Title: Team Formation has no effect on young footballers' match activity

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Abstract:

The purpose of this study was to examine the effect team tactical formation, playing position, and gender had on football match activity. Ten male and 10 female footballers under twelve years of age participated in three, sixty-minute full-sided 11 vs. 11 matches on a 100 x 65 m pitch. Significant differences in total distance (TD) covered (km) and percent of TD spent at various match intensities (walking, jogging, running, high-tempo and sprinting) according to player position were detected using cleat-embedded Adidas® miCoach accelerometer measurement ($p < 0.05$). Midfielders covered significantly greater TD compared to Defenders (4.66 ± .6 vs. 4.04 ± .4 km). Forwards' percent of TD at high-tempo (8.01 ± 2.10) and sprint intensities (3.68 ± 1.8) were significantly greater than midfielders (5.47 ± 2.27 and 1.80 ± 1.42%). Team tactical formation had no significant effect on match activity. These findings indicate that physical demands experienced by young footballers during match play like adult-elite level players are position-dependent and gender specific. Although, distance covered by youth players can be upwards 60% less than that of adult-elite level footballers. Positional training regimens that expose young footballers to match-like movement and intensity are important for individual player development and team performance.

Keywords: miCoach, Position, Soccer, Tactics, Youth

Introduction

Football is an extremely complex sport requiring sport specific-skills and physical fitness. Moments of a football match can be relatively relaxed and of a very mild intensity but can change almost instantaneously to maximal bursts of exercise. The changing back and forth in intensities, from high-intensity (running, sprinting, and cutting) to low intensity (walking, shuffling, jogging and standing) and vice versa over the course of a competitive match places a variety of physiological stresses on the athlete (Alexandre et al., 2012; Di Salvo et al., 2010). With the underlying objective of training being to improve both team and individual match performance, it is certainly necessary to accurately quantify athletes' in-game motor patterns, as this affords coaches the ability to modify and implement training regimens tailored to the precise requirements of each player and each tactical position in the sport.

Activity profiles of elite-level male and female football players have been extensively investigated (Andrzejewski, Chmura, Pluta, & Kasprzak, 2012; Bradley, Di Mascio, Peart, Olsen, & Sheldon, 2010; Carling, Dupont, & Le Gall, 2011). Reports on adult-professional footballers confirm variance in match activity according to players' playing position. On the contrary, the number of studies aimed at examining locomotion of youth football players is limited. Previous studies on young male and female footballers have not established whether positional differences in experienced match activity exist (Berg, LaVoie, & Latin, 1985; Capranica, Tessitore, Guidetti, & Figura, 2001; Castagna, D'Ottavio, & ABT, 2003). Football coaches' organization of players into unique team-tactical formation is important for implementation of a strategy conducive to optimizing players' performance and chance of winning. To the best of our knowledge no study has been published that specifically analyzes variations of in-game activity profiles of young footballers playing in different team-tactical formations. Therefore, the purpose of our study is to determine what effect alternative team-tactical approaches have on match activity profiles of youth football players playing different positions.

Material and methods

Participants

The Institutional Review Board of Georgia State University approved the present study. With parental permission, twenty youth football players under the age of 12, 10 boys and 10 girls, from a United States Youth Soccer Association (USYSA) affiliated club participated in this study. Participants' physical characteristics and prior football experience are outlined in Table 1.

Table 1 *All Footballers' playing experience and characteristics* (n=20)

	Male (n=10)	Female (n=10)
Age (yrs.)	12.1 ± 0.70	11.5 ± 0.52
Height (cm)	155.59 ± 8.84	149.12 ± 10.84
Weight (kg)	43.62 ± 7.49	40.93 ± 9.22
Body Mass Index	17.76 ± 2.30	13.68 ± 22.90
Football Experience (yrs.)	7.36 ± 1.84	7.04 ± 1.12

Club-level Football (yrs.)	3.82 ± 1.47	3.29 ± 0.96
Position (yrs.)	3.82 ± 2.03	3.17 ± 1.74
11 vs. 11 (yrs.)	1.55 ± 0.69	1.39 ± 0.58

Values are reported as means ± standard deviation

Overview of Study Design

Players were separated by gender to form two ten-a-side football teams with goalkeepers. Teams participated in three competitive football matches against the same team (gender-specific and of an equivalent playing ability). For each match, teams were instructed to play in three distinct yet, different team-tactical formations. Within each team-tactical formation subjects were assigned to a playing position. The distance (km) covered by each footballer during each match was measured using cleat-embedded accelerometers, Adidas® miCoach speed cells. Accelerometers were also used to detect precise location (venue, city, state, and country) and time length of match activity. The distance covered by footballers was examined by team-tactical formation played and individual playing position to assess for differences. Goalkeepers participated in match play but their match activity was excluded from analysis.

Pre-Experiment miCoach Accuracy and Reliability Protocol

Twenty players performed 1.6 km shuttle-run to examine Adidas miCoach accelerometer's distance measurement accuracy and reliability. Footballers were positioned at end line of 100 x 65 m pitch instructed to sit down and remove left soccer cleat as research assistants inserted miCoach accelerometer. At self-selected pace footballers completed sixteen consecutive 100 m runs back and forth across length of pitch. After shuttle-run completion players remained still at end line for three additional minutes. Assistants then removed and wirelessly synced accelerometers' data to Adidas miCoach software application for analysis.

Pre-Experiment Sprint Trial and Match Activity Zones

A sprint trial was used to determine each footballer's peak sprint-running velocity. Beginning at the end line of the soccer pitch (Peachtree Athletic Complex, Peachtree City, GA), a 36-meter distance was measured using Rolatape 32-EZ1-4 inch. single measuring wheel and marked by two markers. Each subject then completed five forty-yard maximal sprints with a minimum of a minute and a half of recovery between each sprint. Time (sec) to complete each sprint was measured using an Accusplit Survivor Stopwatch. Adidas® miCoach speed cell recorded the fastest sprint velocity for participating footballers. Footballers' 36 m sprint characteristics are listed in Table 2.

Each participant's peak sprint-running velocity was used to formulate individual running velocity dependent match activity zones (walking, jogging, running, high-tempo running, and sprint) specific to each footballer's current performance capacity. Prior to participation in football matches, Adidas® miCoach speed cells were manually programmed to accurately examine participants' match activities.

Table 2 *Footballers' 36 m Sprint Performance*

	Maximum Spring Velocity	Range
Footballers (km/hr.) (n= 19)	23.04 ± 2.80	18.70 – 28.70
Male (km/hr.) (n = 10)	24.80 ± 2.3	21 – 28.70
Female (km/hr.) (n = 9)	21.07 ± 1.8	18.70 – 23.70

Values are reported as means ± standard deviation

Football Matches

Participants were separated by gender to form two 11 vs. 11 football teams, male and female. Footballers of each team were grouped and organized according to playing position: Forward (F), Midfielder (MF), and Defender (D). Though two subjects participated as teams' Goalkeepers, data from these participants were excluded from study and analysis. Each team of footballers participated

in three sixty-minute competitive matches (no additional stoppage time) against the same opponent. Participants were given a minimum of 72 hours between each match for recovery. Particular attention was made in the selection of both research and non-research football teams to ensure competitiveness during matches. Footballers in the present study and their opposition played for the same club were similar in age, physical, and football-level playing ability. Final game scores for present study's matches suggest comparable level of play and competitiveness amongst teams was achieved.

For each of the three matches participants played in one of the following team tactical formations: 1) 4-4-2 (four D, four MF, two F) 2) 4-3-3 (four D, three MF, three F) 3) 4-5-1 (four D, Five MF, one F). Participants were instructed to not change playing position and team tactical formation during match play. Similarly, the opposing team's footballers were restricted to one playing position and one team tactical formation (4-4-2) for the full duration of all matches. No player substitutions were made in this study.

Prior to each football match, participants' miCoach speed cell's battery was removed and replaced with a new Lithium watch sized CR2032A battery to ensure optimal functioning of speed cell. After participation in thirty-minute warm up players located, sat, and removed left soccer cleat at assigned playing position within team's tactical formation. Research assistants placed personalized Adidas® miCoach accelerometers into the left sole of participating footballers' boots. Players then stood still for three additional minutes prior to kick-off, before licensed referees signaled for match action to begin. Upon completion of first half participants stood still for five minutes. This stoppage was implemented to enable a clear point of identification of actual playing time within the data collected for each footballer. Participants' food and fluid consumption prior to matches and at half time was ad libitum. Teams switched halves on the pitch and match action resumed after a 10- minute half-time period. After the second half period participants remained still as research assistants collected

speed cells. Match data was immediately synced and uploaded to an online database using a laptop computer and mobile "hotspot" connection.

Measurements during Experimental Trials

Footballers' Adidas® miCoach accelerometer measured the total distance (TD) in kilometers (km) covered and number of sprints performed by participants in football matches. Adidas® miCoach software and online application computed the percent (%) of total distance spent walking, jogging, running, high-tempo running and sprinting by each footballer over the course of each match. Participants' activity data for each match was retrieved and collected for analysis.

Statistics

One-sample t-test was used to determine whether distance measurement of subjects' miCoach accelerometer were different to known 1.6 km distance. MANOVA and Hotelling's trace statistic were used to examine position (F, MF, and D) and team tactical formation (4-4-2, 4-3-3, 4-5-1) effects on multiple match activity variables for each experimental match. Bonferroni post hoc tests were conducted to discern significant positional differences among measured match activity variables after adjusted means. Results were considered significant at $p < 0.05$. All statistical analyses were performed using SPSS Statistics Version 22.

Results

Mean miCoach accelerometer pre-experiment shuttle-run distance measurement ($1.69 \pm .08$) was significantly higher than the known distance of 1.6 km ($p < 0.005$). Footballers' mean total distance covered, percent of TD spent walking, jogging, running, performing high-tempo exercise, sprinting and total number of sprints performed during the three experimental matches are outlined in Table 3.

Table 3 *All footballers match activity profile (n = 20)*

	Mean ± SD
Total Distance (km)	4.36 ± .60
% Walking	46.44 ± 6.70
% Jogging	30.43 ± 5.90
% Running	14.51 ± 3.30
% High-Tempo Run	6.10 ± 2.50
% Sprinting	2.44 ± 1.70
Total Number of Sprints	10 ± 5.10

Values are reported as means ± standard deviation

The main finding of this study was that playing position had a significant effect on the total distance covered, % of TD spent walking, jogging, running, at high-tempo, sprinting as well as the total number of sprints performed ($p = 0.003$). Midfielders covered a significantly greater total distance than defenders ($p < 0.05$). The total number of sprints performed by forward players was significantly greater than both midfielders and defenders ($p < 0.05$). Likewise, forwards' percent of total distance spent exercising at high-tempo and sprinting intensities ($p < 0.05$) were significantly greater than midfielders, but not defenders. Midfielders' percent of total distance spent jogging was significantly greater than defenders ($p < 0.05$). Defenders' percent of total distance spent walking was significantly more than forwards and midfielders ($p < 0.05$). Defenders percent of total distance at a running intensity was also significantly less compared to forwards and midfielders ($p < 0.05$).

Table 4 *Playing position effect on match activity*

	Forwards (n=12)	Midfielders (n = 20)	Defenders (n= 24)
Total Distance (km)	4.38 ± .30	4.66 ± .6*	4.04 ± .40
% Walking	43.56 ± 7.50*	44.43 ± 6.40*	49.88 ± 5
% Jogging	28.89 ± 5.50	32.85 ± 7.20#	28.77 ± 3.70
% Running	15.85 ± 3.50*	15.45 ± 2.80*	12.89 ± 3
% High-Tempo Run	8.01 ± 2.10^	5.47 ± 2.27	5.99 ± 2.40
% Sprinting	3.68 ± 1.80^	1.80 ± 1.42	2.45 ± 1.70
Total Number of Sprints	14.25 ± 4 **	8.33 ± 5.10	9.54 ± 4.60

Values are reported as means ± standard deviation. * Denotes statistical significance from Defenders ($p \leq 0.05$). ^ Denotes statistical significance from Midfielders ($p \leq 0.05$). ** Denotes statistical significance from Midfielders and Defenders ($p \leq 0.05$). # Denotes statistical significance from Defenders ($p \leq 0.05$).

Table 5 *Gender Differences in Match Activity (n = 60)*

	Male (n = 30)	Female (n= 30)
Total Distance (km)	4.69 ± .50*	4.03 ± .40
% Walking	44.80 ± 7.20	48.08 ± 5.80
% Jogging	32.89 ± 7.10*	27.97 ± 3
% Running	14.72 ± 3.90	14.29 ± 2.50
% High-Tempo Run	4.95 ± 2.30	7.41 ± 2
% Sprinting	2.63 ± 1.90	2.24 ± 1.60
Total Number of Sprints	10.17 ± 5.20	9.83 ± 5.20

Values are reported as means ± standard deviation. * Denotes statistical significance ($p \leq 0.05$).

Male footballers covered a significantly greater total distance compared to their female counterparts ($p < 0.05$). Males' percent of total distance spent at jogging intensity was nearly 5% greater than that achieved by females ($p < 0.05$). In contrast, female footballers covered 2.5% more total distance at high-tempo exercise intensity ($p < 0.05$). Gender differences in match activity are summarized in Table 5.

Team tactical formation had no significant effect on match activities ($p = 0.89$).

Table 6 Team Tactical Formation effect on Match Activity

	4 – 4 - 2 (n = 20)	4 – 3 - 3 (n= 20)	4 – 5 – 1 (n=20)
Total Distance (km)	4.30 ± .55	4.43 ± .50	4.34 ± .62
% Walking	46.10 ± 6.67	46.96 ± 6.52	46.25 ± 7.07
% Jogging	30.75 ± 7.17	30.57 ± 5.81	29.97 ± 4.86
% Running	14.20 ± 2.88	12.47 ± 3.02	13.10 ± 3.30
% High-Tempo Run	6.27 ± 2.45	5.99 ± 2.41	6.29 ± 2.64
% Sprinting	2.68 ± 1.83	2.18 ± 1.48	2.46 ± 1.87
Total Number of Sprints	10.50 ± 5.33	9.75 ± 5.00	9.75 ± 5.13

Values are reported as means ± standard deviation

Discussion

The effect of playing position on match activity in adult elite-level football players has been previously documented (Andrzejewski et al., 2012; Dellal, Wong, Moalla, & Chamari, 2010). However, previous investigations have failed to address the role of team tactical formation and positional differences in match activity of young footballers (Barbero-Álvarez, Gómez López, Barbero Álvarez, Granda, & Castagna, 2008; Castagna et al., 2003). The present study's main contribution was that significant variation in exercise intensity and load during match competition according to playing position also occurs at the youth level. Despite difference in match length and field dimension, youth footballers seem to cover less distance during match play than their adult-elite level counterparts who on average cover 11-12 km (Andrzejewski et al., 2012; Dellal, Wong, Moalla, & Chamari, 2010). Coaches' understanding and acknowledgement of how match activity varies depending on footballers' playing position can aid development of youth footballers.

The primary aim of many football clubs' academy program is youth player development. It is important that coaches' be knowledgeable of the changes in physical work during match play that occur as youth footballers mature into adult-elite level players. A more detailed understanding of match activity could result in improvements in current training, player selection, and talent identification processes. Coaches' decisions to match footballers' current physiological make up to a specific playing position could further elicit improvements in both individual and team tactical performance.

Talent evaluation in football can be subjective, with opinions varying from coach to coach. Selection of young footballers' readiness for higher-level football should become more calculated by integration of match activity analysis with football expert opinion. In doing so footballers routinely

displaying the tactical awareness, technical ability alongside the work capacity necessary to match the demands of higher level football will be more efficiently recognized and justifiably promoted (Gil, Gil, Ruiz, Irazusta, & Irazusta, 2007; Meylan, Cronin, Oliver, & Hughes, 2010). Taken into consideration that many footballers are often developed playing one position it is possible that players from young age become physiologically accustomed to movement patterns specific to a particular position, of which could potentially hinder some footballers' ability to adapt to a new playing positions and ability carry out new tactical assignments. Coaches and footballer trainers alike should consider the time needed for footballers' to properly adapt to unfamiliar physical demands of a new position.

A thorough understanding of football match activity at the youth level has yet to be attained. There is evidence to confirm gender differences in football match activity. U-12 male Italian footballers covered on average 6.5 km of total distance during match play (Castagna et al., 2003). The total distance, 4 km, completed during match play by female football players in this study was strikingly consistent to that accomplished by Brazilian female footballers of similar age (Barbero-Álvarez et al., 2008). In the present study, male footballers covered a greater total distance, roughly 0.5 km more than their age-matched female counterparts. Two previous studies assessed various match activity intensities using the same exact velocity-based intensity categories to examine match activity in young male and female footballers (Barbero-Álvarez et al., 2008; Castagna et al., 2003). On the contrary, to control for individual age, gender, and potential maturation driven differences in running performance between participating footballers the present study instead implemented individualized velocity-dependent intensity categories based on footballers' individually measured maximum speed. Inconsistency amongst reported total distance covered and relative match intensity of youth footballers may be attributed to overall level of play including differences technical quality, football ability, pitch dimensions, physical fitness of researched teams and their opponents. Discrepancies in measurement of activity due to technological overestimation or underestimation also remain a possibility.

This investigation is one of the first to explore the interaction between team tactical formation and football match activity. Team tactical formation had no statistically significant effect on youth footballers' match activity. Three specific team tactical formations 4-4-2, 4-5-1, and 4-3-3 were examined, however some coaches' preference may be to utilize other team strategic formations such as a 3-5-2 or 5-4-1 during match play of which were not explored in this study. The level of tactical understanding and experience of the footballers in the present study may be a limiting factor. Footballers of higher quality and more experience are better equipped to carry out and maintain coaches' team strategy during matches. For this reason, more research on footballers of various ages, levels, and ability is recommended to better interpret team tactical formation's influence on match activity.

Conclusions

This investigation found that team tactical formation had no measurable effect on young footballers match activity while playing position did. Males cover greater distances during match play than females, respectively, highlighting that football match tempo and activity also differs by gender. While less than adult-elite level players, total distances covered in the present study are similar to those seen in other studies on young footballers. In conjunction with regular team-oriented practice, individualized physical fitness training sessions according to playing position may be a helpful in aiding coaches' preparation and development of footballers.

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