

[原著論文]

Playing formation affects match running performance in youth soccer: 4-4-2 vs 3-6-1

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Abstract

The aim of the current study was to compare the match running distance of elite male youth soccer players according to playing position within and between 4-4-2 and 3-6-1 formations. Global Positioning System was employed to analyze the match running distance of 124 players (age = 17.2 ± 0.8 years, 4-4-2: central defenders (CD₄₄₂), wide defenders (WD₄₄₂), central midfielders (CM₄₄₂), wide midfielders (WM₄₄₂), strikers (ST₄₄₂); 3-6-1: CD₃₆₁, defensive CM (DCM₃₆₁), WM₃₆₁, attacking CM (ACM₃₆₁), ST₃₆₁) from professional soccer academies during 38 matches. CD₄₄₂ covered less total distance than other positions (all P < 0.01). CD₄₄₂ covered less very high-intensity running (VHIR) distance than WD₄₄₂, CM₄₄₂ and WM₄₄₂; and FW₄₄₂ showed less VHIR distance than WM₄₄₂ (all P < 0.05). CD₃₆₁ covered less total distance than ACM₃₆₁, and CD₃₆₁ demonstrated less VHIR distance than WM₃₆₁, DCM and ACM₃₆₁ (all P < 0.05). CD₄₄₂ covered 11-12% less VHIR distance than CD₃₆₁, CM₄₄₂ demonstrated 7% greater total distance than DCM₃₆₁, and ST₄₄₂ showed 6% greater total distance than ST₃₆₁ (all P < 0.05). The results suggest that both formations influence match running performance according to playing position in elite youth soccer. Match running performance differed in CD, CM and ST between the formations.

KEY WORDS : Association football; GPS; match analysis; playing system; and young players.

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INTRODUCTION

Running performance during match play in male youth soccer players has been examined in a large number of studies and an employment of match running performance analysis has lately been suggested to support a fundamental area of the youth development process (Palucci Vieira et al., 2019). In recent years, Global Positioning Systems (GPS) has been used in the majority of time-motion analysis studies of elite youth soccer players to investigate total match running distance and distance covered within certain speed zones. Those studies have established that elite youth soccer players (15 to 18 years old) cover between 9000 and 12,000 m in a 90 min match with ~20 to ~25% of this distance being covered at high speeds (greater than 4.0-4.4 m·s⁻¹) (Buchheit et al., 2010; Goto et al., 2015; Goto and Saward, in press; Hunter et al., 2015; Saward et al., 2016; Varley et al., 2017) and such running performance has been confirmed as playing position dependent (Buchheit et al., 2010; Mendez-Villanueva et al., 2013; Saward et al., 2016; Varley et al., 2017). The previous studies have reported that the lowest total match running distance was covered by central defenders (CD) whilst central midfielders (CM) showed a greater total distance than other playing positions (Buchheit et al., 2010; Varley et al., 2017). Moreover, CD demonstrated less high-intensity running distance (HIR, 3.6 to 4.4 m·s⁻¹) than all other positions; wide defenders (WD) and strikers (ST) covered less HIR distance than CM; and ST completed less HIR distance than wide midfielders (WM) (Buchheit et al., 2010). Furthermore, CD and CM exhibited less sprinting (> 5.3 m·s⁻¹) distance than WD and WM (Buchheit et al., 2010); or CD covered the lowest distance than other playing positions by high-speeds (≥ 5.5 m·s⁻¹) (Varley et al., 2017). Despite this prior work, only one study has interrogated the between-playing position difference in match running performance with a fixed playing formation (Buchheit et al., 2010) and other studies seems to have mixed the match running performance data of various playing formation in the analyses

(Saward et al., 2016; Varley et al., 2017).

Playing formation has been shown to influence match running performance in professional soccer players (Bradley et al., 2011; Tierney et al., 2016). Defenders in 4-4-2 formation covered a greater total and high-speed running (≥ 5.5 m·s⁻¹) distance than in 4-3-3 and 4-5-1 formations (Bradley et al., 2011). CM in 4-3-3 formation covered > 11% greater total distance than in 4-4-2 (Tierney et al., 2016). ST in 3-5-2 formation demonstrated > 45% greater high-speed running distance (≥ 5.5 m·s⁻¹) than in 4-2-3-1 formation (Tierney et al., 2016) and ST in 4-3-3 formation covered 28-32% more high-speed running distance (≥ 5.5 m·s⁻¹) compared with 4-5-1 and 4-4-2 formations (Bradley et al., 2011). It is important to assess the match play demands of each playing position within different playing formations to support coaches and sports scientists in creating individual training and match preparation plans. Within the context of youth soccer, between-playing position differences in match running performance have only been reported in 4-4-2 formation with information derived from combining the match running performance data from a wide age range (under-13 (U13) to U18 age groups) of players (Buchheit et al., 2010). Since, large between-age group differences in match running performance have been previously shown in elite youth soccer players, the analysis should include a narrower age range of players (Buchheit et al., 2010; Goto et al., 2015; Goto and Saward, in press; Saward et al., 2016). Consequently, the aim of the current study was to examine match running performance of elite youth soccer players according to playing position in different playing formations.

MATERIALS AND METHODS

Participants & ethical approval

The participants were 124 (4-4-2 formation: N = 73 players, age = 17.2 ± 0.8 years; 3-6-1 formation: N = 59 players, age = 17.2 ± 0.8 years [mean ± SD]) elite outfield players from 11 U18 Japanese professional soccer club academy teams (U16, U17 and U18 players were joined

together to form the first and second teams). In each week during the season, the players generally participated in five 2-hour training sessions and a match (Saturday or Sunday). Players were provided with a written and verbal explanation 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 signed a consent form prior to the start of 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).

Match analysis

All matches were official league matches and were played 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). A total of 38, 11-a-side matches were analyzed and the teams employed 4-4-2 or 3-6-1 formation (19 matches per formation). The players were analyzed in five playing positions in 4-4-2 (CD₄₄₂, WD₄₄₂, CM₄₄₂, WM₄₄₂, ST₄₄₂) and 3-6-1 (CD₃₆₁, defensive CM (DCM₃₆₁), WM₃₆₁, attacking CM (ACM₃₆₁), ST₃₆₁) formations. There were at least eight players in each position and 209 complete match-files were obtained (4-4-2: 104 files, 3-6-1: 104 files, 1-4 files per player). Match duration was full length of match time (90 min and additional time) and playing formation was consistent throughout the match. The players were required to play a full match in the same playing position for the whole match to be included in the analysis and all matches finished with 22 players. There were ten home matches and nine away matches in both formation and match results were 10 wins, 5 loses and 4 draws for 4-4-2 formation and 9 wins, 6 loses, 4 draws for 3-6-1 formation. Playing

formation of opposition teams was generally 4-4-2 formation. Final league position of the teams and opposition teams was fairly evenly spread from the top to bottom.

Match-running performance

The match-running performance of each player was analyzed with the assessment of distances covered at different speed zones and the speed zones were as follow: HIR (3.6 to 4.4 m·s⁻¹); very high-intensity running (VHIR, 4.5 to 5.3 m·s⁻¹); and sprinting (> 5.3 m·s⁻¹) (Buchheit et al., 2010). The data were expressed in relative terms (per 90 min) as match duration was statistically different between the formations when additional time was included.

Match running performance was analyzed with 15 Hz (5 Hz interpolated to 15 Hz) GPS technology (SPI HPU, GPSports, Canberra, Australia) which has been validated for use by a team sport simulated set up (Johnston et al., 2014). At least 8 satellites (mean ± SD = 9.9 ± 0.7 satellites) were connected during data collection which is the minimum number of satellites required to allow an accurate measurement (Varley et al., 2012; Waldron et al., 2011). The distances covered in speed zones were calculated using Team AMS software version R1.2019.1 (GPSports, Canberra, Australia).

The Yo-Yo intermittent recovery test level 2

The YYIR2 was conducted at the start and end of the season and the mean of two scores was calculated for each player. The test consisted of repeated 20 m shuttle runs at progressively increasing speeds and which were signaled by an audio sounds from a laptop computer. Between each run, the players were given 10 s to jog around a cone which was placed 5 m behind the finish line and get back to the start line. When a player failed to complete the shuttle run in time on two occasions, the test was terminated and the distance covered in the last complete successful shuttle was recorded as the test score. All tests were performed on an outdoors artificial grass

surface where league matches took place and 20 m running lanes were marked by cones. All players were familiarized to the YYIR2 test (Krustrup et al., 2006).

Statistical analyses

In the analysis, between-playing position differences in the YYIR2 score and match running performance within each formation were assessed. Moreover, differences in the YYIR2 score and match running performance between similar playing positions in 4-4-2 and 3-6-1 formations were examined (CD (CD₄₄₂ and CD₃₆₁), WD and WM (WD₄₄₂, WD₄₄₂ and WM₃₆₁), CM (CM₄₄₂, DCM₃₆₁ and ACM₃₆₁), ST (ST₄₄₂ and ST₃₆₁)).

Normality of the data was examined by Kolmogorov-Smirnov test and homogeneity of variance was assessed with Levene's test. One-way analysis of variance (ANOVA) with Bonferroni's post hoc test was employed when the YYIR2 score and match running performance of three or more playing positions were compared whereas an independent sample t-test was employed when there were two playing positions. Log transformation was conducted whenever normality of the data was violated. However, if the transformation could not solve the violation, Kruskal-Wallis tests and pairwise comparisons with adjusted P-values were performed to assess the differences (Field, 2013). When the data was normally distributed but variances were unequal, ANOVA with Games-Howell post hoc test was employed (Field, 2013).

When ANOVA was employed, partial eta-squared (η^2) for the differences was calculated as measures of effect size wherever appropriate and values of 0.01, 0.06 and 0.15 were considered as small, medium and large, respectively (Cohen, 1988). When an independent sample t-test was employed, the effect sizes (d) for the differences were calculated as (mean A – mean B)/ (pooled SD) and effect size values of 0.2, 0.5 and above 0.8 were considered to represent a small, moderate and large differences, respectively (Cohen, 1988). The level of statistical significance was set at

$p < 0.05$ and 95% confidence intervals (CI) for significant differences in means were calculated. Results are presented as mean \pm SD. All the statistical analyses were performed using SPSS version 22.0 (IBM SPSS statistics for Windows, IBM, Armonk, New York, USA).

RESULTS

There were no between-playing position differences in the YYIR 2 scores within 4-4-2 formation (range: 1109 \pm 291 m (CD₄₄₂) to 1186 \pm 215 m (WM₄₄₂)) and within 3-6-1 formation (range: 941 \pm 269 m (DCM₃₆₁) to 1107 \pm 239 m (WM₃₆₁)).

Match running performance of elite youth soccer players according to playing position in 4-4-2 and 3-6-1 is presented in figure 1-4. In 4-4-2 formation, CD₄₄₂ covered 12-17% less total distance than other playing positions (all $P < 0.01$, CI: 139, 1802 m, $\eta^2 = 0.32$, figure 1). For HIR distance, CD₄₄₂ demonstrated 21-27% less distance compared to WD₄₄₂, CM₄₄₂ and WM₄₄₂, and ST showed 21% less distance than CM₄₄₂ (all $P < 0.01$, CI: 55, 630 m, $\eta^2 = 0.32$, figure 2). Moreover, CD₄₄₂ covered 26-36% less VHIR distance compared to WD₄₄₂, CM₄₄₂ and WM₄₄₂ (all $P < 0.01$, CI: 67, 498 m), and FW₄₄₂ showed 21% less VHIR distance than WM₄₄₂ ($P < 0.05$, CI: 10, 385 m) ($\eta^2 = 0.31$) (figure 3). In addition, Kruskal-Wallis tests revealed that CD₄₄₂ sprinted 42-52% less distance compared to WD₄₄₂, WM₄₄₂ and FW₄₄₂, and CM₄₄₂ sprinted 37-43% less distance than WD₄₄₂ and WM₄₄₂ (all $P < 0.01$, figure 4). In 3-6-1 formation, CD₃₆₁ covered 6% less total distance than ACM₃₆₁ ($P < 0.05$, CI: 55, 1237 m, $\eta^2 = 0.12$) and CD₃₆₁ demonstrated 14-22% less VHIR distance compared to WM₃₆₁ ($P < 0.01$, CI: 47, 258 m), DCM ($P < 0.05$, CI: 17, 214 m) and ACM₃₆₁ ($P < 0.01$, CI: 28, 252 m) ($\eta^2 = 0.21$). Moreover, Kruskal-Wallis tests showed that CD₃₆₁ and DCM₃₆₁ sprinted 32-34% less distance compared to WM₃₆₁ (all $P < 0.01$).

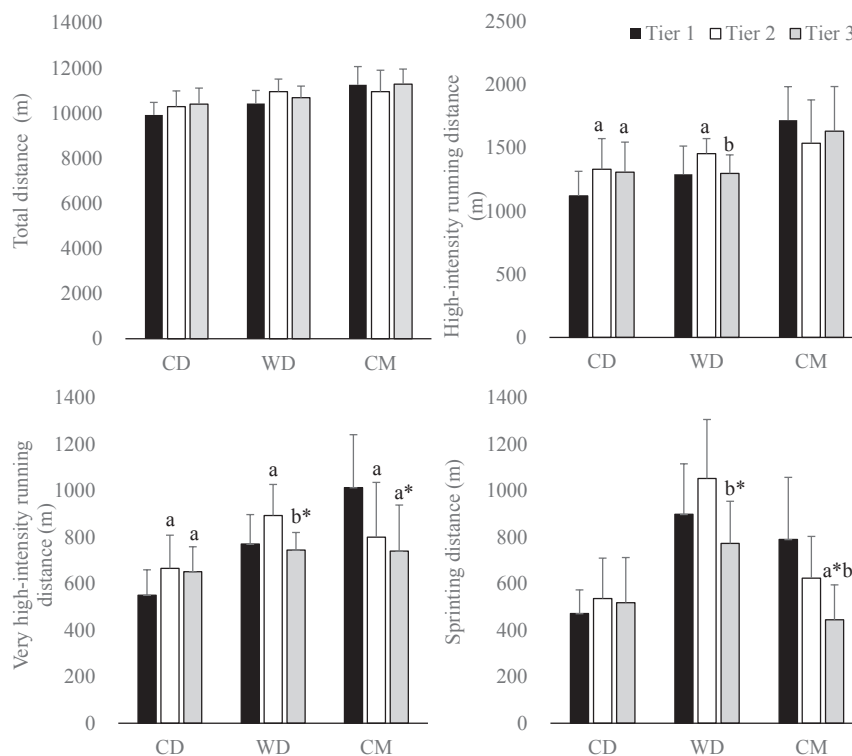


Figure 1. Match running distance across league standard and playing position in youth soccer players. Significantly different at $p < 0.05$ vs. a: tier 1, b: tier 2.

* $P < 0.01$. CD = central defenders, WD = wide defenders, CM = central midfielders.

When comparisons were made between similar playing positions in 4-4-2 and 3-6-1 formations, the YYIR2 score was not different in CD ($CD_{361} = 1027 \pm 241$ m), WD and WM ($WD_{442} = 1168 \pm 240$ m, $WM_{361} = 1107 \pm 239$ m), CM ($CM_{442} = 1120 \pm 269$ m, $ACM_{361} = 974 \pm 140$ m) and ST ($ST_{442} = 1109 \pm 302$ m, $ST_{361} = 1043 \pm 266$ m). For match running distance, CD_{442} covered 11-12% less HIR ($P < 0.01$, CI: 46, 262 m, $d = 0.7$) and VHIR ($P < 0.05$, CI: 14, 133 m, $d = 0.6$) distance than CD_{361} . CM_{442} demonstrated 7% greater total distance than DCM_{361} ($P < 0.01$, CI: 214, 1274 m, $\eta^2 = 0.17$). ST_{442} covered 6% greater total distance compared to ST_{361} ($P < 0.05$, CI: 4, 1142 m, $d = 0.8$). However, there were no differences in match running performance between WD_{442} , WM_{442} and WM_{361} .

DISCUSSION

The current study is the first to investigate match running performance of elite youth soccer players according to playing position in 4-4-2 and 3-6-1 formations. The key findings of the

current study were: 1) match running distance was playing position dependent in both 4-4-2 and 3-6-1 formations in elite youth soccer players; 2) greater between-playing position differences in match running distance was observed in 4-4-2 than 3-6-1 formation; and 3) match running distance differed between similar playing positions from the two formations especially in CD, CM and ST.

In the current study, the YYIR2 revealed that physical capacity was similar between all playing positions within 4-4-2 formation and within 3-6-1 formation. Moreover, the physical capacity was not different between the players when similar playing positions between 4-4-2 and 3-6-1 formations were compared. Given that physical capacity has been shown to strongly relate to match running performance, between-playing position differences does not seem to be due to differences in physical capacity in the current study (Francini et al., 2019; Rebelo et al., 2014). In addition, regardless of playing position and formation, running distance (total, HIR VHIR and sprint distance) of the players during a 90 min match was similar to that reported

by the previous studies on elite youth soccer players in similar age groups (Aquino et al., 2020; Buchheit et al., 2010; Goto and Seward, in press; Hunter et al., 2015; Seward et al., 2016; Varley et al., 2017).

In 4-4-2 formation, there were clear positional differences in match running performance which suggests independent positional roles and responsibilities and these were similar to those previously seen in elite youth players in 4-4-2 formation (Buchheit et al., 2010). In the current study, CD demonstrated the least total, HIR, VHIR and sprinting distance. This is possibly because their major aim is to defend their goal that their movements are restricted to certain strategic areas on the pitch (Buchheit et al., 2013). In contrast, WD are often required to take high and wide position to join attacking build-up play and this may have reflected on their greater VHIR and sprinting than CD and/or CM (Seward et al., 2016). CM showed the most total and HIR distance which is possibly due to their unique positional characteristics to link attack and defense within the team (Di Salvo et al., 2007). Conversely, CM sprinted the least distance. This is potentially because of a less space in central position on the pitch which limits their opportunities to attain high speeds on a regular basis (Seward et al., 2016). WM are often required to produce high-speed runs in order to create goal scoring opportunities which explains their high VHIR and sprinting distance (Faude et al., 2012). Similarly, ST sprinted a fairly long distance which suggests that travelling at high-speeds is required for tasks such as capitalizing on goal scoring opportunities (Faude et al., 2012).

In contrast to 4-4-2 formations, there were only a small number of differences in match running distance between playing positions in 3-6-1 formation. This is in line with a previous study on young professional soccer players where little between-playing position differences in match running performance was observed in 3-4-3 formation which is similar to 3-6-1 formation (Tierney et al., 2016). Similarly with

4-4-2 formation, CD showed the least VHIR and sprinting distance. However, the current results demonstrated that total match running distance was only different between CD₃₆₁ and ACM₃₆₁ by 600 m whereas CM covered more than 1 km compared to CD in 4-4-2 formation. Moreover, there were no between-playing position differences in HIR in 3-6-1 formation but 27% greater HIR distance was covered by CM than CD in 4-4-2 formation. These are interesting findings as CM are expected to cover the most total and HIR distance in 4-4-2 formation, possibly due to their role for linking attack and defense (Buchheit et al., 2010; Di Salvo et al., 2007). This may be explained by the fact that there are 4 CM in 3-6-1 formation and they are likely to be separating main parts of their attacking and defending roles. As expected, WM₃₆₁ demonstrated a greater VHIR and sprinting distance than CD₃₆₁ and DCM₃₆₁ which mimicked 4-4-2 formation. Although high intensity match demands of WM₃₆₁ was still high when it was compared to other playing positions within 3-6-1 formation, WM₃₆₁ could have expected to cover a much greater distance at high-speeds as there were only two players in wide areas in 3-6-1 formation opposed to four players in 4-4-2 formation. Therefore, 3-6-1 formation seems to provide less between-playing position differences in match running performance compared to 4-4-2 formation and this is possibly because positional roles and responsibilities between playing positions are different between the formations.

In CD, HIR and VHIR distance was greater in 3-6-1 formation compared to 4-4-2 formation in the current study. Such differences in match demands between the formations with three and four defenders were not reported by the previous study on young professional players who compared 4-4-2, 3-4-3 and 3-5-2 formations (Tierney et al., 2016). However, as 3-6-1 formation only have three defenders opposed to four defenders in 4-4-2 formation, CD₃₆₁ were possibly responsible to defend greater area than CD₄₄₂ and hence CD in 3-6-1 formation were more physically demanding than 4-4-2 formation. As match running distance

of CD differs between 4-4-2 and 3-6-1 formations in elite youth soccer, coaches and sports scientists are advised to be aware of the possible differences in match demands which players may face when the playing formation is changed during a match or between matches. Moreover, it is important for coaching staff to condition players to be able to cope with the changes in playing formation by providing appropriate training programs.

Interestingly, there were no differences in match running distance between WD and WM in 4-4-2 and 3-6-1 formations. Hence, the players who have regularly played either WD or WM in 4-4-2 formation are likely to be physically capable of playing WM in 3-6-1 formation. However, WM in 3-5-2 formation have been shown to decelerate more frequently than WD in 4-4-2 formation that coaches may need to be cautious when they put players who have been playing WD₄₄₂ in WM₃₆₁ (Tierney et al., 2016).

When CM from 4-4-2 and 3-6-1 formations were compared, the only differences observed was CM₄₄₂ covering 7% greater total distance than DCM₃₆₁. These findings are similar to the previous study which reported no differences in total distance and high-speed running distance during a match between CM in 4-4-2, 3-5-2 and 3-4-3 formations (Tierney et al., 2016). Moreover, little attention has been paid to total match running distance compared to high-speed running distance in elite youth soccer players as it does not differentiate playing standards (Goto et al., 2015; Saward et al., 2016; Varley et al., 2017). Hence, switching formation between 4-4-2 and 3-6-1 does not seem to require an extra consideration on physical match demands in CM especially in running distance at high-speeds. However, changing playing position to CM₄₄₂ from DCM₃₆₁ for the players who have regularly been playing DCM₃₆₁ may require some conditioning as CM₄₄₂ covered almost 1 km greater distance than DCM₃₆₁.

The current study demonstrated no differences in HIR, VHIR and sprint distance in ST between 4-4-2 and 3-6-1 formations but total match running distance was greater in ST₄₄₂ than ST₃₆₁.

Given that no differences in match running performance has been suggested in ST between 4-4-2 and 3-4-3 formations (Tierney et al., 2016), it is understandable that defensive duties for ST is possibly greater in 4-4-2 than 3-6-1 formation. Because the main role of ST₃₆₁ is probably waiting in high position and prepare for attack when teammates are defending as he is the only ST whereas one of ST₄₄₂ would probably have to drop back little deeper to help defending or to receive the ball for an instance when teammates win the ball back.

There are some limitations of this study which should be considered. Although the current study is the first to describe the influence of playing formation on match running performance in elite youth soccer players, no technical performance was included. Playing formation has been shown to influence technical performance in professional soccer players (Bradley et al., 2011) and technical performance has been reported to distinguish playing standards in youth soccer players (Figueiredo et al., 2009; Saward et al., 2019). Hence, it is important to examine influences of playing formation on match technical performance in elite youth soccer players. Moreover, contextual variables have recently been discovered to influence match running performance and the current study managed to control a few variables such as fixture congestion (one match in a week) (Jones et al., 2019), match location (Aquino et al., 2020; Castelano et al., 2011), and playing surface (Anderson et al., 2008; Brito et al., 2017; Vescovi & Falenchuk, 2019). However, match outcome (Aquino et al., 2020; Castelano et al., 2011; Vescovi & Falenchuk, 2019), opponent quality (Aquino et al., 2020; Varley et al., 2016) and opposition formation (Aquino et al., 2020) could not be fully controlled due to sample size.

The current study highlights match running performance of elite youth soccer players according to playing position in 4-4-2 and 3-6-1 formations. Both formations showed that match running performance is playing position dependent and 4-4-2 formation provides greater

between-playing position differences compared to 3-6-1 formation. Furthermore, match running performance of similar playing positions in 4-4-2 and 3-6-1 formations was not different between WD and WM but differences in HIR and VHIR distance was found in CD and total match running distance was different in CM and ST in the two formations. These novel information can potentially support coaches and sports scientists to produce playing position and formation specific training programs to prepare elite youth soccer players for match play.

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