusual and unpredictable lockdown (even if athletes perform a self-training program at home) are not known. Regarding intermittent team sports like football, in which short- and high-intensity actions (i.e. jumping or sprinting) are determinant factors to succeed (Stølen et al., 2005), to assign self-training protocols to players during the mandatory lockdown were a challenge for coaches and physical trainers (Mohr et al., 2020).

External workload variables (i.e. the total distance covered in a match or the number of accelerations) have been shown as valid and reliable variables to assess the physical performance demands in professional football and they allow coaches and physical trainers to quantify and prescribe training loads to improve the players' physical performance (Bradley et al., 2010; Mohr et al., 2003), specific requirements by field position (Di Salvo et al., 2007) or even prevent injuries (Hulin et al., 2016). Besides, previous research has shown that the players' physical fitness (such as sprinting or endurance assessment using field tests) is related to the physical workload demands assessed in competition (Bradley et al., 2013; Mohr et al., 2003), suggesting that players with greater values in physical performance tests are able to reach higher physical workload values in competition (Impellizzeri & Marcora, 2009).

The multifactorial approach to the physical performance in football hindered the ability for trainers or physical coaches to create self-training programs at home aiming to reduce the negative effects of the sport-specific detraining during the COVID-19 mandatory lockdown. This fact, together with the long period that the competition stopped for (7-weeks) and the short period of sport-specific training the players had after the lockdown to get ready to play again (between 3 and 4-weeks), as well as the reduced time to recover between matches after the confinement, created a condition in which players had to return to compete with theoretically lower levels of physical performance and an increased risk of injury. Therefore, monitoring the possible negative effects of performance in this population may have an impact on their return to play safely. Moreover, the importance of this monitoring is high because, as many epidemiology organizations had claimed, there is a risk of a rebound in the number of infections that could lead to another lockdown situation. Therefore, the main aim of the present study was to assess the effects of a mandatory lockdown on the external workload demands in competition and training in a group of professional football players. A secondary aim of the present study was to report the relationship between the players' physical fitness (assessed by physical field tests) and the changes in the workload variables after the confinement period.

Materials and methods

Design

An experimental research design was carried out to examine the effect of an 8-week lockdown period in professional football players. The lockdown period meant a total halt in the players' specific football training and they started to perform a guided self-training at home with five to six training sessions per week. The subjects were required not to perform any other type of physical activity during the lockdown period. The researchers supervised the exercise execution of each player by means of group videocalls during these training sessions to ensure the correct performance of each self-training session. All the players selected for the study completed the 100% of the self-training program. The players' workload demands were registered in competition just before and after the lockdown period and average results for each player in each period were used as the pre- and post-lockdown workload variables. Additional player information such as anthropometrical or physical fitness data were used as independent variables to examine its possible influence on workload variables differences between pre- and post-lockdown periods.

Participants

Seventeen Spanish professional football players from the Spanish 2nd Division League were included in the study. The sample included players from all field positions except for goalkeepers. They were monitored throughout the whole 2019-20 season. All the participants included in the study fulfilled the criteria of having played at least two matches (playing more than 45 minutes in each match) in the pre-lockdown period and at least two matches (more than 45 minutes in each match) in the post-confinement period. Anthropometric data for the sample were: 1.80 ± 0.07 m, 76.53 ± 6.36 kg, 23.51 ± 0.77 kg·m-2, 7.72 ± 0.86 % for height, mass, body mass index and percentage of body fat, respectively. The physical fitness values before the mandatory lockdown were 20.23 ± 1.01 km·h-1, 1.78 ± 0.10 m, 3.54 ± 0.13 m, 5.31 ± 0.22 m, 37.75 ± 6.57 cm for the final velocity in the intermittent fitness test (vIFT 30-15), 10 m, 30 m, 40 m sprint and countermovement jump (CMJ), respectively. In accordance to the Declaration of Helsinki (2013), previously to the data collection, participants signed an informed consent with details of the aims of this study. This protocol was approved by the ethical guidelines of the hosted institution.

Procedure

Players' physical fitness in the pre-season period had been assessed for a different study and it was used as the base-line physical performance of the players. The players' physical fitness was assessed by the velocity obtained in the 30:15 intermittent fitness test (IFT), the height obtained in the countermovement jump (CMJ) and the time it took them to run 10, 30 and 40 meters of a linear sprint. Periodical anthropometrical assessments were carried out throughout the season and the anthropometrical data from March 2020 was used as the pre-lockdown data and the anthropometrical data from May 2020 was used as the post-lockdown one. The last training with the group before the mandatory lockdown was on March 13th 2020 and individual self-training was prescribed and monitored during the lockdown period (supplemental material). For each self-training session, players had to be connected to a video conference in which the technical staff guided and controlled the correct compliance and execution of the training exercises. All the players were provided with a TRX®, a cyclergometer (Technogym®)

and a set of weights (Runwe®). Besides, the self-training volume (weekly) did not differ more than 10% from the average weekly volume prior to the lockdown. For elite athletes, the Spanish Government allowed the end of the home confinement on May 4th, and the first sport-specific training was allowed on May 8th, 2020 in small groups. A total of 10 training sessions with the whole group were carried out prior to returning to compete on June 12th, 2020.

External workload variables were registered in all the official matches of the 2019-20 season. However, to have a similar number of matches in the pre- and post- periods for the analysis and considering that the study aimed to show the changes in these variables from the last competitive period to the end of the confinement period, only the competitive matches from the second leg of the round-robin were analysed (11 matches pre-lockdown and 11 matches post-lockdown). A habitual training task performed by the team along the season was selected to analyze the workload variables in training between the pre- and post-lockdown period. This task was an 11-a-side match in a 90m x 68m natural grass field and with goalkeepers (although goalkeepers were not assessed). This task was replicated three times before the lockdown period and twice in the post-lockdown period.

Anthropometrical and physical fitness data

Body height was assessed using a fixed stadiometer (± 0.1 cm, SECA LTD., Germany) and body weight was assessed using a digital scale (± 0.1 kg, Oregon scientific® GA101/GR101, Spain). Body mass index (BMI) was calculated as weight (kg) / (height (m)2) The percentage of body fat was calculated using Carter's equation (Carter, 1982). The intermittent endurance of players was obtained through the final velocity of the IFT 30-15 test (Buchheit, 2008). The time at 10-, 30- and 40-meter sprints in a straight line was recorded using photoelectric cells (Witty System Microgate, Bolzano, Italy). The jump height in the countermovement jump test (CMJ) was assessed using a contact platform (Globus Ergotester®, Italy).

Match and training workload variables

The players were monitored throughout the whole season (matches and training sessions) with a WIMU PRO TM inertial device (Realtrack Systems SL, Almería, Spain) (18 Hz). The following variables: i) the distance as the total number of meters covered during the match/training (the distance covered at different velocities ranges [0-6 km·h-1; 6-12 km·h-1; 12-18 km·h-1; 18-24 km·h-1 and >24 km·h-1] were also registered); ii) the number of middle-intensity (2-4 m·s-2) and high-intensity (>4 m·s-2) accelerations (acc) and decelerations (dec); iii) the individual high speed running (Ind HSR) which is the distance covered at more than the 85% of the players' individual maximal running speed; iv) the high-metabolic load distance (HMLD) which is the distance covered by the player when his metabolic power is higher than 25.5 W·kg-1; v) the Player load (PLOAD) as the vectorial magnitude derived from the triaxial accelerometer data, which indicates the stress rate to which players subject their body for a match/training (Barreira et al., 2017); vi) and the maximal (Vmax) and average (Vaverage) velocity reached in the match/training (km·h-1) were recorded by technical staff as the players' workload variables in matches and trainings.

Statistical Analysis

Descriptive data was expressed as mean ± standard deviation. Players' individual percentage of change in each workload variable was provided. Differences for match and training workload variables between the pre- and the post-lockdown period were assessed by multiple paired-sample t-test analyses. Additionally, the percentage of the difference between the pre- and the post-lockdown period and the effect size at 95% of the confidence interval (ES [95%CI]) were calculated for each variable. The ES was expressed in Cohen's d units and was interpreted as trivial (< 0.24), small (0.25–0.49), moderate (0.50–0.79), and large (> 0.80) (Cohen, 1992). The coefficient of variation (CV) expressed in percentage was used as a measure of variability of players' performance. Pearson's correlation analysis was employed to assess the relationship between anthropometrical and physical fitness data and the percentage of difference of the match workload variables between the pre- and the post-lockdown period. Pearson's correlation coefficients (r) were interpreted as trivial (< 0.09), small (0.10–0.29), moderate (0.30–0.49), high (0.50–0.69), very high (0.70–0.89) and almost perfect (> 0.90) (Hopkins et al., 2009). The level of statistical significance for the analysis in this study was set at p < .05. All calculations were performed using JASP (Version 0.8.1) and Microsoft Excel (Microsoft, Seattle, WA, USA).

Results

Differences for the players' body weight (t = 0.30, p = .770, ES = 0.07), BMI (t = 0.25, p = .802, ES = 0.06), and the % of body fat (t = -1.47, p = .161, ES = -0.36) between the pre- and the post-lockdown period did not show any significant difference, but the % of body fat presented an increase with moderate ES.

The paired-sample t-test showed no differences for the workload variables in the training task between the pre- and the post-lockdown period (Table 1), except for the total distance covered (12.26%; p = .001) and the player load (15.24%; p = .004) in the task. The examination of the distance covered at different velocities revealed that the increase in the total distance in the task was due to the increase of the distance covered at low intensities (distance covered at 0-6 km·h-1: t = -1.97, p = .070, ES = -0.53; at 6-12 km·h-1: t = -4.37, p < .001, ES = -1.17; at 12-18 km·h-1: t = -1.65, p = .123, ES = -0.44). Furthermore, the distance covered at high intensities did not decrease significantly but ES analysis revealed possible decreases at 18-21 km·h-1 (moderate ES) and 21-24 km·h-1 (small ES).

The paired-sample t-test showed a systematic decrease for the match workload variables (Table 2), which was significant in most of the variables except for the number of sprints, the high-intensity accelerations and decelerations, and the velocity average. Although they did not present significant values, the ES for the number of sprints (ES = 0.47) and the $V_{average}$ (ES = 0.37) was moderate. In addition, the CV analysis showed high variability between players' workload variables (CV%: Distance covered = 14%; number of sprints = 54%; Acc and Dec = 17 to 43%; Ind HSR = 74%; HMLD = 20%; Player load = 15%; V_{max} = 6% and $V_{average}$ = 7%). Furthermore, Figure 1 shows the individual percentage of change between the pre- and the post-lockdown period with the players` average percentage of change (Figure 1).

Table 1. Workload variables comparison between pre- and post-lockdown period in the training task.

Workload variables	Pre-Confinement (Mean ± SD)	Post-Confinement (Mean ± SD)	t	% Change	p	ES	95%CI for ES	
							Lower	Upper
Distance covered (m)	1354.23 ± 62.89	1520.23 ± 126.43*	-4.17	12.26	.001	-1.11	-1.78	-0.43
Sprints (n)	1.80 ± 0.87	1.96 ± 1.61	-0.33	8.89	.749	-0.09	-0.61	0.44
Acc (2-4 $m \cdot s^{-2}$) (n)	26.48 ± 2.56	24.75 ± 4.26	1.05	-6.53	.313	0.28	-0.26	0.81
Dec (2-4 $m \cdot s^{-2}$) (n)	25.65 ± 2.67	24.86 ± 4.68	0.46	-3.08	.656	0.12	-0.41	0.65
Acc (>4 $m \cdot s^{-2}$) (n)	1.48 ± 0.46	1.18 ± 1.10	0.97	-20.27	.352	0.26	-0.28	0.79
Dec (>4 $m \cdot s^{-2}$) (n)	3.01 ± 0.64	3.00 ± 1.59	0.02	-0.33	.986	0.01	-0.52	0.53
Ind HSR (m)	5.14 ± 6.64	3.26 ± 6.22	0.75	-36.58	.467	0.20	-0.33	0.73
HMLD (m)	289.56 ± 32.55	293.79 ± 65.76	-0.22	1.46	.832	-0.06	-0.58	0.47
Player load (a.u.)	18.11 ± 0.96	20.87 ± 2.64*	-3.55	15.24	.004	-0.95	-1.57	-0.30
V_{max} ($km \cdot h^{-1}$)	26.60 ± 1.73	25.59 ± 2.50	1.40	-3.80	.184	0.38	-0.18	0.91
$V_{average}$ ($km \cdot h^{-1}$)	7.20 ± 0.24	7.42 ± 0.58	-1.26	3.06	.232	-0.34	-0.87	0.21

ES: Effect size; CI: Confidence interval; Acc: Accelerations; Dec: Decelerations; Ind HSR: Individual high-speed running; HMLD: High metabolic load distance; PLOAD: Player load; V_{max}: Maximal velocity; $V_{average}$: Average velocity; m: Meters; n: Number; a.u.: Arbitrary units; $km \cdot h^{-1}$: Kilometres per hour.

*Statistical difference between pre- and post-confinement (p<.05)

Table 2. Workload variables comparison between pre- and post-lockdown period in competition.

Workload variables	Pre-Confinement (Mean ± SD)	Post-Confinement (Mean ± SD)	t	% Change	p	ES	95%CI for ES	
							Lower	Upper
Distance covered (m)	9270.47 ± 1092.99	8661.35 ± 1171.93*	2.17	-6.57	.045	0.53	0.01	1.03
Sprints (n)	11.83 ± 5.68	10.54 ± 5.67	1.94	-10.90	.070	0.47	-0.04	0.97
Acc (2-4 $m \cdot s^{-2}$) (n)	157.53 ± 30.69	143.41 ± 23.78*	2.62	-8.96	.018	0.64	0.11	1.15
Dec (2-4 $m \cdot s^{-2}$) (n)	153.69 ± 30.70	136.72 ± 22.97*	3.19	-11.04	.006	0.77	0.22	1.31
Acc (>4 $m \cdot s^{-2}$) (n)	8.44 ± 2.88	8.57 ± 3.10	-0.14	1.54	.889	-0.04	-0.51	0.44
Dec (>4 $m \cdot s^{-2}$) (n)	20.39 ± 6.97	18.96 ± 8.08	1.07	-7.01	.299	0.26	-0.23	0.74
Ind HSR (m)	58.14 ± 37.14	37.46 ± 27.81*	3.69	-35.57	.002	0.92	0.32	1.50
HMLD (m)	1869.03 ± 448.61	1708.67 ± 343.33*	2.70	-8.58	.016	0.66	0.12	1.17
PLOAD (a.u.)	127.09 ± 16.31	118.15 ± 17.14*	2.17	-7.03	.047	0.54	0.01	1.06
V_{max} ($km \cdot h^{-1}$)	30.53 ± 1.91	29.37 ± 1.73*	2.69	-3.80	.016	0.65	0.12	1.17
$V_{average}$ ($km \cdot h^{-1}$)	6.93 ± 0.61	6.79 ± 0.50	1.54	-2.02	.142	0.37	-0.12	0.86

Effect size; CI: Confidence interval; Acc: Accelerations; Dec: Decelerations; Ind HSR: Individual high-speed running; HMLD: High metabolic load distance; PLOAD: Player load; V_{max}: Maximal velocity; $V_{average}$: Average velocity; m: Meters; n: Number; a.u.: Arbitrary units; $km \cdot h^{-1}$: Kilometres per hour.

*Statistical difference between pre- and post-confinement (p<.05)

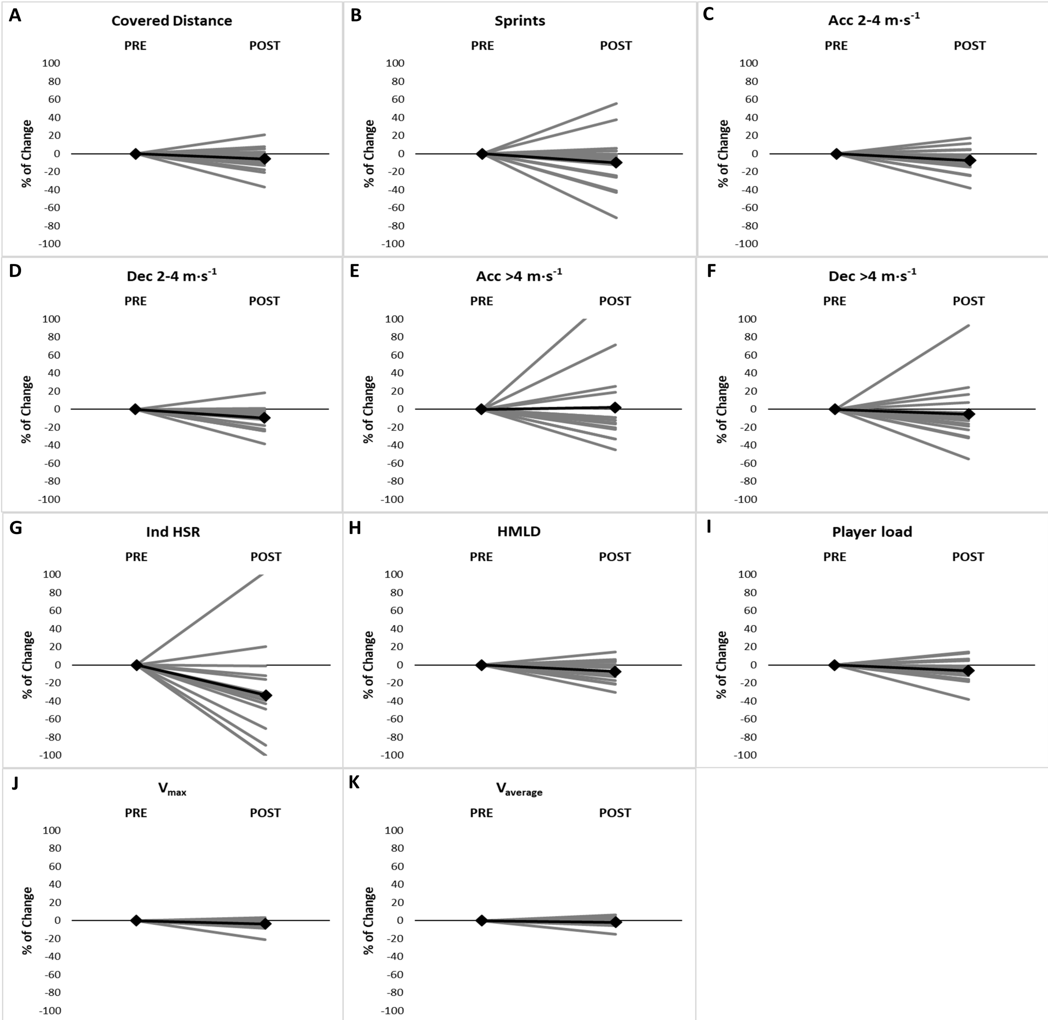

Figure 1: Players' individual percentage of change between pre- and post-lockdown period for the workload variables.

Correlation coefficients between the anthropometrical and physical fitness variables and the percentage of change of the match workload variables between the pre- and the post-lockdown period are shown in Table 3. Significant and *moderate* correlations were found for the % of body fat with some match workload decrements (i.e., with the decrement of the distance covered). A higher performance (less time spent) in sprinting tests correlated to the match workload decrements in the number of sprints. Previous values in each workload variable during the match correlated to the percentage of change in these variables except for the number of sprints (r = -0.07), the number of decelerations (> 4 $m{\cdot}s^{-2}$) (r = -0.16), the Ind HSR (r = -0.36) and the PLOAD (r = -0.41). *High* negative correlations were shown between values in match workload variables prior to the lockdown period and the percentage of change in those variables after the lockdown period in the accelerations and decelerations (r = -0.57 to -0.59; *p* < .05; except high-intensity decelerations), HMLD (r = -0.54; *p* = .024), V_{max} (r = -0.54; *p* = .025) and $V_{average}$ (r = -0.56; *p* = .019).

Table 3. Pearson's correlation coefficients between the percentage of change in match workload variables and anthropometrics, physical fitness and match workload previous values.

% of change of	Body height	Body weight	BMI	% of Body Fat	vIFT 30-15	10m	30m	40m	CMJ	Previous value
Distance covered	-0.09	-0.06	0.02	0.72**	-0.01	0.18	-0.07	0.03	0.17	-0.46
Sprints	0.24	0.27	0.09	0.43	-0.30	-0.56*	-0.69**	-0.67*	0.49	-0.07
Acc (2-4 $m \cdot s^{-2}$)	-0.22	-0.19	0.05	0.56*	0.05	0.15	-0.06	0.03	0.13	-0.58*
Dec (2-4 $m \cdot s^{-2}$)	-0.23	-0.23	-0.06	0.54*	0.06	0.05	-0.11	-0.05	0.17	-0.57*
Acc (>4 $m \cdot s^{-2}$)	-0.15	-0.01	0.34	0.18	0.11	-0.05	0.26	0.14	-0.26	-0.59*
Dec (>4 $m \cdot s^{-2}$)	-0.25	-0.1	0.22	0.16	0.02	-0.07	-0.22	-0.17	0.29	-0.16
Ind HSR	0.42	0.31	-0.22	0.44	-0.46	-0.10	-0.43	-0.30	0.34	-0.37
HMLD	-0.14	-0.01	0.26	0.58*	-0.19	0.06	0.06	0.06	-0.01	-0.54*
PLOAD	-0.18	-0.19	-0.16	0.65*	0.02	0.20	-0.07	0.05	0.21	-0.41
V_{max}	-0.12	-0.06	0.12	0.36	0.07	0.27	0.20	0.25	-0.01	-0.54*
$V_{average}$	-0.04	0.03	0.17	-0.10	0.08	-0.15	-0.09	-0.14	-0.03	-0.56*

BMI: Body mass index; vIFT 30-15: Final velocity in the intermittent fitness test; CMJ: Countermovement jump; Acc: Accelerations; Dec: Decelerations; Ind HSR: Individual high-speed running; HMLD: High metabolic load distance; PLOAD: Player load; V_{max}: Maximal velocity; $V_{average}$: Average velocity.
*$p < .05$; **$p < .05$

Discussion

To the authors' knowledge, this is the first study that examined how this period (with the subsequent training restrictions) impacted professional football players' workload variables (which are commonly used by coaches and physical trainers to quantify and prescribe training loads) in competition and training. The main finding from this research is the overall players' decrement in their physical workload demands in competition, highlighting those parameters related to high-intensity actions.

The main aim of the present study was to evaluate the effects of the mandatory lockdown on competition and training. Although the players carried out a self-training program prescribed by the technical staff during the lockdown period, the authors hypothesized that an individual self-training program with stimulus which are not sport-specific and the short and atypical period (training with reduced groups) they had before they returned to competition would not be enough to maintain the football-specific workload variables reached before the confinement. The results in this study did not show statistical differences in most of the external workload variables assessed in the training task, except for an increase in the total distance covered in the task and the PLOAD. When data from the distance covered was studied at different ranges of intensity, the analysis showed that the increment in the total distance covered in the training task was due to the increase of distance covered at low velocities (0-6 km·h-1 to 12-18 km·h-1) while the distances covered at high velocities (18-21 km·h-1 to >24 km·h-1) remained the same (or they decreased without significant values). These results may be wrongly interpreted as an increment in the players' ability to cover more distance in a training task, but they are really spending more time performing low-intensity actions, which are not directly related to a high performance in football (Stone & Kilding, 2009). Additionally, although they did not show significant differences and the ES was small, the high percentages of change (decrement) in high-intensity accelerations (20%) and the Ind HRS (37%) are remarkable. This may indicate high inter-individual variability in the effect of the confinement period in these variables with players showing high percentages of loss in these variables while other players did not present decrements.

Results from the match workload changes between the pre- and the post-lockdown period revealed a systematic decrease in several variables such as the distance covered, the number of middle-intensity accelerations and decelerations (2-4 m·s-2) (-8.96% and -11.04% respectively; p < .05) while there were no changes (p > .05) in high-intensity (>4 m·s-2) accelerations and decelerations, the Ind HSR (-35.57%; p = .002), HMLD (-8.58%; p = .016), PLOAD (-7.03%; p = .047) and Vmax (-3.80%; p = .016). As expected, the lesser distance covered by players in the competition was mainly due to a reduction in the distances covered at high intensities (18-21 km·h-1 to >24 km·h-1). These results are partially in line with Rampini, Martin et al., (2021) which reported similar high-intensity running activities to the matches played before the lockdown period, but with decrement of total covered distance and very high-speed in professional players.

The physical performance decrement after a detraining period has been widely studied in professional football players with different detraining protocols (Christensen et al., 2011; Joo, 2018; Koundourakis et al., 2014). Joo (2018) showed decrements in the players' ability to repeat sprints (RSA) and in the distance covered in an intermittent aerobic test (Yo-YoIR1). Similarly, Brito de Souza et al., (2021) reported that 8 to 10 competitive matches are needed after a lockdown period to reach the players' steady state of running performance, based on professional football players' distance covered in competition during the last four seasons. However, in this study, the "detraining" period was a mandatory lockdown in which players and technical staff tried to maintain the physical performance adaptations following a guided self-training program, maintaining the weekly average volume and performed individually "at home". In this regard, a previous study by Nakamura et al., (2012) showed no differences in aerobic and anaerobic fitness after a detraining period among players who did not train, players who performed 30-min of running at 70-80% HRmax twice a week, and players who performed a plyometric program twice a week (Nakamura et al., 2012). In contrast, Christensen et al., (2011) showed physical and physiological maintenance after a 2-week period in which football players performed a high-intensity program while players who stopped their activity reduced their values in the same variables. However, the results of the current study cannot be compared with the mentioned study because in their high-intensity program, players performed football-specific tasks (i.e., small-sided games), which the participants of the present study were not able to perform due to the mandatory lockdown. This is directly related to the training specificity principle, as reported by Rodríguez-Fernández et al., (2020), who suggest that only specific training, based on small-sided games and repeated sprint ability allows football players to maintain specific adaptations to football performance (Rodríguez-Fernández et al., 2020). Accordingly, Rampini, Donghi et al., (2021) showed that a home-based training during the lockdown helped professional football players to improve their aerobic fitness, but it did not allow players to maintain their competitive period's power levels.

Nonetheless, anthropometrical variables (body weight, BMI, and % of body fat) did not statistically worsen during the lockdown period. This is in line with the results reported by Joo (2018), who did not show statistical changes in professional football players' body composition after two weeks of detraining. In contrast, Koundourakis et al., (2014) reported a rapid loss of players' optimal body composition status. The discrepancies between their results and the results from the present study may be in the activities performed during the "non-training period". In the present study, players tried to maintain their physical and anthropometrical conditions through a regular self-training program with high-intensity sessions, while in Koundourakis' exercise program, players performed a two-week total detraining period followed by four weeks in which they performed low-intensity aerobic running (Koundourakis et al., 2014).

Although the mean statistical analysis revealed an "average" of decrease in most workload variables, there was a high inter-individual variability in the percentage of change between the pre- and the post-lockdown period (Figure 1). The workload variables which did not show significant decreases between pre- and post-lockdown periods present high variability between players' percentage of change (i.e., sprints or high-intensity accelerations and decelerations, except for the Ind HSR). But high improvements in these variables for one or two players made the general trend of these variables to worsen be seen as non-significant. Showing the individual percentages of change in each variable is relevant because the same training stimulus (or detraining period) may impact differently among players, and individualized training programs should be implemented according to the players' characteristics (Zhanneta et al., 2015). In the practical field, technical staff (i.e., the coach) have to decide the players who are in better conditions to compete each week, and the individual treatment of the data may allow coaches to take better decisions.

In addition, the current study aimed to assess the relationship between the players' physical fitness and the percentage of change between the pre- and the post-lockdown period. Players' time during the 10, 30, and 40-m sprint was related to the percentage of change in the number of sprints, showing a higher loss in those players with initial lower sprint performance. Similarly, the results showed high negative correlations between values in match workload variables prior to the lockdown and the percentage of change in these variables after the lockdown period, indicating higher match workload decrements for players who had higher previous values. These results are in line with those shown by Rodríguez-Fernández et al., (2018), which showed that faster players in a repeated sprint test from both, youth and adult football players had a higher decrement after a 2-week detraining period (Rodríguez-Fernández et al., 2018). Opposing these results, it seems that the lockdown period, with non-specific training in football, affected those players who were in a better competitive condition after the confinement to a greater extent. Also, the percentage of body fat prior to the lockdown period correlated positively to the percentage of change of the total distance covered, low-intensity accelerations and decelerations, HMLD, and PLOAD. Initially, the authors consider these results as a contradiction and no justification in the previous literature was found. However, a subsequent analysis revealed that the percentage of body fat correlated to the distance covered, the number of low- and high-intensity accelerations and decelerations, and the HMLD in the pre-lockdown period. These results can be interpreted as a higher decrement in the workload variables of the players that reached better values (in this case a lower % of body fat) before the confinement, in the same way that it was previously interpreted that those players with higher decrement in workload variables are those who had the best values in those same variables before the confinement. These results regarding the relationship between players' physical fitness or anthropometrics and their changes in workload variables between pre- and post-lockdown period should be interpreted with caution since the statistical analysis do not show causal effects between them. Linear regression analysis was performed with the variables which presented correlation in Table 3 but they did not show significant prediction relationships.

This study presents some limitations that should be considered in further research about football training restrictions and detraining periods. This study was carried out in an ecological environment, since the authors could not foresee the lockdown period and therefore the research describes the changes in physical performance of football players after a mandatory specific-detraining period and it is not based on a research protocol design. The self-training program maintained the training volume that players were used to performing while the training orientation was general (trying to maintain a high general physical condition) since the football-specific stimulus was not possible.

Conclusion

This study presents football players' physical performance detriment due to the mandatory lockdown period experienced by the Spanish population (and in other countries around the world). Although players carried out a guided self-training in their homes, it did not seem to be enough stimulus to maintain football-specific adaptations, which is seen in the decrease of workload variables registered in competition between pre- and post-lockdown periods. In addition, these decreases were higher in those players who had better workload values prior to the confinement period. The results observed in this study take on importance considering that the COVID-19 global pandemic is not controlled yet, and the governments of several countries (including Spain) may have to confine the population again. For future periods in which football-specific training is not allowed, it is necessary to review the best options to prescribe self-training at home with the lesser impact on the players physical performance.

Funding

This work was supported by the Ministerio de Ciencia e Innovación (Plan Nacional de I + D + I) under Grant PID2019-107721RB-I00.

References

Barreira, P.; Robinson, M. A.; Drust, B.; Nedergaard, N.; Raja Azidin, R. M. F., & Vanrenterghem, J. (2017). Mechanical Player LoadTM using trunk-mounted accelerometry in football: Is it a reliable, task- and player-specific observation? *Journal of Sports Sciences, 35*(17), 1674–1681. https://doi.org/10.1080/02640414.2016.1229015

Borges do Nascimento, I. J.; Cacic, N.; Abdulazeem, H. M.; von Groote, T. C.; Jayarajah, U.; Weerasekara, I.; Esfahani, M. A.; Civile, V. T.; Marusic, A.; Jeroncic, A.; Carvas Junior, N.; Pericic, T. P.; Zakarija-Grkovic, I.; Meirelles Guimarães, S. M.; Luigi Bragazzi, N.; Bjorklund, M.; Sofi-Mahmudi, A.; Altujjar, M.; Tian, M., & Marcolino, M. S. (2020). Novel Coronavirus Infection (COVID-19) in Humans: A Scoping Review and Meta-Analysis. *Journal of Clinical Medicine, 9*(4), 941. https://doi.org/10.3390/jcm9040941

Bradley, P. S.; Carling, C.; Gomez Diaz, A.; Hood, P.; Barnes, C.; Ade, J.; Boddy, M.; Krustrup, P., & Mohr, M. (2013). Match performance and physical capacity of players in the top three competitive standards of English professional soccer. *Human Movement Science, 32*(4), 808–821. https://doi.org/10.1016/j.humov.2013.06.002

Bradley, P. S.; Di Mascio, M.; Peart, D.; Olsen, P., & Sheldon, B. (2010). High-Intensity Activity Profiles of Elite Soccer Players at Different Performance Levels. *Journal of Strength and Conditioning Research, 24*(9), 2343–2351. https://doi.org/10.1519/JSC.0b013e3181aeb1b3

Brito de Souza, D.; González-García, J.; López-Del Campo, R.; Resta, R.; Martínez Buldú, J.; Wilk, M., & Coso, J. (2021). Players' physical performance in LaLiga when the competition resumes after COVID-19: insights from previous seasons. *Biology of Sport, 38*(1), 3–7. https://doi.org/10.5114/biolsport.2020.96856

Buchheit, M. (2008). The 30-15 intermittent fitness test: Accuracy for individualizing interval training of young intermittent sport players. *Journal of Strength and Conditioning Research, 22*(2), 365–374. https://doi.org/10.1519/JSC.0b013e3181635b2e

Carter, J. E. (1982). Body Composition of Montreal Olympic Athletes. In Physical Structure of Olympic Athletes (pp. 107–116). Karger Publishers. https://doi.org/10.1159/000406783

Christensen, P. M.; Krustrup, P.; Gunnarsson, T. P.; Kiilerich, K.; Nybo, L., & Bangsbo, J. (2011). VO2 kinetics and performance in soccer players after intense training and inactivity. *Medicine and Science in Sports and Exercise, 43*(9), 1716–1724. https://doi.org/10.1249/mss.0b013e318211c01a

Cohen, J. (1992). A power primer. *Psychological Bulletin, 112*(1), 155–159. http://www.ncbi.nlm.nih.gov/pubmed/19565683

Di Gennaro, F.; Pizzol, D.; Marotta, C.; Antunes, M.; Racalbuto, V.; Veronese, N., & Smith, L. (2020). Coronavirus diseases (COVID-19) current status and future perspectives: A narrative review. *Journal of Environmental Research and Public Health 17*(8). https://doi.org/10.3390/ijerph17082690

Di Salvo, V.; Baron, R.; Tschan, H.; Calderon Montero, F. J.; Bachl, N., & Pigozzi, F. (2007). Performance characteristics according to playing position in elite soccer. *International Journal of Sports Medicine, 28*(3), 222–227. https://doi.org/10.1055/s-2006-924294

Fleck, S. (1994). Detraining: Its effects on endurance and strength. *Strength & Conditioning Journal, 16*(1), 22–28.

Hopkins, W. G.; Marshall, S. W.; Batterham, A. M., & Hanin, J. (2009). Progressive statistics for studies in sports medicine and exercise science. *Medicine and Science in Sports and Exercise, 41*(1), 3–12. https://doi.org/10.1249/MSS.0b013e31818cb278

Hulin, B. T.; Gabbett, T. J.; Lawson, D. W.; Caputi, P., & Sampson, J. A. (2016). The acute: Chronic workload ratio predicts injury: High chronic workload may decrease injury risk in elite rugby league players. *British Journal of Sports Medicine 50*(4), 231–236). https://doi.org/10.1136/bjsports-2015-094817

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 4*(3), 169–170). https://doi.org/10.1080/24733938.2020.1775436

Impellizzeri, F. M., & Marcora, S. M. (2009). Test validation in sport physiology: Lessons learned from clinimetrics. *International Journal of Sports Physiology and Performance 4*(2) 269–277). https://doi.org/10.1123/ijspp.4.2.269

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

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

Mohr, M.; Krustrup, P., & Bangsbo, J. (2003). Match performance of high-standard soccer players with special reference to development of fatigue. *Journal of Sports Sciences, 21*(7), 519–528. https://doi.org/10.1080/0264041031000071182

Mohr, M.; Nassis, G. P.; Brito, J.; Randers, M. B.; Castagna, C.; Parnell, D., & Krustrup, P. (2020). Return to elite football after the COVID-19 lockdown. *Managing Sport and Leisure*. https://doi.org/10.1080/23750472.2020.1768635

Mujika, I., & Padilla, S. (2000a). Detraining: Loss of training-induced physiological and performance adaptations. Part II: Long term insufficient training stimulus. *Sports Medicine 30*(3), 145–154. https://doi.org/10.2165/00007256-200030030-00001

Mujika, I., & Padilla, S. (2000b). Detraining: Loss of training induced physiological and performance adaptation. Part I. Short term insufficient training stimulus. *Sports Medicine, 30*(2), 79–87. https://doi.org/10.2165/00007256-200030020-00002

Mujika, I., & Padilla, S. (2001). Cardiorespiratory and metabolic characteristics of detraining in humans. *Medicine and Science in Sports and Exercise, 33*(3), 413–421. https://doi.org/10.1097/00005768-200103000-00013

Nakamura, D.; Suzuki, T.; Yasumatsu, M., & Akimoto, T. (2012). Moderate Running and Plyometric Training During Off-Season Did Not Show a Significant Difference on Soccer-Related High-Intensity Performances Compared with No-Training Controls. *Journal of Strength and Conditioning Research, 26*(12), 3392–3397. https://doi.org/10.1519/JSC.0b013e3182474356

Neufer, P.; Costill, D.; Fielding, R.; Flynn, M., & Kirwan, J. (1987). Effect of reduced training on muscular strength and endurance in competitive swimmers. *Medicine and Science in Sports and Exercise, 19*(5), 486–490. https://pubmed.ncbi.nlm.nih.gov/3683154/

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-1345-9262

Rampinini, E., Martin, M., Bosio, A., Donghi, F., Carlomagno, D., Riggio, M., & Coutts, A. J. (2021). Impact of COVID-19 lockdown on professional soccer players' match physical activities. *Science and Medicine in Football*, Ahead of print.

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

Rodríguez-Fernández, A.; Villa, J. G.; Sánchez-Sánchez, J., & Rodríguez-Marroyo, J. A. (2020). Effectiveness of a Generic vs. Specific Program Training to Prevent the Short-Term Detraining on Repeated-Sprint Ability of Youth Soccer Players. *Journal of Strength and Conditioning Research, 34*(8), 2128–2135. https://doi.org/10.1519/JSC.0000000000003670

Sarto, F.; Impellizzeri, F. M.; Spörri, J.; Porcelli, S.; Olmo, J.; Requena, B.; Suarez-Arrones, L.; Arundale, A.; Bilsborough, J. C.; Buchheit, M.; Clubb, J.; Coutts, A.; Nabhan, D.; Torres-Ronda, L.; Mendez-Villanueva, A.; Mujika, I.; Maffiuletti, N. A., & Franchi, M. (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. *Sports medicine 50*(8), 1417-1419. https://doi.org/10.31236/osf.io/4zb3a

Seshadri, D. R., Thom, M. L., Harlow, E. R., Drummond, C. K., & Voos, J. E. (2021). Case report: return to sport following the CoViD-19 lockdown and its impact on injury rates in the German Soccer League. *Frontiers in sports and active living*, 3, https://doi.org/10.3389/fspor.2021.604226

Stølen, T.; Chamari, K.; Castagna, C., & Wisløff, U. (2005). Physiology of Soccer. *Sports Medicine, 35*(6), 501–536. https://doi.org/10.2165/00007256-200535060-00004

Stone, N. M., & Kilding, A. E. (2009). Aerobic Conditioning for Team Sport Athletes. *Sports Medicine 39*(8), 615–642). https://doi.org/10.2165/00007256-200939080-00002

Zhanneta, K.; Irina, S.; Tatyana, B.; Olena, R.; Olena, L., & Anna, I. (2015). The applying of the concept of individualization in sport. *Journal of Physical Education and Sport, 15*(2), 172–177. https://doi.org/10.7752/jpes.2015