Effects of a Very Congested Match Schedule on Body-Load Impacts, Accelerations, and Running Measures in Youth Soccer Players

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Abstract

Purpose: The aim of this study was to analyze the effects of a very congested match schedule on the total distance covered (TD), high-intensity running distance (HIR), and frequency of accelerations and body load impacts (BLI) performed in a team of Under-15 soccer players (n=10; 15.1±0.2 yr, 171.8±4.7 cm, 61±6.0 kg) during an international youth competition. **Methods:** Using Global Positioning Systems, player performances were repeatedly monitored in five matches performed over 3 successive days. **Results:** Significant differences were observed between matches ($p < 0.05$) for the frequency of accelerations per minute, BLI and BLI per minute. No differences were observed for the TD covered and TD run per minute, number of high-intensity runs, distance covered in HIR and per minute, peak running speed attained, or frequency of accelerations. The frequency of accelerations per minute decreased across the competition while BLI were higher during the final compared to all other matches. **Conclusions:** These results suggest that BLI and acceleration might be used as an alternative means for representation of the external load during congested match schedules rather than measures related to running speed or distance covered.

Key Words: match congestion, adolescents, GPS, performance, analysis

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INTRODUCTION

Analyses of the physical demands of soccer matches can be used to develop and monitor soccer-specific fitness programs. Accordingly, this area of study has received considerable attention by researchers and practitioners involved in elite soccer.[1] In young soccer players, the assessment of physical performance during competitive matches has been suggested as necessary to complement talent detection procedures and long-term training interventions.[2] Indeed, the physical demands associated with competition in young soccer players have recently been examined in detail notably using Global Positioning Systems (GPS).[2–7]

However, despite the ever-growing body of literature on running activity profiles in young soccer players, less is known about the potential effect of playing successive matches with a short time delay on physical performance in such populations. Official tournaments in which young soccer players participate can involve congested schedules with two matches played per day and 5 or 6 matches within a 3 day-time period. In theory, these schedules would affect physical performance across consecutive games and notably during the latter decisive matches (semi-final and final) played over the final two days of such competitions. These assumptions are based upon results from previous studies which have shown that when the time delay between soccer matches is short, residual fatigue accumulated over successive matches and subsequent incomplete recovery can affect ensuing physical performance.[8–10] In addition, higher injury rates have been reported when senior professional soccer players played 2 matches per week versus 1 match per week (25.6 versus 4.1 injuries per 1000 hours of exposure).[11] From a physiological point of view, increased concentrations of muscle damage markers (creatine kinase and lactate dehydrogenase) have been observed in male junior soccer players playing four competitive soccer matches in 4 days with approximately

24 h between matches.[12] This research highlights the importance of adequate recovery time between successive days of competition.

Despite the aforementioned research, there is limited information on the effect of match congestion on acceleration and body load impact profiles derived from GPS over periods of match congestion in elite youth players. The ability to accelerate is considered decisive in critical activities performed during soccer matches including being first to the ball, moving into and creating space, and generating and denying goal-scoring opportunities.[1] Recent research has shown that post-match fatigue and subsequent recovery in elite soccer players was dependent upon the number of hard accelerations and decelerations performed during play.[13] Therefore, the ability to maintain an elevated number of accelerations during consecutive matches played within a short-time period could be viewed as an important requisite in play. Similarly, no studies have investigated the potential effect of playing consecutive games over a short time period on 'body load impacts' in elite young soccer players. Numerous high intensity actions such as jumps and tackles[14] and frequent hard accelerations and decelerations[15] are performed during soccer matches. Body load impact is determined using the summed accelerations from 3 accelerometer planes and the load and intensity measures for these impacts can be identified as the total number of impacts and impacts per minute, respectively.[16] Again, this measure might be pertinent in monitoring potential changes in physical performance during successive matches played in a tight time frame.

The aim of this study therefore was to analyze the effects of a congested match schedule on total distance, high-intensity running, accelerations, and body load impacts in a team of Under-15 soccer players during an international competition. It was hypothesized that consecutive games played in a short time interval would lead to significant changes in these physical performance variables.

METHODS

Subjects

Altogether, fifteen elite Under-15 outfield soccer players from the same Brazilian soccer club voluntarily agreed to participate. While fifteen athletes initially took part in the study, only the players who performed at least 75% of the match time, in each assessed match (five matches), were included in the analysis. Therefore, data for ten players were considered. The goalkeeper was also not included in the analysis. The 10 assessed participants had the following characteristics: age 15.1±0.2 years, height 171.8±4.7 cm, and body mass 61±6.0 kg. All the assessed players who traveled to participate in the international competition were already involved in the State Championship for their age group in Brazil. Therefore, they were in the competitive phase of the annual season during the analyzed competition. Before the competition, the players were participating on average in ~ 15-17 h of training per week (5-8 training sessions, including small-sided games, conditioning sessions, including strength training sessions, repeated sprint and intermittent running drills) and 1 match per week, the latter usually taking place on weekends. After ethics approval by the local University Research Ethics Committee the experimental protocols were explained in detail. Written informed consent was obtained from each participant and their respective parents or guardians. It was also explained to participants that they could withdraw from the study (thus no longer allowing use of their data) at any time without penalty.

Design

Player performances were monitored using GPS devices (15-Hz GPS receivers, SPI Elite, GPSports, Canberra, Australia) during an international competition which took place in Salzburg, Austria, from 15 to 17 August, 2013. Five matches were played over 3 successive days. The first two matches were played on the first day of the competition (25x25 min;

10min-interval), two on the second day (quarter-final and semifinal; 25x25 min; 10min half-time interval, and one on the third day (30x30 min; 15min-half-time interval) (Table 1). The assessed team won matches 1, 2, and 3, lost match 4 after penalties (no extra-time played), and was defeated in match 5 (Table 1). No systematic post-match recovery regimen was implemented between the assessed matches.

A GPS unit sampling at 15-Hz was fitted to the upper back of each player using an elastic harness. The reliability and accuracy of 15 Hz GPS devices have been reported previously.[17] The variables related to running were: total distance (TD), frequency of accelerations (> 1.8 $m \cdot s^{-2}$), number of high-intensity runs (>18$km \cdot h^{-1}$), and TD performed in high-intensity running. The classification of high-intensity running was in accordance with that previously used.[4,18,19] The adopted value of >1·8 $m \cdot s^{-2}$ for measuring frequency of accelerations allowed assessment of light, moderate and high acceleration actions. The GPS were coupled with a 100Hz tri-axial accelerometer thus estimation of "body load impacts" was possible.[20] This variable is analyzed using six pre-defined zones of *G* force: Zone 1 (5.0–6.0g), Zone 2 (>6.0-6.5g), Zone 3 (>6.5-7.0g), Zone 4 (>7.0-8.0g), Zone 5 (>8.0-10.0g) and Zone 6 (>10.0g). This zone classification system forms the basis of the analysis performed by the Team AMS (GPSports, SPI Elite, Australia) software and involves the use of the acceleration zone forces provided in ''*G*'' force by the accelerometer in the GPS. The impact classification system used in this study was based on methods presented previously in young soccer players,[18] Rugby League,[21,22] and Rugby Union[23] and in accordance with manufacturer guidelines (GPSports, Australia). For the purpose of the present study only data in zone 1 were retained for analysis. Zone 1 is characterized by *G* force <5.0–6.0, in which collisions present light impact, but nevertheless accounts for accelerations, decelerations, and changes in direction while running[21,24]. Accounting for the characteristics of zone 1 it was assumed that this zone would better represent the impacts endured by young soccer players during

match-play. Moreover, despite being an invasion team sport with frequent physical contact, it was assumed that soccer matches do not generate a high occurrence of high-impacts as young soccer players have been shown to endure the highest number of impacts in zone 1 during soccer small-sided games.[18]

Statistical Analyses

All data are reported as means and standard deviation (SD). The normality of data was analyzed by the Shapiro-Wilk test and Levene's test was performed to test the homogeneity of variance. A MANOVA with a Tukey's *post hoc* was performed to examine the differences in mean data between matches in the dependent variables. The level of significance was set at $p<0.05$. To determine the practical magnitude of the differences, effect sizes (ES) (Cohen's d) were determined. Values of 0.2, 0.5, and above 0.8 were considered to represent small, medium, and large differences, respectively.[25]

RESULTS

The maximal running speed ($Km \cdot h^{-1}$) reached for the first, second, third, fourth and fifth matches was 28.0±2.2, 27.9±2.8, 27.8±1.5, 27.7±1.1, 27.3±1.6, respectively. No significant difference was observed for this variable across matches. Table 2 reports data on the other physical performance variables assessed for each match. The only significant differences observed between matches (Wilks' lambda = 0.035; F = 3.49; p = 0.000) were for the frequency of accelerations per minute, body load impacts, and body load impacts per minute. The frequency of accelerations per minute was notably greater during the first match (vs. Austria Wien) compared to the second (vs. Athletic Bilbao; d = 1.24 [large ES]) and final match (vs. Manchester City; d = 1.25 [large ES]). Large effect sizes were also observed for comparisons between the first and the third matches as well as between the first and the fourth matches for frequency of accelerations (d = 2.06 and 1.16, respectively; Table 3).

Higher mean values for body load impacts were obtained during the final match compared to all other matches. The effect sizes for comparisons between the final match and all other matches were large and ranged from 1.35 to 2.30 (Table 3). In addition, the number of body load impacts per minute during the last match was higher compared to matches 2 (vs. Athletic Bilbao), 3 (vs. New York Red Bulls) and 4 (vs. Bayern Munchen). The effect sizes for comparisons between the final match and all other matches for body load impacts per minute were large and ranged from 0.99 to 1.73 (Table 3). The effect sizes of the differences between matches for all variables are reported in table 3.

DISCUSSION

This study investigated the effects of a congested competition match schedule on total distance covered, high-intensity running distance, maximum running speed, frequency of accelerations, and body load impacts in soccer players belonging to an elite Under-15 team. The main findings were that accelerations per minute decreased across the competition, and body load impacts were higher during the final match compared to the other four matches played. In contrast, no significant changes between matches for any other running related variables were observed.

The ability to accelerate is considered decisive in critical activities performed during soccer matches.[1] Indeed, accelerations are frequently performed in team sports[15] and in combination with deceleration actions elicit high metabolic and neuromuscular demands[26] and require elevated rates of force development.[15] To the best of our knowledge, there are no previous reports describing the effect of consecutive matches on accelerations performed in young elite soccer players. In the present study, the frequency of accelerations per minute was statistically greater during the first match (vs Austria Wien) compared to the second (vs

Athletic Bilbao), and the final match (vs Manchester City). The statistical differences were supported by large effect sizes.

These results strongly suggest that a congested competition schedule over 3-days deleteriously affected players' acceleration profiles. It would seem that the capacity of the present young elite soccer players to perform accelerations was compromised across consecutive matches played without what could be considered appropriate recovery time and that this variable might be a useful marker in monitoring fatigue accumulated across a congested competition schedule.

Although the observed reduction in the frequency of accelerations per minute performed might be related to variations in tactical demands or as opponent strength or playing style, it is not unreasonable to speculate that residual fatigue (accumulated fatigue) from match to match impaired the players' capacity to accelerate. Related research by Akenhead et al.[15] provided evidence that acceleration and deceleration capabilities were acutely compromised during match play in a group of Under 21 soccer players. The authors reported significant decrements for distance covered in total accelerations ($> 1 m \cdot s^{-2}$) from the first to the second half (532±47 m versus 492±51m, respectively) as well as for distance covered in low (1-2 $m \cdot s^{-2}$; 233±41 vs. 201±39, respectively) and moderate accelerations (2-3 $m \cdot s^{-2}$; 126±15 vs. 116±14, respectively). Another reasonable explanation for the findings from the present study regarding the impairment in acceleration profiles could be the absence of recovery interventions during the post-match periods. No systematic recovery procedure was implemented between the assessed matches. It has been suggested that recovery interventions could provide a benefit by maintaining running performance in subsequent matches played in a short time frame.[11,14] In addition, Carling et al.[27] suggested that one of the possible explanations for the unchanged high-intensity running performance and injury rate in a professional soccer team investigated during a prolonged period of fixture

congestion (8 successive official matches in 26 days) was linked to post-match recovery strategies (ice bath, compression garments, massage) adopted by the coaching staff. Future studies in young soccer players should investigate the effect of recovery interventions on acceleration profiles over a period of fixture congestion.

Interestingly, despite a reduction in the number of accelerations, the highest BLI occurrence was observed during the final match of the competition. This match was also the only one in which the investigated team suffered a defeat (0-2 vs. Manchester City). Thus, it would seem that the BLI was not adversely affected by fatigue accumulated from playing several matches consecutively within a short-time period. It is difficult to suggest reasonable explanations for this difference in the BLI measure in the final game especially in the absence of data on opposition team performance. Tactical data for example, might have aided in demonstrating whether the playing style differed for the final opponents thus potentially affecting physical output of the present players. Indeed, differences in opposition tactics, team formation, playing style and skill level partly explain variations in competitive physical performance.[28,29]

In addition, one could speculate that changes in motivation (competition final) might have generated different individual behaviors which in turn affected game actions related to impacts. Impacts arise from actions such as changes in direction, falling to the ground, landing after jumping, collisions and tackles, and all of these actions are capable of increasing body load impacts counts. It could therefore be assumed that the present players performed a substantially higher number of these types of actions during the final match of the competition compared to all other matches (while running variables were unchanged).

Despite the aforementioned changes in acceleration profiles and body load impacts across matches, it is noteworthy that running measures such as the total distance covered (TD) and per minute, TD covered in high-intensity running, or the number of high-intensity

runs, were all unaffected over the congested match schedule. These results are generally in line with those reported in adult professional soccer players.[10,11,27,30] Dupont et al.,[11] showed that total distance covered, high-intensity distance, sprint distance, and number of sprints, were not significantly affected by the number of matches played per week (1 versus 2) in soccer players from the same top-level team monitored over 2 seasons. Additionally, Odetoynbo et al.[11] examined the effect of successive games on the running activity profiles of professional soccer players when 3 matches were played in 5 days, and revealed no significant differences for distances covered across matches. Finally, Dellal et al.[30] reported no differences across six successive matches in a congested period, and between non congested and congested periods for both physical and technical activities in 16 international senior players.

The data from the current time motion analysis literature in conjunction with the present findings suggest that simple analyses of running distance and speed are relatively stable during match congestion regardless of the investigated population (adults vs. young soccer players) and are seemingly not sensitive enough to measure accumulated fatigue. In contrast, this investigation has shown that acceleration and body load impact profiles are affected by a congested match schedule. Nevertheless, additional studies are warranted in larger samples of young players and in adult populations to examine whether any observed differences in physical output are simply related to changes in tactical and/or technical performance quantified through match analyses. Combining these data with objective physiological (e.g., creatine kinase concentrations) and physical (e.g., isometric strength) measures of fatigue and subjective measures of performance (e. g., ratings of perceived exertion, delayed onset of muscle soreness) might also provide a more holistic approach to analysing the effects of match congestion.

PRACTICAL APPLICATIONS

The present results suggest that load impact and accelerations might be employed by coaching staff for monitoring external load during congested match schedule rather than using simple time motion measures of running speed and distance covered. Combining this information with physiological and physical data and perceptual measures of effort would provide a more holistic approach to analysing the effects of congested competition schedules in young soccer players.

CONCLUSION

In this study, acceleration profiles and body load impact counts in youth soccer players were the variables most influenced by a congested competition schedule. No differences were observed for measures of running speed and distance covered. Accelerations per minute decreased across the competition and body load impact were higher during the final compared to all other matches. Future studies should examine the physiological mechanisms underpinning these changes. Moreover, additional studies are warranted in larger samples of young soccer players to examine whether changes in these variables are related to changes in tactical or technical performance quantified through match analyses. Indeed, it could be worthwhile to verify the potential relationships between changes in accelerations and body load impact and other external load measures as well as the relations to internal markers such as session-RPE.

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Table 1. Competition schedule and results

	Opponent	Result	Assessed team match outcome	Day of the competition and time of the matches
First match	Austria Wien	2 - 1	Won	1st (15 August) 13:00
Second match	Athletic Bilbao	3 - 1	Won	1st (15August) 15:15
Third match	Red Bull New York	2 - 1	Won	2nd (16 August) 11:00
Fourth match	Bayern Munchen	1 - 1 *	Draw	2nd (16 August) 17:10
Fifth match	Manchester City	0 - 2	Lost	3rd (17 August) 12:00

* The assessed team was defeated after penalties (4 x 5; no extra time played).

Table 2. Descriptive analysis of physical l performance across 5 consecutive games

	1st match	2nd match	3rd match	4th match	5th match
	Austria Wien	Athletic Bilbao	New York Red Bulls	Bayern Munchen	Manchester City
Total distance (TD) (m)	5725±571	5493±820	5130±577	5467±868	5610±925
TD per minute (m/min)	114±13	106±12	104±12	107±16	97±17
TD in high-intensity running (m)	501±233	356±192	291±91	430±134	330±87
Number of high-intensity runs (N)	28±12	23±12	19±5	29±8	21±5
High-intensity running per minute (N/min)	0.56±0.24	0.43±0.21	0.39±0.12	0.57±0.15	0.37±0.11
Frequency of accelerations (N)	91±17	70±16	68±5	74±13	69±18
Accelerations per minute (N/min)	1.82±0.33[a]	1.35±0.22	1.38±0.19	1.45±0.26	1.20±0.36
Body load impacts (N)	959±581	843±441	651±164	821±361	2069±1070[b]
Body load impacts per minute (N/min)	19.5±12.7	16.2±7.9	13.5±4.5	16.2±7.1	37.2±23.1[b]

a=significant difference compared to 2nd and 5th matches; b=significant differences to all other matches

Table 3. The effect size of the differences between matches for physical demand variables

	1st vs 2nd	1st vs 3rd	1st vs 4th	1st vs 5th	2nd vs 3rd	2nd vs 4th	2nd vs 5th	3rd vs 4th	3rd vs 5th	4th vs 5th
Total distance (TD) (m)	0.33	1.04	0.36	0.15	0.52	0.03	-0.13	-0.23	-0.64	-0.16
TD per minute (m/min)	0.66	0.81	0.47	1.16	0.15	-0.11	0.64	-0.12	0.53	0.65
TD in high-intensity running (m)	0.68	1.30	0.39	1.07	0.46	-0.45	0.19	-0.62	-0.44	0.91
Number of high-intensity runs (N)	0.46	1.07	-0.08	0.87	0.42	-0.64	0.21	-0.77	-0.37	1.29
High-intensity running per minute (N/min)	0.59	0.94	-0.02	1.11	0.22	-0.77	0.40	-0.64	0.23	1.53
Frequency of accelerations (N)	1.24	2.06	1.16	1.25	0.24	-0.24	0.09	-0.33	-0.09	0.32
Accelerations per minute (N/min)	1.71	1.66	1.23	1.77	-0.20	-0.45	0.50	-0.15	0.67	0.81
Body load impacts (N)	0.23	2.13	0.29	-1.35	0.63	0.05	-1.62	-0.65	-2.30	-1.74
Body load impacts per minute (N/min)	0.32	1.74	0.34	-0.99	0.43	0.00	-1.36	-0.47	-1.73	-1.40

1st match vs. Austria Wien
2nd match vs. Athletic Bilbao
3rd match vs. New York Red Bulls
4th match vs. Bayern Munchen
5th match vs. Manchester City