A LEVEL AND RELATIONSHIP BETWEEN TAPPING FREQUENCY AND VERTICAL JUMP HEIGHT IN ELITE SLOVAK SOCCER DEFENDERS

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Abstract

The aim of the study was to find out the level and relationship between tapping frequency of lower limbs and vertical jump height in elite Slovak soccer defenders (n = 15, age = 25.4±5.2 years, height = 181.2±5.0cm, weight = 78.0±6.5kg). The level of tapping frequency of lower limbs (TF) was diagnosed by device FiTROtapping, (FiTRONIC, Bratislava, Slovak Republic). The criterion of performance evaluation of every measured soccer player was total number of contacts with both legs on contact mats of mentioned device during 6 s in a standing position. Vertical jump heights were measured by 2 types of vertical jumps with the device FiTROJumper, (FiTRONIC, Bratislava, Slovak Republic): Squat jump (SJ) a Countermovement jump (CMJ). Pearson correlation coefficient (r, α = 0.05) was used for determination of difference significance between observed parameters (TF – SJ; TF – CMJ). Statistical analysis was realized by software IBM® SPSS® Statistics V.19. The average level of TF was indicated by number 58.5±5.5 of contacts on device FiTROtapping. The average performance in the test of SJ was 36.3±4.0cm and in the test of CMJ was 37.3±4.4cm from the point of view of jump abilities. Statistical analysis showed linear dependency between TF and SJ (r = 0.54, p < 0.05) and as well as between TF and CMJ (r = 0.52, p < 0.05).

Key words: jump abilities, fitness training, FiTROtapping, FiTROJumper

Introduction

Present professional soccer is characterized by constant acceleration and intensification. Psotta et al. (2006) state that the biggest changes in soccer in last years were made especially in condition figures which regard to speed-force assumptions in playing performance. The condition according to Bunc (1999) presents 30-40% of playing performance in soccer. Haugen, Tennessen & Seiler (2012) discovered that Norwegian national soccer players and players of the Norwegian Premier league achieved higher performance from the point of view of the acceleration and running speed (p < 0.05) than players from 2nd division (difference 1.0-1.4%), 3rd – 5th division (difference 3.0-3.8%), junior national team (difference 1.7-2.2%) and junior players (difference 2.8-3.7%). Considering that this research lasted more years (1995-2010, n = 939, age = 22.1±4.3 years), the authors had the possibility to determine that players in years 2006-2010 were faster about 1-2% in 20m run in comparison with players in years 1995-1999 and 2000-2005. We agree with the statement of Reilly (1997), Psotta et al. (2006), Orendurff et al. (2010) that soccer is intermittent movement activity which contains very short, usually 1 to 5 seconds continuing intervals of endurance with high to maximum intensity, which alternate with intervals of endurance with lower intensity or inaction lasting from 5 to 10 seconds. Andrzejewski et al. (2012) found out in professional players of European leagues that 90% of all realized sprints in the games are up to 5 seconds. According to Psotta et al. (2006) 50-65% of all realized sprints are shorter than 5m, 75-85% of all sprints are no longer than 10m and the average length of sprints is 9m in a single soccer game. Grasgruber & Cacek (2008) state that length of sprints is ca 15m and in principle no more than 30m, every ca 90s, that means 0.8 to 1km in the whole soccer match. Hipp (2007) declares that in the soccer match we can observe by player around 100 to 150 sprints with different length. Bangsbo, Mohr & Krstrup (2006), Bangsbo, Iaia & Krstrup (2007) state in professional players 150 to 250 short intensive activities in a match. According to authors (Holienka, 2003; Psotta et al., 2006; Grasgruber & Cacek, 2008) jump abilities is the most important part in starting running speed and running acceleration from all movement abilities. The findings of Lakoma (1984, In Psotta et al., 2006) indicate that jump abilities is decisive parameter in starting running speed and running acceleration ca up to 10 - 12m of running, it means 1.85 to 2.00s. Soccer game is characterized largely with different forms of speed and speed-dynamic abilities and success of a soccer match is depending on and determined by their level. Production and absorption of force reveals in final performance (rational and effective solution of physical activity of the player) but reveals as possible cause of player´s injury too (Malý et al., 2011). Integral part of complex speed performance of the soccer player is tapping frequency too. We agree with the statement of Grasgruber & Cacek (2008) that speed of runner (soccer player) is the result of interaction between frequency and step length. According to Doležajová & Lednický (2002) in evaluation of complex performance of speed abilities, the most important factors are maximal speed of movement in straight direction, acceleration and maximal frequency of cyclic movements.
We agree with Zemková, Chren & Štefániková (2013), who write that there is little knowledge about tapping frequency of sportsmen in literature, despite the fact that this ability presents one of important factors of sport performance in various kinds of sports. Tapping frequency and jump abilities demonstrated in running acceleration and vertical jumps make important partial components of qualitative complex speed and speed-force performance of a soccer player. The aim of the study is to find out if there is a relationship between tapping frequency and jump abilities in elite Slovak soccer defenders, specifically if there is linear dependency between them.

**Methods**

**Characteristics of the group**
The observational group consisted of defenders (n = 15, age = 25.4±5.2 years, height = 181.2±5.0 cm, weight = 78.0±6.5 kg) of three Slovak elite soccer teams (MŠK Žilina, FK Dukla Banská Bystrica and AS Trenčín). In the season 2010/2011 the soccer players MŠK Žilina and FK Dukla played the highest Slovak soccer league and AS Trenčín was the leader of the second highest soccer league. This team won this league and promoted to the highest league too.

**Organizing of measurements**
Measurements were realized during February and March 2011 (MŠK Žilina – February 8th 2011, FK Dukla - February 26th 2011 and AS Trenčín – March 23rd 2011) in morning hours when we can speak about the first daily peak of performance in accordance with Jančoková (2000). The measurements of tapping frequency of lower limbs took place in training complex Fitaréna in Banská Bystrica in the same standard conditions. The research was approved by the Ethical Committee of Matej Bel University in Banská Bystrica. Measurements were carried out in accordance with the ethical standards of Declaration of Helsinki and ethical standards in sport and exercise science research (Harriss & Atkinson, 2011).

**Realization of measurements**
Soccer players went through general warm-up (10 minutes) and speed warm-up (10 minutes). Tapping frequency of lower limbs (TF) was measured by the device FITROtapping (FITRONIC, Bratislava, Slovak Republic) consisting of a contact mat placed on the floor and fixed with interface to the computer. We had measured vertical jump height on 2 types of vertical jumps: Squat jump (SJ) and Countermovement jump (CMJ). We had chosen the best jump from three trials in both SJ and CMJ. Vertical jump height was measured with accuracy 0.1 cm. The device FITRO Jumper uses this relationship \( h = (g \times Tf^2) / 8 \) for measurement of jump height. The producer FITRONIC s.r.o. guarantees accuracy and reliability of the device with certified simultaneous measurements with a spring mat from the company KISTLER.

**Statistical analysis**
In presented study we have used within periphrastic characteristics of descriptive statistics arithmetic average (x) from position measures and standard deviation (SD) from variability measures. We have used Pearson correlation coefficient (r) for statistical determination of significance of linear dependency among studied parameters (TF and SJ; TF and CMJ). The probability of type I error (alpha) was set at 0.05 in all statistical analyses. Statistical analysis was realized with software IBM® SPSS® Statistics V19 (Statistical Package for the Social Sciences).

**Results**
Average level of tapping frequency of lower limbs (in the whole group) was 58.5±5.5 contacts on the device FITROtapping. Average performance from the point of view of vertical jump height was in the test on Squat jump 36.3±4.0 cm and in the test on Countermovement jump 37.3±4.4 cm (Table 1).

**Table 1 The level of frequency tapping of lower limbs and vertical jump height (tests: Squat jump and Countermovement jump), (n = 15)**

<table>
<thead>
<tr>
<th>Defender</th>
<th>Tapping frequency (number of contacts in 6 s)</th>
<th>Vertical jump height</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Squat jump (cm)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Countermovement jump (cm)</td>
</tr>
<tr>
<td>1</td>
<td>51</td>
<td>30.8</td>
</tr>
<tr>
<td>2</td>
<td>51</td>
<td>31.3</td>
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<tr>
<td>3</td>
<td>54</td>
<td>32.6</td>
</tr>
<tr>
<td>4</td>
<td>55</td>
<td>33.8</td>
</tr>
<tr>
<td>5</td>
<td>55</td>
<td>34.3</td>
</tr>
<tr>
<td>6</td>
<td>63</td>
<td>41.7</td>
</tr>
<tr>
<td>7</td>
<td>69</td>
<td>43.6</td>
</tr>
<tr>
<td>8</td>
<td>56</td>
<td>36.4</td>
</tr>
<tr>
<td>9</td>
<td>58</td>
<td>37.1</td>
</tr>
<tr>
<td>10</td>
<td>59</td>
<td>38.5</td>
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<tr>
<td>11</td>
<td>59</td>
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<td>12</td>
<td>61</td>
<td>40.8</td>
</tr>
<tr>
<td>13</td>
<td>55</td>
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</tr>
<tr>
<td>14</td>
<td>63</td>
<td>33.7</td>
</tr>
<tr>
<td>15</td>
<td>68</td>
<td>32.0</td>
</tr>
<tr>
<td>group</td>
<td>58.5±5.5</td>
<td>36.3±4.0</td>
</tr>
</tbody>
</table>

We have found out following results with statistical analysis. Linear dependency \( r = 0.54, p < 0.05 \) was found out between tapping frequency of lower limbs and Squat jump (Figure 1).
Integral parts of complex speed performance of a soccer player are tapping frequency and jump abilities too. Regarding game demands, high level of jump abilities presents an advantage in personal air duels but in running and total speed performance of a soccer player too. Fast comebacks into defense, sprint tendencies behind the defense line, offensive backup of outside players (mostly defenders) and fast “switching” from defense to offense (or vice versa) have a complementary character from the point of view of speed presuppositions of players. In this study we have measured tapping frequency of lower limbs during time interval of 6 seconds. Zemková, Chren & Štefániková (2013) mention the test of tapping frequency of mainstream population usually lasting 10 seconds. According to definition of intermittent movement structure of soccer as state Reilly (1997), Psotta et al. (2006), Orendurff et al. (2010) we have changed time interval to 6 seconds because speed performance of a soccer player very seldom lasts longer in the match.

We had measured jump abilities and vertical jump height on two types of jumps: squat jump (SJ) and countermovement jump (CMJ). When we speak about the level of tapping frequency, we did not come across results of soccer players in the literature. Results of soccer players from the point of view of vertical jumps belong to frequent solved problem in condition training in soccer. In our study we have decided to observe defenders. In other studies, authors dealt the problem of performance comparison according to playing positions and various performance levels and they came to different findings. Lago-Peñas et al. (2011) found out that young soccer players (n = 321, age = 15.63±1.82 years) achieved the best performances in vertical jumps in the group of goalkeepers and central defenders in comparison with the group of all defenders, midfielders and forwards. Forwards reached higher performance than midfielders and defenders. Haugen et al. (2012) found out that Norwegian players including senior and junior national soccer players (n = 939, age = 22.1±4.3 years) in years 1995-2010 had reached significantly lower performance (p < 0.05) in vertical jumps in the group of midfielders compared to other groups divided according to playing positions. Gil et al. (2007) state the highest performance of forwards in all observed parameters of endurance, speed, agility and jump abilities. The authors mention that they did not examine elite young soccer players (n = 241, age = 17.31±2.64 years). Wisløff et al. (1998) discovered that players from elite Norwegian League had achieved significantly higher level of jump abilities in the group of defenders and forwards in comparison with the group of midfielders. Mujika et al. (2009) did not determine differences (p > 0.05) between the height of vertical jumps of elite senior soccer players and elite young soccer players. Gissis et al. (2007) compared performance of young soccer players (n = 54) divided into group of young national soccer team of Greece, high-performance young soccer players and recreational soccer players.

Figure 1 Linear dependency (r = 0.54, p < 0.05) between tapping frequency of lower limbs and Squat jump

Figure 2 Linear dependency (r = 0.52, p < 0.05) between tapping frequency of lower limbs and Countermovement jump

Linear dependency (r = 0.52, p < 0.05) was found out between tapping frequency of lower limbs and Countermovement jump too (Figure 2).

Discussion

We agree with statements of Reilly, Bangsbo & Franks (2000) that soccer players do not have to dispose of extraordinary performance in any area of high level within all areas. Bunc & Psotta (2001) notice that physiological preconditions and norms are necessary conditions for success at the professional level, although not sufficient. Speed and speed-force movement abilities belong to limiting factors of individual playing performance of a soccer player, especially at elite professional level. In spite of high demands from the point of view of speed abilities during the match dividing at accelerating, decelerating and maximal speed and agility, it is necessary to perceive these components integrated.
Considering jump abilities there were observed differences (p < 0.05) among national soccer team and other groups. There were not observed differences in evaluation of vertical jump height among high-performance and recreational young soccer players. Kalapotharakos et al. (2006) compared three teams (n = 19, age = 26.4±4 years, n = 15, age = 24.4±4 years, n = 20, age = 23.3±3 years) of Greek Super League from the point of view of several anthropometric and condition parameters. They found out that tolerance of lactate, isokinetic power of the knee extensors and performance in vertical jumps showed higher values (p < 0.05) in the team which belonged to three best teams of Super league compared to values of observed teams which were in the middle and among last teams of the League. Wong & Wong (2009) found out that Asian young players (n = 16, age = 16.2±0.6 years) achieved lower performance in vertical jumps in comparison with European and African players. Considering the vertical jump height Arnason et al. (2004) discovered that jump height of elite Icelandic soccer players was SJ = 37.8 cm and CMJ = 39.4 cm. Casajús (2001) discovered that the jump height of Spanish elite team (n = 15) was SJ = 39 cm and CMJ with use of arms = 47.8 cm. Boone et al. (2012) found out that adult soccer players (n = 289) of six teams in Belgian Pro League achieved average performance (SJ) = 40.7±4.6 cm and CMJ = 43.1±4.9 cm. In our study average performance of all players in field was 36.3±4.0 cm in SJ and 37.3±4.4 cm in CMJ. Wisloff et al. (2004) dealt with research of correlation between speed and speed-force components in elite soccer players. They found out linear dependency between maximal power in half squats with performance in sprint in 10 m (r = 0.94, p < 0.001), with performance in sprint in 30 m (r = 0.71, p < 0.01), with performance in 10 m shuttle run (r = 0.68, p < 0.02) and with vertical jump height (r = 0.78, p < 0.02). We have found out linear dependency and relationship between performance in the test of tapping frequency of lower limbs and SJ and CMJ in our study too. It is necessary to mention limits of carried research too. Tapping frequency and jump abilities are only partial indicators of complex non-specific and also specific speed demonstration and speed-force performance of the soccer player. We also have to evaluate other components as frequency speed, reaction speed, direct accelerating and running speed, but specific speed demonstration with the ball too, so that we can create evaluation of complex speed performance of soccer players. The certain limit presents unrepeated measurement together with limitation in reliability too. The unrepeated measurement can be influenced by external conditions but also by actual internal disposals of examined individual. However we had to adapt to time limiting and organizing possibilities of individual teams.

Conclusion

Jump abilities and tapping frequency are important parts of complex speed and speed-force performance of a soccer player. The results of statistical analysis showed that between tapping frequency of lower limbs and two types of vertical jumps exists linear dependency. Potential transfer of mentioned matters into conditional training of soccer players must be proved by experimental stimulation of tapping frequency and jump abilities. There must be determination of changes at the level of these movement abilities because correlation itself does not mean demonstration of causal relationship that change of variable X causes changes in variable Y according to Hendl (2009). Results of this study can be a useful material for condition and soccer coaches, scientists, experts but for people interested in soccer and condition training in soccer too. Found matters are impulse for realization of other researches in field of correlation of movement abilities in soccer.

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RAZINA I ODNOS IZMEĐU FREKVENCIJE TAPINGOM I VERTIKALNOG SKOKA U VIS KOD SLOVAČKIH ELITNIH NOGOMETNIH BRANIĆA

Sažetak
Cilj istraživanja bio je saznati razinu i odnos između brzine tapinga očenje donjih ekstremiteta i vertikalne visine skoka u elitnih slovačkih nogometnih branića (n = 15, uzrast = 25,4 ± 5,2 godina, visina = 181,2 ± 5,0cm, težina = 78,0 ± 6,5kg). Taping frekvencija je donjih udova (TF) je dijagnosticirana uređajem FiTROtapping, (FITRONIC, Bratislava, Republika Slovačka). Kriterij ocjenjivanje svakog mjerenja nogometaša je ukupan broj kontakata s obje noge na kontakt tapetu spomenutog uređaja tijekom 6 sekundi u stojećem položaju. Skok uvis je mjeren na dva načina, tj. 2 vrste vertikalnih skokova s uređaja FiTROJumper, (FITRONIC, Bratislava, Slovačka Republika): Čuvački skok (SJ) i Kontraskok (CMJ). Pearsonov korelacijski koeficijent (r, α = 0,05), je bio korišten za određivanje povezanosti između značenja ispitivanih parametara (TF - SJ, TF - CMJ). Statistička analiza je ostvarena softverom SPSS® V19. Prosječna razina TF je utvrđena sa 58,5 ± 5,5 kontakata na uređaju FiTROtapping. Prosječni nastup u testu SJ je 36,3 ± 4,0cm i na testu CMJ je 37,3 ± 4,4cm sa stajališta sposobnosti skoka. Statistička analiza pokazala je linearnu ovisnost između TF i SJ (r = 0,54, p <0,05) i kao između TF i CMJ (r = 0,52, p <0,05).

Ključne riječi: sposobnosti skoka, fitness trening, FiTROtapping, FiTROJumper

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