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ASSESSMENT OF THE PHYSICAL DEVELOPMENT OF SOCCER PLAYERS WITH THE METHOD OF INDICES

K.V. Vybornaya[1], R.M. Radzhabkadiev[1], S.V. Klochkova[2], D.B. Nikityuk[1]
[1]Federal State Budgetary Scientific Institution "Federal Research Centre of Nutrition, Biotechnology and Food Safety", Moscow, Russia
[2]People's Friendship University of Russia, Moscow, Russia

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Annotation. For an express assessment of the physical development and physique of soccer players using the index method, the players of one of the Moscow soccer clubs of the professional soccer league of the second division were examined. In the surveyed soccer players (n=24, average age – 24,16±0,87 years), on average in the group and in groups, when divided into playing roles, the body mass index values were within the normal range. At the same time, the body mass index value of the goalkeepers in the group was 1,7-1,8 units lower than that of the outfield players. The team was identified as representatives with a well-developed chest (Erisman's index was 8,85±0,9) and with a narrow chest (Erisman's index was 0,94±1,93) were identified. When assessing the level of physical development by BMI, it was shown that 21 soccer players have normal, and 3 soccer players have increased BMI values. According to Chernorutskij's somatotyping scheme, 37,5% of hypersthenics (Pignet's index was 2,5±2,04) with a strong physique and 62,5% of normostenics (Pignet's index was 16,9±1,29) with a good and average physique were identified. Assessment of the degree of somatic sexual differentiation showed that 87,5% of athletes belong to andromorphs (Tanner's index was 97,7±1,3) and 12,5% – to mesomorphs (Tanner's index was 88,0±0,6).

Introduction. History of the assessment of the physical development (PD) began with using height to weight charts with values of main anthropometric signs and calculation of quantitative anthropometric indices (physical development indices). Their widespread use was due to a simplicity of calculation and use. The indices allowed characterizing the PD in relation to separate anthropometric signs shown in mathematical formulae [1]. The method of indices is used currently for an express assessment of the PD level and the nutritional status during health screening [2]. However, a main downside of this method is an initial concept of the fact that form, dimensions and ratio of body components in all people are changing

proportionally. Modern anthropology rejects this idea: modern studies demonstrate that when one of the body's dimensions is changing, there is no proportional changes in the other. That is the reason why the method of indices without an evaluation of the body's components is not practically used for evaluating the PD and is an additional method when evaluating the PD comprehensively [1-4].

The most common indices are called simple and include two signs (body mass and body length or body length and chest girth). They are also called weight to height or chest to height indices. The weight to height indices include the body mass index (BMI, Quetelet II) that reveals both body mass deficit and excessive body mass with regard to height, but it practically does not depend on features of physique and constitution and does not allow objectively evaluate due to which body mass component changes occur in the organism [1-2]. The chest to height indices include the Erisman's index (EI) that shows the proportionality of height and chest girth and reveals a narrow chest or a broad chest in surveyed people [1]. One more simple index that allows evaluating a degree of somatic sex differentiation is the Tanner's sexual dimorphism index [3].

A complex index that includes three or more indicators is the Pignet's index (PI), which evaluates physique. The lower the indicators of this index, the stronger the physique [1].

Despite the aforementioned information, we consider it interesting to evaluate soccer players of one team with different playing roles using the method of indices to reveal differences in their PD.

Aim and tasks of the study: to give characteristics of the PD of players of one of the Moscow soccer clubs of the professional soccer league of the second division using the method of indices (both in general and in terms of dividing into playing roles) and reveal differences of surveyed athletes from elite ones.

Methods and organization. The study included 24 soccer players of one of the Moscow soccer clubs of the professional soccer league of the second division. Average age of athletes was 24,16±0,87 years. Training experience is 12-15 years. The surveyed players were divided into groups depending on playing roles: goalkeepers (n=3), halfbacks (n=11), forwards (n=4) and backs (n=6). The study was carried out according to standards of the Ethics Committee of the Federal Research Centre of Nutrition, Biotechnology and Food Safety. All participants were informed before the examination. They also signed an informed consent for its voluntary conduct.

All studies were carried out at morning on an empty stomach, in a medical room in compliance with standard measuring conditions. We made the anthropometric measuring using the standard method [1-2]. Body length (BL) was registered using the Martina anthropometer with a precision of up to 1 mm. Body

mass (BM) was registered using the VEM-150 electronic medical scales with a precision of up to 0,1 kg. Chest girth (CG) was measured with the measuring tape in three positions (on maximum inhale (inhale, cm), on maximum exhale (exhale, cm), on respiratory pause (pause, cm)) with a precision of up to 1 mm.

To assess the PD, we used the method of indices. The BMI was calculated with the following formula: BMI=BM(kg)/BL(m^2) [1-4]. The Erisman's index (EI) that allows defining a proportionality of the chest's development was calculated with the following formula: EI=CG_{pause}(cm)–BL(cm)/2 [1]. EI indicators that are equal or higher than the value of +5,8 cm show good development of the chest, Indicators lower than these limits or negative values show a narrow chest. The Pignet index (PI) that defines sturdiness was calculated with the following formula: PI=BL(cm)-(BM(kg)+CG_{exhale}(cm)) [1]. The lower the value of PI, the better the indicator of sturdiness. Interpretation of the PI indicators for adults is as follows: less than 10 – very sturdy; 10-20 – good; 21-25 – average; 26-35 – weak; 36 and more – very weak. M.V. Chernorutskij used the PI index values to define a body constitution. According to his classification, normosthenics have the PI of 10-30, asthenics – more than 30, hypersthenics – less than 10 [1]. A degree of somatic sexual differentiation was assessed according to the Tanner's sexual dimorphism index (SDI): SDI=SW*3-PW, where SW – shoulder width and PW – pelvis width [3]. SDI indicators that were lower than 72 were considered as the gynecomorphic body type, 72-91 – as the mesomorphic body type, more than 91 – as the andromorphic body type.

The intragroup analysis of BM and BL data of athletes of different roles was carried out with combining methods of statistical analysis incusing using the ANOVA, two-way ANOVA and the correlation analysis. Tests for normal distribution and homoscedasticity were used to apply parametric methods of the analysis. The normal distribution test was conducted using the Pearson's test (χ^2-test), the homoscedasticity test – with the Cochran's test. In case of not corresponding to normal distribution and homoscedasticity, we used the ANOVA and two-way ANOVA (in particular – the Kruskal-Wallis test (H-test)) as methods of nonparametric statistical analysis. The significance level was equal to 0,05 [5].

In the course of the study, we did not use statistical analysis methods as a method of a quantitative comparison to analyze intergroup differences according to all other mentioned indicators (including indices). The basic method of comparison was the standard value of the surveyed index. Thus, this study has a partial quantitative and demonstrative character, and it did not establish on the selection power of athletes. Data in a table below are shown in the form of the arithmetic mean, the standard error of the arithmetic mean (M±σ), minimum and maximum (min÷max) for a more convenient and clear imaging of some data.

Results and discussion. Mean indicators of body mass and length, chest girth in three positions, as well as mean values of physical development indices in the whole group of surveyed soccer players and in divided groups according to game roles are demonstrated in the table.

Table

Main anthropometric indicators and values of physical development indices of surveyed soccer players in the whole group and in groups divided according to playing roles

Indicators	Playing role				All athletes (n=24)
	Goalkeepers (n=3)	Halfbacks (n=11)	Forwards (n=4)	Backs (n=6)	
BM (kg)	75±3,44 (71,2÷81,9)	74,1±1,5 (66,8÷82,8)	80,5±6,5 (62,3÷91,5)	79,7±2,97 (69,2÷87)	76,7±1,53 (62,3÷91,5)
BL (cm)	184,7±3,18 (181÷191)	177,2±1,7 (170÷186)	183,5±3,52 (175÷192)	183±1,77 (177÷190)	180,6±1,25 (170÷192)
CG (pause, cm)	94,7±1,67 (93÷98)	95,3±1,22 (90,3÷103,5)	96,8±3,9 (86÷103)	98,9±1,94 (93÷104)	96,3±0,98 (86÷104)
CG (inhale, cm)	98±1,53 (96÷101)	98,5±1,09 (94÷106)	99,8±3,77 (89÷105)	102,1±1,96 (96÷108)	99,5±0,94 (89÷108)
CG (exhale, cm)	91±1,26 (89,5÷93,5)	91,6±1,2 (86,5÷99,5)	93,3±3,72 (83÷99)	94,1±2,03 (89÷103)	92,4±0,94 (83÷103)
Physical development indices					
BMI (kg/m^2)	22±0,27 21,7÷22,5	23,7±0,51 21,1÷28	23,8±1,14 20,5÷25,7	23,8±0,52 22,1÷25,4	23,5±0,33 20,5÷28
PI	18,6±1,53 (15,6÷20,5)	11,5±2,57 (-10,3÷24)	9,8±7,02 (-1,5÷29,7)	9,2±3,14 (0÷18,8)	11,5±1,82 (-10,3÷29,7)
EI	2,3±0,16 (2÷2,5)	4,2±2,7 (-19,5÷17,5)	5,0±2,35 (-1,5÷9,5)	7,4±1,24 (3,5÷11)	4,9±1,33 (-19,5÷17,5)
SDI	106±6,8 (99÷119,5)	94,9±1,26 (87÷101)	94,2±2,93 (89÷102)	96,3±2,16 (88÷102,5)	96,5±1,35 (87÷119,5)

Note: data are presented as the arithmetic mean and the standard error of the arithmetic mean (M±σ), minimum and maximum min÷max

In the process of statistical data processing with the use of the ANOVA and two-way ANOVA, it was shown that groups divided according to playing roles have uneven data of BM and BL of athletes. The ANOVA (Kruskal-Wallis test) revealed an absence of statistically significant correlation between playing roles and BM (p=0,312), playing roles and BL (p=0,095) of athletes [5].

When evaluating the PD in terms of the BMI, it was revealed that 21 soccer players have normal values, 3 of them – increased BMI values. At the same time, BMI values in the whole group and in groups that formed according to playing roles remained within limits of standard values. However, it is notable that BMI values in goalkeepers were lower by 1,7-1,8 units than in outfield players.

When calculating the EI, we revealed athletes with both a broad chest and a narrow chest. Their number was divided equally (50% each, 12 people). IE in the group of people with a broad chest was 8,85±0,9 (5,75÷17,5), in the opposite group

– 0,94±1,93 (-19,5÷5,0). When dividing into playing roles, all groups (except the gatekeepers' group) revealed people with both chest types. The gatekeepers' group included 3 people (100%) with a narrow chest; the halfbacks group – 6 people (54,5%) with a broad chest and the mean EI value of 8,9±1,76 (5,75÷17,5), and 5 people (45,5%) with a narrow chest and the mean EI value of 8,9±1,76 (5,75÷17,5); the forwards' group – 2 players (50%) with a broad chest and the mean EI value of 8,25±1,25 (7÷9,5) and 2 players (50%) with a narrow chest and the mean EI value of 1,75±3,25 (-1,5÷5); the backs' group – 4 players (66,7%) with a broad chest and the mean EI value of 9,1±0,97 (6,5÷11), and 2 players (33,3%) with a narrow chest and the mean EI value of 4±0,5 (3,5÷4,5). The groups of halfbacks and forwards have one player each with negative EI indicators. The most players with a narrow chest are in the gatekeepers' group (100%), the least – in the backs' group.

The mean PI indicator in the whole group was 11,5±1,82. According to somatic types scheme developed by Chernorutskij, we registered 9 hypersthenics (37,5%) with the mean PI indicator of 2,5±2,04 (-10,3÷9,5), who have a sturdy body type, and 15 normosthenics (62,5%) with the mean PI indicator of 16,9±1,29 (10,5÷29,7), who have a good and average body type. There were no people with weak and very weak body type.

When dividing athletes into playing roles, we discovered that the lowest PI indicator was revealed in the backs' group, the highest – in the gatekeepers' group. It shows that backs had sturdier body type than rest of soccer players. Gatekeepers take the last place in terms of sturdiness, halfbacks and forwards take middle positions. All goalkeepers (100%, 3 people) belonged to normosthenics, among halfbacks there were 8 normosthenics (72,7%) and 3 hypersthenics (27,3%), among forwards – 3 normosthenics (75%) and 1 hypersthenic (25%). The division is equal in the backs' group – 3 normosthenics (50%) and 3 hypersthenics (50%).

The mean SDI values in the whole group was 96,5±1,35. Of all 24 soccer players, 21 athletes (87,5%) had the andromorphic type (with the mean value of 97,7±1,3), in other three cases (12,5%) – the mesomorphic type (with the mean value of 88,0±0,6). Division according to playing roles revealed that the highest mean group SDI indicator was registered in goalkeepers, followed by backs. Equal indicators were found in groups of halfbacks and forwards. Moreover, soccer players with the mesomorphic types were found in groups of forwards, halfbacks and backs (1 person each). No person with the gynecomorphic somatic type was found among athletes. The conducted analysis indicates a high level of androgenization in surveyed athletes.

Fajzullin D.E. conducted an analysis of anthropometric indicators of elite goalkeepers in comparison with outfield players. It was discovered that the highest players who play in teams of the Major League (n_{goal}=18, $n_{forward}$=46, n_{back}=36) are

goalkeepers (179,9±7,62 cm). They are higher than forwards (174,7±6,1 cm) and backs (173,9±5,4 cm) ($p<0,05$). Also, goalkeepers have bigger body mass (72,7±5,82 kg) than forwards (68,1±6,0 kg) and backs (69,1±5,19 kg) ($p<0,05$). The outfield players did not have any differences in BM and BL ($p>0,05$) [6].

According to the same study, the goalkeepers (179,5±2,91 cm) appeared to be the highest players of the Super League ($n_{goal}=10$, $n_{forward}=26$, $n_{back}=26$). They are significantly higher than forwards (175,5±5,7 cm) and backs ($p<0,05$). The goalkeepers also have bigger body mass (72,7±5,82 kg) than forwards (68,1±6,0 kg) and backs (69,1±5,19 kg) ($p>0,05$). The outfield players also did not have and significant differences in BM and BL ($p>0,05$) [6].

When examining players of the futsal national team of Russia ($n_{goal}=10$, $n_{forward}=25$, $n_{back}=20$), Fajzullin revealed the same result – gatekeepers were the highest players (BM – 181,5±3,5 cm) in comparison with outfield players (forwards – 178±3,26 cm, backs – 177±3,53 cm) ($p<0,05$). The mean body mass indicator in goalkeepers (79,6±2,1 kg) is also higher than in forwards (76,1±7,63 kg) and backs (74,0±8,44 kg), indicators between outfield players were not different.

In the course of studying the morphological indicators of soccer players of different teams that participated in the 2018 FIFA World Cup, researchers demonstrated that soccer players have specific body dimensions and a number of their differences depending on playing role. Goalkeepers' indicators (n=96, average age – 29,1±0,4 years, BL – 188,8±0,5 cm, BM – 82,2±0,6 kg) exceeded indicators of backs (n=242, average age – 27,6±0,3 years, BL – 183,5±0,4 cm; BM – 76,9±0,4 kg), halfbacks (n=288, average age – 26,7±0,2 years, BL – 179,3±0,4 cm, BM – 73,0±0,4 kg) and forwards (n=110, average age – 27,0±0,4 years, BL – 182,8±0,6 cm, BM – 77,3±0,6 kg) in body mass and length. The most massive and highest among the outfield players were the forwards. Halfbacks had the lowest morphological parameters [7].

The analysis of the physical development indicators of Spanish soccer players who perform in three most famous sports clubs demonstrated that the morphological indicators of athletes, including elite players, are substantially different from each other. However, it has no effect on their achievements and athletic prowess. Nonetheless, anthropometric indicators play a big role when making a list of the first team and reserve players, their position in the field and combining effort of closest players when the other one is sent off the field.

Results of anthropometric indicators of goalkeepers of Spanish clubs are as follows. FC Barcelona: average age is 26,5±2,12 years, BL – 186,0±1,41 cm, BM – 84,0±1,41 kg, BMI – 24,28±0,04 kg/m², body surface area (BSA) – 2,1±0,03 m². Real Madrid CF: average age is 27,0±4,9 years, BL – 186,0±2,55 cm, BM – 81,33±2,94 kg, BMI – 23,5±0,2 kg/m², BSA – 2,07±0,05 m². Atlético Madrid:

average age is 26,00±4,42 years, BL – 189,67±1,47 cm, BM – 84,0±0,71 kg, BMI – 23,35±0,18 kg/m², BSA – 2,14±0,02 m².

Results of anthropometric indicators of forwards of Spanish clubs are as follows. FC Barcelona: average age is 25,40±2,22 years, BL – 176,40±2,2 cm, BM – 73,80±3,6 kg, BMI – 23,70±0,92 kg/m², BSA – 1,90±0,05 m². Real Madrid CF: average age is 27,2±2,06 years, BL – 182,4±2,48 cm, BM – 78,4±2,5 kg, BMI – 23,54±0,31 kg/m², BSA – 2,01±0,05 m². Atlético Madrid: average age is 27,00±2,24 years, BL – 175,60±2,97 cm, BM – 71,20±2,3 kg, BMI – 23,08±0,19 kg/m², BSA – 1,87±0,05 m².

The body surface area of goalkeepers of three chosen clubs exceeds 2 m². Because of that, the researchers assumed that greater body surface area allows goalkeepers to defend the goal better. It was also revealed that forwards of all clubs have lower morphological parameters, which is related to a necessity to pick up higher speed, overtake opponents and score [8].

Goalkeepers from our study were higher in BL in comparison to outfield players. However, according to BM and BMI, they took the second last position among four groups. Their results were higher in comparison to halfbacks only. Moreover, BL of goalkeepers from our study was higher than those of goalkeepers of the Major League, Super League and the futsal national team of Russia, whose morphological data were presented in the Fajzullin's study [6]. Nonetheless, the BL indicator was lower than those of goalkeepers of different teams that participated in the 2018 FIFA World Cup and goalkeepers of Spanish soccer clubs, whose morphological data was presented in the studies of Perevoznik et al. and Ryshik et al. [7-8].

Based on the conducted analysis of literature, results of which show clear difference between outfield players and goalkeepers according to the anthropometric data and comparison of our results with literature data, we can conclude that the surveyed goalkeepers do not meet requirements made for goalkeepers of the major league teams. Elite goalkeepers are higher and more massive, they have substantially high indicators of body length and mass in case of standard BMI and BSA values of more than 2 m^2 with a standard for men of up to 1,9 m^2.

If we compare PI values of the surveyed players with the data from similar studies, we can see that our data do not correspond with the data given by O.V. Filatova et al. Their data demonstrated that the mean PI value in the group of young male soccer players aged 17-21 years, with the mean body length of 181,2±1,94 cm, body mass – 62,9±2,31 kg, BMI – 19,1±1,27, CG – 88,4±1,33 cm was 27,4±2,22. Moreover, 42% of surveyed players were normosthenics, 58% – asthenics. These differences can be explained with the fact that PI value depends on three main morphological parameters: BL, BM and CG_{exhale}. The soccer players from

our study were different from the compared group of young men according to morphological inficators: in case of having the same body length, the mean body mass indicator was higher by 12 kg. [9]

When comparing the obtained data with the same study, which revealed that all examined soccer players had the andromorphic body type, we can suggest that physical development of the andromorphic type is typical for male soccer, since 87,5% of surveyed athletes from our study also had the andromorphic type [9].

Conclusion. The conducted analysis of the obtained data confirms a necessity to take into account anthropometric indicators as a model in professional soccer.

Results of the express assessment of the physical development level of soccer players using the method of indices revealed that the surveyed athletes have a sturdy body type according to Chernorutskij and the Pignet's index, mainly the andromorphic and mesomorphic type of the development according to the sex dimorphism index and mainly a broad chest according to the Erisman's index.

At the same time, the PD level of goalkeepers differ from those of outfield players. They have lower BMI indicators, a narrow chest and the average body type, which indicates the development of the andromorphic body type. Nonetheless, the goalkeepers from our study do not meet requirements made for goalkeepers of the major league. Elite goalkeepers are higher and more massive, they have substantially high indicators of body length and mass in case of standard BMI values and BSA values of more than 2 m^2 with a standard for men of up to 1,9 m^2.

Results of the conducted study can be used as comparative characteristics of athletes in case of an individual PD evaluation. They can also be used for discussing results of similar studies and serve for orienting and selecting in soccer.

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Information about the authors: Ksenia Valer'evna Vybornaya – Standardization Expert, Executive Secretary of the Technical Committee 036 "Specialized nutrition products", Researcher of the Laboratory of Sports Anthropology and Nutritional Sciences of the Federal Research Centre of Nutrition, Biotechnology and Food Safety, Moscow, e-mail: dombim@mail.ru; **Radzhabkadi Magomedovich Radzhabkadiev** – Junior Researcher of the Laboratory of Sports Anthropology and Nutritional Sciences of the Federal Research Centre of Nutrition, Biotechnology and Food Safety, Moscow; **Svetlana Valer'evna Klochkova** – Doctor of Medical Sciences, Professor of the Department of Human Anatomy of the People's Friendship University of Russia, Moscow; **Dmitrij Borisovich Nikityuk** – Corresponding Member of the Russian Academy of Sciences, Doctor of Medical Sciences, Professor of the Federal Research Centre of Nutrition, Biotechnology and Food Safety, Moscow.