



## Parameters of Physical Performance of Qualified Football Players in the Preparatory Period of Training

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### Abstract

**The purpose of the work:** to determine the level of physical fitness of qualified football players in the preparatory period of the annual macrocycle based on test indicators for the formation of rational programs for their preparation for competitive activities.

**Material and methods.** Contingent: 25 qualified football players of MFC “Metalurg” (Zaporizhzhya): 15 athletes – application form “A” and 10 athletes – application form “B” of the second stage of the “Champion” group VBET UA 2022-2023 season of Professional Football League of Ukraine. Methods: Analysis and systematization of data from scientific and methodical literature and the electronic resource of global information network “Internet”; pedagogical observations; pedagogical testing: PWC<sub>170</sub> (Physical Working Capacity); Harvard Step-Test; pedagogical experiment of controlling orientation; methods of mathematical statistics.

**Results.** During the educational and training meetings, the test indicators had statistically significant differences in the direction of decreasing values of special physical capacity, from retractable microcycle to percussive microcycle ( $p < 0.05$ ):  $aPWC_{170} - 1469.33 \pm 50.11$  and  $1377.67 \pm 49.11$  ( $kg \cdot m \cdot min^{-1}$ ),  $rPWC_{170} - 20.87 \pm 0.69$  and  $20.71 \pm 0.71$  ( $kg \cdot m \cdot min^{-1} \cdot kg^{-1}$ ),  $aVO_2 \max - 4002.23 \pm 115.23$  and  $3857.54 \pm 117.34$  ( $ml \cdot min^{-1}$ ),  $rVO_2 \max - 61.57 \pm 1.51$  and  $54.37 \pm 1.67$  ( $ml \cdot min^{-1} \cdot kg^{-1}$ ), in accordance. Also, during the educational and training meetings, the test indicators had statistically significant differences in the direction of increment values of special physical capacity: from percussive microcycle to submersible microcycle ( $p < 0.05$ ):  $aPWC_{170} - 1377.67 \pm 49.11$  and  $1494.34 \pm 51.78$  ( $kg \cdot m \cdot min^{-1}$ ),  $rPWC_{170} - 20.71 \pm 0.71$  and  $21.37 \pm 0.85$  ( $kg \cdot m \cdot min^{-1} \cdot kg^{-1}$ ),  $aVO_2 \max - 3857.54 \pm 117.34$  and  $3997.09 \pm 114.89$  ( $ml \cdot min^{-1}$ ),  $rVO_2 \max - 54.37 \pm 1.67$  and  $63.67 \pm 1.71$  ( $ml \cdot min^{-1} \cdot kg^{-1}$ ), in accordance.

**Conclusion.** The way to solve this problem is the proposed methodical approach, which allows, on the one hand, to comprehensively approach the solution of the issue of the complex orientation of the training process of qualified football players in the preparatory period of training, on the other hand, it provides for the differentiation of the team composition into typological groups of athletes, which allows to have a targeted influence on indicators of special physical capacity and technical and tactical potential of qualified football players.

**Keywords:** football, qualification, training, special physical capacity, functional readiness.

### Introduction

The modern system of training qualified football players in the annual macrocycle assumes the main focus on the formation of basic mechanisms that ensure the manifestation of functional readiness and physical capacity. The construction of the training process for qualified football players is

considered classic, when, in the preparatory period (Kokareva, Kokarev & Doroshenko, 2018), the foundations for the development and improvement of special motor skills are formed, the basis of functional readiness and physical capacity is formed (Lisenchuk, Zhigadlo, Tyshchenko, 2019). This is a necessary prerequisite for the effective implementation of the technical and tactical skills of football players in variable competitive activities (Mitova, 2020). It is also important to determine the current level of physical performance of

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qualified football players. Thus, issues of physical fitness in sports remain relevant while maintaining high competition between athletes and teams (Lisenchuk et al., 2023; Nurimov, 2021; Pertsukhov & Shalenko, 2021).

Individual issues of this issue have repeatedly been in the focus of researchers' attention. In particular, (Balsom, Hawkins, & Strudwick, 2022) emphasized the importance of rationalizing the physical training of modern elite football players for national and international competitions with an emphasis on avoiding physical overload according to the parameters of the intensity of special game exercises. At the same time, the issue of using models of maximum power exercises with dynamic external resistance is significant (Bergstrom et al., 2021). The researchers note (Permadi, 2019) that the development of models of physical and psychological training has an applied orientation – to increase the effectiveness of competitive activities in football and for modeling and analysis of specific physical capabilities of soccer players based on the training evaluation index (Li & Zeng, 2021). This situation creates the basis for a comparative analysis of the physical and anthropometric qualities of football players, which systematizes the search for sports talents in elite junior football (Woods et al., 2017) and regarding the physiological aspects of identifying sports talents in football (Dodd & Newans, 2018). Similar trends were recorded in the study, on the material of testing football players of other qualifications (Kaczorowska, Tota, & Pałka, 2022)

The issue of the relationship between indicators of physical performance and bioenergetic mechanisms of ensuring the playing activity of qualified football players is significant, they note (Lyzohub et al, 2020). This situation is reinforced by the variability of indicators of cumulative load and anaerobic power in youth elite football in the context of taking into account indicators of biological maturation of their organism (Nobari, Gorouhi & Mallo, 2023).

A significant group of researchers emphasizes the need to use the most rational approaches to planning significant physical exertion. Failure to comply with the methodological requirements for the ratio of volume and intensity of training loads can significantly increase the rates of injuries of the musculoskeletal system of qualified football players and the risks of the development of accompanying pathologies (Dambroz, Clemente & Teoldo, 2022; Doroshenko, 2015; Doroshenko et al., 2019; Garrett et al., 2019; Griffin et al., 2020; Sirenko et al., 2022).

This problem is actualized in the context of the age-related development of athletes' bodies, psychophysiological features, gender differences, etc. (Chau, 2021; Hanapiah et al., 2020; Kalinowski et al., 2021). The accounting of this complex of issues allows us to state that the scientific problems related to the physical performance of qualified football players remain relevant and timely, and the implementation of the results of experimental studies will allow to increase the effectiveness of competitive activities (Hoff, 2005; Kapelman, Kızılet & Bozdogan, 2022).

The above allows us to assert the presence of a problematic situation, which contains a contradiction between the classical system of sports training of qualified football players in the annual macrocycle and the need to modify existing approaches to improving physical performance (Kostiukevych, Shchepotina & Vozniuk, 2020; Kostiukevich et al., 2017; Shchepotina et al., 2021).

*Hypothesis.* The study of indicators of the dynamics of the physical working capacity of qualified football players will contribute to the development of new approaches to improving their physical and functional fitness in the preparatory period of the annual training macrocycle.

*The purpose of the work:* to determine the level of physical fitness of qualified football players in the preparatory period of the annual macrocycle based on test indicators for the formation of rational programs for their preparation for competitive activities.

## Material and methods

### Participants

25 qualified football players of MFC "Metalurg" (Zaporizhzhya): 15 athletes – application form "A" and 10 athletes – application form "B" of the second stage of the "Champion" group VBET UA 2022-2023 season of Professional Football League of Ukraine. Age range: 18-36. Term of preparatory training period: 09.03.2023 – 08.04.2023 (Morshyn of the Lviv region).

### Methods of research

Analysis and systematization of data from scientific and methodical literature and the electronic resource of global information network "Internet"; pedagogical observations; pedagogical testing: PWC<sub>170</sub> (Physical Working Capacity); Harvard Step-Test; pedagogical experiment of controlling orientation; methods of mathematical statistics.

### Organization of research

Experimental studies were carried out during the preparatory period to the second stage of the "Champion" group VBET UA 2022-2023 season of Professional Football League of Ukraine. The educational and training meetings of MFC "Metalurg" (Zaporizhzhya) contained 5 training microcycles: retractable microcycle (4 days); basic microcycle (7 days); percussive microcycle (7 days); restorative microcycle (7 days); submersible microcycle (6 days).

PWC<sub>170</sub> (Physical Working Capacity). Athletes perform three consecutive workloads on a cycle ergometer. Begin by setting up subject on bike to ensure correct seat height (knee slightly bent at bottom of cycle). Place heart rate monitor on the subject. Check their exercise history to determine the starting workload (estimated to achieve a heart rate between 100-115). Start the test and measure heart rate each minute and continue for 3-4 minutes (until a steady heart rate is achieved). Continue the test for 2nd and 3rd workloads, set to achieve a HR between 115-130 and 130-145 beats per minute respectively. Each steady-state heart rate and workload are graphed, with the line of best fit for the three points extrapolated to estimate the workload that would elicit a heart rate of 170 beats per minute. This workload value then be compared to norms.

Harvard Step-Test. The football players steps up and down on the platform at a rate of 30 steps per minute (every two seconds) for 5 minutes or until exhaustion. Exhaustion is defined as when the athlete cannot maintain the stepping rate for 15 seconds. The football players immediately sits down on

**Table 1.** The scale of qualitative assessment of the level of indicators of PWC<sub>170</sub> and VO<sub>2</sub> max of male athletes 18-35 years old (Malikov, Bogdanovs'ka, & Svatiev, 2006)

Level	PWC <sub>170</sub>		VO <sub>2</sub> max	
	aPWC <sub>170</sub> (kg•m•min <sup>-1</sup> )	rPWC <sub>170</sub> (kgm•min <sup>-1</sup> •kg <sup>-1</sup> )	aVO <sub>2</sub> max (ml•min <sup>-1</sup> )	rVO <sub>2</sub> max (ml•min <sup>-1</sup> •kg <sup>-1</sup> )
Low	≤ 1067.50	≤15.25	≤ 3.50	≤ 50.00
Below average	1067.51 – 1294.50	15.26 – 18.49	3.51 – 3.85	50.01 – 54.99
Average	1294.51 – 1750.00	18.50 – 25.00	3.86 – 4.55	55.00 – 65.00
Above average	1750.01 – 1995.00	25.01-28.25	4.56 – 4.90	65.01 – 70.00
High	> 1995.00	> 28.25	> 4.90	> 70.00

completion of the test, and the total number of heart beats are counted between 1 to 1,5 minutes after finishing. This is the only measure required if using the short form of the test. If the long form of the test is being conducted, there is an additional heart rate measures at between 2 to 2,5 minutes, and between 3 to 3,5 minutes.

The results of testing the level of physical performance of qualified football players are differentiated into 5 levels in accordance with the data in the table 1.

During the experimental studies, the participants gave informed consent to the processing of personal data in accordance with the requirements of the Declaration of Helsinki of the World Medical Association "Ethical principles of medical research with the participation of a person as an object of research".

Statistical analysis. The obtained experimental materials were processed by the package of application programs "IBM SPSS Statistics" with the calculation of the following indicators: arithmetic mean (X); arithmetic mean error (S);  $\sigma$  – mean square deviation; Student's t-test, which is a test of the reliability of the normal distribution for equal and unequal samples with (n-1) degrees of freedom. Statistically reliable differences are accepted as significant at a 5% significance level of  $p < 0,05$ .

## Results

Experimental studies were carried out during the educational and training gathering of qualified football players of MFC "Metalurg" (Zaporizhzhya) taking into account the direction of training loads, which is presented in table 2.

**Table 2.** Orientation of training loads of qualified football players of MFC "Metalurg" (Zaporizhzhya) in microcycles of the preparatory period, %

Types of sports training	Types of microcycles				
	retractable	basic	percussive	restorative	submersible
general physical training	15	15	10	0	0
special physical training	0	10	15	5	10
technical and tactical training	20	20	20	30	30
integrated training	0	0	0	30	35
psychological preparation	5	5	5	5	5
control game	40	30	30	0	0
MFR and stretching	5	5	5	10	5
restorative measures	5	5	5	10	5
theoretical training	5	5	5	5	5
testing	5	5	5	5	5
total	100	100	100	100	100

The predominant focus of the training process is the comprehensive development of technical and tactical preparedness and physical capacity of qualified football players. The main task of the educational and training camp of qualified football players MFC "Metalurg" (Zaporizhzhya) is integral preparation for official competitions – to the second stage of the "Champion" group VBET UA 2022-2023 season of Professional Football League of Ukraine.

Table 3 shows the indicators of the physical performance of qualified football players, which were recorded by control tests at the end of the retracting, impact and subduction microcycles in the preparatory period of training

Analysis of the dynamics of indicators of special physical performance of qualified footballers according to tests PWC<sub>170</sub> and VO<sub>2</sub> max allows us to state that the proposed methodical approach is sufficiently effective. During the educational and training meetings, the test indicators (PWC<sub>170</sub> and VO<sub>2</sub> max) had statistically significant differences in the direction of decreasing values of special physical capacity, from retractable microcycle to percussive microcycle ( $p < 0,05$ ): aPWC<sub>170</sub> – 1469,33 ± 50,11 and 1377,67 ± 49,11 (kg•m•min<sup>-1</sup>), rPWC<sub>170</sub> – 20,87 ± 0,69 and 20,71 ± 0,71 (kgm•min<sup>-1</sup>•kg<sup>-1</sup>), aVO<sub>2</sub> max – 4002,23 ± 115,23 and 3857,54 ± 117,34 (ml•min<sup>-1</sup>), rVO<sub>2</sub> max – 61,57 ± 1,51 and 54,37 ± 1,67 (ml•min<sup>-1</sup>•kg<sup>-1</sup>), in accordance.

Also, during the educational and training meetings, the test indicators had statistically significant differences in the direction of increment values of special physical capacity: from percussive microcycle to submersible microcycle ( $p < 0,05$ ): aPWC<sub>170</sub> – 1377,67 ± 49,11 and 1494,34 ± 51,78 (kg•m•min<sup>-1</sup>), rPWC<sub>170</sub> – 20,71 ± 0,71 and 21,37 ± 0,85

**Table 3.** Dynamics of indicators of physical performance of qualified football players MFC “Metalurg” (Zaporizhzhya), n=25

Tests & Indicators	Types of microcycles & Levels		
	retractable	percussive	submersible
aPWC <sub>170</sub> (kg•m•min <sup>-1</sup> )	1469.33 ± 50.11 average	1377.67 ± 49.11* average	1494.34 ± 51.78** average
rPWC <sub>170</sub> (kgm•min <sup>-1</sup> •kg <sup>-1</sup> )	20.87 ± 0.69 average	20.71 ± 0.71* average	21.37 ± 0.85** average
aVO <sub>2</sub> max (ml•min <sup>-1</sup> )	4002.23 ± 115.23 average	3857.54 ± 117.34* average	3997.09 ± 114.89** average
rVO <sub>2</sub> max (ml•min <sup>-1</sup> •kg <sup>-1</sup> )	61.57 ± 1.51 average	54.37 ± 1.67* average	63.67 ± 1.71** average

Notes: \* – statistically significant differences between indicators at retractable and percussive microcycles (p<0,05); \*\* – statistically significant differences between indicators at percussive and submersible microcycles (p<0,05);

(kgm•min<sup>-1</sup>•kg<sup>-1</sup>), aVO<sub>2</sub> max – 3857,54 ± 117,34 and 3997,09 ± 114,89 (ml•min<sup>-1</sup>), rVO<sub>2</sub> max – 54,37 ± 1,67 and 63,67 ± 1,71 (ml•min<sup>-1</sup>•kg<sup>-1</sup>), in accordance.

In addition, during the retractable, basic and percussive microcycles, six control games were held:

- 11.03.2023. MFC “Metalurg” (Zaporizhzhya) – FC “Scala-1911” (Morshyn) – 1:0;
- 12.03.2023. MFC “Metalurg” (Zaporizhzhya) – FC “Mykolaiv” (Mykolaiv) – 0:2;
- 18.03.2023. MFC “Metalurg” (Zaporizhzhya) – FC “LNZ” (Chercasy) – 1:1;
- 22.03.2023. MFC “Metalurg” (Zaporizhzhya) – FC “Bukovina” (Chernivtsi) – 1:1;
- 24.03.2023. MFC “Metalurg” (Zaporizhzhya) – FC “Ruh” (Lviv) – 1:0;
- 25.03.2023. MFC “Metalurg” (Zaporizhzhya) – FC “Prykarpattya” (Ivano-Frankivsk) – 0:3.

As a result of the control games, the quantitative and qualitative indicators of the competitive practice of qualified footballers were taken into account: the level of the rival team (Premier League, I, II league, amateur team) and the main typological groups of athletes were determined (the main composition of the team; protocol lineup for the game; entry list for the competition).

As a result of the complex application of methods of developing technical and tactical preparedness and special working capacity of qualified footballers MFC “Metalurg” (Zaporizhzhya) in the preparatory period of training, a methodical approach has been determined that allows to effectively combine these areas during the training camp.

Thus, the methodical approach to the complex development of technical and tactical preparation and physical capacity of qualified football players MFC “Metalurg” (Zaporizhzhya), which is applied in the preparatory period of training qualified football players for official competitions to the second stage of the “Champion” group VBET UA 2022-2023 season of Professional Football League of Ukraine, contains the following components:

- determination of a promising group of professional footballers to be included in the main team, taking into account game specialization;
- comparative analysis of quantitative and qualitative indicators of the level of competitive practice (national or international competitions; friendly or official; starting lineup or substitution; indicators

of time played; chronological development of the game, etc.);

- differentiation of the team composition into typological groups with appropriate individualization of their training: main team (11 footballers); protocol squad for the game (18 footballers); application squad for the competition (25 footballers);
- special analysis, assessment and interpretation of indicators of competitive activity of footballers (performance, efficiency of technical and tactical actions in different zones of the playground, chronological segments of time, etc.);
- differentiated analysis, assessment and interpretation of indicators of competitive activity of footballers according to certain typological groups: the main composition of the team; protocol lineup for the game; entry list for the competition (efficiency, effectiveness of technical and tactical actions).

## Discussion

In the experimental researchers, a scientific problem with elements of scientific novelty was raised: added data on the training of qualified football players (Hoff, 2005; Kaczorowska, et al., 2022), testing of their special physical performance indicators using instrumental methods: PWC<sub>170</sub> and VO<sub>2</sub> max (Kokareva et al., 2018; Lisenchuk et al., 2019). Problematic issues concerning the adequacy of determining the indicators of special preparedness among young football players based on taking into account the age-related features of the development of their bodies have gained further development (Chau, 2021; Hanapiyah et al., 2020; Kalinowski et al., 2021).

Modern scientific concepts regarding testing of functional readiness, development and improvement of special physical capacity of qualified football players have been expanded (Kostiukevych et al., 2020; Kostiukevich et al., 2017; Shchepotina et al., 2021).

In the course of experimental studies, it has been shown that long-term maximum physical exertion, including high-intensity test exercises, can provoke increased traumatism of the musculoskeletal system of athletes (Dambroz et al., 2022; Doroshenko, 2015; Doroshenko et al., 2019).

The researchers note that, in this context, the problems of interrelationship of the mechanisms of energy supply for

the muscular activity of qualified football players and the functional diagnosis of their current physical condition are significant (Lyzohub et al., 2020; Malikov et al., 2006).

This creates the necessary prerequisites for effective implementation of the existing technical and tactical potential of qualified football players in competitive activities, management of long-term training of athletes and control of the main parameters of their preparation: special physical capacity and integral playing qualities (Lisenchuk et al., 2023; Mitova, 2020; Nobari et al., 2023).

In further generalization, this indicates the need to differentiate the composition of the team into typological groups for effective sports training for official competitions at the national or international levels (Hoff, 2005; Kaczorowska et al., 2022; Kokareva et al., 2018; Lisenchuk et al., 2019).

Prospects for further research in this direction relate to the improvement of instrumental testing technologies for the special physical performance of qualified football players (testing protocols, evaluation and interpretation of the obtained indicators). Also promising are the issues related to the improvement of modern methodological approaches to determining the effectiveness of the complex application of training directions: to the development and improvement of special physical capacity and the maximum realization of the available technical and tactical potential of a football player in competitive activities.

## Conclusions

Analysis and systematization of data from scientific and methodical literature and the electronic resource of global information network "Internet" indicates the final non-completion of this problem.

The way to solve this problem is the proposed methodical approach, which allows, on the one hand, to comprehensively approach the solution of the issue of the complex orientation of the training process of qualified football players in the preparatory period of training, on the other hand, it provides for the differentiation of the team composition into typological groups of athletes, which allows to have a targeted influence on indicators of special physical capacity and technical and tactical potential of qualified football players.

Analysis of the dynamics of indicators of special physical performance of qualified footballers according to tests PWC<sub>170</sub> and VO<sub>2</sub> max allows us to state that the proposed methodical approach is sufficiently effective. During the educational and training meetings, the test indicators (PWC<sub>170</sub> and VO<sub>2</sub> max) had statistically significant differences in the direction of decreasing values of special physical capacity: from retractable microcycle to percussive microcycle ( $p < 0,05$ ). In accordance, during the educational and training meetings, the test indicators had statistically significant differences in the direction of increment values of special physical capacity: from percussive microcycle to submersible microcycle ( $p < 0,05$ ).

## Conflict of interest

The authors state no conflict of interest.

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# Параметри фізичної роботоздатності кваліфікованих футболістів у підготовчий період підготовки

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; Е – збір коштів

Реферат. Стаття: 7 с., 3 табл., 32 джерела.

**Мета роботи:** визначити рівень фізичної підготовленості кваліфікованих футболістів у підготовчий період річного макроциклу за тестовими показниками для формування раціональних програм їх підготовки до змагальної діяльності.

**Матеріал і методи.** Контингент: 25 кваліфікованих футболістів МФК «Металург» (Запоріжжя): 15 спортсменів – заявковий лист «А» і 10 спортсменів заявковий лист «В» до II етапу групи «Чемпіон» VBET UA 2022-2023 сезону Професіональної Футбольної Ліги України. Методи: аналіз та систематизація даних науково-методичної літератури та електронних ресурсів глобальної інформаційної мережі «Інтернет»; педагогічні спостереження; педагогічне тестування: PWC<sub>170</sub> (Physical Working Capacity); Гарвардський степ-тест; педагогічний експеримент контролюючої спрямованості; методи математичної статистики.

**Результати.** Під час навчально-тренувальних зборів показники тестів мали статистично значущі відмінності у бік зменшення значень спеціальної фізичної працездатності з втягувального до ударного мікроциклу ( $p < 0,05$ ): aPWC<sub>170</sub> – 1469,33 ± 50,11 та 1377,67 ± 49,11 (кг·м·хв<sup>-1</sup>), rPWC<sub>170</sub> – 20,87 ± 0,69 і 20,71 ± 0,71 (кг·м·хв<sup>-1</sup>·кг<sup>-1</sup>), aVO<sub>2</sub> max – 4002,23 ± 115,23 і 3857,54 ± 117,34 (мл·хв<sup>-1</sup>), rVO<sub>2</sub> max – 61,57 ± 1,51 і 54,37 ± 1,67 (мл·хв<sup>-1</sup>·кг<sup>-1</sup>), відповідно. Також під час навчально-тренувальних зборів показники тестів мали статистично значущі відмінності за напрямом приросту значень спеціальної фізичної працездатності: від ударного до підвідного мікроциклу ( $p < 0,05$ ): aPWC<sub>170</sub> – 1377,67 ± 49,11 і 1494,34 ± 51,78 (кг·м·хв<sup>-1</sup>), rPWC<sub>170</sub> – 20,71 ± 0,71 і 21,37 ± 0,85 (кг·м·хв<sup>-1</sup>·кг<sup>-1</sup>), aVO<sub>2</sub> max – 3857,54 ± 117,34 і 3997,09 ± 114,89 (мл·хв<sup>-1</sup>), rVO<sub>2</sub> max – 54,37 ± 1,67 і 63,67 ± 1,71 (мл·хв<sup>-1</sup>·кг<sup>-1</sup>), відповідно.

**Висновок.** Шляхом реалізації мети дослідження є запропонований методичний підхід, який дозволяє, з одного боку, комплексно підійти до вирішення питання комплексної спрямованості тренувального процесу кваліфікованих футболістів у підготовчий період підготовки, з іншого боку, передбачається диференціація складу команди на типологічні групи спортсменів, що дозволяє цілеспрямовано впливати на показники спеціальної фізичної працездатності та техніко-тактичного потенціалу кваліфікованих футболістів.

**Ключові слова:** футбол, кваліфікація, підготовленість, спеціальна фізична працездатність, функціональна підготовленість.

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