Physical Fitness profile of Competitive Young Soccer Players: Determination of Positional Differences

Original investigation

Mário C. Marques [1,2], Mikel Izquierdo [3], Tim J. Gabbett [4,5], Bruno Travassos [1,2], Luís Branquinho [1], Roland van den Tillaar [6]

[1] Department of Sport Sciences, University of Beira Interior (Covilhã, Portugal)
[2] Research Centre in Sports, Health and Human Development (CIDESD, Portugal)
[3] Department of Health Sciences, Public University of Navarre (Navarre, Spain)
[4] School of Exercise Science, Australian Catholic University (Brisbane, Australia)
[5] School of Human Movement Studies, The University of Queensland (Brisbane, Australia)
[6] Department of Teacher Education, Nord Trøndelag University College (Levanger, Norway)

Corresponding Author and address:
Mário C. Marques
Department of Sport Sciences, University of Beira Interior (Covilhã, Portugal)
Email: mariomarques@mariomarques.com

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ABSTRACT

The aim of this study was to compare the anthropometric and physical fitness characteristics of the different playing positions in adolescent soccer players. Furthermore, differences among playing ages (under 14, under 16, and under 18 years) were determined. One hundred and sixty-seven young male national level soccer players, were tested on anthropometric characteristics and physical performance tests (30m sprint, ball kicking, overhead medicine ball throw and countermovement jump [CMJ]). The results demonstrated differences in anthropometric characteristics between positions ($p<0.05$). Differences were also found in the physical performance tests; forwards performed better in the throwing, CMJ and sprint tests than defenders. Midfielders demonstrated greater CMJ performances than right defenders. Our results highlight that there is an influence of playing position on the anthropometric and physical qualities in adolescent players. This emphasizes the importance of evaluating the physical profile of players and their development according to playing age and playing position.

Keywords*:* soccer, specificity, strength, playing position, young players

INTRODUCTION

Playing positions in team sports involve specific physical activity and technical skill demands to successfully compete. Several investigations have been undertaken to determine the specific physical demands of match-play, and the underlying fitness qualities required for competitive success in different team sports. For instance, positional player profiles have been studied in volleyball,[1, 2] ice hockey,[3, 4] field hockey,[5] basketball,[6] netball,[7] and soccer.[8, 9]

The technical and time-motion demands of soccer have been studied in great detail in recent years.[10] Soccer is characterized as a prolonged, high-intensity, intermittent team sport that places an emphasis on explosive movements such as repeatedly jumping, sprinting and kicking. Also, due to the complexity and unpredictability of game conditions, constant adaptations of technical actions are required.[11, 12] In keeping with the variability of the game, a soccer team comprises 11 players with team positions broadly defined as goal keepers, defenders, midfielders, and forwards.[13-15] Each of these positions play a specific role during a soccer match, such as defending the goal, defending the forwards to prevent shots at goal, restricting the space in the midfield to prevent progression of the opposing team, and when in attack, exploring spaces to progress on the field, and create situations to shoot at goal, respectively.[14] However, due to the demands of each position on the field, a recent study[8] suggested that soccer playing positions should be defined with greater accuracy. Based on the analysis of specific physical activity demands of different playing positions, the authors proposed that players should be divided into goal keepers, central defenders, external defenders, central midfielders, external midfielders and forwards,[8] where each is subject to specific requirements.[16]

Some studies have evaluated the effect of age on high-speed running differences in young soccer players.[17] However, given that age may influence the physical and anthropometric qualities of young soccer players, it is surprising that there are not more studies that focus on this issue. Recent studies have focused on the relationship between the anthropometric and physical characteristics, although comparisons between age groups have not been made.[18, 19] To the best of our knowledge there are no studies that have assessed the anthropometric and physical qualities of the different playing positions among different age levels. It is also noticeable that in elite junior players a limited number of soccer studies report the physical characteristics of different positions.[9] In doing so, one may understand the requirements of different playing levels and the factors that may require development in order to attain high levels of performance in young talented players. Data extending across the teenage years could have far reaching implications for coaches and sports scientists who use performance indices to evaluate players within the current sport structure (i.e., under-13-15 years old) by providing normative data for comparative chronological ages. In addition, an understanding of the physical characteristics (e.g. jumping ability, throwing performance, sprinting skills, and kicking ball velocity) limiting performance is required in order to provide optimal strength and conditioning programs to improve soccer performance.

Therefore the aim of this study was to compare the anthropometric and physical characteristics of young soccer players competing in different playing positions. Furthermore we investigated if differences existed among the age of players (U14, U16, and U18 players) for these physical and anthropometric characteristics. We hypothesized that the anthropometric and physical qualities of soccer players would vary according to the different playing positions. We also expected to observe an increase in anthropometric and physical qualities of soccer players from U14 to U18. If significant differences exist among playing positions, it may provide insight into the physical qualities important for success in that position, while also providing a greater understanding of the factors limiting performance for those players. Also, this information can be used to provide appropriately structured training programs for each playing position.

METHODS

Subjects

A group of 167 young male soccer players (mean±SD age: 15.7 ± 1.7 years) participated in the study. Players were categorized according to playing position and role. Players were categorized as central defenders (n = 23), right defenders (n = 17), left defenders (n = 18), central midfielders (n = 37), right midfielders (n = 15), left midfielders (18), and forwards (n = 39). Before commencing the study, players had a physical examination by the team physician, and each was cleared of any medical disorders that might limit full participation in the investigation. All participants were fully informed verbally and in writing about the nature and demands of the study, as well as the known health risks. They completed a health history questionnaire and were informed that they could withdraw from the study at any time, even after giving their written consent. All parents gave their informed consent attesting the voluntary participation of their children in the study, which had the approval of the Academy's Ethical Advisory Commission.

Experimental design

Participants belonged to three different Portuguese teams playing at the national level in their age category in either under 14 (U14, n=57), under 16 (U16, n=58), or under 18 years (U18, n=52) age groups. All players competed in one match per week combined with four soccer practice sessions. Players had completed a pre-season testing and training program prior to the initiation of this in-season study. The players were in good physical condition and were adequately familiarized with all procedures prior to commencing the study. Apart from standard technical and tactical practice sessions (2 hours per day) and regular competitions, the subjects completed a simple physical training regimen that included upper and lower-body exercises targeting strength and power. Briefly, the program was performed twice per week, with each session lasting approximately 20 minutes. The principal resistance exercises were push-ups, vertical jumps, ball throwing and parallel squats using their body mass. The training program was equally applied to all age groups. All subjects underwent a plyometric and sprint program in addition to normal soccer training. Subjects also completed upper- and lower-body power exercises (vertical jumping activities and medicine ball throwing, and sprinting).

Methodology

All testing was carried out during one week at the completion of the second half of the in-season, which took place between January and May. Before the pretest stage the participants were familiarized with the different tests during a practice session in order to minimize learning effects. Pre- and post-tests were performed with maximal intensity. All tests were conducted in an indoor facility in order to eliminate the effect of weather conditions on results. Tests were performed over a 2-day period: day 1 - anthropometric measures, countermovement jump and overhead medicine ball throw; day 2 – 30 meters sprint and kicking ball velocity. These were tests that could be rapidly administered, and were highly specific to soccer.

The anthropometric variables of height and body mass were measured in each subject. Height and body mass measurements were made on a leveled platform scale (Año Sayol, Barcelona, Spain) with an accuracy of 0.001 m and 0.01 kg, respectively.

Countermovement jump (CMJ) height was measured using a trigonometric carpet (Ergo jump Digitimer 1000, Digest Finland) using previously described methods.[20] Subjects began from a standing position, performed a crouching action followed immediately by a jump for maximal height. The hands were on the hips during the whole jump. Each participant performed three jumps and the highest jump was recorded. Between each repetition there was a two minute rest period.

The overhead medicine ball throw was performed according to the protocol described elsewhere.[20] After a general warm-up of 10 minutes, which included throwing with different weighted balls to warm up the shoulders, throwing with the soccer ball and 5 kg medicine ball was tested. The participant stood with both feet parallel to each other while throwing the balls. All participants started by holding the ball in front of them with both hands. They were instructed to throw the medicine ball as far and fast as possible with both hands over their head and hyper-extending their back and shoulders (soccer throw-in movement). Players were required to throw the ball as fast as possible in a straight line. Both feet were kept in contact with the ground at all times during and after the throw and no preliminary steps were allowed. Torso and hip rotation was also prohibited. When a participant did not keep both feet on the ground during the throw the attempt was not approved and a new attempt was performed. An expert in throwing controlled this test. Three approved attempts were made with each ball with one-minute rest between each attempt. Throwing distance with an accuracy of 10 cm was measured for the medicine ball. Only the best attempts with each ball were used for further analysis.

The 30 m sprint was performed in an indoor school physical education facility with a Copolymer Polypropylene floor, with subjects wearing indoor shoes. Before the test, the players performed a 20-minute warm-up involving three sprints for a distance of 5-10 m and two sprints for a distance of 20-30 m. Time to run 30 m was obtained using photocells (Brower Timing System, Fairlee, Vermont, USA). Times at 10 m and 20 m were also recorded. Prior to each sprint, each subject trod the cell pad using the right hand with the time being recorded from when the subject intercepted the photocell beam. All subjects were encouraged to run as fast as possible and to decelerate only after listening to the beep emitted by the last pair of photocells. Each player repeated the same procedure for 3 attempts and only the best time taken to cover the 30 m distance in the sprint test was used in data analysis. A rest period of 10 min was provided between attempts.

For the kicking speed and accuracy test, a standard soccer ball (mass approximately 430 g, circumference 70 cm) was used. After a general warm-up of 15 min which included jogging and kicking drills, kicking performance was tested. The instruction was to kick a regular ball with maximum force and attempt to hit a target from 11 m distance, aiming at a 1 m by 1 m circled target at 2 m height located in the middle of a goal (3 x 2 m). Kicking velocity of the ball was determined using a Doppler radar gun (Sports Radar 3300, Sports Electronics Inc.), with ± 0.028 $m \cdot s^{-1}$ accuracy within a field of 10 degrees from the gun. The radar gun was located 1 m behind the goal at ball height. Three trials were conducted and the highest ball kicking velocity was used for further analysis.[21]

Statistical analysis

Data is expressed as mean ± SD. To compare the anthropometric and physical qualities of the different playing positions, a one way ANOVA was used. In addition, to determine if the anthropometric and physical qualities differed between playing positions and across the three age-groups, a two way ANOVA (age x playing position) was used. Where significant differences were found, a Holm-Bonferroni probability adjustment *post hoc* test was used to determine the source(s) of those differences. Effect size was evaluated with η^2_p (partial eta-squared) where $0.01 < \eta^2_p < 0.06$ represents a small effect, $0.06 < \eta^2_p < 0.14$ represents a medium effect, and a large effect when $\eta^2_p > 0.14$. All analyses were performed using SPSS Version 19.0. Statistical significance was set at $p<0.05$. The intraclass correlation coefficient (ICC) and coefficient of variation were respectively 0.97 and 4.1% (maximal ball velocity), 0.95 and 3.6% (overhead medicine ball throw), 0.96 and 1.3% (30 m sprint) and 0.90 and 3.9% (CMJ).

RESULTS

Significant differences were found among the individual playing positions for height ($F=2.81$, $p=0.011$, $\eta^2_p = 0.097$) and body mass ($F=2.43$, $p=0.028$, $\eta^2_p = 0.084$, Fig. 1A). Post hoc comparison showed that the right defenders were significantly shorter ($p<0.05$) than all other positions except the left defenders. The right defenders were also significantly lighter ($p<0.05$) than the forwards, central defenders and midfield players, while the left defenders were lighter and shorter than the central defenders (Fig. 1A). Furthermore, height and body mass increased significantly by age group ($F=17.4$, $p<0.001$, $\eta^2_p = 0.181$), but post hoc comparison showed a significant increase from the U14 to the U16 group ($p<0.001$), no significant differences were found in U16 to U18 age groups ($p>0.53$). No significant (age x position) interaction effects were found for either height or body mass ($F=0.57$, $p\geq0.68$, $\eta^2_p \leq 0.014$) (Fig. 1B).

- Please insert Figure 1A and 1B

Significant differences were found among playing positions for counter-movement jump height ($F=3.36$, $p=0.004$, $\eta^2_p = 0.112$), throwing distance ($F=2.77$, $p=0.014$, $\eta^2_p= 0.094$) and 20 m ($F=2.25$, $p=0.041$, $\eta^2_p = 0.078$) and 30 m ($F=4.2$ $p=0.001$, $\eta^2_p = 0.137$) sprint times, while no significant differences were found for 10 m sprint times ($F=0.525$, $p=0.789$, $\eta^2_p = 0.019$) and maximal ball kicking velocity ($F=1.50$, $p=0.18$, $\eta^2_p = 0.053$) (Fig. 2A-3A). Post hoc comparison showed that the forwards jumped higher and threw significantly further than the players on the left, right and central defender positions (Fig. 2A; $p<0.05$). The forwards were significantly ($p<0.05$) faster over 20 m and 30 m compared with the left, right and central defenders (Fig. 3A). Furthermore, players from the left, right and central midfielder positions had a higher jumping height ($p<0.05$) than the right defenders, and the left and central defenders were significantly slower over 30 m than the central and left midfielders (Fig. 3A).

- Please insert Figure 2A and 2B

Two way ANOVA (with age group and playing position) revealed a significant effect of age on each physical performance test ($F\geq16.0$, $p<0.001$, $\eta^2_p = 0.169$), except for the 10 m sprint times ($F=0.52$, $p=0.597$, $\eta^2_p \geq 0.007$). Also a significant effect of playing position for the CMJ, throwing distance and 20 and 30 m sprint times was found ($F\geq9.6$, $p<0.001$, $\eta^2_p \geq 0.109$), in addition to an interaction (age x playing position) for the best 20 and 30 m sprints, and CMJ ($F\geq4.1$, $p\leq0.004$, $\eta^2_p \geq 0.093$). Post hoc comparison showed that U14 players had lower results in CMJ, kicking velocity, throwing distance and 20 and 30 m sprint times than the other two age groups ($p<0.001$; Fig. 2B and 3B). In addition the defenders had a significantly poorer CMJ, overhead medicine ball throwing distance and 20 and 30 m sprint times than forwards ($p\leq0.002$)

- Please insert Figure 3A, 3B

DISCUSSION

A uniqueness of the present study was the investigation of the interaction of age and playing position on the anthropometric and physical qualities of young male soccer players. The results of the present study suggest that even in adolescent soccer players there is an influence of playing position on the anthropometric and physical qualities. It may provide insight into the physical qualities important for success in that position, while also providing a greater understanding of the factors limiting performance for those players. In addition, this information can be used to provide appropriately structured training programs for each playing position. Forwards jumped higher and threw significantly further than the players on the left, right and central defender positions. This type of research can also be used to monitor the development of players during, and across seasons, comparing the physical qualities of a player in relation to a normalized position profile for each playing level.

In agreement with our experimental hypotheses, the results demonstrated that there were important position-specific anthropometric, speed, and muscular power differences in young soccer players. Significant differences may show intentional selection of some players with certain body types for specific positions, or that certain physical and anthropometric qualities are more suited to specific positions.[18] Our findings indicate that the external defenders were shorter than the other players, and the right defenders were also lighter than others. On the other hand, the forwards were the tallest and heaviest players followed by the external midfielders and the central defenders. These results are consistent with a previous study in older players[22] and have some bias to studies using similar populations.[13] In fact, assessing a small group of a national team, the latter authors noticed that a gradient in stature occurs from forwards (shortest) to defenders (tallest). However, in a more recent study,[9] it was demonstrated that differences were due more to playing level, than to the chronological age of players. In the present study, central defenders were heaviest, followed by the forwards.[23, 24] It is possible that this bias can be explained by the amounts and specificity of work performed by each of the different playing positions.[25] Therefore, there are likely to be anthropometric predispositions for positional roles, with taller players being the most suitable for central defensive positions and for the “target” player among the forwards. These morphological characteristics may be linked with pre-selection of early maturers for key positional roles where body size, rather than playing skills, provides an advantage.[18]

In general, and as expected, differences were observed in physical fitness among playing positions. Regardless of age group analysed, forwards performed better than defenders on the jump, throw and sprints. These results point toward the requirement of a high level of fitness to be a high quality forward.[9, 25]

External defenders obtained the lowest vertical jump height compared to the other positions, whereas the highest jumps were performed by the forwards. Previous studies have shown similar results, demonstrating that forwards need to have a higher ability to reach higher than midfielders.[26] Furthermore, these results may be related to the greater number of jumping tasks required of forwards during a match, compared to the external defenders.[8] Commonly, forwards are required to win challenges with central defenders, who tend to be taller players.[22]

Regarding ball shooting speed, few studies have compared this technical task among playing positions. In fact, being such an important task for the sport it seems relevant to obtain more data. In the study by Wong et al.[24] no differences were observed among positions for the maximal velocity instep place kick of a stationary ball. Similar results were obtained in the present study with a wider range of ages. This similarity reinforces the idea that all players need to develop this task to a high quality standard, in order to be high level soccer players.[27]

The 30 m sprint test has often been used by authors to assess maximal velocity of soccer players.[9, 24, 25] Furthermore, in the present study we also assessed 10 and 20 m speed. Post hoc comparisons showed that forwards were significantly ($p<0.05$) faster over 20 m and 30 m compared with the external and central defenders. One plausible explanation for this finding is the fact that defenders sprint less frequently than forwards and midfielders.[8] In fact, forwards have to sprint the longest distances during a soccer match.[14] The further running distances required in the modern game, suggest that conditioning coaches should prescribe training programs to develop a greater sprinting ability in forwards. On the other hand, central defenders were significantly slower over 30 m than the central midfielders. This is accordance with the abovementioned characteristics of the modern game, which imposes high-speed profiles to control the middle of the field. The absence of significant differences in the 10 m tests can be attributed to the small distance to differentiate velocity profiles. Likewise, the 20 and 30 m tests revealed to be much more informative to the specificity of the sport.

It is commonly accepted that taller athletes can throw faster and further distances than shorter athletes. In fact, it has been shown that taller players could throw faster due to the longer lever lengths of the upper body and therefore have a longer trajectory to accelerate the ball.[16] The ball replacement from the sideline is a common task in soccer, which has not received much attention. However, in some situations it has shown to be a discriminating factor between winning and losing teams. Forwards were significantly taller than players from other positions; and also had demonstrated greater throwing distances than other positions.

Age-related differences

It was also interesting to note that the main differences between age groups were observed between U14 and U16 players and not between U16 and U18 players. This finding may be attributed to the lack of upper body specific activities during competition in these players. However, while characteristics relating to the training sessions performed may explain some of this finding, it can be suggested that these differences occur predominantly due to differences in the maturational development of players. Based on previous assumptions regarding the Long-Term Development model,[28] the age period from 12 to 17 years is a critical period of physical development and the main windows for optimal trainability of physical aspects such as strength, velocity and aerobic qualities. The training and regular physical activity are usually interpreted as having a favorable influence on growth, maturation and physical fitness of young people.[29] Adolescents who have advanced maturation usually show better performances than late maturers.[30] When comparing young athletes from different age groups, sport scientists should consider if differences are due to training or variability of the maturation process, since a major part of the differences in dimensions, shape, body composition and performance is controlled by maturational status.[31]

During adolescence (i.e., the timing of progress toward the adult mature state),[29] maturation varies considerably between individuals of the same chronological age.[32] This maturation includes changes in the nervous and endocrine systems and leads to anthropometric and physiological changes,[33] which in turn affect the current level of motor performance and the response to learning and training stimuli.[34] For anthropometric characteristics, height and body mass increased across U14, U16 and U18 age categories in junior sub-elite rugby league players.[35] For physical characteristics, vertical jump, sprint speed and maximal aerobic power have all been identified to increase from Under 13 to 19 age categories.[35, 36]. The recent study of Till and Jones[37] demonstrated that players with greater maturity had greater anthropometric and fitness characteristics, for vertical jump, sprint speed, medicine ball chest throw, but not endurance performance. These findings, coupled with the large degree of inter player variability highlights the importance of tracking the development of fitness and strength characteristics of an individual.[38] As physical performance is related to biological maturation during adolescence,[39] boys advanced in biological maturity are generally better performers in physical tasks (e.g., speed, strength, power) than their later-maturing peers.[30]

The main changes in the maturation process of males occur between 12-16 years.[32] Between 16 and 18 most of the players selected were unlikely to still be in puberty. In this study it was not possible to measure the maturation state of the players in the different age groups, which makes it difficult to assert that this was the main reason for our findings. Although various studies showed that age, biological maturity, number of years of training, morphology and anthropometry affect the physical and physiological profile of players,[15, 33] few studies have investigated the relationship among these variables in young soccer players.[34] Understanding the correlation between physical and anthropometrics demands of youth soccer players could have practical implications for training prescription.[34] Future studies on this topic should include assessments of the state of maturity of the subject in order to understand the influence of maturational stage on physical qualities in these age groups in football.

CONCLUSION

In conclusion, our results highlight that even in adolescent soccer players there is an influence of playing position on the anthropometric and physical qualities. In this sense, our results emphasize the importance of evaluating the physical profile of players and their development according to their age and playing position. For the long term development of players, coaches should prescribe training programs that contribute to the development of the specific physical qualities required by each positional role, but also to potentiate the skill abilities of players.

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Figure Legends

Figure 1. Anthropometric characteristics (body mass and height) of A) the different playing positions B) the different positions divided into defenders, midfielders, and attackers.

indicates a significant difference from all other positions except with left defender position at a $p<0.05$ level.

***** indicates a significant difference between these two positions at a $p<0.05$ level.

∂ indicates a significant difference from all other ages at a $p<0.05$ level.

Figure 2. Maximal countermovement jump height, kicking ball velocity and overhead medicine ball throw distance of A) the different playing positions B) the defenders, midfielders, and attackers in the three different age groups.

indicates a significant difference between the forward position with the center, left and right defender positions at a $p<0.05$ level.

† indicates a significant difference between the right defender position compared with the left, right and center midfielder positions at a $p<0.05$ level.

∂ indicates a significant difference from all other ages at a $p<0.05$ level.

* indicates a significant difference between these two positions at a $p<0.05$ level.

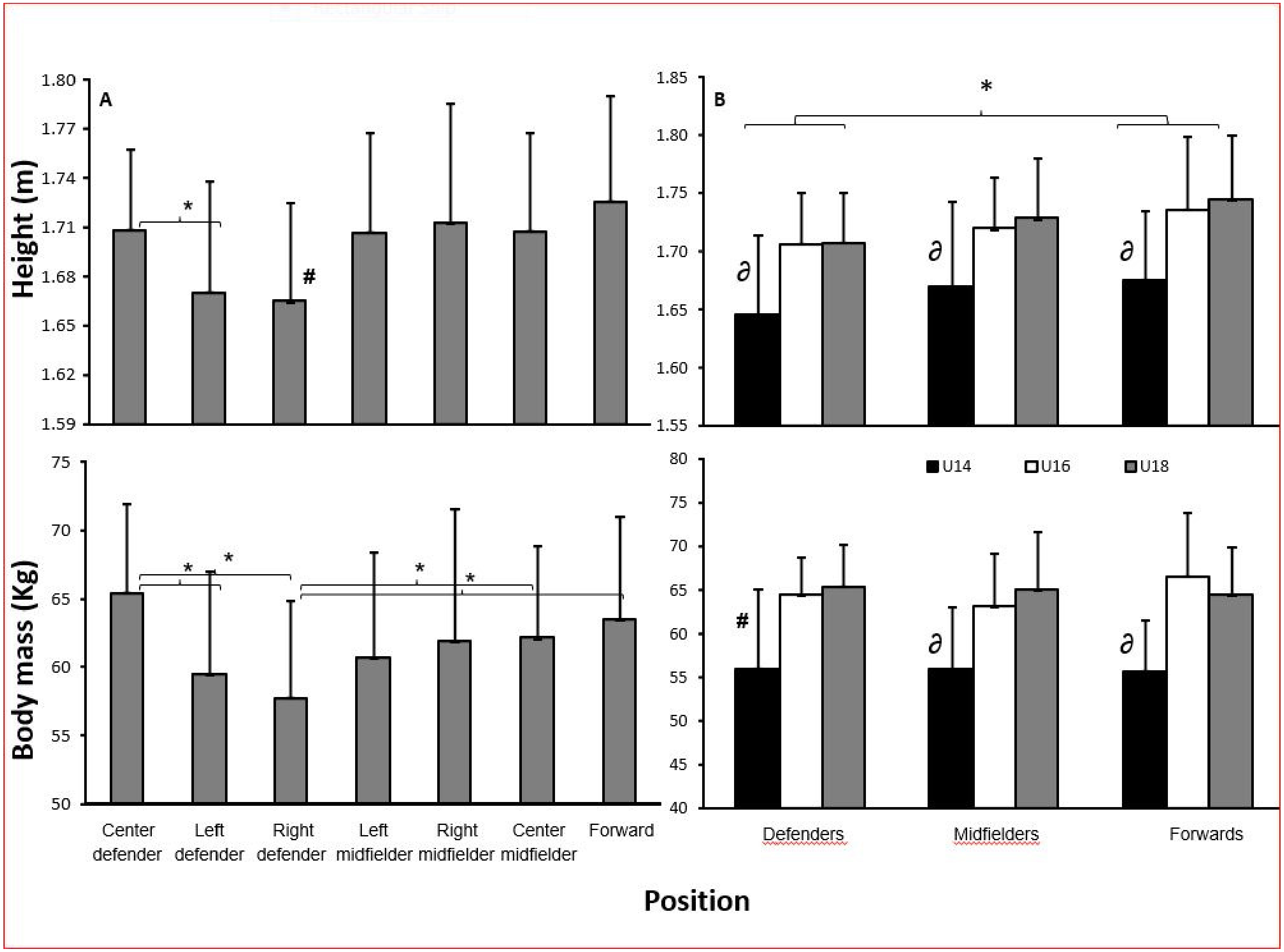
Figure 3 Best 10, 20 and 30 m sprint times of A) the different playing positions B) the defenders, midfielders, and attackers in the three different age groups.

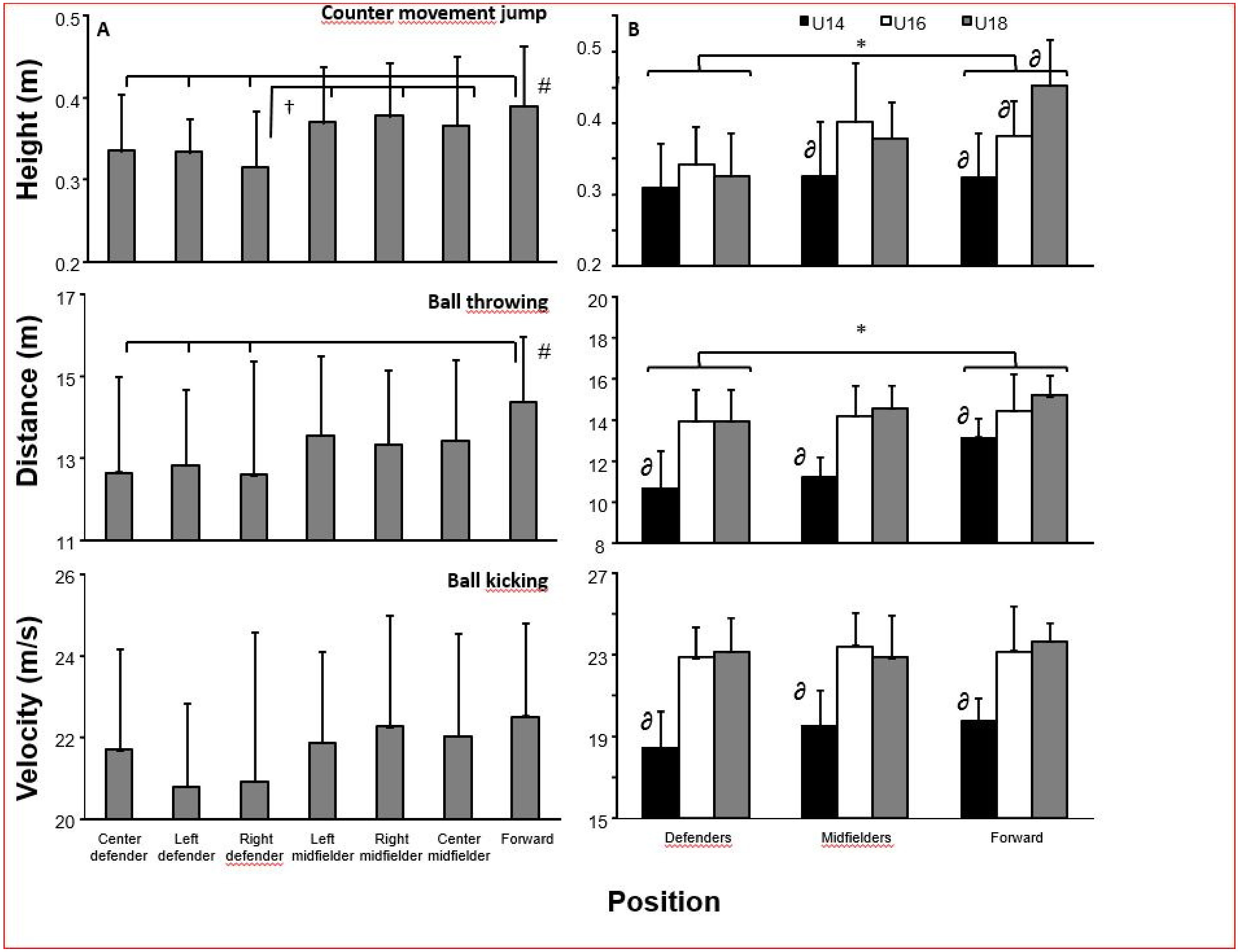
indicates a significant difference between the defending positions and forwards at a $p<0.05$ level.

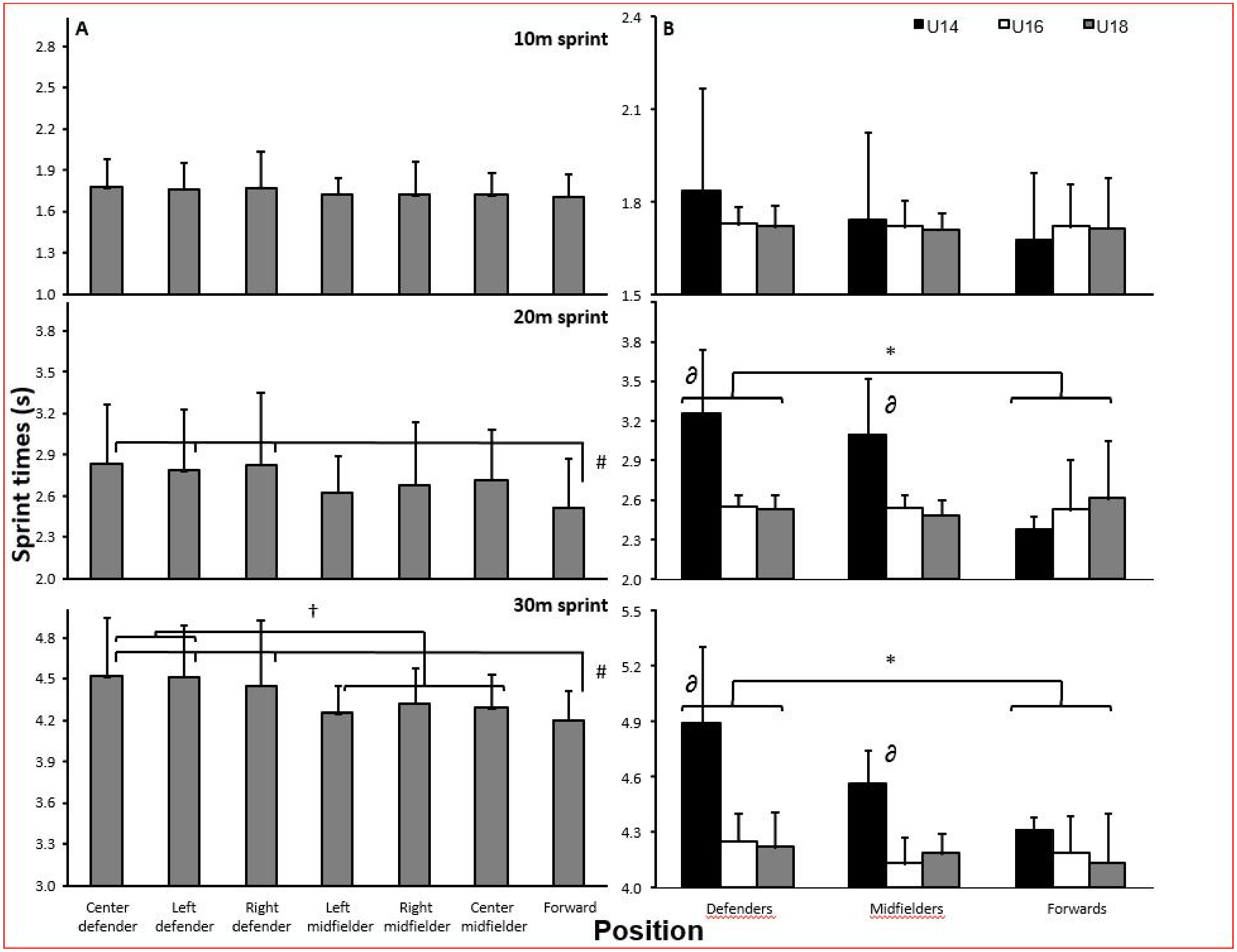
† indicates a significant difference between center and left defender, and center and left midfielders at a $p<0.05$ level.

∂ indicates a significant difference from all other ages at a $p<0.05$ level.

***** indicates a significant difference between these two positions at a $p<0.05$ level.


A
B
Height (m)
1.80
1.77
1.74
1.71
1.68
1.65
1.62
1.59
1.85
1.75
1.70
1.60
1.55
Body mass (Kg)
75
70
65
60
55
50
80
45
40
U14
U16
U18
Center defender
Left defender
Right defender
Left midfielder
Right midfielder
Center midfielder
Forward
Defenders
Midfielders
Forwards
Position


A
B
Counter movement jump
Ball throwing
Ball kicking
Height (m)
Distance (m)
Velocity (m/s)
U14
U16
U18
Center defender
Left defender
Right defender
Left midfielder
Right midfielder
Center midfielder
Forward
Defenders
Midfielders
Forward
Position


A
10m sprint
20m sprint
30m sprint
Sprint times (s)
2.8
2.5
2.2
1.9
1.6
1.3
1.0
3.8
3.5
3.2
2.9
2.6
2.3
2.0
4.8
4.5
4.2
3.9
3.6
3.3
3.0
#
†
Center defender
Left defender
Right defender
Left midfielder
Right midfielder
Center midfielder
Forward
Position
B
U14
U16
U18
2.4
2.1
1.8
1.5
5.5
5.2
4.9
4.6
4.3
4.0
∂
*
Defenders
Midfielders
Forwards