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Original

Have COVID-19 health restrictions affected the preseason training load of U-20 soccer players?

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ABSTRACT

Objective: Public health restrictions due to COVID-19 have played a central role in the management of training programs, in which studies focusing on the quantification of training loads in the preseason are scarce, especially involving young soccer players. Therefore, this study monitored the internal training load (ITL) over the 2020/2021 preseason during the COVID-19 pandemic of U-20 soccer players.

Methods: Fourteen U-20 soccer players were monitored over the course of 7 weeks during the 2020/2021 preseason. The ITL of all training sessions was estimated, in arbitrary units, by multiplying the rating of perceived exertion (RPE) for the entire training session by the length of each training session in minutes (RPE-session). Monotony and training strain were also estimated. A one-way repeated-measures ANOVA compared the dependent variables over time.

Results: In the 4th week, ITL and training strain were statistically lower compared to the other weeks (P<0.05). The monotony index of the 7th week was higher compared to the 1st, 3rd, and 4th weeks (P<0.05).

Conclusion: COVID-19 health restrictions have negatively affected the preseason training load of U-20 soccer players. However, the monotony index showed that the training loads were well distributed over the 7 weeks.

Keywords: Athlete; training monitoring; quantification; soccer; sports performance.

¿Han afectado las restricciones sanitarias del COVID-19 la carga de entrenamiento de pretemporada de los futbolistas Sub-20?

RESUMEN

Objetivo: Las restricciones de salud pública por el COVID-19 han jugado un papel central en la gestión de los programas de entrenamiento, en los que son escasos los estudios enfocados en la cuantificación de las cargas de entrenamiento en pretemporada, especialmente en futbolistas jóvenes. Por lo tanto, este estudio monitoreó la carga de entrenamiento interno (CEI) durante la pretemporada 2020/2021 durante la pandemia de COVID-19 de los jugadores de fútbol Sub-20.

Método: Catorce futbolistas Sub-20 fueron monitoreados durante 7 semanas durante la pretemporada 2020/2021. El CEI de todas las sesiones de entrenamiento se estimó, en unidades arbitrarias, multiplicando el índice de esfuerzo percibido (IEP) para la sesión de entrenamiento completa por la duración de cada sesión de entrenamiento en minutos (IEP-sesión). También se estimaron la monotonía y la tensión de entrenamiento. Un ANOVA unidireccional de medidas repetidas comparó las variables dependientes a lo largo del tiempo.

Resultados: En la cuarta semana, la CEI y la tensión de entrenamiento fueron estadísticamente más bajas en comparación con las otras semanas (P<0,05). El índice de monotonía de la semana 7 fue mayor en comparación con las semanas 1, 3 y 4 (P<0,05).

Conclusión: Las restricciones sanitarias por el COVID-19 han afectado negativamente la carga de entrenamiento de pretemporada de los futbolistas Sub-20. Sin embargo, el índice de monotonía mostró que las cargas de entrenamiento estaban bien distribuidas durante las 7 semanas.

Palabras clave: Atleta; vigilancia; cuantificación; fútbol; rendimiento deportivo.

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As restrições sanitárias do COVID-19 afetaram as cargas de treinamento na pré temporada de jogadores de futebol Sub 20?

RESUMO

Objetivo: As restrições de saúde pública devido ao COVID-19 têm desempenhado um papel central na gestão dos programas de treinamento, nos quais são escassos os estudos com foco na quantificação das cargas de treinamento na pré-temporada, principalmente envolvendo jovens jogadores de futebol. Portanto, este estudo monitorou a carga interna de treinamento (CIT) ao longo da pré-temporada 2020/2021 durante a pandemia de COVID-19 de jogadores de futebol Sub-20.

Métodos: Quatorze jogadores de futebol Sub-20 foram monitorados ao longo de 7 semanas durante a pré-temporada 2020/2021. A CIT de todas as sessões de treinamento foi estimado, em unidades arbitrárias, multiplicando-se o valor de esforço percebido (PSE) para toda a sessão de treinamento pela duração de cada sessão de treinamento em minutos (PSE-sessão). O índice de monotonia e o *strain* de treinamento também foram estimadas. Uma ANOVA de medidas repetidas unidirecionais comparou as variáveis dependentes ao longo do tempo.

Resultados: Na 4ª semana, CIT e strain de treinamento foram estatisticamente menores em relação às outras semanas (P<0,05). O índice de monotonia da 7ª semana foi maior em relação à 1ª, 3ª e 4ª semanas (P<0,05).

Conclusão: As restrições de saúde do COVID-19 afetaram negativamente a carga de treinamento de pré-temporada de jogadores de futebol sub-20. No entanto, o índice de monotonia mostrou que as cargas de treinamento foram bem distribuídas ao longo das 7 semanas.

Palavras-chave: Atleta; monitoramento de treinamento; quantificação; futebol; desempenho esportivo.

Introduction

In soccer, organization and planning of physical training are fundamental to the success of athletes and sports teams [1]. This notion should be applied not only in competitive seasons but throughout the entire athlete's training process [1-3]. Different studies have highlighted the improvement in the structuring of collective tactics and technical performance to increase the chances of winning in games and competitions [4,5]. This highlights the need for an integrated and efficient training process to reach a highly competitive level.

The success of training, in turn, depends on the balance between the magnitude of the training load and the applied recovery. Thus, monitoring training loads is relevant, especially the internal training load (ITL) which, ultimately, will be responsible for the development of the desired adaptations and, consequently, performance improvements. In this scenario, the training session's rating of perceived exertion (RPE) [6] has been widely used as a method to quantify ITL in young soccer players [7-9]. This method is valid for several training modes (strength, interval training, technical-tactical training) and it has been related to changes in fitness and performance during training periods [10]. However, previous investigations have only reported information about sessions or short training cycles (≤5 weeks) [9,11,12].

Due to the COVID-19 pandemic, one of the most significant discussions to be addressed in the context of sports performance was the influence of social distancing measures and different health restrictions on athletic training [13-15]. Soccer practice has also been affected by these pandemic-related restrictive measures, including the postponement of national and state tournaments around the world which involve large audiences [16]. Thinking about minimizing the abrupt return process and its associated risks, players from several countries (e.g., Brazil, Argentina), that declared quarantine, adopted training strategies in the home environment [17]. However, it is known that insufficient and unspecific stimuli can lead to a loss of adaptation promoted by training, and it is essential to control training loads to ensure optimal levels of volume and intensity [18].

Research on monitoring training loads during this period of confinement has been more focused on professional athletes [14,15]. In the Brazilian scenario, studies focusing on the quantification of training loads in the preseason are scarce, especially those involving young soccer players [8]. Therefore, further investigations of youth soccer players involved in systematic and standardized training programs are critically needed. Moreover, COVID-19 public health restrictions played a central role in managing training programs, since during confinement there were reductions in the volume of training and hence changes in the ITL occurred and induced behavioral and physiological changes [15], as well as a drop in athletes' performance. Therefore, this study aimed to monitor the ITL throughout the preseason during the COVID-19 pandemic of U-20 soccer players.

Methods

Design

This cross-sectional study took place from March through April 2021. The study was approved by the research ethics committee of the local university (protocol: 42075421.2.0000.5175) and all volunteers signed a written consent form. Moreover, the present investigation complies with the precepts established by the Declaration of Helsinki.

Participants

Participants were recruited exclusively from a soccer team of the 1st division in the city of João Pessoa, PB, Brazil that competed at state and regional levels. Twenty-one under-20 soccer players [age: 18(1) years; height: 1.76(0.04) m; body mass: 68.1(6.2) kg; fat percentage: 13.2(2.8) %] were monitored for a period of 7 weeks during the 2020/2021 preseason. The team was engaged in full-time training 5 days per week (90-120 minutes). No injured players were included in the study. Athletes who did not complete 85% of the study had their measures excluded.

An a priori sample calculation (PASS 2021, NCSS, USA) was performed. A single-factor, repeated measures design with a sample of 14 subjects, measured at 7 time points, achieves 82% power to detect differences among the means using a Geisser-Greenhouse Corrected F Test (α = 0.05 and Cohen's d= 1.0). The pattern of the covariance matrix is to have all correlations equal with a correlation of 0.2 among point measurements.

Training overview

The analysis period consisted of 4 weeks of the general preparation phase (GP) and 3 weeks of specific preparation (SP). The soccer players were monitored in physical and tactical-technical

Table 1. Number of tactical-technical and physical training sessions completed in the preseason of U-20 soccer players.

Training Program	General preparation				Specific preparation		
	1st week	2nd week	3rd week	4th week	5th week	6th week	7th week
Physical	5	3	3	5	3	2	6
Technical	5	3	5	0	5	5	6
Tactical	0	0	2	0	2	3	0
Friendly match	0	0	0	0	1	1	0
Evaluation	0	2	0	0	0	0	0

training sessions that took place over 7 weeks before the State U-20 Championship (Table 1). The training sessions lasted an average of 122 (12) minutes. From the first to the third week of training, the athletes had physical training sessions composed of localized muscular endurance exercises, static and dynamic stretching, balance, motor coordination, and aerobic exercises on the soccer field. In addition, technical training sessions composed of specific ball exercises per athletes' position, and tactical training sessions were also carried out, composed of offensive and defensive transition exercises. In the 2nd week, physical evaluations of body composition, muscle power, aerobic and anaerobic endurance, flexibility, speed, and agility were performed. In the 4th week, due to local health restrictions of COVID-19, the soccer players perform only physical training sessions at home. Session training consisted of muscle stretching, balance activities, motor/control coordination, and strength exercises using body weight-based and plyometric exercises. From the 5th to the 7th week of training, the physical training sessions were composed of maximal strength and plyometric exercises, agility and speed exercises, and high-intensity interval running. The technical training sessions were composed of small-sided games, and the tactical training sessions were composed of set-piece situations, situational games, and offensive and defensive transitions.

Determination of internal training load (ITL) parameters

A priori, anchoring procedures were performed to allow players to memorize the low and high ends of the RPE scale (CR-10) following the recommendations of Haile, Gallagher and Robertson [19] . In the first training sessions, each player was assessed using the 30-15 Intermittent Fitness Test (30-15 IFT) [20] on a natural grass field. The players were instructed to consider the effort of the initial speed of 8.0 km/h as 1 on the scale (very weak) and when the maximum effort was reached, the memorized score should be 9 (very strong). Therefore, the players employed these parameters when asked about their RPE after the training sessions.

The session duration was recorded using a digital stopwatch (HS-3V-1R, Casio, USA), and 30 minutes after the end of the session the athlete was asked to answer the following question: “How was your workout?” using the RPE scale (Borg's CR-10 scale) [21] via the messaging application WhatsApp. The ITL of all training sessions was estimated, in arbitrary units (AU), by multiplying the RPE for the entire training session by the length of each training session in minutes (RPE-session) [6] .

On days that featured two training sessions, the training load (TL) of the sessions was summed, obtaining the daily TL (DTL). In each microcycle (7 days), the total weekly training load (TWTL) was calculated by adding the DTLs. In addition, the monotony and training strain indexes proposed by Foster et al.. were calculated. Monotony indicates the load variability between training sessions, in which high scores may contribute to negative training adaptations [6,22] . Training monotony was calculated using the following formula: Monotony= weekly mean TL/SD, where weekly mean TL is the average daily TL during the week and SD is the standard deviation of the daily TL calculated over a week. In turn, strain is usually related to the level of adaptation to training, in which periods with high load associated with monotony may increase the incidence of infectious diseases and injuries. This index is equal to the multiplication of the TWTL and the monotony scores.

Statistical Analysis

Multiple imputations of missing data were performed for the variables of ITL, monotony, and training strain over the 7 weeks [23] , with contrary evidence that the data were MCAR (Little's test) [24] . Data presented normal distribution (Shapiro-Francia Test) and were reported by mean and standard deviation (SD) or 95% confidence interval (CI95%). One-way repeated-measures ANOVA with Greenhouse-Geisser correction was used to compare all dependent variables over time. When significant differences were detected, pairwise comparisons were performed by Bonferroni posthoc. The significance level adopted was $P<0.05$. The analysis was performed using IBM Statistical Package for the Social Sciences (SPSS) 27.0 (IBM Corp., Armonk, USA), MedCalc®. Statistical Software 20.105 (MedCalc Software Ltd, Ostend, Belgium), and Prism 8 for Windows (GraphPad Software, San Diego, USA).

Results

Of the 21 players recruited, seven were excluded for not completing the minimum required measurements throughout the study, leaving a total sample size of 14 U-20 soccer players.

A significant time effect was detected for ITL across the 7 weeks ($F_{3.5, 46.1}= 26.1$; $P<0.001$). The ITL of the 4th week was lower compared to the 1st ($P= 0.035$), 2nd ($P<0.001$), 3rd ($P<0.001$), 5th ($P= 0.002$), 6th ($P= 0.002$), and 7th ($P= 0.004$) weeks (Figure 1). In addition, ITL of the 7th week was higher compared to the 1st ($P<0.001$), 2nd ($P= 0.003$), 3rd ($P<0.001$), 4th ($P<0.001$), 5th ($P<0.001$) and 6th ($P= 0.003$) weeks (Figure 1).

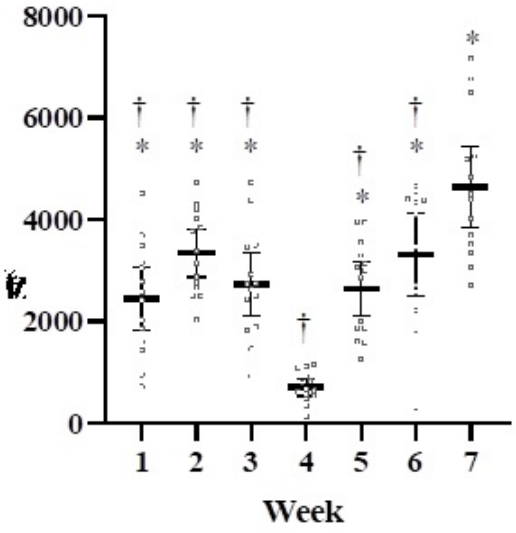

Figure 1. Internal training load (ITL) accumulated by RPE-session method of U-20 soccer players over the 2020/2021 preseason (n= 14). Data presented by mean and 95%CI.

*Significant difference from week 4 (P<0.05).

†Significant difference from week 7 (P<0.05).

As for monotony, a significant time effect was observed across the 7 weeks ($F_{3,3, 43.4}$= 8.1; P= 0.001; Figure 2). The monotony of the 7th week was higher compared to the 1st (P= 0.002), 3rd (P= 0.009), and 4th (P= 0.008) weeks. In addition, the monotony of the 5th week was statistically higher than the values of the 1st week (P= 0.042).

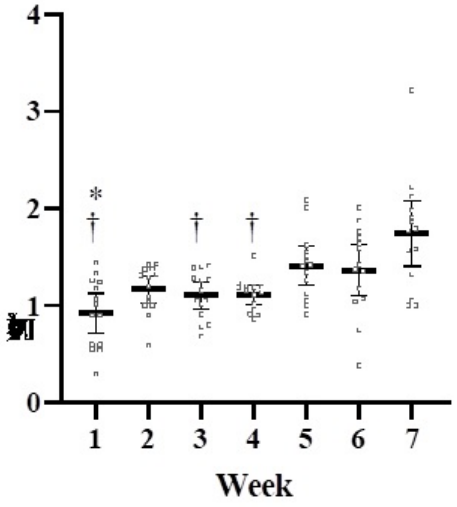

Figure 2. Monotony index of training loads of U20 soccer players over the 20202021 preseason (n= 14) Data presented by mean and 95%CI

*Significant difference from week 5 (P<0.05).

†Significant difference from week 7 (P<0.05).

Regarding the training strain analysis, a significant time effect was observed ($F_{2.6, 33.9}$= 16.0; P= 0.001; Figure 3). The 4th-week strain was lower compared to the 2nd (P<0.001), 3rd (P<0.001), 5th (P<0.001), 6th (P= 0.002), and 7th (P<0.001) weeks (Figure 3). Moreover, training strain in the 7th week was higher in comparison to the 1st (P= 0.002), 3rd (P= 0.005), and 4th (P<0.001) weeks (Figure 3).

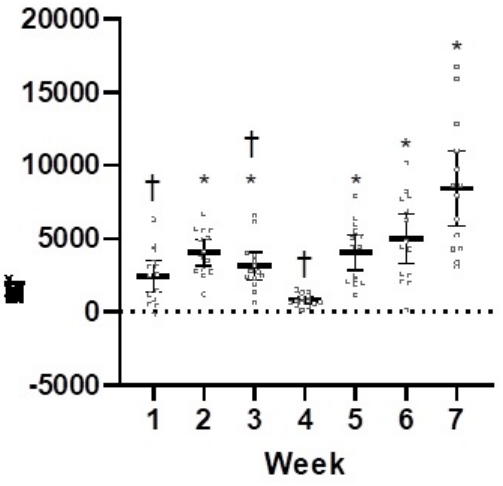

Figure 3. Training strain of U-20 soccer players over the 2020/2021 preseason (n= 14). Data presented by mean and 95%CI.

*Significant difference from week 4 (P<0.05).

†Significant difference from week 7 (P<0.05).

Discussion

The current investigation monitored the ITL throughout the 2020/2021 preseason of U-20 soccer players during the COVID-19 pandemic. The main findings of the study were: i) total cumulative weekly TL and strain were reduced in the 4th week of training and ii) training load monotony showed changes throughout the 7 weeks of training. Thus, even though the ITL has been affected by the restrictions due to COVID-19, the monotony indicated an adequate application of training loads over the period.

The mean ITL of the first four weeks of training in the present study was lower compared to that of U-19 Brazilian soccer players (>4000 AU) using the RPE-session method [8]. This may have occurred due to the ITL at week 4 was considerably lower than at weeks 1 (−70.1%) and 7 (−84.5%). This significant reduction in the TL in week 4 is closely related to the quarantine due to COVID-19, which paralyzed all activities at the club's facilities, including friendly matches scheduled. As a strategy to mitigate the negative effects on the training load, a remote training program was started, in which the players performed daily supervised physical exercises. In the fourth week of training of the U-20 athletes, the recommendations of previous studies for the practice of physical exercise in a home environment were used [17,25]. These training sessions were carried out using body weight-based exercises, in different spaces of the house such as rooms, balconies, and backyards. Exercises included muscle strengthening, balance activities, motor control/coordination, stretching, or a mixed combination of these conditioning and coordinative abilities [16]. In this scenario, the lower intensity of the training loads, as well as greater recovery between sessions could be attributed to the fact that players were in the comfort of their homes and without using specific training materials.

The decrease of ITL in the fourth week of training could also be due to the absence of interaction and collaboration-opposition situations between players, which would entail less difficulty in the actions and the loss of training specificity [26]. Along the same line, the lack of specificity during the confinement period could be due to the different spaces and materials available to the athletes. These data are in line with studies by Mon-Lopez et al. [15] which showed a similar number of training days (5 days) and training volume in terms of hours (<10 hours). As expected, the training volumes were markedly reduced during confinement. This behavioral change does not seem to be exclusive to soccer players, as the overall population of young

individuals has also reduced their levels of physical activity during COVID-19 confinement [27].

In our investigation, the ITL indicator (RPE-session) determined by the average daily weekly training load of U-20 soccer players in the first three weeks, showed values of 592 AU. Values less than or equal to 400 AU were reported by Mortatti et al. [28] who monitored 4 weeks of training of U-20 soccer players in preseason. These differences may have occurred due to the amount of physical, tactical-technical training, and physical evaluations in the present study, a fact that was not verified in the Mortatti et al. [28] study, in which he had a restricted number of weekly training sessions (<5 sessions). From this perspective, in our study, the weekly ITL was higher than in a previous investigation with a French U-19 soccer team (1588 AU) that held training sessions 5 days per week including one game per week [11] . The observed intensity of the evaluated training sessions seems to represent the only significant point of variation between this study and ours. In this regard, it is plausible that the game philosophy of the teams studied varied according to the specific country in which the data were collected, thus impacting the intensity of the training sessions observed.

The total weekly internal load in the first two weeks of training in the current study was similar to the study by Wrigley et al. [9] with U-18 soccer athletes (3948 AU). Additionally, the average of the four weeks of training in the present study was similar to the investigations by Impellizzeri et al. [29] and Raya-Gonzalez et al. [30] (2605 and 2664 AU, respectively) during the same period of the season.

As for the monotony index, statistical differences between the weeks were observed, but not enough to promote a high picture of training monotony, since this index is dependent on the intensity and CIT variability (the higher the variation in load, the lower the monotony) [31] . At 7 weeks of training, scores below 2.0 AU were identified, which suggests adequate variation in loads and, consequently, positives to training [32] . Furthermore, Foster et al. [6] report that monotony scores below 2.0 AU do not contribute to overtraining syndrome. Thus, our monotony index results indicate that training loads were well distributed during the 7 weeks of training, in which loads varied with high and low intensities, interspersed with appropriate recovery.

Additionally, significant changes in strain over the 7 weeks of training of U-20 soccer players were shown. This measure signals the overall stress required from the athlete during a given training period. An intensification of ITL in the 7th week of training was observed, which allowed differences in Strain from week 7 compared to weeks 1 to 2 and 4 to occur. However, strain values were low throughout the study, which may indicate positive adaptations to training [31] . Consequently, control of airway inflammation and upper respiratory tract infection, which often indicate early stages of overtraining syndrome, may minimize absenteeism among athletes [33] .

These data, obtained during a 7-week preseason of U-20 soccer players, demonstrate the important role of exterior factors in the training process (e.g., pandemic restrictions). The current study provides the first reference that during the pandemic period of COVID-19, health restrictions altered the application of training loads for U-20 Brazilian soccer players. However, information about the competitive and post-competitive periods was not collected. Another limitation of the current study was the absence of comparisons between different playing positions. Finally, our study was restricted to subjective measures, which could have been enhanced by noninvasive measures (e.g., heart rate variability).

Conclusion

COVID-19 health restrictions have negatively affected the preseason training load of U-20 soccer players. However, the monotony index pointed out that training loads were well distributed over the 7 weeks of training.

Conflict of interests The authors declare that they have no conflict of interest.**Data confidentiality** The authors declare that they have followed the protocols of your workplace on the publication of athlete data.**Right to privacy and informed consent** The authors declare that no patient data appear in this article.**Protection of people and animals** The authors declare that for no experiments have been conducted on animals for this research.**Acknowledgments** The authors appreciate the collaboration provided by the athletes and technical staff of soccer team.

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