Original Article

Influence of team success, fixture congestion and playing position on physical performance of elite youth soccer players during an international tournament

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ABSTRACT

The purpose of the present study was to examine the influence of team success, fixture congestion and playing position on physical performance of elite youth soccer players during an international tournament. Physical match data was collected from 22 matches for U17 soccer players (n = 112) across 12 clubs during the play-off stage of the 2015-2016 Future Talents Cup International tournament. Match data was collected using a GPS device for physical performance measures across different positions, level of team success and during match congestion (MD1, MD 2 and MD3). The top ranked teams produced significantly higher total and low speed running distances compared to bottom ranked teams ($p < .05$). Players covered significantly more total distance and PlayerLoad™ on MD1 compared to MD2 and MD3 ($p < .05$). High speed distance output remained unaffected during this period of match congestion. Central defenders were found to have the lowest output across physical performance variables compared to all other positions ($p < .05$). Wide players (WD and WM) produced the greatest outputs at higher speed distances compared to other positions ($p < .05$). Therefore, the present study revealed that teams who had higher levels of success produced greater physical outputs compared to those of lower rankings. Match congestion resulted in a reduction in total and lower speed distances covered. Finally, differences in physical demands across playing positions was evident. Coaches should be aware of the implications of fatigue during periods of fixture congestion and the individual positional requirements for youth soccer players.
Keywords: GPS; Football; Match play; Position; Time motion analysis.

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INTRODUCTION

Soccer is a highly demanding intermittent sport that is characterized by short bouts of high intensity activity interspersed with low intensity recovery periods (Di Salvo et al., 2009). Recent research has found that high intensity running outputs during elite level match play have increased by approximately a third during the past decade (Barnes et al., 2014). Whilst some of this variance in physical output can be explained by the contextual variation of match play (Gregson et al., 2010), it could be suggested that the physical requirements of professional soccer players has increased in recent times. Aerobic energy production has been suggested to account for ~90% of the total energy consumption during match play, with only ~10% anaerobic in nature (Bangsbo, 1994). Whilst the majority of the match is spent in this aerobic state, the key performance actions in soccer (e.g. goal scoring) has been attributed to actions that are predominantly anaerobic in nature (e.g. sprinting) (Faude et al., 2012). Therefore, it is important that practitioners are able to fully comprehend the recent changes in physical output during match play in order to appropriately condition players to cope with these demands.

The long term athlete development (LTAD) of youth soccer players is a complex phenomenon that aims to optimize athletic development throughout childhood and adolescence (Cetolin et al., 2019). It has been suggested that the gradual and systematic progression of overall load placed upon youth athletes in respect to stress and recovery will aid this process (Vaeyens et al., 2008). Elite youth soccer players are often involved in multiple competitions both domestically and internationally during a competitive season. Particularly with international soccer tournaments, players are subjected to congested fixture schedules in which they are expected to play multiple matches within the space of several days (Zanetti et al., 2018). This type of competition format may place high physical strain on the players and potentially limit physical output during match play. Match play physical load is an important aspect of the LTAD model within soccer, with previous research suggesting that an imbalance between stress and recovery may hinder physical adaptation across a competitive season (Noon et al., 2015). Therefore, further understanding of the external demands of match play during elite youth soccer tournaments may help coaches to adapt physical preparation and recovery planning in relation to the demands.

There are several previous studies that have attempted to quantify the external match play demands of mid-late adolescent youth soccer players using either global positioning systems (GPS) (Brito et al., 2017; Buccheit et al., 2010; Goto et al., 2015; Al Haddad et al., 2015; Harley et al., 2010; Hunter et al., 2015; Mendez-Villanueva et al., 2013; Saward et al., 2016; Zanetti et al., 2018) or video-based tracking technologies (Aslan et al., 2012; Pereira Da Silva el al., 2007; Rebelo et al., 2014; Sporis et al., 2017; Varley et al., 2018). This research has revealed that central defenders cover the least amount of both total and high intensity distance during match play compared with other positions (Brito et al., 2017; Buchheit et al., 2010; Mendez-Villanueva et al., 2013; Varley et al., 2018). When analysing the influence of team success on physical performance outputs, previous research has found that less successful teams cover less sprint distance compared to more successful teams (Varley et al., 2017). One major limitation the current literature in the area is due to the use of outdated technology (e.g., 1-Hz and 5-Hz GPS units) as the main source of external match play data collection. There is also limited research available on match play demands during international youth tournaments when the players face congested fixture schedules during this time (Varley et al., 2017; Zanetti et al., 2018). Since the International Football Association Board (IFAB) decided to allow the use of wearable technology in official soccer matches, this provides opportunity to further understand the demands during elite youth soccer tournaments using the latest wearable tracking technologies.

The purpose of the present study was to evaluate physical match performance during an elite international youth soccer tournament. Specifically, the study aimed to evaluate the match demands based on position, match fixture congestion and team success.

METHODS

Participants and match data

Physical match data was collected from 22 matches for U17 soccer players (n = 112) across 13 clubs during the play-off stage of the 2015-2016 Future Talents Cup International tournament held in April 2016. Due to issues with data collection from one club, the data was removed from final analysis (i.e., leaving 12 clubs' data in total). The tournament consisted of elite soccer clubs from a variety of leagues including Austrian, Belgian, Bosnian, Croatian, Czech, Dutch, Hungarian, Italian, Polish, Serbian, Slovak, Slovenian and Ukrainian teams. All matches were played on a 105x67m artificial 3G pitch. All teams played 3 matches on 3 consecutive days during the play-off stage. The match format consisted of 2 x 35-minute halves of match play. An overview of the tournament structure is shown in Figure 1.

Match data was collected using a GPS device (firmware version v727, Optimeye S5, Catapult Sports, Melbourne, Australia) worn in the manufacturers custom-made garment positioned between the scapula. The device has previously shown acceptable levels of reliability (Thornton et al., 2018) and validity (Roe et al., 2017) for velocity-based metrics and also accelerometer-derived data (Nicolella et al., 2018). The data collection process was in accordance to the recommended guidelines for the use of GPS data in sport (Malone et al., 2017). The minimum effort duration to detect velocity was set at 0.4 seconds across all data files. GPS data were downloaded using the manufacturer's software (Catapult Sprint, version 5.1.7; Catapult Sports). The study was approved by the local ethics committee and conformed to the recommendations of the Declaration of Helsinki.

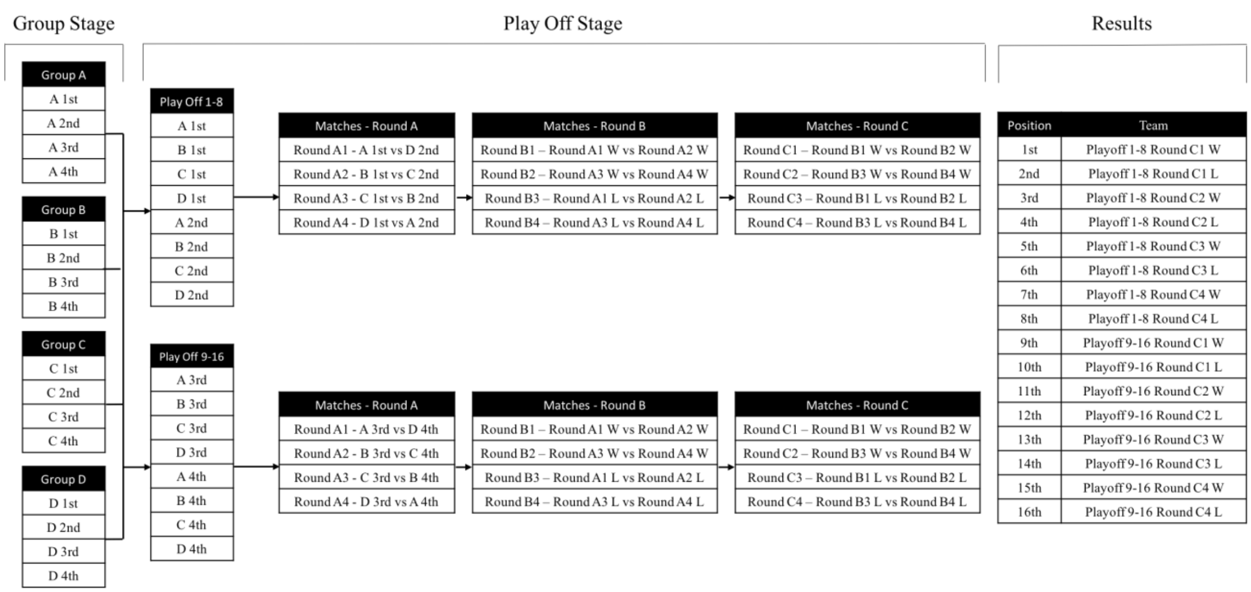


Figure 1. Schematic representation of the tournament structure including both the group and play off stages.

Positional analysis

In order to determine any positional differences in physical performance, individual player data were analysed for players based on the following positions: wide defender (WD; n = 28), central defender (CD; n = 27), wide midfielder (WM; n = 16), central midfielder (CM; n = 31) and attacker (ATT; n = 10). Data was only included for players who completed the full match duration across both halves. Goalkeepers were excluded from the data analysis.

Influence of team success

To determine the influence of team success on physical performance, teams were separated into 3 groups based on their final rank in the tournament: top (rank 1–4, teams reached the final or 3rd place play-off), middle (rank 5–8, teams did not successfully progress past the quarter finals) and bottom (rank 9–12, teams did not progress past the group stage).

Influence of match fixture congestion

In order to determine the influence of match fixture congestion on physical performance across the 3 day data collection period, data was separated and analysed for each of the 3 matches played in succession (i.e., match day 1 (MD1), match day 2 (MD2) and match day 3 (MD3)).

Physical performance measures

Player physical match data were reported as total distance (TD), low speed running distance (LSR; < 14.4 km/h), high speed running (HSR; > 14.4 km/h), very high speed running distance (VHSR; > 19.8 km/h) and sprint distance (SPR; > 25.2 km/h) (Di Salvo et al., 2009; Varley et al., 2017). All distances were expressed in absolute terms (m). In addition, PlayerLoad™ (au) was reported based on the triaxial accelerometer data that measures the instantaneous change in acceleration (Barrett et al., 2014).

Statistical analysis

All data are presented as mean ± standard deviation (SD). Data normality was checked and verified using the Kolmogorov–Smirnov test. Analysis were performed for all physical performance measures using a generalised linear mixed model using the statistical package for the social sciences (SPSS, version 24, SPSS Inc, Chicago, IL, USA). To determine any positional differences in physical performance measures, analysis was performed using player position as a fixed main effect (CD, WD, CM, WM and ATT). A random effect for each player and match was included. To determine the influence of team success, separate analyses were performed using the final rank of the team (top, middle, bottom) as fixed main effects. To determine the effect of match fixture congestion, separate analyses were performed across the 3 consecutive matches (MD1, MD and MD3) as fixed main effects. A random effect for team and for each match was included in the model. If there was a significant main effect, post hoc analysis (Tukey's HSD) was carried out to examine where the difference occurred. Effect size (ES), according to Cohen's d (Cohen, 1988), was calculated to determine the meaningfulness of the difference across physical performance variables. The magnitude of d was classified as trivial (< 0.2), small (0.2-0.6), moderate (0.6-1.2), large (1.2-2.0) and very large (> 2.0) (9). The level of significance was set at $p < .05$. Confidence intervals (95% - CI) are provided for mean differences.

RESULTS

Positional differences in physical performance

Physical performance measures for each position are presented in Figure 2. CD players covered significantly less total distance compared to CM (ES = 1.55, *large*; CI = -694 to -1455 m), WD (ES = 0.86, *moderate*; CI = -207 to -1005 m) and WM (ES = 1.01, *moderate*; CI = -191 to -1149 m) players (p < .05). CM players covered significantly more total distance compared to WD (ES = 0.65, *moderate*; CI = 91 to 846 m) and ATT (ES = 0.88, *moderate*; CI = 32 to 1261 m) players (p < .05). CM players also covered significantly more LSR distance compared to CD (ES = 1.35, *large*; CI = 339 to 860 m), WD (ES = 1.05, *moderate*; CI = 202 to 719 m), WM (ES = 1.08, *moderate*; CI = 161 to 792 m) and ATT (ES = 1.57, *large*; CI = 252 to 1093 m) players (p < .05). CD players covered significantly less HSR distance compared to WD (ES = 1.12, *moderate*; CI = -220 to -650 m), CM (ES = 1.17, *moderate*; CI = -284 to -689 m), WM (ES = 1.52, *large*; CI = -296 to -814 m) and ATT (ES = 1.25, *large*; CI = -169 to -869 m) players (p < .05).

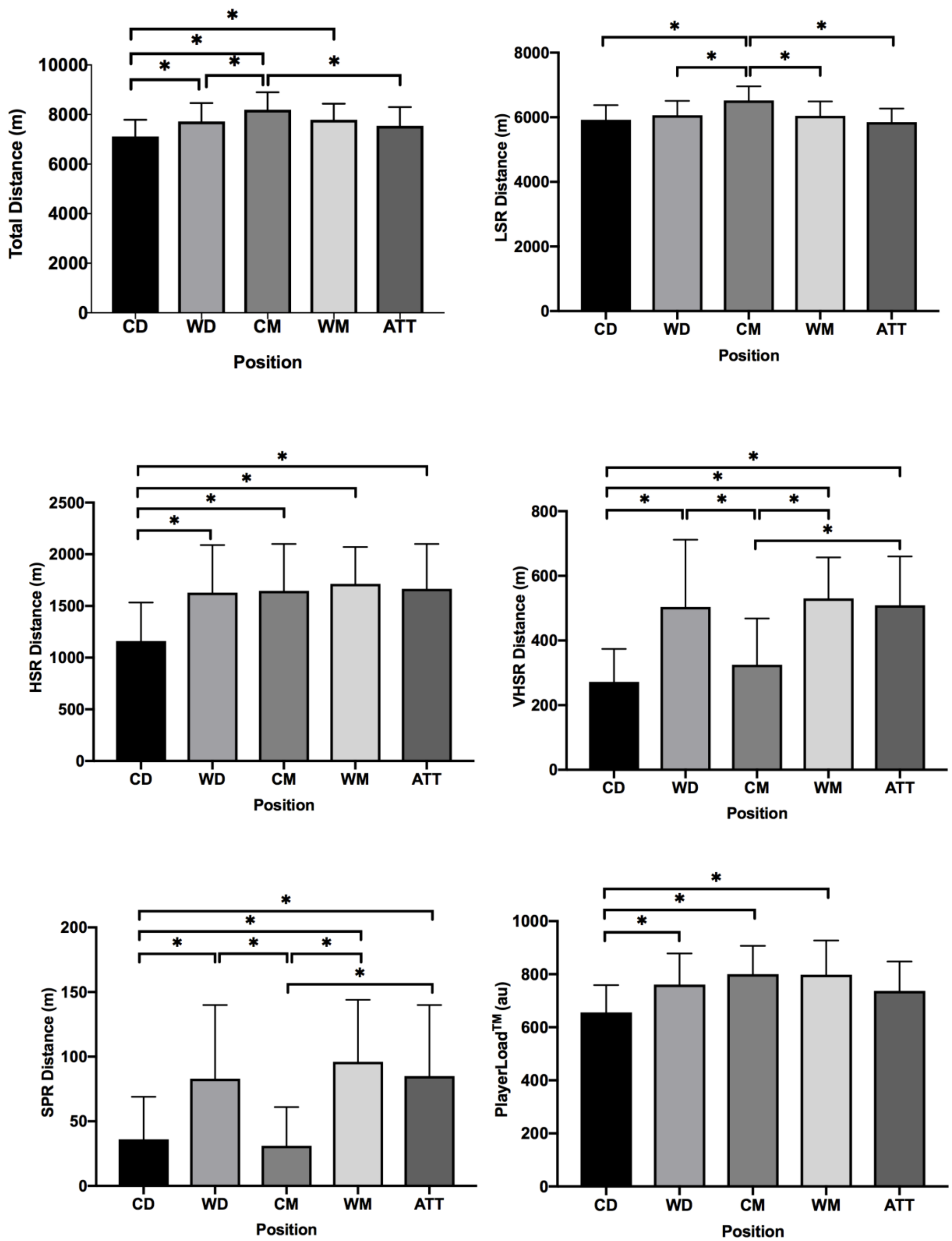
CD players covered significantly less VHSR distance compared to WD (ES = 1.41, *large*; CI = -123 to -286 m), WM (ES = 2.24, *very large*; CI = -156 to -353 m) and ATT (ES = 1.84, *large*; CI = -90 to -356 m) players. In addition, CM players also covered significantly less VHSR distance compared to WD (ES = 1.00, *moderate*; CI = -74 to -229 m), WM (ES = 1.52, *large*; CI = -107 to -297 m) and ATT (ES = 1.25, *large*; CI = -40 to -301 m) players (p < .05). CD players covered significantly less SPR distance compared to WD (ES = 1.01, *moderate*; CI = -17 to -61 m), WM (ES = 1.46, *large*; CI = -26 to -80 m) and ATT (ES = 1.08, *moderate*; CI = -2 to -75 m) players (p < .05). In addition, CM players also covered significantly less SPR distance compared to WD (ES = 1.14, *moderate*; CI = -22 to -64 m), WM (ES = 1.62, *large*; CI = -32 to -83 m) and ATT (ES = 1.22, *large*; CI = -7 to -78 m) players (p < .05). CD players had a significantly lower PlayerLoad™ compared to WD (ES = 0.95, *moderate*; CI = -40 to -170 au), CM (ES = 1.37, *large*; CI = -82 to -207 au) and WM (ES = 1.22, *large*; CI = -64 to -221 au) players (p < .05).

Influence of team success on physical performance

The influence of team success (i.e., final tournament ranking) on physical performance measures are presented in Figure 3. Teams who finished in the top group covered significantly more total distance compared to the bottom group (ES = 0.54, *small*; CI = 67 to 846 m; p < .05). The top group covered significantly more LSR distance compared to both the middle (ES = 0.66, *moderate*; CI = 68 to 549 m) and bottom (ES = 0.56, *small*; CI = 32 to 530 m) groups (p < .05). The bottom group covered significantly less VHSR (ES = 0.45, *small*; CI = -5 to -160 m) and SPR (ES = 0.56, *small*; CI = -2 to -42 m) distance compared to the middle group (p < .05). There were no differences found between team ranking groups for HSR distance and PlayerLoad™ (p > .05).

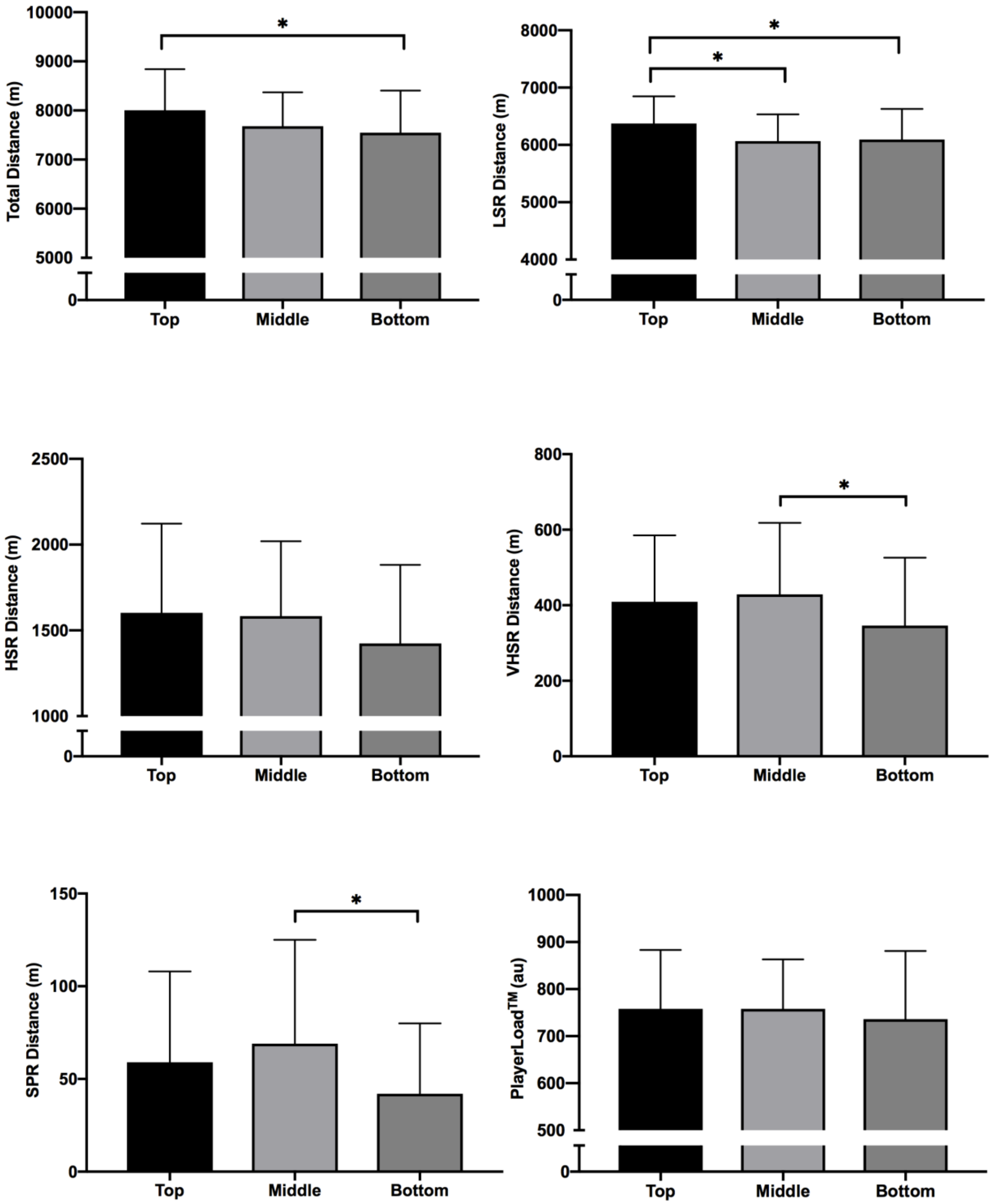
Influence of match fixture congestion on physical performance

The influence of match fixture congestion across the 3 consecutive matches on physical performance measures are presented in Figure 4. Players covered significantly more total distance on MD1 compared to MD2 (ES = 0.54, *small*; CI = 66 to 762 m) and MD3 (ES = 0.62, *moderate*; CI = 162 to 845 m) (p < .05). Players also covered significantly more LSR distance on MD1 compared to MD2 (ES = 0.45, *small*; CI = 2 to 429 m) and MD3 (ES = 0.68, *moderate*; CI = 133 to 553 m) (p < .05). Players also recorded significantly higher PlayerLoad™ values on MD1 compared to MD3 (ES = 0.57, *small*; CI = 10 to 124 m) (p < .05). There were no differences found across match days for HSR, VHSR and SPR distance covered (p > .05).



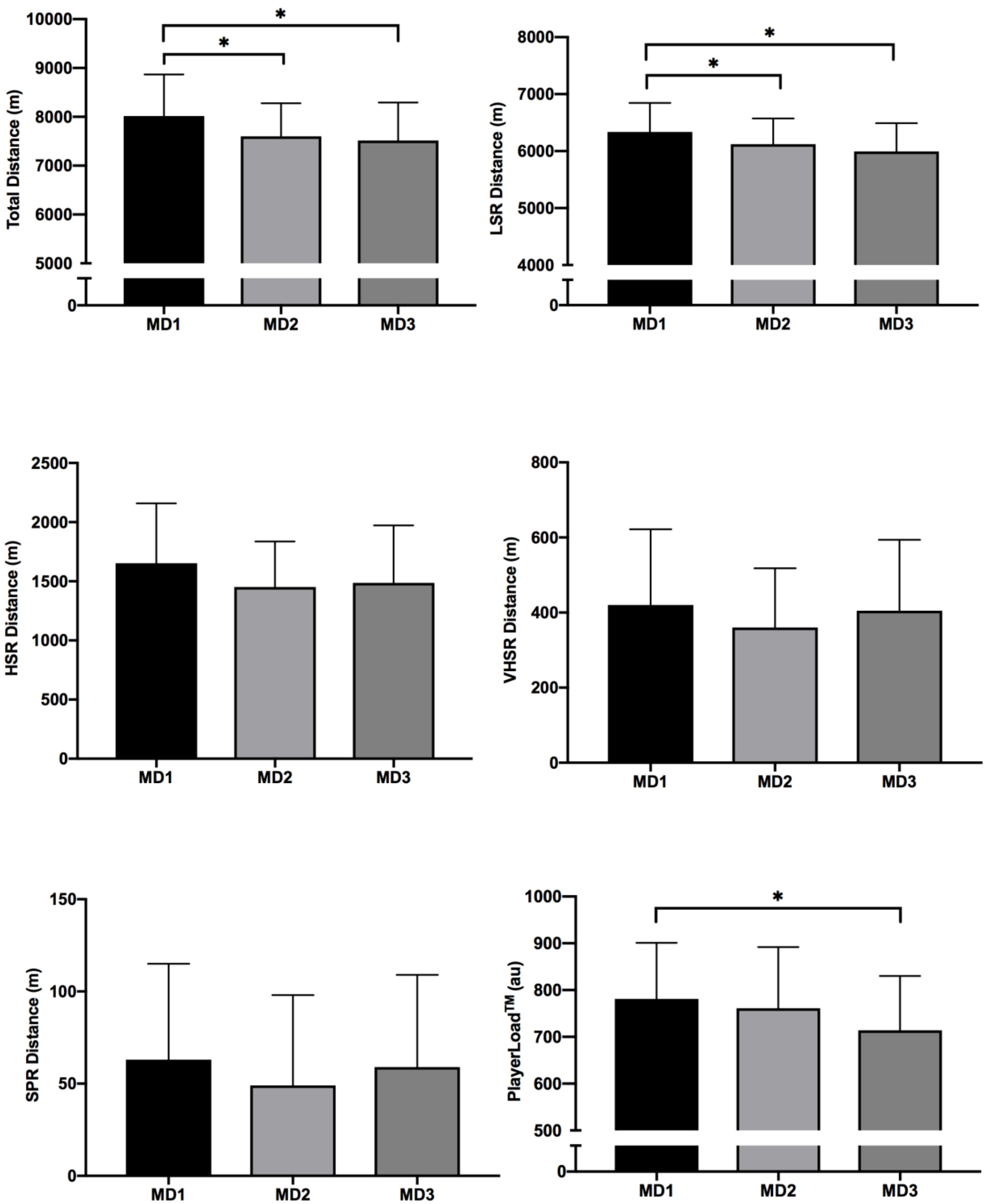
*Note: * Indicates significant difference between positions.*

Figure 2. Positional differences in physical performance measures across full matches (mean ± standard deviation).



*Note: * Indicates significant difference between groups.*

Figure 3. Physical performance measures relating to the influence of team success in the international cup tournament.



*Note: * Indicates significant difference between match days.*

Figure 4. Physical performance measures relating to the influence of match fixture congestion across 3 consecutive matches.

DISCUSSION

The present study evaluated the physical match performance of elite youth soccer players during an international tournament. The main finding of the study was that the teams who had higher levels of success in the tournament (i.e., higher final ranking) produced greater physical outputs at both low and high speed distances. Match fixture congestion resulted in a decrease in total distance, LSR distance and PlayerLoad™ across the 3 consecutive matches. However, high speed distance output remained unaffected during this period of fixture congestion. Finally, CD players produced the lowest physical output compared to all other positions, with wide players (WD and WM) producing the greatest outputs at higher speed distances.

Varley et al (2017) investigated the physical and technical performance of youth soccer players during an international tournament. The authors found that top ranked teams produced moderately higher total sprint distance compared to middle and bottom ranked teams. This partially agrees with the findings of the present study in which the bottom ranked teams covered significantly less VHSR and SPR compared to the middle ranked group. However, our data revealed no difference between the top and bottom ranked teams in the youth soccer tournament. It must be acknowledged that soccer match play involves several contextual factors that may subsequently influence physical performance. Examples of such factors include match location, opposition quality and match status (Castellano et al., 2011; Lago-Penas et al., 2011; Lago et al., 2010; Rampinini et al., 2009). Previous research has found that more successful soccer teams have higher overall match ball possession percentages compared to less successful teams (Collet, 2013). Rampinini et al (2009) found that more successful teams produced significantly more physical output when in possession of the ball. However, when also including out of possession physical output, higher ranked teams cover a lower amount of both total distance and high speed distance compared to bottom ranked teams (Rampinini et al., 2009; Di Salvo et al., 2009). This may be due to lower ranked teams having to chase the ball in order to retain possession, whilst the successful teams are able to keep possession and concentrate their physical efforts in offensive situations. Due to a lack of technical variables measured in the present study, it is unclear whether team tactics may have influenced physical output. However, our data would suggest that in order to be successful at international youth tournaments, players need to produce higher physical performance output.

One of the main findings from the present study was that elite youth soccer players produced lower physical performance outputs (total distance, LSR distance and PlayerLoad™) during fixture congestion across 3 consecutive matches. This finding disagrees with previous research that revealed no differences when comparing both regular and congested match periods (Zanetti et al., 2018) and also across a youth soccer tournament (Arruda et al., 2014). This was despite both of these previous studies quantifying physical performance output from 5 games within a 3-day period (i.e., even greater match play physical demands). The differences in findings may be due to the present study quantifying physical performance output across all teams playing in the tournament, whereas previous research has adopted a case study approach from a single club (Arruda et al., 2014; Zanetti et al., 2018). When evaluating congested fixture periods in senior soccer players, previous research shows that physical performance generally remained unaffected during these periods (Carling et al., 2012; Dellal et al., 2015; Djaoui et al., 2014). Varley et al (2018) found no difference in higher speed distances covered across 3 consecutive matches within an U23 international soccer tournament which disagrees with our findings. However, in these previous studies the players had a minimum of 72h of recovery between matches which may have allowed sufficient recovery for players to maintain physical performance outputs. Therefore, the observed reduction in physical performance output in the present study may be due to a lack of recovery time available between matches played. Previous research has highlighted the hinderance in physical adaptation across a competitive youth soccer season if an imbalance between stress and recovery occurs (Noon et al., 2015).

Similar to previous research in youth soccer match play, CD players in the present study reported the lowest values for total distance (Mendez-Villanueva et al., 2013) and high speed distance activities (Andrzejewski et al., 2009; Brito et al., 2017; Buccheit et al., 2010; Varley et al., 2017). In addition, WM and ATT players covered the highest amount of higher speed distances which is also in line with previous research (Buccheit et al., 2010; Al Haddad et al., 2015). In terms of accelerometer-based loading (i.e., PlayerLoad™) across positions, CD players were found to have the lowest total values compared to all other positions apart from ATT players. This is in agreement with previous research in youth soccer match play, albeit over 90 mins compared to 70 mins in the present study (Barron et al., 2014). Understanding the positional demands of youth soccer players is important to help inform training practices for development of position-specific training regimens (Ade et al., 2016). The present study adopted arbitrary speed thresholds in order to quantify the low and high intensity demands of youth soccer match play which is common practice amongst practitioners. However, the absence of standardization in speed thresholds and use of the same technology directly makes comparisons across the literature difficult. There is also an argument that thresholds, particularly for youth athletes, should be individualised based on physiological markers (Hunter et al., 2015). Therefore, future research should aim to establish standardized thresholds and methods across different youth soccer age groups within match play.

The main limitation of the present study is the lack of technical data in order to further understand the contextual interaction between physical performance output and tactical information (Bradley et al., 2018). This is one of the main advantages of using camera-based tracking systems during match play, as they provide both physical and technical data together. However, such systems can be expensive for teams, particularly for those in the lower leagues with limited budgets. Therefore, GPS devices offer a practical alternative to collect physical performance data on a daily basis during both training and match play. The use of GPS devices in the present study provided a novel insight into the accelerometer-based demands (i.e., PlayerLoad™) which is unavailable when adopting camera-based optical tracking systems. The players in the present study wore heart rate belts during match play in order to also quantify the internal load response to the external load. Unfortunately, due to inconsistency in both player adherence and poor quality data (i.e., data file drops out), we excluded this data from the study. Anecdotally, players appear to have an issue when wearing heart rate belts during match play, particularly at senior level. Therefore, the introduction of GPS vests that house the heart rate belt within the vest without the need for the strap around the body will hopefully help improve player adherence and data quality in future studies.

In conclusion, the present study revealed that teams who had higher levels of success in the international youth soccer tournament produced greater physical outputs compared to those of lower rankings. Match fixture congestion resulted in a decrease in total distance, LSR distance and PlayerLoad™ across the 3 consecutive matches. However, high speed distance output remained unaffected during this period of fixture congestion. Finally, CD players produced the lowest physical output compared to all other positions, with wide players (WD and WM) producing the greatest outputs at higher speed distances.

PRACTICAL APPLICATIONS

The present findings would suggest that in order for youth teams to be successful during international tournaments, then players need to be physically developed to produce high outputs during match play. This relates to both overall distances covered and also distance covered at higher speed thresholds. The positional analysis revealed that WD and WM players produced the highest physical performance at higher speed distances. Therefore, coaches would be encouraged to design soccer-specific drills that focus on producing higher velocity movements by increasing the available space for these specific positions. For example, a drill that is focused on either offensive situation (e.g., overlapping movements) or transitional situations (e.g., defensive to offensive moments) across a half pitch space would allow this type of movement to occur during training. The lack of recovery between matches in tournament situations caused a reduction in physical output, which may lead to an imbalance between stress and recovery. Therefore, practical recommendations would be for either the tournament organisers to factor in recovery time between games or coaches to adopt appropriate player rotation policies.

AUTHOR CONTRIBUTIONS

BMK and MB carried out the majority of the study data collection. JJM, PB and GP conceived and developed the original study idea and supervised the project. JJM led the write up of the study manuscript, with input from all authors. All authors read and approved the manuscript and agreed to submit it into JHSE as original investigation.

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DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

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