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Age-related Physical Performance Differences in Male Soccer Players

Mustafa Karahan

School of Physical Education and Sport, Aksaray University, 6810 Aksaray, Turkey

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ABSTRACT The aim of this study is to identify the differences of physical performance characteristics between the amateur male adolescent soccer players in different age groups. One hundred and twenty-eight male players voluntarily participated in this study and athletes were classified in three chronological age groups as U-15, U-17 and U-19. Physical performance data showed that the U-15 group tended to be slower over 10 and 20 meters, and had the poorest agility and anaerobic power. Except for explosive power, the performance values of U-17 were lower than U-19 ($p<0.05$). In conclusion, there were significant differences between three groups. These age-related differences were strongly correlated with differences in physical performance characteristics. Results suggest that anaerobic performance and sprint ability improves during maturation of amateur male adolescent soccer players. Thus, the coaches should take into consideration differences in age-related physical performance in player selection for a team or training practices.

INTRODUCTION

Soccer is a sport requiring high, moderate or low intensity, non-continuous exercises that include many jumping, agility, sprint activities, and so on (Bangsbo 1994). The performing of these skills at high levels is closely related to motor abilities such as speed, agility, explosive and anaerobic power, which are determinants of sporting anaerobic performance (Helgerud et al. 2001). Although soccer is a sport of high aerobic characteristics, movements such as sprinting, tackling opponents, sudden changes of direction and jumping are highly influenced by anaerobic metabolism. Therefore, as well as aerobic capacity, the anaerobic performance characteristics are considered to be important components of physical performance in soccer (Stolen et al. 2005).

The development of physical performance characteristics continues from childhood to adulthood, and nutrition, physical activity and exercise are important factors affecting this development (Malina et al. 2015). It was reported that while age-related physical performance differences were at insignificant levels before adolescence, these differences might be more significant or more distinctive after adolescence (Rummenich and Rogol 1995; Mulazimoglu 2014) because youth players, especially between the ages of 13 and 16, are in the process of continual and rapid growth and maturation (Malina et al. 2015; Iri et al. 2009). Hence, physical performance is related to biological maturation during male adolescence (Barnsley et al. 1985). Thus, growth would appear to contribute significantly to enhanced physical performance with age (Armstrong et al. 2001). Many studies have been conducted on the relationship between growth and physical performance and its variation by age. They found that anthropometric, physiological, psychological, experiential, technical, and tactical characteristics develop during growth, that there is a significant relationship between growth and performance in soccer, and that significant differences occur according to age (Davids et al. 2000; Williams 2000; Gil et al. 2007; Lloyd et al. 2015).

During the adolescence process, physical performance characteristic of players might be fluctuating due to heredity, environmental conditions or trainability level (Malina et al. 2015). Coaches and trainers require a more detailed understanding of the relationships and variations with age, in order to obtain a greater appreciation of the individual patterns of growth and potential short-term disruptions of performance during the adolescent years. Previous studies of elite soccer players of different age groups ex-

Address for correspondence:
Mustafa Karahan, PhD
Associate Professor,
School of Physical Education and Sport,
Aksaray University,
6810 Aksaray, Turkey
Phone: 0090-382-288 2664
E-mail: mkarahan@aksaray.edu.tr

amined differences between either the positions of the players or some specific characteristics. Vaevens et al. (2006) reported significant differences between elite male soccer players of U-15 and U-17 groups in terms of anaerobic power and that these differences were distinctive factors in match categories. However, other studies reported no significant difference between elite U-15 and U-17 elite male soccer players in vertical jump height (Gall et al. 2010), and anaerobic performance tasks including 10-meter and 20-meter sprint, vertical jump and agility (McKenna 2010).

According to the rules of most football federations worldwide, players must compete within distinct age groups. However, in amateur teams of today, soccer players with small age groups could compete and participate in training program in an upper age group teams because of their technical and tactical proficiency. But it is not clear yet that whether they have got physical performance capacity for playing and training or they will be adapted to competition conditions in upper age group teams. Compared with training studies in elite adolescent athletes, less is known about the trainability of amateur adolescents. This has raised concerns that perhaps the specific practice of increasingly early soccer inclusion and greater training volume during development in the process of age might expose to a greater risk of either short or long-term injuries. In previous studies with elite adolescent soccer players (Gall et al. 2010; McKenna 2010), age-related differences in physical performance are not yet clear. In addition, in studies conducted as this date, there was no found available knowledge for adolescent amateur soccer players as relation to this subject. In relation to this matter, it is suggested that better knowledge about the physical performance characteristics during adolescence stage, especially between age groups, could light the way in selecting players and implementing or preparing training programs (Mala et al. 2010). Therefore, the main purpose of this study was to investigate how much the age related differences of selected physical performance characteristics of three amateur soccer age groups at three different stages during the adolescent years. A second aim was to determine the relationship between age and physical performance variations and how these relationships differed through the age groups in the amateur adolescence soccer players.

METHODOLOGY

Participants

Given that according to the soccer federation rules, players are matched by and compete according to chronological age rather than biological maturation, players were classified by age group. A total of 128 adolescent male soccer players with ages ranging from 14 to 19 years (U-15, n= 43; U-17, n=43 and U-19, n=42), except for goalkeepers, representing all playing positions, voluntarily participated in this investigation. All volunteers were members of the development programs of the various professional soccer clubs. Written and oral information on risks and benefits associated with participation to the study was provided to the players or their guardians before taking their written consent to participate. Tests were carried out in accordance with ethical rules and under the control supervision of players' coaches.

Testing Procedures

All tests were performed over two consecutive days at the beginning of the competitive season. The test sessions were carried out in indoor halls with synthetic floors. Participants were asked whether they had prior experience with the tests to be carried out. Therefore, testing protocol was separately explained to each group of participants who had not been previously tested on any occasions in previous seasons for training prescription purposes. In addition, all participants were requested to have their last meal three hours before the tests and not to participate in any prolonged exercise 24 hours before the tests.

Sprint Test: Sprint ability was evaluated using a 10-meter test, which involves sprinting for the distance as fast as possible from a stationary start position. Maximum speed was assessed using a flying 20-meter test, involving a maximum 20-meter sprint from a maximum speed start. Both tests were performed on an indoor synthetic pitch, and electronic timing gates were used to record completion times. 10-meter and 20-meter sprint tests were repeated three times with a 90-second rest period and the best timing was taken to represent the sprint performance.

Agility Test: Soccer players require the ability to rapidly accelerate, decelerate, and change direction. The agility of players was evaluated using a zigzag agility test (Miller 2006) using dual-beam electronic timing gates. Players were instructed to run as quickly as possible during the agility run. Agility times were rounded to the nearest 0.01 second, with the fastest value obtained from two trials taken as the agility score.

Running-based Anaerobic Sprint Test (RAST): Running-based Anaerobic Sprint Test was used to determine anaerobic power. Each athlete was weighed prior to the test and warmed up for a period of five minutes, which was followed by three minutes of recovery time. The test consists of six 35-meter discontinuous sprints. Each sprint represents a maximal effort with 10 seconds allowed between each sprint for the turnaround. Power output was calculated with the following equation:

Power: [weight (kg) x distance (m^2) / time (s^3)] (Zagotta 2009).

Counter Movement Vertical Jump (CMJ) Test: Vertical jump height was measured using the Vertec. Participants performed in three trials with a 60-second rest period between each jump activity and the best vertical jump height of each player was calculated with the following equation to determine the explosive power of each player (Johnson and Bahamonde 1996):
[43.vertical jump height (cm)+32.7*body mass (kg)-16.8*body height (cm)+431]

Statistical Analysis

Descriptive statistics were used to derive means and standard deviations (SD) and all data was presented in the form, mean (X) ± standard deviation (SD). One-way analysis of variance (ANOVA) was designed to evaluate between group differences. When a significant *F* value was achieved, post hoc comparisons were accomplished via a Benferroni test. The relationships between the physical performances were determined by Pearson correlations. The level of significance was set at $p<0.05$. All calculations were performed using SPSS 17 packet program.

RESULTS

The mean values of groups analyzed in ANOVA and Benferroni methods are presented in Table 1. When the tested values of the volunteers in this study are compared with each other, it is found out that there are significant differences between groups (p <0.05) in all the data except height. According to the analysis of Benferroni test, all three groups had significant differences in terms of age, vertical jump, 10-meter and 20-meter sprints, agility and anaerobic capacity. In particular, it was seen that the values of the U-19 age group were much better than the other groups (p <0.05). Body weight and explosive power values of U-15 group were at a lower level (p <0.05) than the others, while U-17 and U-19 had no significant differences between each other.

The correlation analysis was performed in order to determine the degree of relationship of the tested values of the players with each other. According to the results of the analysis, age, height, body weights had significant negative statistical correlations with the agility, sprinting 10-meter and 20-meter, and significant positive correlations with the anaerobic power and capacity (p <0.05) (Table 2).

Table 1: The demographic characteristics and the physical performance values of the groups

	U–15 (n=43) *X±SD*	*U–17 (n=43)* *X±SD*	*U–19 (n=42)* *X±SD*	*F*	*P*
Age (year)	14.5± 0.5[a]	*U* 16.5± 0.4[b]	18.4± 0.4[c]	643.667	0.001
Body Height (cm)	158.9± 1.3	167.3± 1.3	165.4± 4.1	2.820	0.063
Body Mass (kg)	49.8± 1.0[a]	61.3± 1.3[b]	63.8± 1.1[b]	40.994	0.001
10m Sprint (s)	2.2± 0.02[a]	2.1± 0.01[b]	2.05± 0.01[c]	36.287	0.001
20m Sprint (s)	3.76± 0.01[a]	2.79± 0.01[b]	2.74± 0.01[c]	1225.990	0.001
Agility (s)	8.2± 0.05[a]	7.6± 0.02[b]	7.4± 0.04[c]	99.126	0.001
Anaerobic Capacity (watt)	297.9± 8.1[a]	417.3± 12.9[b]	517.2± 17.4[c]	68.003	0.001
Vertical Jump Height (cm)	33.23± 0.18[a]	36.65± 0.48[b]	36.76± 0.22[b]	37.338	0.001
Explosive Power (watt)	846.2± 29.7[a]	1233.2± 26[b]	1284.8± 24[b]	78.252	0.001

For each row [a,b,c] different, significantly (p<0.05).

Table 2: The correlation among data

	Body height	*Body mass*	*10 m sprint*	*20 m sprint*	*Agility*	*Anaerobic capacity*	*Explosive power*
Age	.154	.590**	-.606**	-.867**	-.766**	.721**	.682**
Body height		.442**	-.233**	-.219*	-.297**	.380**	.342**
Body mass			-.337**	-.583**	-.517**	.842**	.902**
10m sprint				.596**	.838**	-.507**	-.449**
20m sprint					.801**	-.633**	-.715**
Agility						-.615**	-.638**
Anaerobic capacity							.788**

**. The correlation is significant at the 0.01 level.*. The correlation is significant at the 0.05 level.

DISCUSSION

Physical performance characteristics develop in line with growth during adolescence and show rapid development from the start of adolescence. Hence, physical performance is related to biological maturation during male adolescence (Barnsley et al. 1985). It was reported that while age-related physical performance differences were at insignificant levels before adolescence, these differences might be more significant after adolescence (Rummenich and Rogol 1995; Mulazimoglu 2014; Lloyd et al. 2015). Thus, growth would appear to contribute significantly to enhanced physical performance with age (Armstrong et al. 2001). In the present study, while the values of explosive power of U-15 group were significantly lower than those of other groups, there was no significant difference between U-17 and U-19 groups. This might be because the athletes (U-17 and U-19) have similar body mass, body height and vertical jump height, and hence, explosive power determined in the present study were based on the formulation of body mass, body height and vertical jump height of athletes. Explosive power represents ability of maximum muscle activity that makes possible to the acceleration of body in some activities such as vertical or horizontal jumping. Thus, physical characteristics variability (body mass and height) can be considered as important factors to affect explosive power. Data for the general population of adolescent males suggested that maximal gains in explosive power occur after peak body height velocity and closer to peak body mass velocity (Malina et al. 2015). For this reason, there was a positive relationship between explosive power and body mass, body height and vertical jump height and this result is consistent with a previous study (Kalinski et al. 2002). Yet, in the present study, body height difference was not significant between the groups. Therefore, the differences between the groups for explosive power may be more due to differences in vertical jump height and body mass rather than body height. Previous studies reported no significant difference between elite U-14 and U-16 male soccer players in vertical jump height, and that this might be due to the small age difference between the groups (Gall et al. 2010). McKenna (2010) reported that there was no difference between U-15 and U-17 groups in terms of physical performance (10-meter and 20-meter sprint, vertical jump and agility), whereas there were differences between U-14 and U-15 groups. Based on the literature information this result can be interpreted that explosive power may vary depending on the variable age groups in adolescences and this differences become smaller in the late stages of adolescence.

Anaerobic characteristic is considered as an important criterion of high performance, particularly in soccer, and trainers wish athletes to have a high-level anaerobic capacity due to its effect on matching performance (Reilly et al. 2000). Performance in a one-to-one challenge with an opponent, performing high level of technical and tactical skills, or an athletes' endurance to fatigue during the match, mainly depend on anaerobic characteristics as well as aerobic endurance (Cometti et al. 2001). For this reason, movements such as speed, power, and agility, which require anaerobic characteristics, are considered as a distinctive characteristic in the classification of athletes according to age (Williams 2000; Gil et al. 2007). In this study, significant differences were found among all three groups with regard to anaerobic capacity, agility and sprint time. These differences in agility and sprint time were strongly correlated with differences in body mass between the age groups. Also, Silvestre et al. (2006) reported that there was strongly relationship between anaerobic characteristics such as agility and sprint and body mass, especially lean body mass**.** In addition, since these properties are considered as the components of anaerobic characteristic (Gaitanos et al. 1993) they showed a significant relationship. There was a positive relationship between anaerobic capacity, power, and age, while there was a negative relationship between agility and maximum speed. Kasabalis et al. (2005) reported similar relationships regarding age and anaerobic performance. Another study reported significant differences between soccer players of 13-14 and 15-16 years age groups in terms of anaerobic capacity, and that these differences were distinctive factors in match categories (Vaeyens et al. 2006). These relationships can be considered an important indication of age-related physical performance difference between the groups. Analysis of percentage values of physical performance differences between the groups revealed that the smallest difference was in agility while the greatest difference was in anaerobic capacity. This is consistent with general observations that anaerobic performance, which is generally defined as the ability of athletes to endure fatigue (Fornier et al. 1982), probably improves into late adolescence (Malina et al. 2015). The results of the present study revealed that athletes' anaerobic capacity increased parallel to age. Although anaerobic capacity is influenced by genetic factors, the effect of training is also important, and anaerobic trainability increases with age from childhood to adulthood (Schutte et al. 2015). Based on the findings of the present study, it can be suggested that anaerobic capacity develops in parallel to age in growth period. For this reason, older adolescent players could be less fatigued throughout competitions, and could show a better level of anaerobic fitness throughout the season (Hoffman et al. 2000).

Abrantes et al. (2004) compared repeated sprint ability in six different groups of soccer players and reported that players aged less than 16 years were already able to perform very close to the level of professional senior players, confirming the high trainability of anaerobic pathways for energy turnover at these ages. The present findings showed that the differences between 10-meter sprint values were higher than 20-meter sprint values. Based on these values, it can be stated that acceleration ability showed was closely related to growth when compared to maximum speed (Meyers et al. 2015). However, although there was a significant difference between maximum speed and acceleration abilities, it was observed that this difference was not in parallel with agility when compared to maximum speed. Previous studies reported that soccer players performed poorly in converting their speed abilities into agility, and that there was a small but significant relationship between speed and agility (Warren et al. 2001).

CONCLUSION

In conclusion, physical performance differences between amateur soccer groups included in the present study, who were classified according to age groups, were found to be significant. It was observed that as the age difference between the groups increased, differences in physical performance also increased. The results show that physical performance differences enhance markedly with age from U-15 to U-19, but much more slowly thereafter between U-17 and U-19, and that these age-related differences correlate strongly with differences in physical characteristics of the players. While the differences in body mass and vertical jump characteristics were insignificant between the ages of U-17 and U-19, other characteristics were significant.

RECOMMENDATIONS

Physical performance differences might be attributable to genetic factors, athlete selection, and training frequency. For this reasons, it might be necessary to conduct further studies on adolescent soccer players at different ages to reach a better judgment on age-related variations in physical performance.

REFERENCES

Abrantes C, Maças V, Sampaio J 2004. Variation in football players' sprint test performance across different ages and levels of competition. *Journal of Sports Science and Medicine,* 3(1): 44-49.

Armstrong N, Welsman JR, Chia MY 2001. Short term power output in relation to growth and maturation. *British Journal of Sports Medicine,* 35(2): 118-124.

Bangsbo J 1994. The physiology of soccer with special reference to intense intermittent exercise. *Acta Physiologica Scandinavica,* 619: 1-155.

Barnsley RH, Thompson AH, Barnsley PE 1985. Hockey success and birth date: The relative age effect. *Journal of the Canadian Association of Health, Physical Education and Recreation,* 51: 23-28.

Cometti G, Maffiuletti NA, Pousson M, Maffulli N 2001. Isokinetic strength and anaerobic power of elite, sub elite and amateur French soccer players. *International Journal of Sports Medicine,* 22(1): 45-51.

Davids K, Lees A, Burwitz L 2000. Understanding and measuring coordination and control in kicking skills in soccer: Implications for talent identification and skill acquisition. *Journal of Sports Science,* 18(9): 703–714.

Gaitanos GC, Williams C, Boobis LH, Brooks S 1993. Human muscle metabolism during intermittent maximal exercise. *Journal of Applied Physiology,* 75(2): 712-719.

Gall F, Carling C, Williams M, Reilly T 2010. Anthropometric and fitness characteristics of international, professional and amateur male graduate soccer players from an elite youth academy. *Journal of Science and Medicine in Sport,* 13(1): 90–95.

Gil S, Ruiz F, Irazusta A, Gil J, Irazusta J 2007. Selection of young soccer players in terms of anthropometric and physiological factors. *Journal of Sports Medicine and Physical Fitness,* 47(1): 25–32.

Helgerud J, Engen LC, Wisloff UA, Hoff J 2001. Aerobic endurance training improves soccer performance. *Medicine and Science in Sports and Exercise,* 33(11): 1925-1931.

Hoffman J, Epstein S, Einbinder M, Weinstein Y 2000. A comparison between the Wingate anaerobic power test to both vertical jump and line drill tests in basketball players. *The Journal of Strength and Conditioning Research,* 14(3): 261-264.

Iri R, Sevinc H, Suel E 2009. The effect of football skill exercise applied to children aged 12-14 on basic motor features. *International Journal of Human Sciences,* 6(2): 122-131.

Johnson DL, Bahamonde R 1996. Power output estimate in university athletes. *The Journal of Strength and Conditioning Research,* 10(3): 161-166.

Kalinski M, Norkowski H, Kerner M, Tkaczuk W 2002. Anaerobic power characteristics of elite athletes in national level team-sport games. *European Journal of Sport Science,* 2(3): 1-21.

Kasabalis A, Douda H, Tokmakidis SP 2005. Relationship between anaerobic power and jumping of selected male volleyball players of different ages. *Perceptual and Motor Skills,* 100(3): 607-614.

Lloyd Rhodri S, Oliver JL, Radnor JM, Rhodes BC, Faigenbaum AD, Myer GD 2015. Relationships between functional movement screen scores, maturation and physical performance in young soccer players. *Journal of Sports Sciences,* 33(1): 11-19.

Mala L, Maly T, Zahalka F, Bunc V 2010. The profile and comparison of body composition of elite female volleyball players. *Kinesiology,* 42(1): 90-97.

Malina RM, Rogol AD, Cumming S, Coelho-e-Silva MJ, Figueirido AJ 2015. Biological maturation of youth athletes: Assessment and implications. *British Journal of Sports Medicine,* 49(13): 852-859.

Malina RM, Pena Reyes ME, Eisenmann JC, Horta L, Rodrigues J, Miller R 2000. Height, mass and skeletal maturity of elite Portuguese soccer players aged 11-16 years. *Journal of Sports Science,* 18(9): 685-693.

McKenna M 2010. *Methods of Identifying High Velocity Growth in Youth Soccer Players, in Scotland*. Master Thesis, Unpublished. Faculty of Biomedical and Life Sciences. Glasgow: University of Glasgow.

Meyers RW, Oliver JL, Hughes MG, Cronin JB, Lloyd RS 2015. Maximal sprint speed in boys of increasing maturity. *Pediatric Exercise Science,* 27(1): 85-94.

Miller DK 2006. *Measurement by the Physical Educator: Why and How.* 5th Edition. New York: McGraw Hill.

Mujika I, Spencer M, Santistebanbd J, Goirienab JJ, Bishop D 2009. Age-related differences in repeated-sprint ability in highly trained youth football players. *Journal of Sports Science,* 27(14): 1581-1590.

Mulazimoglu O 2014. The relative age effect in youth and professional soccer players in Turkey. *Anthropologist,* 18(2): 391-398

Philippaerts RM, Vaeyens R, Janssens M, Van Renterghem B, Matthys D, Craen R, Bourgois J, Virijens J, Beunen G, Malina RM 2006. The relationship between peak height velocity and physical performance in youth soccer players. *Journal of Sports Science,* 24(3): 221–230.

Reilly T, Williams AM, Nevill A, Franks A 2000. A multidisciplinary approach to talent identification in soccer. *Journal of Sports Science,* 18(9): 695–702.

Rummenich JN, Rogol AD 1995. Physiology of growth and development: its relationship to performance in the young athlete. *Clinics in Sports Medicine,* 4(3): 483-501.

Silvestre R, West C, Maresh CM, Kraemer WJ 2006. Body composition and physical performance in men's soccer: A study of NCAA Division I team. *Journal of Strength and Conditioning Research,* 20(1): 177-183.

Schutte NM, Nederent I, Hudziak JJ, de Geus EJ, Bartles M 2015. Differences in adolescent physical fitness: A multivariate approach and meta-analysis. *Behavior Genetics,* 1(11): 217-227.

Stolen T, Chamari K, Castagna C, Wisloff U 2005. Physiology of soccer: An update. *Sports Medicine,* 35(6): 501-536.

Vaeyens R, Malina RM, Janssens M, Van Renterghem B, Bourgois J, Vrijens J, Philippaerts RM 2000. A multidisciplinary selection model for youth soccer: The Ghent youth soccer project. *British Journal of Sports Medicine,* 40(11): 928–934.

Warren B, Young M, Mcdowell H, Bentley J 2001. Scarlet specificity of sprint and agility training methods. *Journal of Strength and Conditioning Research,* 15(3): 315–319.

Williams AM 2000. Perceptual skill in soccer: Implications for talent identification and development. *Journal of Sports Science,* 18(9): 737–750.

Zagotta AM, Beck WR, Gobatto CA 2009. Validity of the running anaerobic sprint test for assessing anaerobic power and predicting short distance performances. *Journal of Strength and Conditioning Research,* 23(6): 1820-1827.

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