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Age-related Effects of Speed and Power on Agility Performance of Young Soccer Players

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Abstract

The purpose of this study is to determine the age-related effects of power and running speed on agility ability of young soccer players. A total of eighty-one soccer players, who do not have professional contracts with any professional club but play for various local and school teams on a regular basis, have participated (mean age: 17.7±1.16, range 16–19) in this study. Tests consist of anthropometric variables, power and speed measurements, and the agility test (T-Agility). At the completion of the warm-up protocol, players completed assessments of countermovement jump (CMJ), squat jump (SJ), speed (10-, and 30-m sprints, respectively), and the agility test (Agility T-Test). An analysis of variance (ANOVA) analysis was used to compare the parameters between each group and Pearson correlation analyses were applied to determine the relationships between agility test, speed, and power. When evaluated by age, only U16 players displayed moderate correlation between Agility T-Test and S10m and S30m ($P<0.05$). The only significantly weak correlation was found between the Agility T-Test and S30m for U19 players ($P<0.05$). Similarly, the only significantly weak correlation was found between the Agility T-Test and CMJ and SJ for U19 players ($P<0.05$). In conclusion, the results showed that speed and lower extremity power should not be considered as important predictors of agility performance in young athletes.

Keywords: agility performance, linear speed, power, field tests, performance

1. Introduction

Agility is the ability to move and change direction and position of the body quickly and effectively while under control (Twist & Benicky, 1996). The field and court sports mostly involve some straight sprinting, but these sports more often involve repeated short sprinting with changes of direction. In field and court sports, an athlete's ability to sprint repeatedly and change direction while sprinting has a major effect on sport performance (Sheppard & Young, 2006). According to Hachana et al. (2013), the Illinois Agility Test (IAT) and the agility T-test are 2 of the most effective tests to measure agility, respectively. It is suggested that successful CODS is influenced by various physical and technical attributes, including straight sprinting speed/acceleration, eccentric and concentric strength and power and reactive strength (Young et al., 2002).

In many sports, particularly in team and racquet sports, successful performance of rapid movements such as jumps, sprints, and quick changes of direction is crucial (Gabbett et al., 2008; Little & Williams, 2005; Polat, Öz, Orhan, Yarim, & Cetin, 2014). For this propose, several studies have investigated the relationship between muscle power and sprinting abilities and agility for both skills (Los Arcos et al., 2017; Volpi Braz et al., 2017; Meylan et al., 2009). According to McFarland et al. (2016), the 30 m was strongly related to vertical jump performance in female athletes. However, a slightly stronger correlation was found between CMJ and both the 10 and 30 m in male soccer players. In a study conducted by Volpi Braz et al. (2017), the correlation magnitude between S10m-S20m ($r=0.83$), SJ-CMJ ($r=0.86$), and ZZT-Acyclic Sprint ($r=0.79$) were found to be very large. It was reported in another study that the correlation magnitudes between the change of direction ability, sprint speed, and jumping performance in nonprofessional soccer players were between .09 and .69 (Los Arcos et al., 2014).

According to various studies, jumping and sprint ability in two large groups of male soccer players continued to improve until approximately 16–17 years of age (Vaeyens et al., 2006; Gil et al., 2007). Vescovi et al. (2009) reported that the 18–21-year-old group did better than the 14–17-year-old group in sprint speed on the second and fourth 9.1m splits and 36.6m sprint speed as well as performance on the Illinois agility test. Gabbet (2002) reported that age has a significant effect on muscular power, speed, and agility in sub elite junior and senior rugby league players. Muscular power, agility, and speed were found to be higher in senior teams than junior teams.

According to FIFA (2016), soccer is a global sport, and it mainly involves, kicking a ball to score a goal. Running, sprints, jumps and changes of direction are important performance factors which are requiring maximal strength and anaerobic power of the neuromuscular system (Cloak et al., 2016). Sport scientists put great effort into finding effective methods to identify physical characteristics that may have influence on sport performance. Some of the objectives of soccer agility training involve enhanced power, balance, speed, and coordination. Physical ability testing is one of the common methods of assessing athletic skills (Chu & Vermeil, 1983). Soccer coaches and conditioning specialists utilize agility tests to diagnose specific weaknesses, screen for possible health risks that may arise due to strenuous exercise, provide data for outlining individual exercise prescriptions, and evaluate training period cycles (Altug et al., 1987). Correlation analysis with other fitness variables (i.e., power, speed, strength.) needs to be established to optimize agility training programs (Negra et al., 2017). Hence, the aim of the current study is to evaluate the age-related effects of running speed, and power on agility ability in several age groups.

2. Method

2.1 Participants

Eighty-one soccer players, who do not have professional contracts with any professional club but play for various local and school teams on a regular basis, have participated (mean age: 17.7±1.16, range 16–19) in this study. All player have been practicing regularly for at least 3 years (three days a week), and involved of combined soccer training and competitive play per week. The players were grouped on the basis of chronological age into 1-year age categories: under 16 (U16), under 17 (U17), under 18 (U18), and under 19 (U19). At the beginning of the study, participant athletes were verbally informed about research protocols and written consents were obtained from the athletes prior to participation in the study. The study was conducted in accordance with the Declaration of Helsinki.

2.2 Procedures

All tests were carried out in two sessions before the 2018/2019 season. At the beginning of the testing session, anthropometric characteristics and the power and running speed were performed. Agility tests (T-Agility) were performed on the second day. Before the tests, the athletes were asked to wear clothes and shoes that would not restrict their movements. Athletes were informed that they should not perform any intense activities 48 hours before the measurements.

After the anthropometric variables were measured and recorded for each athlete, a standard warm-up including, light walking, running, light jumping and dynamic stretch exercises, was performed by the researcher. Subsequently, participants were allowed to perform three sub-maximal trials for each test. First, the countermovement jump (CMJ) and squat jump (SJ) were performed. After this measurement, the athletes performed Agility T-Test, 10-m and 30-m sprint tests on the grass field. The test was repeated three times for each participant for reliability purposes and the best value was recorded (Hopkins, 2000). Each tests were took place at the same time of the day (9–11 AM), and the tests were completed in July.

2.3 Instruments

2.3.1 Anthropometric Data

The athlete's body heights were measured with a scale having a sensitivity of 0.01 m (m), and their body weights (VA) were measured with electronic scales (SECA, Germany) with a sensitivity level of 0.1 kilograms (kg). The BMI was calculated as a ratio of the BW (kg) and squared BH (m).

2.3.2 Power

Two different jumping tests were performed as a SJ, in which subjects were jumping from a stationary semi-squatting position (knee angle = 90^0), and a CMJ, in which subjects were allowed to perform a countermovement with the lower limbs before jumping. These tests were conducted through a SmartJump (Jumpmeter). During the test, in order to avoid unmeasurable work, horizontal and lateral displacements were minimized, and the players were warned to keep their hands on the iliac crest and jump upwards as high as possible. In order to avoid the bending of the knee and alteration of measurements in both tests, the subjects were warned to land on the same point of takeoff, and rebound with straight legs when landing. Each test was measured with 3 trials, and 1-minute pauses were allowed between trials. Approximately 15 minutes of pauses were given between 2 tests in a testing session (Markovic et al., 2004). The measured jump heights were recorded in cm.

2.3.3 Agility Test

Munro and Herrington's protocol was used to administer the test (Moore et al., 2015). To set up the Agility T-Test track, four cones were placed to form a T. One of the cones was placed from the starting cone (9.14 m) and 2 additional cones placed from either side of the second cone (4.57 m). Following the start command, the participant starts from cone "A", runs straight to cone "B", and touches the cone with the right hand. Then he runs leftward to cone "C" in side steps and touches the cone with the left hand. Then he runs to the right side and touches cone "D" with the right hand. Then he runs side step back to cone "B" and touches the cone with the left hand. Then he runs back to cone "A". The stopwatch is stopped as soon as he reaches the "A" cone. In this measurement, the participant makes a maximum of 3 repetitions with full rests in between. The best trail was recorded to be used for further analysis.

2.3.4 Running Speed

Sprint speed (10-m and 30-m) was measured on the grass scene with a photocell stopwatch system. When 10 m was given as the acceleration criterion, it was evaluated as the maximal sprint velocity measured at 30-m. In these tests, the photocell doors were placed at the start and finish points. The soccer players started from a standing position 0.3 m ahead of the starting line. Each athlete was given three trials in every 3 minutes, and the best rating was used for further analysis.

2.4 Data Analysis

Descriptive statistical parameters, arithmetic mean, and standard deviation values, were calculated for all variables. Normality of distributions for each variable was tested though the skewness and kurtosis test. An analysis of variance (ANOVA) was used to compare the parameters between each group. When ANOVA showed a significant group effect, group differences were allocated by using post hoc Tukey test. Pearson correlation analyses were applied to determine the relationships between agility test, speed, and power. The significance level for all calculations was interpreted as $p < 0.05$, R-values were evaluated as weak (≤ 0.39), moderate ($0.40 \leq r \leq 0.69$) or strong (≥ 0.70) (Cohen et al. 2013). IBM SPSS (version 23) analysis program was used for all analysis. Statistical significance was accepted at $P < 0.05$.

3. Results

Table 1 and 2 show the mean values (±SD) of the variables of the characteristics and performance tests of the players according to age group. All anthropometric variables, except the BMI, showed no age-related differences (U19>U16; $P<0.005$) (Table 1). U19 players had faster ($P<0.05$) S30m and Agility T-Test times than U16 players, and also U19 players were faster ($P<0.05$) than U17 players in all sprint running (Table 2). In addition, U18 players had faster ($P<0.05$) S30m time than U17 players (Table 2).

Table 3 presents the relationships between the variables of the agility and running speed and power. When evaluated by age, only U16 players displayed moderate correlation between Agility T-Test and S10m and S30m ($P<0.05$). The only significantly weak correlation was found between the Agility T-Test and S30m for U19 players ($P<0.05$). Similarly, the only significantly weak correlation was found between the Agility T-Test and CMJ and SJ for U19 players ($P<0.05$).

Table 1. Characteristics of U16, U17, U18, and U19 soccer players*

Variables	U16 (N=17) Mean±SD	U17 (N=19) Mean±SD	U18 (N=17) Mean±SD	U19 (N=28) Mean±SD
Height (cm)	176.2±4.13	176.7±6.77	177.3±6.28	175.8±6.67
Mass (kg)	64.4±7.59	66.7±8.34	66.5±6.63	70.3±8.16
BMI (kg/m^2)	20.7±2.15*	21.3±2.18	21.1±1.78	22.7±1.87

SD: standard deviation; BMI = Body Mass Index.

**Significant difference in relation to U19 (p < 0.05).*

Table 2. Performance tests for U16, U17, U18, and U19 soccer players*

Variables	U16 (N=17) Mean±SD	U17 (N=19) Mean±SD	U18 (N=17) Mean±SD	U19 (N=28) Mean±SD
S10m (sec)	1.57±0.12	1.63±0.13†	1.56±0.09	1.52±0.12
S30m (sec)	4.23±0.2*	4.37±0.14† §	4.2±0.19	4.04±0.14
CMJ (cm)	36.7±5.31	38.8±6.15	41.3±5.03	40.6±5.73
SJ (cm)	35.8±2.88	35±4.96	37±4.24	38.4±6.86
T-Test (sec)	10.54±0.75*	10.52±0.54†	10.2±0.28	9.83±0.42

SD: standard deviation; S10 = sprint 10m; S30 = sprint 30m; CMJ: Counter movement jump; SJ: Squat jump.
**Significant difference in relation to U19 (p < 0.05); † Significant difference in relation to U19 (p < 0.05); § Significant difference in relation to U18 (p < 005).*

Table 3. Pearson's correlation coefficients between running speed, power, and agility performance by age (r-values)*

Group	Variables	S10m	S30m	CMJ	SJ
U16		0.72*	0.68*	-0.46	-0.47
U17	T-Test (sec)	-0.18	0.44	0.09	-0.07
U18		-0.04	-0.33	-0.30	-0.30
U19		0.25	0.51**	-0.41*	-0.40*

S10 = sprint 10m; S30 = sprint 30m; CMJ: Counter movement jump; SJ: Squat jump.
**Denotes significant Pearson's correlation coefficient at the level 0.05 level.*
***Denotes significant Pearson's correlation coefficient at the level 0.01 level.*

4. Discussion

Strength and conditioning programs for team sports athletes should definitely include agility and it should be eveloped and routinely implemented (Paul et al., 2016). The aim of this study was to investigate the effects of running speed and power on agility ability in different age categories of nonprofessional soccer players. The results showed that running speed is significantly related to agility performance among U16 soccer players and only S30m is found to be an important predictor of the agility performance among U19 soccer players. In addition, a weak effects of detected on agility performance among U19 soccer players but not among U16, U17, and U18 players.

As in most previous studies (Vescovi & Mcguigan, 2008; Alemdaroğlu, 2012; Ateş & Çetin, 2017; Mendez-Villanueva et al., 2011), a statistically significant strong negative relationship was found between CMJ and running time. The ability to run fast and move quickly have an important pre-requisite for success in most sporting and recreational physical activities (Korhonen et al., 2009). Children's and adolescents' sprint-running performances depend on several factors induced by growth and maturation (Mendez-Villanueva et al., 2011). The results indicate that agility performance was positively and moderately correlated to S10m and S30m (r-value 0.72 and 0.68, respectively) only among U16 players. And also, the correlation between agility performance and S30m (r-value 0.51) in the U19 players was found to be weak. Jeffreys (2006) detected that agility is an independent physical ability. Considering the findings of Abrantes et al. (2004), the differences resulting from different age groups (Sub 16, Sub 14 and Sub 12) were discriminated by sprint test performances. It has also been suggested that some locomotor specialization into more sprinting or aerobic profiles can occur around or after puberty (Rowland, 2002). Little and Williams (2005) found that running speed and agility were distinct motor characteristics in professional male soccer players. However, LIyod et al. (2013) found in an investigation conducted with young athletes that the straight-line running speed could be one of the important contributors to the agility outcomes.

Many studies showed that the low effects of power on agility ability in sports where athletes performed sprints with change of direction (Markovic et al., 2007; McFarland et al., 2016; Hazır et al., 2010; Young et al., 2002). Thus, our results comply with the previous studies. The weaker correlation was found between power and agility measures only among U19 soccer players but not among U16, U17, and U18. In a study by McFarland et al. (2016), in which the relationship between two different jump tests (CMJ and SJ) and change in direction speed ability was reviewed in male and female Division II college athletes (soccer players), no significant relationship was found between CMJ and agility tests in male athletes. In addition, Peterson et al. (2006) reported that there was an insignificant relationship between vertical jump performance and the agility T-test performance. In contrast to these studies, Negra et al. (2016) reported that the agility performance, speed time, and jumping ability, could represent the same motor abilities in competitive-level young male team sports athletes. Our results show that agility performances and a variety of field tests are correlated with each other within both team sports group. Furthermore, LIyod et al. (2013) found that the lower limb strength and power could be some of the important contributors to the agility outcomes.

Unilateral and bilateral use of agility tests are found in practices on different bases in literature. For example, in a study, in which the vertical jumping performance of male team players was unilaterally and bilaterally assessed, no significant correlation was found between left leg vertical jumping performance and T-Test time, while a significant correlation was found between right leg vertical jumping performance and T-Test time ($r = -0.380$ to -0.512, $p \leq 0.05$). In the same study, a significant correlation was found between left leg long jump and side jump and both T-Test and 505 agility tests ($r = -0.370$ to -0.729, $p \leq 0.05$) (Lockie et al., 2014).

In conclusion, the results of this study showed that running speed and lower extremity power should not be considered as an important predictor of agility performance in young athletes.

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