THE QUALITY OF ACTIVE MASS AND SEGMENTAL FLUIDS BODY DISTRIBUTION IN YOUNG ELITE SOCCER PLAYERS

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Abstract

Purpose: The aim of the study was to compare parameters identifying the quality of active mass as a predisposition for performance in elite soccer teams of junior and adolescent categories and also to present distribution of fluids in individual segments, which absents in the literature, with indication of asymmetry and possible muscle imbalance. Material and methods: The screened sample was composed of two elite soccer teams from Czech Republic. The first team (junior team, n = 50, age = 20.04 ± 2.69 years, body height = 180.48 ± 6.52, body mass = 74.78 ± 8.42 kg) was a leader of the junior Czech league (two season, cohort teams). The second team (adolescent team, n = 33, age = 16.15 ± 0.87 years, body height = 177.44 ± 7.65, body mass = 67.55 ± 8.99 kg) was a leader of the Czech soccer league U17 category. Body composition was measured using the bioimpedance method. Results: Total body water demonstrated a significant difference between the monitored groups (p<0.01). Juniors compared to adolescents had significantly higher fat free mass in both absolute and relative values, but significantly higher proportion of fat mass (FM) was detected in younger players (FM = 14.64 ± 2.43 %) in comparison to junior players (FM = 12.15 ± 2.83 %). Segmental analysis showed a higher proportion of muscle mass in the trunk of older players when compared to younger players (p< 0.01). Muscle asymmetry between the dominant and non-dominant leg was significantly higher in younger players (p>0.05). We did not record significant differences in comparison of the upper limbs, but lower limbs revealed significant differences in muscle mass proportion (Junior team: t = 7.319; p< 0.01, Adolescent team: t = 12.087; p< 0.01). Discussions and conclusions: The detected values showed that the active component measured by bioimpedance method should achieve significantly higher muscle mass in both absolute and relative values, but significantly higher proportion of fat mass in both younger and adolescent players. Differences in fluid distribution in the lower limbs is the effect of maladaptation on the specific load of the soccer players. These differences should be taken into account in the training practice and compensated by the adequate exercises. In terms of practice, the results may be beneficial for fitness coaches, nutrition specialist, team medical staff and other clinical staff in professional soccer.

Key words: body fat, fat free mass, soccer, maladaptation, morphological asymmetries

Introduction

Soccer performance is the interaction of several components. Reilly, Bangsbo, and Franks (2000) reported that top-class soccer players have to adapt to the physical demands of the game, which are multifactorial. Players may not need to have an extraordinary capacity within any of the areas of physical performance but must possess a reasonably high level within all areas. From the physiological point of view, soccer puts high demands on nervous and humoral regulation systems. From the motoric perspective, a dynamic course of the game and rapid changes of playing situations require a high level of speed and strength abilities, explosive strength of lower limbs and coordination as well as a high level of specific endurance which determines adequate physical predisposition in terms of optimal body composition of a soccer player. Monitoring of body composition in terms of recording an excessive amount of adipose tissue as a useless mass (Reilly, 1996) and active mass contributing to increasing predispositions for explosive strength production which is important for high intensity physical activity (cyclic as well as acyclic, i.e. static and dynamic muscular contraction) is one of the important indicators of an athlete’s performance (Warner, Fornetti, Jallo, & Pivarnik, 2004) and predispositions for optimal soccer performance. Available literature emphasizes the importance of diversity in body composition and general morphology among elite athletes of various sport disciplines (Loko, Aule, Sikkut, Ereline, & Viru, 2000; Smith & Thomas, 1991). In general, youth soccer players present above average values for height and mass and tend to be advanced in biological maturity status with increasing age during adolescence and in elite development programmes (Malina, 2011). The several authors present differences in anthropometric parameters according to different playing positions within elite youth soccer players (le Gall, Carling, Williams, & Viru, 2000; Reilly, 2010; Reilly et al., 2000). Melchiorri et al. (2007) present that it is very important to analyze body composition in football players, not only with the aim to evaluate the variation of weight in a quantitative and qualitative way, but also with the purpose of selecting players for specific roles. The available literature (Ostojc, 2003; Silvestre, West, Maresh, & Kraemer, 2006) emphasizes seasonal alternations in body composition and sprint performance of elite soccer players. (Baker & Davies, 2004) point out the importance of
parameters identifying body composition in soccer player diagnostics when during monitoring interrelationships between laboratory and field measures of performance they found significant correlations between cycle ergometry peak power outputs using both the total body mass and fat free mass protocols and all field measures of performance. Since the game of soccer frequently involves one-sided activities such as kicking, tackling and passing asymmetries in muscle apparatus are possible. During the game, strength and power movements are accumulated on both lower extremities. This occurs in an asymmetrical manner and may gradually lead to strength or power movements are accumulated on both lower extremities. Similarly, differences of body fluids were reported in female basketball players from Czech national team (Malá, Malý, Zahálka, Teplan, & Kaplan, 2013). The aim of the study is not only to focus on the level and differences in parameters identifying the quality of active mass as a predisposition for performance in elite soccer teams of junior and adolescent categories, but also to present distribution of fluids in individual segments, which absent in the literature, with indication of asymmetry and possible muscle imbalance.

**Methods**

**Study sample**

The screened sample was composed of two elite soccer teams: category (cohort) from Czech Republic. The first team (junior team, n = 50, age = 20.04 ± 2.69 years, body height = 180.48 ± 6.52, body mass = 74.78 ± 8.42 kg) was a leader of the junior Czech league (two season). The second team (adolescent team, n = 33, age = 16.15 ± 0.87 years, body height = 177.44 ± 7.65, body mass = 67.55 ± 8.99 kg) was a leader of the Czech soccer league U17 category. In terms of periodization, testing was carried out at the beginning of the preparatory period. Participants recruited were not injured or rehabilitating from injury at time of testing.

**Methods of data collecting and processing**

Before analysis of body composition (BC), the participants took part in basic measurement of anthropometric parameters. Body height (BH) was measured using a digital stadiometer (SECA 242, Hamburg, Germany) and body mass (BM) using a digital scales (SECA 769, Hamburg, Germany). BC was measured using the bioimpedance method under the standard conditions described in the BIA guidelines (Kyle et al., 2004). In the 24 hours prior to the measurements, the participants did not consume any medications (including alcohol and caffeine) or pharmacological agents that could influence the results of the measurement. They were also told not to eat or drink before the measurement and to maintain good hydration and a normal routine. Furthermore, the athletes did not perform high intensity physical activity of any significant duration for the 48 hours before the tests. The room temperature was kept between 20 and 24°C to prevent undesirable changes in body water composition (Dittmar, 2003). BC of our research group was determined with the whole-body bioimpedance method using a BIA 2000 M device (Data Input GmbH, Germany), which works on four frequencies 1, 5, 50 and 100 kHz. The measurement was carried out using tetra-polar electrodes which were placed on the limbs on the same side of the body. Electrodes were placed in the middle of metacarpal bones and wrist and metatarsal bones and the ankle. Standard conditions of bioimpedance measurement were kept during the diagnostics. We monitored parameters identifying the amount of liquids in the body, namely total body water (TBW), percentage of fat mass (FM), fat free mass (FFM) and relative value of fat free mass calculated per kilogram of body mass (FFM/kg). The segmental proportion of muscle mass was assessed from parameters obtained by the multi-frequency bioimpedance method using a Tanita MC-980MA device (Tanita Corporation, Japan). This device uses 8-point electrodes and works on 6 frequencies (1, 5, 50, 250, 500 and 1000 kHz). We focused on parameters related to proportion of muscle mass on paired limbs – dominant and non-dominant arm (DA and NA) and dominant and non-dominant leg (DL and NL). The participants received a verbal description of the study procedures before testing and completed a written informed consent that was approved by the ethical committee of Faculty of Physical Education and Sport, Charles University in Prague. Measurements were performed according to the ethical standards of the Helsinki Declaration and the ethical standards in sport and exercise science research described by Harriss and Atkinson (2011).

**Statistical analysis**

Collected data were subjected to statistical analysis and effect size analysis. From methods of descriptive statistics we used the mean as a measure of central tendency and standard deviation and standard error of the mean as measures of variability. The statistical significance of teams’ differences in parameters of the participants’ body composition was determined using results of a t-test for independent samples which was preceded by analysis of variance identity based on an F-test. The statistical significance of differences in bilateral distribution of muscle mass was assessed on the basis of comparative analysis using a t-test for dependent samples. Moreover, effect size between the means of the screened groups was assessed using Cohen’s coefficient of effect size „d“.
It was calculated as the difference of the means of the compared parameters and divided by a "pooled" standard deviation (Thomas & Nelson, 2001). The coefficient was assessed as follows:
d = 0.20 – small effect, d = 0.50 – medium effect and 
d = 0.80 – large effect (Cohen, 1992).
Statistical analysis was performed using IBM® SPSS® v21 (Statistical Package for Social Science, Inc., Chicago, IL, 2012). Statistical analysis showed a significant difference in age, body mass and body mass index (p < 0.01, Table 1). The difference in BH between the observed groups was not significant (p > 0.01). TTW demonstrated a significant difference between the monitored groups (t = 4.77, p < 0.01, d = 1.07). Juniors compared to adolescents had significantly higher FFM in both absolute and relative values (FFM per kg). On the contrary, significantly higher proportion of FM was detected in younger players (FM = 14.64 ± 2.43 %) in comparison to junior players (FM = 12.15 ± 2.83 %). Segmental analysis showed a higher proportion of muscle mass in the trunk of older players when compared to younger players (t = 5.11, p < 0.01, d = 1.15). Higher proportion of muscle mass was also recorded in the upper extremities (both dominant and non-dominant arm) in older players (Table 1). However, we did not find any significant difference in muscle asymmetry in the upper extremities between the tested groups (t = -1.08, p > 0.05, d = 0.23). In case of lower extremities, the proportion of fat mass was higher in older players (both dominant and non-dominant leg (p < 0.01). Muscle asymmetry between the dominant and non-dominant leg was significantly higher in younger players (t = -1.94, p > 0.05, d = 0.23). Table 2 and Figure 1 depict a comparison of bilateral proportion of muscle mass in individual body segments for both groups. In any of the groups of soccer players, we did not record significant differences in comparison of the upper limbs (Junior team: t = 1.184; p > 0.05, Adolescent team: t = 0.783; p > 0.05). When comparing paired lower limbs of soccer players we found significant differences in muscle mass proportion (Junior team: t = 7.319; p < 0.01, Adolescent team: t = 12.087; p < 0.01). A higher proportion of muscle mass was detected in the dominant limb for both groups.

### Table 1 Comparison of body composition indicators of two soccer teams with respect to their age

<table>
<thead>
<tr>
<th>Variables</th>
<th>Junior players</th>
<th>Adolescent players</th>
<th>t</th>
<th>Sig</th>
<th>d</th>
<th>Effect Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>20.04 ± 2.69</td>
<td>16.15 ± 0.87</td>
<td>8.02</td>
<td>p &lt; 0.01</td>
<td>1.95</td>
<td>high</td>
</tr>
<tr>
<td>BH (cm)</td>
<td>180.48 ± 6.52</td>
<td>177.44 ± 7.65</td>
<td>1.94</td>
<td>N.S.</td>
<td>0.43</td>
<td>medium</td>
</tr>
<tr>
<td>BM (kg)</td>
<td>74.78 ± 8.42</td>
<td>67.55 ± 8.99</td>
<td>3.73</td>
<td>p &lt; 0.01</td>
<td>0.83</td>
<td>high</td>
</tr>
<tr>
<td>TBW (l)</td>
<td>47.79 ± 4.63</td>
<td>42.79 ± 4.76</td>
<td>4.77</td>
<td>p &lt; 0.01</td>
<td>1.07</td>
<td>high</td>
</tr>
<tr>
<td>FFM (kg)</td>
<td>66.96 ± 6.54</td>
<td>58.28 ± 6.74</td>
<td>5.84</td>
<td>p &lt; 0.01</td>
<td>1.31</td>
<td>high</td>
</tr>
<tr>
<td>BMI (kg.m⁻²)</td>
<td>22.90 ± 1.62</td>
<td>21.37 ± 1.66</td>
<td>4.17</td>
<td>p &lt; 0.01</td>
<td>0.93</td>
<td>high</td>
</tr>
<tr>
<td>DA (l)</td>
<td>3.85 ± 0.52</td>
<td>2.82 ± 0.43</td>
<td>9.48</td>
<td>p &lt; 0.01</td>
<td>2.17</td>
<td>high</td>
</tr>
<tr>
<td>NA (l)</td>
<td>3.83 ± 0.52</td>
<td>2.80 ± 0.38</td>
<td>9.82</td>
<td>p &lt; 0.01</td>
<td>2.27</td>
<td>high</td>
</tr>
<tr>
<td>∆DA–NA (l)</td>
<td>0.06 ± 0.07</td>
<td>0.08 ± 0.10</td>
<td>-1.08</td>
<td>N.S.</td>
<td>0.23</td>
<td>small</td>
</tr>
<tr>
<td>Trunk (l)</td>
<td>33.98 ± 3.41</td>
<td>30.17 ± 3.19</td>
<td>5.11</td>
<td>p &lt; 0.01</td>
<td>1.15</td>
<td>high</td>
</tr>
<tr>
<td>DL (l)</td>
<td>11.11 ± 0.91</td>
<td>10.12 ± 1.27</td>
<td>4.17</td>
<td>p &lt; 0.01</td>
<td>0.90</td>
<td>high</td>
</tr>
<tr>
<td>NL (l)</td>
<td>10.86 ± 1.05</td>
<td>9.75 ± 1.28</td>
<td>4.33</td>
<td>p &lt; 0.01</td>
<td>0.95</td>
<td>high</td>
</tr>
<tr>
<td>∆DL–NL (l)</td>
<td>0.27 ± 0.19</td>
<td>0.38 ± 0.18</td>
<td>-1.94</td>
<td>p &lt; 0.05</td>
<td>0.60</td>
<td>medium</td>
</tr>
<tr>
<td>FFM/kg</td>
<td>0.90 ± 0.04</td>
<td>0.87 ± 0.04</td>
<td>3.63</td>
<td>p &lt; 0.01</td>
<td>0.82</td>
<td>high</td>
</tr>
</tbody>
</table>

(BH – body height; BM – body mass; TBW – total body water; FFM – fat free mass; BMI – body mass index; DA – dominant arm, NA – non-dominant arm; ∆DA–NA – difference between dominant vs. non-dominant arm, DL – dominant leg, NL – non-dominant leg, ∆DL–NL – difference between dominant vs. non-dominant leg, FFM/kg – relative value of fat free mass, FM – fat mass, N.S. – non significant difference, X̅ – arithmetic mean, SD – standard deviation)

### Table 2 Significance of difference in muscle mass bilateral proportion in the limbs

<table>
<thead>
<tr>
<th>Variables</th>
<th>Difference of means</th>
<th>Standard deviation</th>
<th>95% of CI interval of Lower</th>
<th>Upper</th>
<th>t</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junior players</td>
<td>DA – NA</td>
<td>0.02</td>
<td>0.10</td>
<td>-0.01</td>
<td>0.04</td>
<td>1.18</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>DL – NL</td>
<td>0.25</td>
<td>0.24</td>
<td>0.18</td>
<td>0.32</td>
<td>7.32</td>
<td>49</td>
</tr>
<tr>
<td>Adolescent players</td>
<td>DA – NA</td>
<td>0.02</td>
<td>0.13</td>
<td>-0.03</td>
<td>0.07</td>
<td>0.78</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>DL – NL</td>
<td>0.38</td>
<td>0.18</td>
<td>0.31</td>
<td>0.44</td>
<td>12.09</td>
<td>32</td>
</tr>
</tbody>
</table>

A significant difference between the basic anthropometric parameters of the observed groups indicates better predispositions for performance in older players (junior players). The results correspond with (Bloomfield, Polman, Butterly, & O’Donoghue, 2005), according to whom the players of the top league achieve the highest body height, body weight and BMI. Optimal anthropometric profiles of a successful soccer player were discussed in several studies. According to (Reilly et al., 2000), elite soccer teams are characterized by a relative heterogeneity in body size. Tall players tend to have an advantage in certain playing positions and, therefore, are oriented towards these roles, notably in goalkeeping, central defence and central attack. Monitoring of BC as a predictor of physical performance in soccer is oriented on the desired active component and undesired inactive component. The active component (fat free mass, body cell mass, muscle mass) represent atotal mass of body cells. The recorded value of fat free mass (Table 1) in junior players is comparable with values presented in elite soccer players by (Ostojić, 2003) 67.4±6.2 –69.5±4.9 % depending on periodization of training cycle (thirty professional male soccer players, age = 23.5±3.1 years, BH = 182.8±6.0 cm, BM = 76.8±6.1 kg).J. Baker and Davies (2004) reported in male university students (moderately trained soccer players) fat free mass of 65 ± 7 kg. However, this comparison is limited by comparing absolute values and using different methods. Intra-individual values (not presented at study) of our tested players revealed fat free mass values at the level of elite athletes even in the group of younger players (Gil, Ruiz, Irazusta, Gil, & Irazusta, 2007; le Gall et al., 2010; Ostojić, 2003; Reilly et al., 2000; Rico-Sanz, 1998; Silvestre et al., 2006; Unnithan, White, Georgiou, Iga, & Drust, 2012; D. P. Wong & Wong, 2009).
Pantelis (2012), who presents an inverse relationship of FM with aerobic power \((r = -0.29, p<0.001; r = -0.44, p<0.001, \text{respectively})\), maximal anaerobic power \((r = -0.23, p=0.009; r = -0.47, p<0.001)\) and local muscular endurance \((r = -0.36, p<0.001; r = -0.67, p<0.001)\). A significant increase of FM due to age, which Wittich et al. (2001) present in the soccer players using the correlation between age and FM—significant \((r = 0.53, p<0.001)\), was also verified by a significant difference between our monitored groups. Silvestre et al. (2006) found that FM in soccer players \((n = 27, \text{age} = 19.9 \pm 1.3 \text{ years}, \text{BH} = 177.6 \pm 6.3 \text{ cm}, \text{BM} = 77.5 \pm 9.2 \text{ kg}, \text{FM} = 10.6 \pm 5.8 \text{ kg}, \text{or} 13.9 \pm 5.8\%\) showed a positive correlation with speed \((r = 0.60)\) and a negative correlation with VO\textsubscript{2max} \((r = -0.67)\). According to P. L. Wong, Chamari, Dellal, and Wisloff (2009), greater body mass was positively related to faster ball shooting speed \((r=0.58, p<0.001)\) and inversely related to 30-m sprint times \((r = -0.54, p<0.001)\) in a cohort of elite U-14’s players \((n = 70)\). Gil et al. (2007) and Unnithan et al. (2012) reported anthropometric parameters for selection of young soccer players and identification of talent in young soccer players. Their results indicate that around 10% of BM. BC is important for elite soccer players but that homogeneity between players at top professional clubs results in little variation between individuals. Wittich et al. (2001) emphasize diversity between playing positions with the midfielders had a significantly higher percentage of fat \((13.6 \pm 3.3\%)\) than backs or forwards \((11.1 \pm 2.8 \text{and} 11.0 \pm 2.3\%, p<0.05 \text{and} p<0.06, \text{respectively})\). Monitoring of changes in BC throughout the periodization of sport training is important feedback for the training control (Carbuhn, Fernandez, Bragg, Green, & Crouse, 2010). Monitoring of BC in soccer is also recommended as prevention from negative effects of improper nutrition, eating habits and nutrition supplements on the soccer player’s body. Any observed changes in the proportion of active and inactive mass, in terms of increase of FFM and reduction of FM, indicate, in most cases, an increased level of BC and higher muscle quality. However, the changes can also be caused due to loss of water in extracellular space observable in fluid loss after the training or competitive process (subsequent indirect estimation of FM using bioimpedance method may show reduction). Changes of FM and its components are caused by its 73% proportion in TTW reported in Table 1\((\text{FFM} = \text{TBW} / 0.73)(\text{Wang et al., 1999})\). Eventual loss of TTW or even more dehydration will be reflected in decrease of players’ attention (L. B. Baker, Conroy, & Kenney, 2007). Fluid replacement is essential for maintaining concentration, attention and optimal performance during the competition. Continual recording of fluid distribution in individual body segments enables us to monitor changes during compensation of muscle imbalances or recovery from injury. Monitoring of segmental distribution of water and the quality of active mass must be done continually, during the selected periods of the annual training cycle with following feedback on frequency and intensity of training load and recovery time (Bresciani et al., 2010). In segmental distribution of body water in the limbs and trunk, we recorded a significant difference in the lower limbs only \((p < 0.01)\). Asymmetry was found in favour of the dominant lower limb (Table 2). This difference indicates the need for exercises focused on compensation of the detected bilateral deficit. The difference may have been caused by unilateral load and it is a result of maladaptation on the morphological level. Differences between the lower limbs (dominant, non-dominant) were found in several indicators in soccer players: isokinetic strength (Lehnert, Urban, Herbert, Procházka, & Psotta, 2011; Malý et al., 2010), power – height of jump (Zahalka, Maly, Teplan, & Hrasky, 2013), motoric tests – running speed with turning on the dominant and non-dominant leg (Maly, Zahalka, Mala, & Teplan, 2014) and other. These asymmetries may predict the player’s injury and therefore their diagnostics and compensation using the proper exercises is inevitable from the perspective of practice.

**Conclusion**

The recorded parameters of body composition revealed values corresponding with elite soccer teams. Junior players compared to adolescents had significantly higher FFM in both absolute and relative values (FFM per kg). On the contrary, significantly higher proportion of fat mass was detected in younger players. The detected values showed that the active component measured by bioimpedance method should achieve almost 90% of total body mass in junior elite soccer players and 87% in adolescent players. The presented data may serve as a standard for comparison of BC quality in soccer players of two age categories. The detected asymmetry in fluid distribution in the lower limbs is the effect of maladaptation on the specific load of the soccer players. These differences should be taken into account in the training practice and compensated by the adequate exercises. Unilateral strength and skills exercises should be thus performed more for the limb where the deficit was found. The necessity of diagnostics of the mentioned asymmetries and their subsequent targeted compensation should be carried out already at younger age and early phase of sport training of soccer players. In terms of practice, the results may be beneficial for fitness coaches, nutrition specialist, team medical staff and other clinical staff in professional soccer.
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References


**Sažetak**
Namjena: Cilj istraživanja bio je usporediti parametre i identificirati kvalitetu aktivnog mase kao predispozicije za nastup u elitnoj nogometnoj momčadi iz juniora i adolescentne kategorijama i predstaviti raspodjelu tekućine u pojedinim segmentima, čega nema u literature s naznakom asimetrije i moguće neravnoteže mišića. Materijal i metode: prikazivan uzorak sa stoji od dvije elite nogometne ekipa iz Češke. Prva momčad (juniorski team, n = 50, uzrast = 20,04 ± 2,69 godina, tjelesne visine = 180,48 ± 6,52, tjelesne mase = 74.78 ± 8.42 kg) bila je najbolja u Češkoj juniorskoj ligi (dvije sezone, kohortni timovi). Druga ekipa (adolescentni tim, n = 33, uzrast = 16,15 ± 0,87 godina, tjelesna visina = 177,44 ± 7,65, tjelesne mase = 67.55 ± 8.99 kg) bila je najbolja u eškoj juniorskoj ligi U17. Sastav tijela je mjeren pomoću bioimpedance. Rezultati: Ukupno količina vode pokazala je značajnu razliku između promatranih skupina (p <0,01). Juniori u odnosu na adolescentne imali su značajno veću masu bez masača i u apsolutnim i relativnim vrijednostima, ali značajno veći udio masnom tkiva (FM = 14.64 ± 2.43%) u odnosu na junior (FM = 12,15 ± 2,83%). Segmentima analiza pokazala je veći udio mišićne mase u trupu starijih igrača u odnosu na mlade igrače (p <0,01). Mišićna asimetrija između dominantne i nedominantne noge bila je značajno veća u mladih igrača (p > 0,05). Nisu zabilježene značajne razlike u odnosu na gornje udove, ali donji udovi pokazuju značajne razlike u udjelu mišićne mase (junior tima, T = 7,319; p <0,01, Adolescent momčadi: t = 12,087, p <0,01). Rasprava i zaključci: detektirane vrijednosti pokazala su da aktivni sastojak mjerenom metodom bioimpedance treba postići gotovo 90% od ukupne tjelesne mase kod mladih elitnih nogometaša i 87% kod igrača u pubertetu. Otkrivena asimetrija u raspoloživim tekućinama u donjim ekstremitetima je učinkovan kompleksne dekompensacije nogometaša. Ove razlike treba uzeti u obzir u praksi izobrazbe i kompenzirati odgovarajućim vježbama. U smislu prakse, rezultati mogu biti korisni za fitness trenera, specijalistu nutricionistu, tiskovog liječnika, i ostalo kliničko osoblje u profesionalnom nogometu.

**Ključne riječi:** tjelesna mase, slobodna mase, nogomet, neadptiranost, morfološka asimetrija

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