Journal of Physical Education and Sport ® (JPES), 18(2), Art 104, pp. 710 - 714, 2018
online ISSN: 2247 - 806X; p-ISSN: 2247 – 8051; ISSN - L = 2247 - 8051 © JPES

Original Article

Functional preparedness of football players with different qualifications

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Published online: June 30, 2018
(Accepted for publication May 10, 2018)
DOI:10.7752/jpes.2018.02104

Abstract:
In the given work results of research of functional readiness of football players of various game roles of teams of the first and second leagues of championship of Ukraine are revealed. The criteria for the functional readiness of football players were such indicators as maximum oxygen consumption and physical performance. The functional condition of the players was determined in the research laboratory of Kharkiv State Academy of Physical Culture. Differences in the structure of the functional readiness of players of different qualifications of various playing roles (goalkeepers, central and wing defenders, central and wing midfielders and attackers) are exposed.
Key words: football players, playing role, functional readiness, VO2max, PWC170.

Introduction

Management of the modern training process can not be successful without the availability of objective data on the functional capabilities of the athletes' body (Tyulenkov, 2007). In situational sports, the long-term adaptation reactions that are formed to serve only as the basis on which an urgent adaptation of the athlete's organism to the conditions of a concrete game is formed which, along with the stability of the basic adaptation reactions, determines their wide variability (Platonov, 1988).

A large amount of competitive activity in football requires the maximum mobilization of psycho-physiological functions of the body. Moreover, as noted by S.Yu. Tulenkov (2007), the problem of assessing adaptive reactions is one of the conditions for avoiding disruption of adaptation. The criteria for the functional readiness of football players are such indicators as maximum oxygen consumption (VO_2max), physical performance (PWC_{170}) and other indicators (Kostyukevich, 2006; Przibylski, 2005; Shamardin, 2012).

A lot of work has been devoted to determining the level of IPC indices and physical working capacity as criteria for the functional preparedness of athletes (Belotserkovskii, 2005; Kostyukevich, 2006; Ordzhonikidze, Pavlov, 2008; Stroyer et al., 2004; Tamlin, 2001).

So, according to some experts, the VO_2max value reliably characterizes the physical performance of the athlete. It is established that between the VO_2max value and the sports result, especially in cyclic sports, there is a highly reliable correlation. In turn, in the training process the VO_2max of football players serves as one of the criteria for characterizing the overall functional state and the indicator of their adaptation to training and competitive loads at various stages of the one-year training cycle.

According to other specialists (Ordzhonikidze, Pavlov, 2008; Shamardin, 2012), the VO_2max value is an integral indicator of the efficiency of oxygen transportation systems and a bioenergetic indicator of aerobic capacity. Studies by Russian specialists (Ordzhonikidze, Pavlov, 2008; Ordzhonikidze et al., 2007) showed a significant correlation between the VO_2max score and the distance that the player overcomes during the match. Based on the results of these same studies, a high correlation was established between the VO_2max and the distribution of team locations in the European Championships.

According to different authors (Godik, 2006; Thales, 2001; Evangelista et al., 1992; Helgerud et al., 2002), the average values of VO_2max in high-skilled football players fluctuate in a fairly wide range, from 48.6 $ml/min \cdot kg^{-1}$ to 77 $ml/min \cdot kg^{-1}$.

It has long been known (Kostyukevich, 2006; Lysenchuk, 2003; Lkshinov, 2003; Shamardin, 2012) that the VO_2max indicators during the one-year training cycle tend to change, depending on the stage of preparation and the state of entry into the sports form of the players. Some experts (Casajus, 2001) believe that the level of maximum oxygen consumption is the subject to growth during the season, with the release of it to the maximum value to its end. So, the magnitude of the increase in the VO_2max digits is determined mainly by the initial level of the VO_2max, the regime and orientation of the training process. Depending on this, the increment of the VO_2max can reach 40%. Nevertheless, for the well-trained elite class athletes, the fluctuations in the VO_2max values mostly do not exceed 15%. However, in many cases, the teams are experiencing a decline in VO_2max by the end of the season (Drust et al., 2000; Heller et al., 1992; Wisloff et al., 1998). The described differences,

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apparently, are due to the fact that a number of teams finish the season in a state of severe physical fatigue, which determines the decline in the athlete's physiological parameters. In addition to the maximum consumption of oxygen (VO_2max), the criterion for the functional fitness of players is physical performance (PWC_{170}).

The determination of physical performance through the PWC_{170} test is primarily due to the fact that the increase in heart rate in muscle work is directly proportional to its intensity. However, the linear portion of the curve, characterizing this dependence of the heart rate on the intensity of work, ends at a heart rate close to 170 beats per minute. This explains why this heart rate was chosen for PWC_{170} (Belotserkovsky, 2005; Tyulenkov, 2007).

The model indicators of the physical performance of high-qualified players according to the data of different authors (Kostyukevich, 2006; Ordzhonikidze, Pavlov, 2008) range from 18.8 to 22,5 kg·m/min·kg^{-1}.

Material & methods

The research was conducted in the research laboratory of Kharkiv State Academy of Physical Culture. 25 football players of the first league and 26 players of the second league of the championship of Ukraine took part in the research. To evaluate the functional readiness of athletes, the electrocardiography complex CARDIOLAB was used.

The electrocardiography complex CARDIOLAB is designed for the removal of human biological signals through electrocardiography channels, the analysis of heart rate variability, the exercise of samples with physical activity, the processing of the signals taken and their display on the screen and printing.

The complex of express diagnostics of functional readiness of athletes was used by the method of prof. S.A.Dushanin. The physical performance was assessed using a submaximal load test PWC_{170}. The meaning of this test is to determine the power of work that an athlete is able to perform at a heart rate of 170 beats per minute. Physical loads were performed on a veloergometer in the sitting position. The seat of the veloergometer was set at such a level that in the lower position of the pedal the foot of the football player was completely straightened at the knee joint. There were two loads of 5 minutes each; the rest interval between the loads was 3 minutes. Calculation of the power of the first and second loads was carried out taking into account the body weight. The first load was selected from the calculation of 1 W (6 kg·m/min) per 1 kg of body weight, the second – 2 W (12 kg·m/min) per 1 kg of body weight.

At the end of the first and second loads, the heart rate was recorded. The heart rate at the end of the first load should be 100-120 beats/min, at the end of the second – 140-160 beats/min. The difference in heart rate between the first and second loads should be 40 beats/min. If the HR difference of 40 beats/min was not reached, then after 3 minutes of rest, a third load was performed at a rate of 2.5-3 W (15-18 kg·m/min) per 1 kg of body weight. In this case, the first and third loads were taken into account. Calculation of physical performance indicators was carried out according to the formula:

$$PWC_{170} = N_1 + (N_2 - N_1)\frac{170 - f_1}{f_2 - f_1},$$

where: PWC – exercise power at a heart rate of 170 beats/minute in W or kg·m/min;

N_1 and N_2 – the power of the first and second loads in W or kg·m/min;

f_1 and f_2 – the heart rate at the end of the first and second loads.

All the results of the research were processed by the generally accepted methods of mathematical processing of experimental data with the calculation of the arithmetic mean, the standard error of the arithmetic mean, the criterion for the difference in the mean values of the Styudent. Reliability was considered essential at a five percent level of significance.

Methods of mathematical statistics are used in accordance with the known recommendations using computer programs «EXCEL» and «SPSS».

Results

Table 1 presents the indicators of the functional readiness of players of different playing roles of the team of the first league of the championship of Ukraine. It is revealed that the values of some indicators of the functional readiness of players of different gaming specialization are not the same.

Table 1. Indicators of the functional readiness of football players of different playing roles of teams of the first league of Ukraine ($\overline{X}$ ±m)

Gaming Role	Indicators	
	VO_2max, ml/min·kg^{-1}	PWC_{170}, kg·m/min·kg^{-1}
Goalkeepers (n=3)	57,4±1,6	21,7±0,6
Central defenders (n=5)	66,2±1,0	23,1±0,3
Wing defenders (n=4)	66,6±1,0	23,2±0,4
Central midfielders (n=4)	67,7±0,9	23,3±0,3
Wing midfielders (n=5)	64,7±0,9	23,0±0,3
Forwards (n=4)	63,2±1,1	22,8±0,4
On the average for the group (n=26)	64,4±0,7	22,9±0,2

The analysis of the maximum oxygen consumption (VO_2max) of the players of the first league team shows that this indicator was in the range from 54,7 ml/min·kg^{-1} to 70,4 ml/min·kg^{-1}, with an average value of 64,4±0,7 ml/min·kg^{-1}.

Comparing the indicators of the VO_2max of the players of the first league of different playing roles, it can be seen that the highest values of the VO_2max are typical for central midfielders (67,7±0,9 ml/min·kg^{-1}). The lowest indices of VO_2max were observed in goalkeepers (57,4±1,6 ml/min·kg^{-1}).

Goalkeepers are significantly inferior to central defenders (t=4,66; p<0,01), wing defenders (t=4,88; p<0,01), central midfielders (t=5,61; p<0,01), the wing midfielders (t=3,98; p<0,01) and the attacker (t=2,99; p<0,05). In addition, central midfielders in this indicator significantly exceed the wing midfielders (t=2,36; p<0,05) and attackers (t=3,17; p<0,05).

Analysis of the physical performance (PWC_{170}) of the players of the first league teams of various roles shows that this indicator was in the range from 21,1 kg·m/min·kg^{-1} to 25,2 kg·m/min·kg^{-1}, with an average value 22,9±0,2 kg·m/min·kg^{-1}.

It should be noted that the highest indicator of physical performance was recorded in central midfielders (23,3±0,3 kg·m/min·kg^{-1}). The lowest indicators of physical performance (PWC_{170}) are noted in goalkeepers (21,7±0,6 kg·m/min·kg^{-1}).

Table 2 presents the indicators of the functional readiness of the players of various roles of the team of the second league of the championship of Ukraine.

Table 2. Indicators of the functional readiness of players of different playing roles of teams of the second league of Ukraine ($\overline{X}$ ±m)

Gaming Role	Indicators VO_2max, ml/min·kg^{-1}	PWC_{170}, kg·m/min·kg^{-1}
Goalkeepers (n=3)	55,7±0,8	21,6±0,3
Central defenders (n=5)	63,1±1,4	22,7±0,7
Wing defenders (n=4)	66,2±1,3	23,0±0,5
Central midfielders (n=5)	65,1±1,2	23,0±0,4
Wing midfielders (n=5)	64,3±1,5	22,9±0,6
Forwards (n=4)	62,4±0,8	22,5±0,3
The average for the group (n=26)	63,3±0,8	22,7±0,2

The results of the study show that the maximum oxygen consumption (VO_2max) for the second league players ranged from 54,4 ml/min·kg^{-1} to 70,2 ml/min·kg^{-1}, with an average value of 63,3±0,8 ml/min·kg^{-1}.

At the same time, the highest values of the VO_2max among the players of the second league were noted in the wing defenders (66,2±1,3 ml/min·kg^{-1}), and the smallest – for goalkeepers (55,7±0,8 ml/min·kg^{-1}).

As a result of the comparative analysis it was found that the goalkeepers are much inferior to the central defenders (t=4,59; p<0,01), the wing defenders (t=6,88; p<0,001), central midfielders (t=6,52; p<0,01), the wing midfielders (t=5,06; p<0,01) and the attacker (t=5,92; p<0,01). In turn, the wing defenders in this indicator significantly exceed the players of the attack line (t=2,49; p<0,05).

Analysis of the physical performance of the players of the teams of the second league shows that the PWC_{170} for this group of players was in the range from 20,7 kg·m/min·kg^{-1} to 25,1 kg·m/min·kg^{-1}, with an average value of 22,7±0,2 kg·m/min·kg^{-1}.

The highest indicators of physical fitness among the players of the second league of Ukraine were registered with the wing defenders (23,0±0,5 kg·m/min·kg^{-1}) and central midfielders (23,0±0,4 kg·m/min·kg^{-1}). The lowest indicators of physical performance (PWC_{170}) are noted in goalkeepers (21,6±0,3 kg·m/min·kg^{-1}).

Comparative analysis of indicators of physical performance of the players of the second league of different playing roles shows that the goalkeepers in this indicator are significantly inferior to the central midfielders (t=2,80; p<0,05). At the same time, it should be noted that significant differences in physical performance are characteristic only for the indicators of goalkeepers and field players. There are no significant differences in the performance of PWC_{170} defenders, midfielders and attackers (p>0,05).

Tables 3 and 4 show the average values of the indicators of the functional readiness of the players of the teams of the first and second leagues of the championship of Ukraine. Differences in the level of the investigated parameters among players of different playing roles of teams of different qualifications are noted.

Table 3. Indicators of maximum oxygen consumption (VO_2max) of the players of the teams of the first and second leagues of the championship of Ukraine

Game Role	Football players of the first league (n=25)	Football players of the second league (n=26)	t	p
Goalkeepers (n=3)	57,4±1,6	55,7±0,8	0,95	>0,05
Central defenders (n=5)	66,2±1,0	63,1±1,4	1,80	>0,05
Wing defenders (n=4)	66,6±1,0	66,2±1,3	0,24	>0,05
Central midfielders (n=5)	67,7±0,9	65,1±1,2	1,73	>0,05
Wing midfielders (n=5)	64,7±0,9	64,3±1,5	0,23	>0,05
Forwards (n=4)	63,2±1,1	62,4±0,8	0,59	>0,05
On the average for the group (n=26)	64,4±0,7	63,3±0,8	1,03	>0,05

Table 4. Physical capacity (PWC_{170}) football players of the first and second league players of championship of Ukraine

Game Role	Football players of the first league (n=25)	Football players of the second league (n=26)	t	p
Goalkeepers (n=3)	21,7±0,6	21,6±0,3	0,15	>0,05
Central defenders (n=5)	23,1±0,3	22,7±0,7	0,53	>0,05
Wing defenders (n=4)	23,2±0,4	23,0±0,5	0,31	>0,05
Central midfielders (n=5)	23,3±0,3	23,0±0,4	0,60	>0,05
Wing midfielders (n=5)	23,0±0,3	22,9±0,6	0,15	>0,05
Forwards (n=4)	22,8±0,4	22,5±0,3	0,60	>0,05
On the average for the group (n=26)	22,9±0,2	22,7±0,2	0,71	>0,05

Discussion

This research continues a number of works devoted to the study of the functional preparedness of football players of different ages and qualifications (Ordzhonikidze, Pavlov, 2008; Ordzhonikidze, et al., 2007; Pertsukhov, 2010; Pshibylski, Mishchenko, 2005; Shamardin, et al., 2008; Shamardin, 2012).

The obtained data partially confirm the results of other studies (Godik, 2006), in which the author established that the successes of football teams are ensured, first of all, by the high level of technical and tactical preparedness of football players, and only then by aerobic capabilities. This situation is explained by the fact that in football, special qualities and abilities are leading. However, in our opinion, there is a minimum level of aerobic capabilities, below which a professional football player has no right to go down.

The conducted research allowed to determine that the minimum value of the maximum oxygen consumption of players lies about 60 ml/min·kg^{-1}. This assumption was confirmed in their work by other specialists (Godick, 2006; Davies, et al., 1992), who in the laboratory and field conditions examined football players-professionals, semi-professionals and amateurs.

This study complements and expands data on the functional preparedness of players of different playing roles. Thus, many authors (Kostyukevich, 2006; Ordzhonikidze, Pavlov, 2008; Pertsukhov, 2010; Shamardin, 2012; Bangsbo, 1994; Puga, 1993) it is noted that the indicators of maximum oxygen consumption (VO_2max) and physical performance (PWC_{170}) for players of different roles are not the same. Differences in the obtained data can be explained by the features of the motor activity in conditions of competitive activity and the load characteristics in the training activity of players of different roles.

In this regard, it can be assumed that the differentiation of the training load for players of different roles contributes not only to improving the functional readiness in accordance with the model structure of playing roles, but also ensures the improvement of the quality of the game activity of each player separately, and the entire team as a whole.

Most researchers believe that the level of VO_2max is subject to growth during the season, with the release of it to the maximum values to its end (Casajus, 2001). However, in some cases, the teams have a decline in VO_2max indicators by the end of the season (Drust, Reilly, Cable, 2000). Such differences can be explained by the fact that players of many teams end the season in a state of strong physical fatigue, which determines the decline in the athlete's physiological parameters.

Prospects of further researches

Further studies will be devoted to the study of the dynamics of the VO_2max and PWC_{170} indicators of the players of the teams of the second and the first leagues of Ukraine at different stages of the annual training cycle.

Conclusions

The results of this study show that the greatest level of aerobic performance is characteristic of wing players and midfield players. So, according to our data, the VO_2max indicators of central midfielders range from 63,1 to 69,6 ml/min·kg^{-1}. But, especially important is aerobic performance for the flank, or, the wing players who perform the greatest amount of work on the field. It has been established that the VO_2max of wing defenders is in the range from 64,6 to 70,2 ml/min·kg^{-1}. Low aerobic performance is observed in goalkeepers (54,4-60,3 ml/min·kg^{-1}), as this type of their activity is not determinative.

According to the data received, the average level of the VO_2max for professional football players is 63,8±0,5ml/min·kg^{-1}. Attention is drawn to the fact that according to the indicators studied – the VO_2max and PWC_{170} – there were no differences between the players of the teams of the first and second leagues of the championship of Ukraine. This means that the aerobic abilities of players of different skills are the same.

Conflicts of interest

The authors declare that there is no conflict of interests.

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