The relationship between sprint ability, agility and vertical jump performance in young soccer players

Relation entre la performance de l’habilité de sprint, l’agilité et le saut vertical chez des jeunes joueurs de football

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Summary
Objective. — The purpose of this study was to examine the relationships between speed, agility and vertical jump performance in young soccer players.

Material and methods. — Fifteen soccer players (average age 16.0 ± 0.8 years; average height 168.4 ± 4.7 cm; average body mass 62.6 ± 7.7 kg; average training age 6.0 ± 2.0 years) participated in this study voluntarily. The sprinting ability of each player was determined using 10-m and 30-m single-sprint times; zigzag agility with the ball (ZAWB) and without the ball (ZAWHB) test times were used to determine their agility; and squat jump (SJ) and countermovement jump (CMJ) heights were used for the determination of vertical jump ability.

Results. — The results of Pearson Product Moment Correlation analysis indicated moderate to strong correlations between 10-meter sprint times and 30-meter sprint times \( (r = 0.714; P = 0.01) \) and ZAWHB \( (r = 0.567; P = 0.02) \). Similarly, 30-meter sprint times were moderate to strong correlated with CMJ ability \( (r = -0.599; P = 0.02) \) and ZAWHB \( (r = 0.744; P = 0.01) \). A strong correlation was also found between CMJ ability and SJ ability \( (r = 0.706; P = 0.01) \) and between CMJ ability and ZAWHB \( (r = -0.769; P = 0.01) \). In addition, SJ ability was strongly correlated with ZAWHB \( (r = -0.712; P = 0.01) \). Finally, ZAWHB was moderate correlated with ZAWB \( (r = 0.566; P = 0.02) \). In conclusion, the findings of the present study indicated that there is a significant correlation between sprint ability and agility. In addition, significant correlations were found both between

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vertical jumping ability and sprinting ability and between vertical jumping ability and ZAWHB test performance in soccer players.

Conclusion. — The results of the study therefore suggest that speed, agility without the ball and vertical jumping ability share common physiological and biomechanical determinants.

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1. Introduction

High-intensity movements during soccer games can be categorized into actions requiring rapid acceleration (10-m sprint), actions at maximum speed (30-m sprint), or actions requiring agility [1]. Maximum speed and acceleration are important qualities in field sports, with running speed over short distances fundamental to success [2]. Stolen et al. [3] reported that 96% of sprint bouts during a soccer game are shorter than 30-m, with 49% being shorter than 10-m. Agility, meanwhile, requires rapid, repetitive decelerations and accelerations over short distances apparently using a different running technique; it also involves perceptual skill [4].

Numerous studies have focused on the relationships between high intensity movements in soccer players. However, the findings appeared to be inconsistent. Of those that have, some have found a strong correlation between high intensity movements, while other studies have found a weak correlation. For example, Little and Williams [1] found high level correlations between 10-m sprint, 20-m sprint and Zigzag performance in professional soccer players (P < 0.0005). In another study, Spaniol et al. [5] have investigated the relationship between 40 yard dash times (speed) and 20 yard shuttle run times (agility) of professional football players. The results showed that there were significant relationships between speed and agility of professional football players. Similarly, Köklü et al. [6] found high level significant relationship between 10-m and 30-m speed times in young soccer players. On the other hand, Cronin and Hansen [7] reported weak associations between counter-movement and squat jump performance and 5-m, 10-m, and 30-m sprint times. Similarly, Salaj and Markovic [8] found weak correlations between 5-m, 10-m and 20-m speed and 20 yards shuttle run times (agility) of professional football players. Moreover, Buttifant et al. [9] reported no significant correlations between 20-m sprinting and 20-m agility. Salaj and Markovic [8] reported that the reason of observed discrepancy between results of these studies could be several factors such as the subjects’ age, gender, and level of physical fitness and skill, sample size, type of performance tests used, or rest intervals between tests. In addition, no study has examined the relationships between sprinting, agility with the ball and vertical jump performance, even though vertical jumping and agility with the ball are integral to effective soccer performance. If a significant relationship can be found between speed, agility and vertical jump performance, it could help coaches to use the available training time more efficiently. Therefore, the purpose of this study was to examine the relationship between speed, agility and vertical jump performance in young soccer players.

2. Methods

2.1. Subjects

Fifteen soccer players (average height 168.4 ± 4.7 cm; average body mass 62.6 ± 7.7 kg; average age 16.0 ± 0.8 years;
average training experience 6.0 ± 2.0 years) voluntarily participated in this study. This study was carried out over a week’s pre-season training period in September 2010–2011, during which the soccer players who participated were not involved in any other training or matches. All the players were members of the same youth team competing in an elite academy league and they generally trained four days per week for two hours. Written informed consent was obtained from all the participants and their parents. All players and parents were notified of the research procedures, requirements, benefits, and risks before giving informed consent. The study was approved by the local Ethics Committee, and was conducted in a manner consistent with the institutional ethical requirements for human experimentation in accordance with the Declaration of Helsinki.

2.2. Procedures

2.2.1. Anthropometric measurements
The players’ heights were measured using a stadiometer with an accuracy of ±1 cm (SECA, Germany); electronic scales (SECA, Germany) with an accuracy of ±0.1 kg were used to measure the body mass.

2.2.2. Vertical jump measurements
Vertical jump performance was assessed using a portable force platform (Newtest, Finland). Players performed countermovement (CMJ) and squat jumps (SJ) according to the protocol described by Bosch et al. [10]. Before testing, the players performed self-administered submaximal CMJs and SJs (2–3 repetitions) as a practice as well as additional warm-up. During the testing, the players were asked to keep their hands on their hips to prevent any influence of arm movements on the vertical jumps and to avoid coordination as a confounding variable in the assessment of the leg extensors [11]. Each subject performed 3 maximal CMJs and SJs, with approximately 2 minutes’ recovery time between them. The players were asked to jump as high as possible; the highest jump was then recorded in centimetres [11].

2.2.3. 10-m and 30-m sprint tests
The subjects performed 3 maximal 30-m sprints (with 10-m split times also recorded) on a synthetic grass pitch. There was a recovery period of 3 minutes between the 30-m sprints. The shortest time taken to cover the 30-m distance in the sprint test was used in the data analysis. Prior to each sprint test, players performed a thorough warm-up consisting of 10 minutes of jogging at 60–70% of HRmax and then 5 minutes of exercise involving fast leg movement (e.g., skipping, cariocas) over short distances of 5 to 10-m and 3–5 single 15-m shuttle sprints with 2 minutes of passive recovery. Timings were taken using an electronic timing system (Prosport TMR ESC 2100, Tumer Engineering, Ankara, Turkey).

2.2.4. Zigzag agility tests with and without the ball
The subjects performed zigzag agility tests with and without the ball 3 times on a synthetic grass pitch. There was a recovery period of 3 minutes between trials. The shortest time was recorded as zigzag agility tests with and without the ball performance. The zigzag agility tests course consisting of four 5-m sections set out at 100° angles (see Fig. 1). Mirkow et al. [12] reported that coefficient of variation was 21, 12%, intraclass correlation coefficient was 0.81, 0.84 and typical error of measurement was 0.21 and 0.098 for zigzag agility tests with and without respectively. The zigzag test was chosen because it requires the acceleration, deceleration, and balance control facets of agility, and the subjects’ familiarity with the test, not to mention its relative simplicity, meant that learning effects would be minimal [1]. There is no specific rule such as number of the ball touches during the zigzag agility with ball test. Time was measured using an electronic timing system (Prosport TMR ESC 2100, Tumer Engineering, Ankara, Turkey).

2.3. Statistical analyses
The mean and standard deviation values for each test were calculated for all players. The relationships between speed, agility and jump performance were analyzed using the Spearman Correlation Analysis (r), with the level of statistical significance set at P < 0.05 in SPSS for Windows, version 15.0 (SPSS, Inc., Chicago, IL).

3. Results
The players’ physical characteristics and test performances are shown in Table 1. The results of the Spearman Correlation Analysis indicated moderate to strong correlations between 10-m sprint times and 30-m sprint times and between 10-m sprint times and zigzag agility without the ball. Similarly, 30-m sprint times showed moderate to strong correlations with both countermovement jump performance and with zigzag agility without the ball. There was a strong correlation between countermovement jump ability and squat jump performance and between countermovement
and zigzag agility without the ball. In addition, squat jump performance had a strong correlation with zigzag performance without the ball. Finally zigzag agility without the ball was moderate correlated with zigzag agility with the ball (Table 2).

4. Discussion

The purpose of the present study was to examine relationships between sprinting ability, agility and vertical jump performance in young soccer players. The main finding is that there are significant relationships between these soccer performance indicators.

The findings of the present study show moderate to strong correlations between acceleration, maximum speed, and agility without the ball in young soccer players (r = 0.566 to 0.714). Therefore, present study findings demonstrated that acceleration, maximum speed and agility without ball share common physiological and biomechanical determinants. In line with the present study, Little and Williams [1] reported that 10-m test for acceleration, the flying 20-m test for maximum speed, and the zigzag test for agility were all correlated at high levels of statistical significance (P < 0.0005). In contrast, Buttifant et al. [9] reported no significant correlations between 20-m sprinting and 20-m agility. In addition, Vescovi and McGuigan [13] reveal a weak correlation between 9.1-m sprint and the performance of two agility tests. The differences between studies in terms of findings may be explained by several facts. One of the possible reasons is those players’ different physical fitness level and skill. Elite soccer players have greater values of physical fitness level and skill when compared with non elite soccer players [14]. Another possible reason is the players’ level of perception and decision-making. Young and Farrow [15] reported that a player may have average speed but be very agile because the player is highly skilled in the perceptual and decision-making factors. Another reason could be the distance used in the sprint tests. In the present study, acceleration (10-m) and maximal speed (30-m) of players were evaluated and 20-m flying time of players were not evaluated, however, players covered the distances 20-m in both Zigzag agility with and without tests. Therefore, different distances should be used in the future studies which evaluate relationship between agility and sprint performance of players.

The findings of the present study also show vertical jumping ability moderate to strong correlations with maximum speed, and agility without the ball (r = 0.599 to 0.769) in young soccer players. According to our results, CMJ performance shows a moderate correlation with 30-m sprint times, with the relationship becoming increasingly stronger over

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Soccer players’ physical characteristics and test performances.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum</td>
</tr>
<tr>
<td>Age (year)</td>
<td>15.00</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>161.00</td>
</tr>
<tr>
<td>Body mass (kg)</td>
<td>50.00</td>
</tr>
<tr>
<td>Training age (year)</td>
<td>2.00</td>
</tr>
<tr>
<td>10-m sprint (s)</td>
<td>1.68</td>
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<tr>
<td>30-m sprint (s)</td>
<td>4.19</td>
</tr>
<tr>
<td>CMJ (cm)</td>
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</tr>
<tr>
<td>SJ (cm)</td>
<td>27.00</td>
</tr>
<tr>
<td>Zigzag agility with the ball (s)</td>
<td>7.30</td>
</tr>
<tr>
<td>Zigzag agility without the ball (s)</td>
<td>6.31</td>
</tr>
</tbody>
</table>

CMJ: Countermovement jump; SJ: Squat jump.

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Correlations between sprinting speed, agility and vertical jump performance.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10-m sprint</td>
</tr>
<tr>
<td>10-m sprint</td>
<td>1</td>
</tr>
<tr>
<td>30-m sprint</td>
<td>0.714*</td>
</tr>
<tr>
<td>CMJ</td>
<td>−0.123</td>
</tr>
<tr>
<td>SJ</td>
<td>0.030</td>
</tr>
<tr>
<td>Zigzag agility with the ball</td>
<td>0.479</td>
</tr>
<tr>
<td>Zigzag agility without the ball</td>
<td>0.567*</td>
</tr>
</tbody>
</table>

CMJ: Countermovement Jump; SJ: Squat Jump.

* Correlation is significant at the 0.01 level.
* Correlation is significant at the 0.05 level.
Sprint ability, agility and vertical jump performance in soccer players

increasing sprint distances. The strongest correlation was found between CMJ and agility without ball \( r = -0.769 \). Similarly, Mero et al. [16] found a significant correlation between sprinting performance and vertical jumping performance. Moreover, Wisslaff et al. [17] showed that vertical jump height performance was strongly correlated with both 10-m \( r = 0.72, P < 0.001 \) and 30-m sprint times \( r = 0.60, P < 0.01 \) in soccer players. On the other hand, Vescovi and McGuigan [13] have reported weak associations between CMJ performance and various sprint distances. In addition, Köklü et al. [6] showed that agility performance without the ball was weakly correlated with squat jump height \( r = -0.353, P < 0.05 \) in young soccer players. Moreover, Chamari et al. [18] reported that CMJ was not correlated with flying 20-m and 30-m sprint times for a group of high school soccer players. The differing findings in terms of the correlation between CMJ and sprint times might be due to the differences between participants in the studies; Chamari et al. [18] suggest a potential effect of age or experience when examining the relationship between these locomotor skills.

Lastly, this study did not find correlations between agility with the ball and vertical jump performance, acceleration, and maximum speed in young soccer players. The reason for this appears to be that players’ technical skill levels become a factor in zigzag agility performance with the ball. In line with present study, Sporiš et al. [19] found that zigzag agility performance without the ball was moderately correlated with both 20-m sprint times \( r = 0.603, P < 0.05 \) and 30-m sprint times \( r = 0.560, P < 0.05 \), whereas zigzag agility performance with the ball was not correlated with 20-m and 30-m sprint times in young soccer players. This study also showed that although the same energy system (ATP-PC) contributed to the energy demand for both zigzag agility with and without ball tests, there is only moderate correlation between zigzag agility with and without ball tests \( r = 0.56 \). This means that agility with and without ball tests are affected from different factors and the main reason of moderate correlation could be technical capacity of players. In the light of these result, it can be said that the two tests evaluate different soccer’s capacities. Therefore, coaches should use both tests in order to determine performance level of soccer players. In addition, coaches should not only use agility without ball training, but also they should use agility with ball training in order to improve agility with ball performance of their players.

In conclusion, the findings of the present study indicate a significant correlation between sprint ability and vertical jump performance and zigzag agility without the ball in young soccer players. One of the possible reasons for these findings is that sprinting, agility and vertical jumping include dynamic movements requiring high muscle power and that one would therefore expect these performances to be closely related. Another explanation for the high association between sprint, agility and vertical jump performance may be the same energy systems that each movement type demands. None of the tests lasted more than 8 seconds, and hence the phosphagen system (ATP-PC) contributed to the energy demand for all of them. The results of the present study therefore suggest that sprinting speed, agility without the ball and vertical jumping ability share common physiological and biomechanical determinants.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

References