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[原著論文]

League tier and Playing Position Influence Match Running Performance at high-speeds in Male Youth Soccer Players: 4-4-2 Formation

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Abstract

The aim of the current study was to compare match running distance and intermittent-endurance fitness of male youth soccer players according to league tiers. Participants were 119 outfield players (central defenders (CD), wide defenders (WD) and central midfielders (CM)) who belonged to an under-18 soccer league in tier 1 (T1), tier 2 (T2) or tier 3 (T3) in Japan. Forty-one, 11-a-side official league matches (all 4-4-2 formation) were analyzed (149 complete match-files) using a Global Positioning System (15Hz). The players performed the Yo-Yo intermittent recovery test level 2 (YYIR2) to determine intermittent-endurance fitness. CD covered more than 14% less high-intensity running (HIR) and very high-intensity running (VHIR) distance in T1 than T2 and T3 (all $P < 0.05$). WD covered 12-20% greater HIR and VHIR distance in T2 than T1 and T3 (all $P < 0.05$). CM sprinted at least 27% greater distance in T1 ($P < 0.01$) and T2 ($P < 0.05$) than T3. Moreover, CM covered at least 12% greater YYIR2 distance in T1 ($P < 0.01$) and T3 ($P < 0.05$) compared to T2. In youth soccer, match running distance at high-speeds varies with league tiers depending on playing position and intermittent-endurance fitness may not be a determinant of such performance when 4-4-2 formation is employed.

KEY WORDS : Association football; competitive level; match analysis; physical performance; young players.

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1. INTRODUCTION

Match running performance in male youth soccer players has been extensively studied in the past decade and the monitoring of such performance has recently been considered as a fundamental area of the youth development process (Vieira et al., 2019). A large number of time-motion analysis studies in youth soccer have employed Global Positioning Systems (GPS) to measure total match running distance and distance covered within certain speed zones. These studies have established that youth soccer players (15 to 18 years old) cover between 9,000 and 12,000 meters in a 90 min match with ~20 to ~25% of this distance being covered at high-speeds (greater than 4.0-4.4 $m \cdot s^{-1}$) (Buchheit et al., 2010; Goto et al., 2015; Goto and Saward, 2020; Hunter et al., 2015; Saward et al., 2016; Varley et al., 2017). Such running performance has been confirmed as playing position dependent and wide defenders, wide midfielders and strikers have been demonstrated to cover greater distance at high-speeds (Buchheit et al., 2010; Saward et al., 2016; Varley et al., 2017). Moreover, match running distance has been shown to directly influence playing status (retained or released from an academy) (Goto and Saward, 2020; Saward et al., 2016) and team success (final rank in a tournament) (Varley et al., 2017). In previous studies, players who were retained at an English professional soccer club academy (under-15 - under-18 (U15-U18)) demonstrated a greater match running distance by low- to moderate-speeds compared with counter parts who were released from the academy (Goto et al., 2015). Moreover, low ranked teams in an U17 international tournament sprinted less distance than top and middle ranked teams (Varley et al., 2017). However, to the authors' knowledge, differences in match running performance of youth soccer players according to different league tiers have not been investigated. An investigation of differences and similarities in match running performance between different league tiers may support coaching staff to deliver league specific training programs (Bradley et al., 2013a).

In senior soccer players, match running performance of the highest three English professional leagues have been reported (Bradley et al., 2013a; Di Salvo et al., 2013). The studies showed that total match running distance were lower in the highest league compared to the lower leagues in all field playing positions (Bradley et al., 2013a; Di Salvo et al., 2013). However, the differences were only reported in central defenders and central midfielders when the second and third leagues were compared (Bradley et al., 2013a).

On the other hand, distance covered at high-speeds (high-speed running and sprinting) were lower in the highest league compared to the lower leagues in all field playing positions except sprinting in central midfielders (Bradley et al., 2013a; Di Salvo et al., 2013). However, the differences were only reported in limited playing positions and match running performance at high-speeds when the second and third leagues were compared (Bradley et al., 2013a). Hence, the differences in match running performance seems to strongly exist between the highest and second highest leagues but the differences may only appear in limited playing positions between the second and third highest leagues.

An investigation of such information in youth soccer would provide clear insights to coaches and sports scientists regarding the differences and similarities in match running performance between the leagues in different tiers in each playing position. Such data may support coaching staff to deliver league specific training programs for each playing position (Bradley et al., 2013a). Moreover, the information may allow coaching staff to make their players physically and mentally ready when the team is promoted or relegated a league or when they compete in regional or national tournament where inter-league matches can take place (Bradley et al., 2013a).

Previous studies comparing match running distance of professional soccer players according to league tiers have explored intermittent-endurance fitness using the Yo-Yo intermittent

endurance test level 2 or the Yo-Yo intermittent recovery test level 1 (Bradley et al., 2013a; Mohr et al., 2003) which have been widely employed in amateur to elite professional soccer (Schmitz et al., 2018). Bradley et al. (2013a) demonstrated that intermittent-endurance fitness was similar between players regardless of their league tier. This is despite match running distance declining as league tier increased (Bradley et al., 2013a). Other evidence suggests that both high-intensity match running distance and intermittent-endurance fitness improved together with the league tiers (Mohr et al., 2003). The relationship between intermittent-endurance fitness and match running performance is complex and it is not always the major factor to decide match running distance. While a greater intermittent-endurance fitness could be advantageous in running performance during a soccer match (Francini et al., 2019), it is vital to recognize that the tactical role and situational variables associated with individual playing positions and/or competitive standards could change the relationship (Castellano et al., 2011; Sarmento et al., 2014; Varley et al., 2017). Hence, it is important to investigate the relationship between match running performance and intermittent-endurance fitness in youth soccer players according to league tiers.

Therefore, the aim of the current study was to compare match running distance and intermittent-endurance fitness of youth soccer players according to league tiers. We hypothesized that both match running performance and intermittent-endurance fitness would vary between league tiers and would be dependent on playing position.

2. METHODS

2.1. Participants

The participants were 119 U18 outfield soccer players from tier 1 (T1), tier 2 (T2) and tier 3 (T3) leagues in Japan (see Table 1 for details). The upper three tiers of the U18 soccer leagues are formed as follows: the two highest leagues (T1, East Japan League and West Japan League); the nine second highest leagues (T2, regional leagues which are created by separating the whole of Japan into nine regions); and 47 Prefecture leagues (T3, one league in each prefecture). There are promotions and relegations between T1 and T2 leagues and T2 and T3 leagues. There were 10 teams in each league and the participants were recruited from three T1 teams, four T2 teams and four T3 teams. The teams recruited were the only teams authors asked to participate in the study. Average league position was 6.7th for T1 teams, 4.3th for T2 teams and 5.0th for T3 teams. All teams were recruited from the same T1 region and all T3 teams were recruited from the same region as the T2 teams. Players were provided with written and verbal explanations of the study including all measurements to be taken. Each player signed an informed assent form and completed a health screen questionnaire prior to participation in the study. Each player's parent, guardian or care-giver signed a consent form before the study. Players were free to withdraw from the study without giving any reasons and without any penalty regarding their position within the soccer club and this was explained to them verbally and in writing. Participants were withdrawn from the study if they did not have a satisfactory health status. The study was approved by a University Ethics Committee (ethics number: 2017-19).

2.2. Match analysis

All matches were official league matches which took place on Saturday or Sunday during April and May. The matches were performed on international match size (length = 100-110 m, width = 64-75 m, Fédération Internationale de Football Association (FIFA)) flat artificial grass pitches (third generation astroturf). The players performed only one match during a week. A total of 41, 11-a-side matches were analyzed and 149 complete match-files were obtained (see Table 1 for details). All teams recruited for the study were employing 4-4-2 formation (traditional flat system) and they only played in 4-4-2 formation in all analyzed matches and the formation was not changed during the

Table 1. Age, number of players, number of complete match-files and YYIR2 distance of youth soccer players according to league tier and playing position.

		Tier 1	Tier 2	Tier 3
Age (years)				
CD	Mean	17.3	17.6	17.6
	SD	0.6	0.6	0.8
WD	Mean	17.2	17.2	17.1
	SD	0.9	0.8	0.5
CM	Mean	17.4	17.8	17.4
	SD	0.6	0.7	0.8
Number of players (counts)				
CD		14	15	15
WD		12	13	12
CM		13	12	13
Number of complete match-files (counts)				
CD		18	19	21
WD		14	15	14
CM		16	15	17
YYIR2 distance (m)				
CD	Mean	1205	1027	1027
	SD	170	269	278
WD	Mean	1278	1175	1106
	SD	155	265	305
CM	Mean	1238	952[a*]	1087[b]
	SD	175	122	150

Significantly different at $P < 0.05$ vs. a: tier 1, b: tier 2. *$P < 0.01$. YYIR2 = Yo-Yo intermittent recovery test level 2, CD = central defenders, WD = wide defenders, CM = central midfielders.

matches as well. Match duration was 90 min (not including additional time) and players were required to play a full match in the same position throughout the match to be included in the analysis. Playing formation of the opposition was also 4-4-2 in all matches. In some matches, the oppositions were not playing 4-4-2 formation or at least 1 player got sent off during a match even though the teams analyzed were playing 4-4-2 formation and these matches (5, 3 and 5 matches from T1, T2 and T3 teams, respectively) were neglected from the study (not part of 41 analyzed matches). The playing formation was decided by the coaches of the teams and the coaches were interviewed immediately before and after the matches regarding the playing formation they intended to play and whether the same playing formation was employed throughout the matches. Moreover, matches were recorded using a video camera (HC-V230M, Panasonic, Osaka, Japan). A holder of the Asian Football Confederation “B” coaching license clarified that the playing formation was the same during the whole matches and the players competed in the same playing positions throughout. The current study only included CD, WD and CM in the analysis and WM and strikers were neglected as these attacking positions were frequently substituted and sufficient complete match-files could not be collected. As match running distance tends to differ between the first and second halves in youth soccer, a normalization of match data of substituted players were avoided (Vieira et al., 2019).

2.3. Match running performance

Match running performance was analyzed throughout the matches using 15 Hz GPS technology (SPI HPU, GPSports, Canberra, Australia) which has been reported to possess sufficient validity and reliability to analyze soccer matches (Barr et al., 2019; Johnston et al., 2014). The match running performance of each player was analyzed with the assessment of distances covered at different speed zones as follows: high-

intensity running (HIR; 3.6 to 4.4 $m \cdot s^{-1}$), very high-intensity running (VHIR; 4.5 to 5.3 $m \cdot s^{-1}$) and sprinting (> 5.3 $m \cdot s^{-1}$) (Goto and Saward, 2020; Buchheit et al., 2010). In the current study, the same GPS unit could not always be worn by a player in different matches due to logistical issues. At least 8 satellites (mean ± SD = 9.8 ± 0.8 satellites) were connected during data collection which is the minimum number of satellites required to allow an accurate measurement (Varley and Aughey, 2012). The distances covered in speed zones were calculated using Team AMS software version R1.2019.1 (GPSports, Canberra, Australia).

2.4. The Yo-Yo intermittent recovery test level 2

The YYIR2 was conducted in March and all players were familiarized with the YYIR2 prior to the data collection (Krustrup et al., 2006).

2.5. Statistical analyses

A priori statistical power calculation was performed (G*Power3.1.9.2; Dusseldolf, Germany) on primary outcome variables (i.e., sprinting distance) using data from a previous investigation. The investigation employed a similar experimental design to the current study and examined the influence of league tier and playing position on match running performance of professional soccer players who belonged to the three highest leagues in England. With an effect size of 0.50, power of 0.80 and alpha of 0.05, 14 complete-match files were required per group to provide sufficient statistical power for the present study.

The match running performance and YYIR2 performance data were compared between all three tiers for all positions (CD, WD and CM) and separately for CD, WD and CM using One-Way Analysis of Variance with the Tukey post hoc test. Outcome variables for match running performance included total, HIR, VHIR and sprinting distance. Outcome variables were tested for normality using the Kolmogorov-Smirnov test, histograms, box plots and QQ plots of the residuals. Homogeneity of variance was assessed using the Levene's statistic. Skewed raw data were log transformed. For log transformations that provided normal distributions, the post hoc comparisons were back transformed. The 95% confidence intervals (CI) are reported wherever appropriate (Field, 2013). The effect size (η_p^2) for differences were calculated wherever appropriate and values of 0.01, 0.06 and 0.15 were considered small, medium and large, respectively (Cohen, 1988). The level of statistical significance was set at $P < 0.05$. Results are presented as mean ± SD unless stated otherwise and all statistical analyses were performed using SPSS version 22.0 (IBM SPSS statistics for Windows, IBM, Armonk, New York, USA).

3. RESULTS

When all playing positions were analyzed together, no differences in total match running distance (T1 vs T2 vs T3 = 9984 ± 578 m vs 10585 ± 614 m vs 11255 ± 794 m) and distance covered by HIR (1190 ± 239 vs 1299 ± 180 m vs 1676 ± 318 m), VHIR (579 ± 122 m vs 770 ± 137 m vs 844 ± 219 m) and sprinting (462 ± 99 m vs 887 ± 263 m vs 617 ± 229 m) were observed between the tiers ($P > 0.05$ for all). Match running distance according to playing position in each tier are presented in Figure 1. Total match running distance according to playing position was not different between the tiers (all $P > 0.05$). For CD, HIR and VHIR distance was less in T1 than T2 and T3 (all $P < 0.05$). WD covered greater HIR and VHIR distance in T2 than T1 and T3 (all $P < 0.05$). Moreover, WD sprinted a greater distance in T2 compared to T3 ($P < 0.01$). CM showed a greater VHIR distance in T1 compared to T2 ($P < 0.05$) and T3 ($P < 0.01$). Furthermore, CM sprinted a greater distance in T1 ($P < 0.01$) and T2 ($P < 0.05$) than T3.

There were no differences in the YYIR2 scores between the tiers in CD and WD (all $P > 0.05$) (Table 1). CM covered a greater YYIR2 distance in T1 ($P < 0.01$) and T3 ($P < 0.05$) compared to T2 (Table 1).

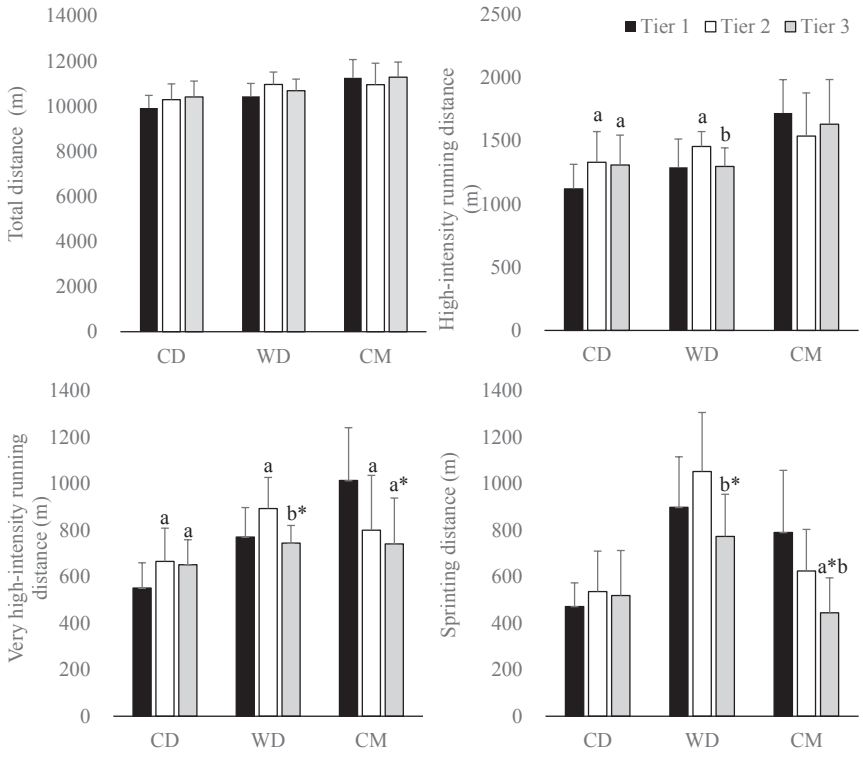

Figure 1. Match running distance across league tier and playing position in youth soccer players. Significantly different at $P < 0.05$ vs. a: tier 1, b: tier 2.
*$P < 0.01$. CD = central defenders, WD = wide defenders, CM = central midfielders.

4. DISCUSSION

This study is the first to investigate differences in match running performance of youth soccer players in three league tiers according to playing position when 4-4-2 formation is employed. The key findings of the current study were: total match running distance was similar between all tiers regardless of playing position; CD covered less HIR and VHIR distance in T1 compared to the lower tiers; WD demonstrated a greater HIR, VHIR and sprint distance in T2 than T1 and/or T3; VHIR and sprinting distance increased with league tiers in CM; and the YYIR2 score was not different between the tiers except CM where T2 showed a lower score than the other tiers.

Regardless of league tier, the players from the current study covered approximately 10 to 12 km; a similar finding to previous studies on elite youth (Buchheit et al., 2010; Hunter et al., 2015; Saward et al., 2016; Varley et al., 2017) and professional (Bradley et al., 2013a; Di Salvo et al., 2013) soccer players. When the players were separated into different playing positions, the total match running distance was still similar between the tiers in all playing positions (CD, WD and CM). Previous studies have reported a lower total match running distance in the highest league compared to the lower leagues in English professional soccer leagues (Bradley et al., 2013a; Di Salvo et al., 2013). In contrast, there are mixed findings on total match running distance in elite youth soccer players. Studies reporting that players retained in an English professional soccer club academy have demonstrated greater (Goto et al., 2015) or similar (Goto et al., 2015; Hunter et al., 2015; Waldron and Murphy, 2013) total match running distances than the released players. Elite youth players have shown to cover greater total distance than sub-elite players (Bradley et al., 2013b) and the total match running distance was not different between elite players from high, middle and low ranked teams who competed in an U17 international

soccer tournament (Varley et al., 2017). Soccer is a complex sport and total match running distance can be influenced by many factors which include ball possession (Bradley et al., 2013b), the environment (Mohr et al., 2012), the opponent (Varley et al., 2017), physical capacity (Krustrup et al., 2006), playing formation (Bradley et al., 2011), playing surface (Andersson et al., 2008), seasonal period (Mohr et al., 2003; Rampinini et al., 2007), tactics (Bradley et al., 2013a) and technical level (Rampinini et al., 2009). Given that total distance has been shown to possess the lowest match-to-match variability compared with other match running performance parameters (e.g., jogging, sprinting) (Bush et al., 2015), total match running distance alone is possibly too insensitive to establish distinctions between league tiers in youth soccer (Saward et al., 2016).

In the current study, CD covered less distance by HIR and VHIR in T1 compared to T2 and T3. However, sprint distance was similar between the tiers. Despite this, the findings regarding HIR and VHIR were similar to a previous study which showed that CD cover a greater distance at high-speeds during a match as the league tiers declined in the three highest English professional soccer leagues (Bradley et al., 2013a). This is unlikely to be due to differences in intermittent-endurance fitness according to league tiers; intermittent-endurance fitness estimated by the YYIR2 was similar between the tiers in the current study and a similarity in intermittent-endurance fitness between the three highest English professional leagues has also been reported previously (Bradley et al., 2013a). A potential rationale for the increase in match running distance with a decline in the league tiers in the highest three English professional soccer leagues has been suggested as the tactical differences between the leagues (Bradley et al., 2013a). The study reported that pass related events and average touches per ball possession increased with the league tiers, whereas, the number of headers and interceptions was the opposite (Bradley et al., 2013a). Hence, the teams in the higher leagues were assumed to employ more possession based tactics as they probably possess a superior technical ability than the teams in the lower leagues and the teams in the lower leagues are speculated to use more transient long ball tactics (Bradley et al., 2013a). The differences in technical ability between tiers may also exist in youth soccer and such differences can influence team tactics and possibly lead to a greater running distance by high-speed as league tiers decline (Figueiredo et al., 2009).

WD covered a greater distance by HIR and VHIR in T2 than T1 in the current study. Although sprint distance was not statistically different between the two tiers, such findings agree with previous studies from English professional soccer which reported that a distance covered by WD generally increased as league tier declined (Bradley et al., 2013a; Di Salvo et al., 2013). However, such findings were not fully supported by the current results as WD demonstrated less HIR, VHIR and sprint distance in T3 than T2. This difference in running distance between T2 and T3 is not likely to be because of a difference in intermittent-endurance fitness as their YYIR2 score was not statistically different. It has been argued that a rationale for the differences in running distance in the three highest English professional league was the tactical differences due to a possession of superior technical ability by WD who belonged to the higher leagues (Bradley et al., 2013a). Similarly, the technical and tactical differences may explain the current findings where WD covered less distance at high-speeds in T3 than T2. In modern soccer, WD are generally responsible to overlap quickly when an attack starts and recover to own position fast when the attack ends, and such a role frequently requires the players to travel long distance at high-speeds. However, these situations may occur less frequently in lower leagues (i.e., T3) due to a possession of less technical ability and potential lack of tactical understanding (Figueiredo et al., 2009). Future research is warranted to examine this suggestion by including technical and tactical data analysis.

In the present study, VHIR and sprinting distance increased with league tiers in CM. It has previously been shown that CM in the English professional leagues cover a greater distance at high-speeds as league tier declines (Bradley et al., 2013a). This discrepancy is possibly caused by differences in tactical requirement in CM in these particular leagues as the tactical elements of soccer leagues can differ between countries (Dellal et al., 2011). In the youth soccer leagues of the current study, an importance of CM to quickly move their position during attacking and/or defending or in transition between attacking and defending could grow as the league tier improves.

There are a few limitations to this study which should be considered when interpreting the evidence. The current data could not include attacking positions in the analysis (wide midfielders and strikers) due to frequent substitutions in these playing positions which discarded a collection of sufficient number of complete match-files. The current study analyzed match running performance and intermittent-endurance fitness of youth soccer players in three league tiers but no technical and tactical information were included. Such information would support a deeper understanding of differences and similarities between the tiers (Bradley et al., 2013a). Contextual variables that influence match running performance have recently been discovered and the current study controlled for a few variables such as playing formation of the team and opposition (4-4-2) (Bradley et al., 2011), fixture congestion (one match in a week) (Jones et al., 2019) and playing surface (Anderson et al., 2008; Brito et al., 2017). However, other variables (e.g., match location (Aquino et al., 2020; Castelano et al., 2011), match outcome (Aquino et al., 2020; Castelano et al., 2011) could not be controlled for which are recommended in future studies to improve study generalizability (Palucci Vieira et al., 2019).

In conclusion, the current findings suggest that total match running distance does not seem to distinguish league tiers in youth soccer regardless of playing position (CD, WD and CM). However, distance covered at high-speeds can increase or decrease with league tiers and the change can depends on playing position. Moreover, intermittent-endurance fitness may not be a determinant of the differences in match running performance between different league tiers. Such data may help coaches and sports scientists to produce league specific training programs across playing position. Moreover, coaching staff are recommended to make the players fully aware of the possible differences in match running performance when the team faces a league promotion or relegation and when competing in a domestic cup where inter-league matches can take place.

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