ORIGINAL ARTICLE

The impact of a congested fixture schedule on neuromuscular performance in young soccer players

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ABSTRACT

This study aimed to analyse the effects of successive matches on vertical jump performance in youth soccer players and compare responses between starters and reserves. Seventeen players participated in a regional tournament with five consecutive matches (two 40-minute periods with a 10-minute interval between periods), separated by 24-hour intervals. Internal competitive load was monitored using session-RPE, while vertical jump performance was assessed pre- and post-match for matches 1 and 5. Results indicated a significant reduction in vertical jump height among starters after the fifth match (pre: 37.24 ± 4.58 cm vs. post: 33.72 ± 4.66 cm, $p < .05$), whereas reserves showed no significant changes. Starters also experienced higher internal load, monotony, and strain than reserves ($p < .05$). These findings highlight the disproportionate impact of congested schedules on starters, emphasizing the need for tailored load management strategies to mitigate neuromuscular fatigue and maintain player readiness during competitions with excessively congested schedules. This study underscores the importance of individualized recovery protocols and strategic rotation of players to optimize performance and prevent overtraining. Coaches and sports scientists are encouraged to incorporate neuromuscular and internal load monitoring to enhance player health and performance sustainability in competitive settings.

Keywords: Sport medicine, Successive matches, Vertical jump, Session-RPE, Football, Adolescent.

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INTRODUCTION

Currently, the physiological demands of the modern soccer player are highly complex and depend on factors such as the player's position, the team's style of play, and the level of the opponent (Dolci et al., 2020; Williams, Drust, & Ford, 2023). In youth populations, sports competitions are usually organized over a short period and with a relatively high number of matches (Arruda et al., 2015; Moreira et al., 2016), and this organization often fails to consider the specific needs of athletes in training (Capranica & Millard-Stafford, 2011). Today, soccer players, especially at the youth level, can play many matches during a season, resulting in fewer adequate recovery periods between matches (Carling et al., 2018; Moreira et al., 2016; Pinto et al., 2021). As a result, official matches, there is significant psychophysiological stress on young athletes (Campbell, Irving, Bailey, Dilworth, & Abel, 2018; Dolci et al., 2020; Mehrsafar, Serrano Rosa, Moghadam Zadeh, & Gazerani, 2020), and this demand inherent in competitive play can lead to an increase in biochemical stress markers (de Lima Pinto, Fortes, Lemos, & Mortatti, 2019; Moreira et al., 2016; Mortatti et al., 2020; Pinto et al., 2021) and a reduction in physical performance (Pinto et al., 2021; Pinto, Menezes, Fonteles, & Mortatti, 2022).

In official matches, athletes can cover approximately ten kilometres, performing acceleration and deceleration actions that significantly strain the neuromuscular system (Dolci et al., 2020). Robineau et al. (2012) demonstrated that an official match leads to a reduction in speed and vertical jump capacity, so periods of congested matches are a potential factor in reducing the neuromuscular aspects of soccer players (Freitas et al., 2021). Still, on neuromuscular aspects, Rojas-Valverde et al. (2018) observed that due to accumulated fatigue and poor muscle recovery resulting from periods of congested matches in young soccer players, there is a decrease in muscle quality markers (maximum muscle displacement and contraction speeds). In this way, monitoring the training load can detect variations in fatigue and help maximize the athlete's physical potential (Furtado Mesa, Stout, Redd, & Fukuda, 2023).

Parallel to the monitoring of neuromuscular aspects, the acquisition of information on the internal training load that young athletes experience during official matches must be carried out. For effective management of the demands of training and competition, a holistic approach is essential. This includes understanding the interaction between internal and external load, well-being, psychological aspects, and the impacts of these demands on athletes' performance and health (Gabbett et al., 2017). Recent findings highlight that monitoring training load using tools such as session rating of perceived exertion (sRPE) can be crucial for coaches to prevent negative adaptations in young soccer players (Nobari, Kharatzadeh, Khalili, Pérez-Gómez, & Ardigò, 2021). In addition, sRPE shows a strong relationship with external load markers, making it a useful, simple, and inexpensive tool for monitoring internal training load (Marynowicz, Kikut, Lango, Horna, & Andrzejewski, 2020). In addition, considering the implementation of strategies to reduce discrepancies in training load between starters and reserves, such as individualized monitoring of training loads and matches, can help implement more balanced load management programs.

Given the change in neuromuscular performance during official matches in young starting players (Pinto et al., 2021, 2022; Rojas-Valverde et al., 2018) and its association with the accumulation of competitive internal load, it is pertinent to understand whether this behaviour is similar between the players who make up the team (starters vs. reserves). In contemporary soccer, clubs often compete in several matches throughout the season with inadequate recovery time. Insufficient rest and recovery between matches can expose players to the risk of competing before they have fully recovered (Julian, Page, & Harper, 2021). It is important to understand the dose-response relationship between consecutive matches and recovery over periods of training and competition. Therefore, this study aimed to monitor young players during a competition with

successive matches and to evaluate the effect of successive matches on training load and neuromuscular performance, comparing starters and reserves. It is hypothesized that successive matches will reduce the neuromuscular capacity of young soccer players, along with the accumulation of internal competitive load (sRPE, monotony, and strain). It is also expected that starting players will have greater negative impacts compared to reserve players due to less participation during matches and compensatory training of lesser magnitude than the official match.

MATERIALS AND METHODS

Participants

Seventeen young soccer players (16.6 ± 0.51 years; 175 ± 8cm; 65 ± 7.9kg) were selected for a regional competition with five successive matches. All athletes were associated with the club for at least a year, undergoing daily training five times a week in one shift (Monday: general force, special force, technical and tactical; Tuesday: coordination, speed, and agility, technical and tactical; Wednesday: flexibility and technical-tactical; Thursday: match training; Friday: general force, technical and tactical). Throughout the competition period, the athletes remained housed at the club, following the same schedule routine throughout the week. This study was performed in accordance with the Declaration of Helsinki and approved by the responsible person, approved by the Ethics and Research Committee of the Federal University Rio Grande do Norte (n°1.525.503).

Experimental design

The investigation was conducted during a regional tournament involving under-17 teams from the northeastern region of Brazil, in which they played five matches of the qualifying phase held in five consecutive days (with a 24-hour rest interval between each match). All matches occurred at the same location (soccer stadium) at 3:00 pm and lasted for 80 minutes (two 40-minute periods with a 10-minute interval between the periods) with a technical stop in each half for hydration. The participants went through the same process of conviviality in concentration during the week of the competition. Before (pre) and after (post) the first and fifth matches, the vertical jump height with countermovement was evaluated, and during the matches, the athletes' time in the field was monitored. Finally, approximately 30 minutes after the match session rating of perceived exertion was measured (Figure 1).

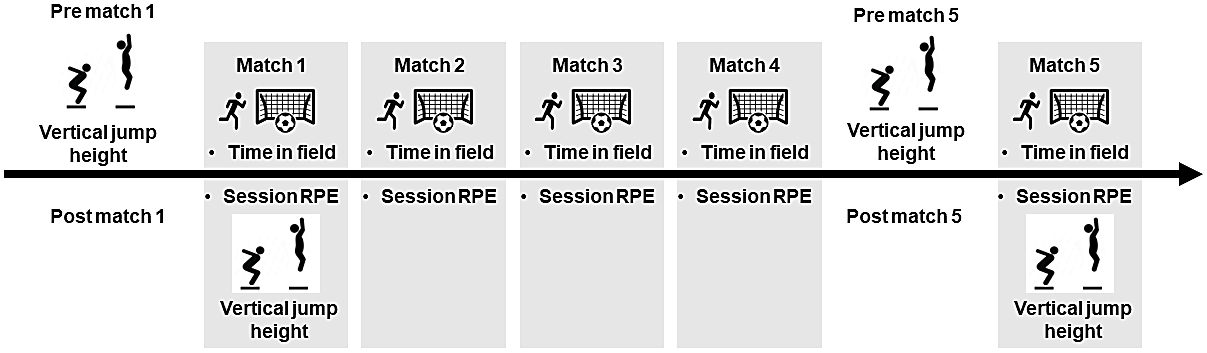


Figure 1. Study design.

Procedures

Competitive internal load

The competitive internal load was quantified at the end of each match using the sRPE method proposed by Foster et al. (2001). This method presents sufficient validity and applicability in different sports modalities,

including soccer (Haddad, Stylianides, Djaoui, Dellal, & Chamari, 2017). The values were obtained from the product of the perceived exertion value on the Borg CR-10 scale by the match duration (minutes). Thirty minutes after each match, players answered the question, "*How was your workout?*" avoiding any contact between players. The result, time x RPE product, is presented in arbitrary units and represents the internal load response to the physiological stress of the matches. The time in each athlete's field was computed by two evaluators to calculate the internal load as well as to quantify the sum of minutes of the players throughout the competition.

Vertical jump performance

Participants performed the vertical countermovement jump (CMJ) test on a contact mat (*CEFISE*®, Brazil) stored in the software *Jump System Pro.* Each athlete performed three maximal jumps with hands on the hips, separated by a rest of approximately 10 s. The jumps were performed on four occasions: pre- and post-match 1 and pre- and post-match 5. All players were largely familiarized with this procedure, which was usually performed during their training program.

Statistical analysis

Data are presented in descriptive statistics (mean, standard deviation, and 95% confidence interval). The Shapiro-Wilk test attested to the normality of the data. ANOVA of repeated measures compared the height vertical jump of the pre- and post-match in matches 1 and 5 in the general group and divided between starters and reserves; partial eta (η^2) was used for effect size in ANOVA, considering the criterion of Ferguson (2009): no effect (ES < 0.04), minimum effect (0.04 < ES < 0.25), moderate effect (0.25 < ES < 0.64), and strong effect (ES > 0.64). An independent t-test compared internal load, sRPE, time in field, strain, and monotony between starters and reserves. The effect size (ES) was measured according to Hedges', considering the sizes as small (0.20–0.49), medium (0.5–0.79), or large (≥ 0.8).

RESULTS

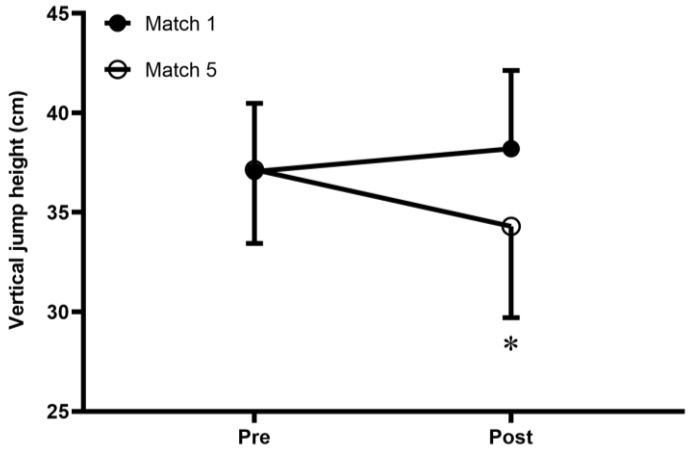
Table 1 shows the general values and those divided between reserves and starters for the athletes' external and internal competitive load during the competition. Starting players had higher sums of time on the field over the five matches (p < .05, MD: -204.3 ± 29.31, 95% CI: -266.7 to -141.8) and higher average times on the field (p < .05, MD: -40.85 ± 5.86, 95% CI: -53.35 to -28.36) compared to reserve players. In general, the intensity of the matches was "*difficult*" according to the sRPE, with starting players reporting higher intensity values compared to reserves (p < .05, MD: -2.82 ± 0.71, 95% CI: -4.342 to -1.301). A greater sum (p < .05, 95% CI: -2359 to -925.7) and average (p < .05, 95% CI: -471.8 to -185.1) of competitive internal load was observed in starting players compared to reserves. Values for strain (p < .05, 95% CI: -1677 to -1721) and monotony (p < .05, 95% CI: -4.446 to -0.191) were also higher in starters compared to reserves.

Table 1. Internal and external load responses during successive matches.

	All (n = 17)	Starters (n = 10)	Reserves (n = 7)	t	*p*-value	ES
Sum time on the field (min)	245.49 (118.55)	329.60 (67.31)	125.33 (45.27)	6.96	<.001*	3.2
Mean time in the field (min)	49.09 (23.71)	65.92 (13.46)	25.06 (9.05)	6.96	<.001*	3.2
Session RPE (AU)	5.35 (2.00)	6.51 (1.48)	3.69 (1.39)	3.95	.001*	1.8
Sum internal load (AU)	1586.79 (1063.29)	2263.06 (814.49)	620.69 (410.62)	4.88	<.001*	2.2
Mean internal load (AU)	317.35 (212.66)	452.61 (162.89)	124.13 (82.12)	4.88	<.001*	2.2
Monotony (AU)	3.00 (2.29)	3.95 (2.53)	1.63 (0.79)	2.32	.034*	1.1
Strain (AU)	6594.36 (8375.85)	10402.46 (9215.56)	1154.21 (996.23)	2.61	.019*	1.2

Note. RPE: Rate of Perceived Exertion. AU: arbitrary unit. ES: effect size.

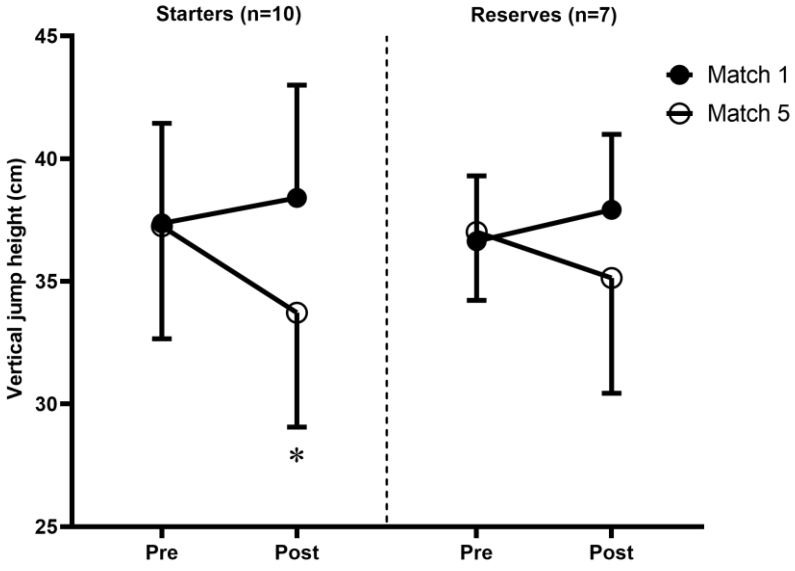
Figure 2 presents the vertical jump height before and after matches 1 and 5. There was a difference in vertical jump height between the pre-and post-match measurements (F (3.16) = 8.468, p = .003, η^2 = 0.34). Post-hoc analysis revealed a decrease in jump height in the fifth match (pre: 37.15 ± 3.71 cm vs post: 34.30 ± 4.58 cm, Δ = -2.84 ± 3.39; p = .006, 95% CI: 0.807 to 4.891).



Note. Significant difference.*

Figure 2. Vertical jump height in match-1 and match-5.

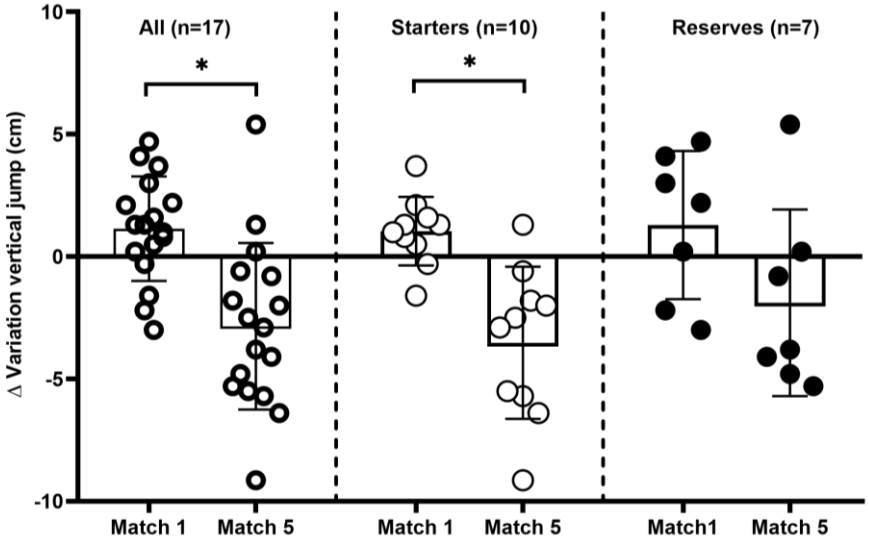
Figure 3 presents the vertical jump performance between starters (A) and reserves (B). Starting players showed a difference in vertical jump height between pre- and post-matches F (3.9) = 10.590, p = .0040, η^2 = 0.54. Post-hoc analysis revealed a difference only in the fifth match (pre: 37.24 ± 4.58 cm vs. post: 33.72 ± 4.66 cm; Δ = -3.52 ± 3.10, p = .025, 95% CI: 0.454 to 6.593). There was no significant difference in vertical jump height between pre- and post-matches among reserve players, F (3.24) = 0.888, p = .4614, η^2 = 0.09.



Note. Significant difference.*

Figure 3. Vertical jump height between starters and reserves in match-1 and match-5.

Figure 4 presents the changes in vertical jump height between matches 1 and 5, overall and separately for starters and reserves. Comparing the change in vertical jump height for the entire team (matches 1 and 5), there is a greater reduction in the change of jump height after the fifth match (t (16) = 4.821, p = .0002, 95% CI: -5.745 to -2.236). This reduction is maintained only in starters (t (9) = 4.690, p = .001, 95% CI: -6.765 to -2.363) and is not observed in reserves (t (6) = 2.130, p = .077, 95% CI: -6.816 to 0.472).



Note. Significant difference.*

Figure 4. Variation in vertical jump height before and after match-1 and match-5 for all players, starters, and reserves.

DISCUSSION

This study aimed to analyse the effect of successive competitive matches on the neuromuscular performance of young footballers. The main finding was that young athletes subjected to successive matches showed a reduction in vertical jump performance. This reduction occurs in starting players who, in turn, have accumulated a greater internal competitive load, more time on the field, and greater monotony and strain compared to reserve players. The fact that young athletes reduce their vertical jump performance after matches has been reported in the literature (Curtis et al., 2021; Jagim et al., 2022), but few studies have observed this reduction in a scenario of successive matches. Pinto et al. (2021) observed reduction in vertical jump height in young athletes subjected to a sequence of four matches with 24 hours of recovery; this reduction is associated with accumulated fatigue from successive matches. In addition, these findings may also be due to the demands that official matches place on athletes, such as a high number of accelerations and a high distance covered (Curtis et al., 2021). Hader et al. (2019) state that external load variables present in official matches reflect acute and residual changes in neuromuscular responses and also noted that for every 100 meters of high-intensity running covered, the vertical jump can decrease by 0.5%.

Maintaining neuromuscular performance is crucial for specific actions during official matches, and relevant findings confirm that the reduction in neuromuscular performance is due in response to the demand (internal and external load) of matches (Marqués-Jiménez, Calleja-González, Arratibel-Imaz, & Terrados, 2022; Silva et al., 2018). Marqués-Jiménez et al. (2022) demonstrated that neuromuscular fatigue in soccer players is due to the activities performed on the field, such as acceleration and deceleration activities performed in the

match. In addition, the fact that official matches are played with short rest intervals (24 hours) can also be considered to reduce performance, given that a period of 72 hours after the match is not long enough to restore muscle damage, physical condition, and well-being to a state of rest (Silva et al., 2018). The results show that successive matches had an influence on neuromuscular performance only in the starting players, while the reserve players maintained their initial values after five successive matches. Due to the limited information on the drop in neuromuscular performance in starters and reserves in successive matches, these findings are difficult to explore; however, in young athletes, there is a clear reduction in neuromuscular performance as a result of matches with short time intervals (Pinto et al., 2021, 2022). Thus, although we can infer that a period of highly congested matches significantly compromises the physical fitness of soccer players (Saidi et al., 2022), these findings must consider the athlete's participation in the match.

Managing the training load in a sports team is a challenge for the coaching staff. Attesting to the initial hypothesis, starting players had greater internal and external load demands during successive matches. It has already been reported that players in the starting line-up are exposed to greater demands during training periods (Nobari, Alijanpour, Martins, & Oliveira, 2022). However, this study provides some of the first information on the demands placed on starting and reserve players during successive matches. Thus, players who completed an average of 65 minutes played reported "*moderate to high*" intensity values (RPE), while reserve players, who spent an average of 25 minutes on the pitch, reported "*moderate to light*" intensity values. Recently, Oliveira et al. (2023) confirmed our findings; the authors observed significantly lower values for reserve players in terms of cumulative time in training/match and internal load. Managing training loads during short competitive periods is a very difficult task, but it needs to be done, as the starting players must maintain their readiness for optimal performance during matches (Dalen & Lorås, 2019; Nobari et al., 2022).

From the disparities between starters and reserves in this study, it is possible to infer that starting players reduce their neuromuscular performance throughout the competition, which could necessitate the substitution of players to maintain the team's physical performance over successive matches and reduce the chances of injury (Nobari et al., 2021), as shown by the high monotony values. However, several factors determine team changes (Williams, Drust, & Ford, 2023), such as technical level and competitive maturity. In addition, the chances of winning seem to suffer from the effect of substitutions during youth competitions, and the chances of winning reduce even more when the match takes place in the knockout phase (Ribeiro, Siqueira, Pinto, & Silva, 2020). In addition to these aspects, it should be considered that reserve players in successive match situations may lose performance because they do not play during official matches, requiring stimulation at appropriate times.

This study offers a pertinent contribution to sports science, but some limitations can be listed for extrapolation to other populations. Firstly, there is a lack of data on external load (total distance covered, high-speed runs, number of sprints) and training load during matches between starters and reserves. In addition, future research should include tactical and performance variables to understand other interactions. Despite the limitations, the information presented offers information for young soccer athletes with significant ecological validity in a competitive environment.

CONCLUSION

In conclusion, during successive matches, young starting soccer players report moderate to high internal competitive load, accumulate high monotony and strain, and show reduced neuromuscular performance. The behaviour of these responses occurs only in starting players because they accumulate a greater internal competitive load, more time on the field, and greater monotony and strain during matches compared to

reserve players. As a practical application, it is recommended that coaches monitor internal and neuromuscular load responses during competitive periods with congested matches. This approach helps understand and minimize the impact of psychophysiological and neuromuscular stress, thus preserving the health of the players and maintaining the quality of the match. Additionally, it is recommended that match schedules be planned to ensure sufficient recovery time between matches, as well as controlling playing and training time for starters and reserves.

AUTHOR CONTRIBUTIONS

J.C.B.L.P., R.S.C.O., and A.L.M. conceived and designed the study, and they also collected the data. The authors, J.C.B.L.P., A.I.F., R.S.C.O., and A.L.M., analysed and interpreted the data, wrote the manuscript, and made significant changes. All authors have read and agreed to the published version of the manuscript.

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DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

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