

Original Article

Improvement of physical condition of football referees by athletics

ALEXANDER MASLENNIKOV¹, MIKHAIL SOLOVIEV², LYUDMILA VAKALOVA³, DMITRIY ZAIKO⁴, IGOR DMITRIEV⁵

¹Associate Professor, Candidate of Sciences (Pedagogy), Professor of the Department of Theory and Methods of Athletics; Department of Theory and Methods of Athletics, the Faculty of Summer Olympic Sports, Lesgaft National State University of Physical Education, Sport and Health, RUSSIAN FEDERATION

²Candidate of Sciences (Pedagogy), teacher of physical education; state budgetary educational establishment, secondary school No. 17 of the Vasileostrovsky district of St. Petersburg, RUSSIAN FEDERATION

³Professor, Candidate of Sciences (Economics), Professor of the Management and Economics of Sport Department, Faculty of Economics, Management and Law, Lesgaft National State University of Physical Culture, Sport and Health, RUSSIAN FEDERATION

⁴Associate Professor, Candidate of Sciences (Pedagogy), Head of the Department of Theory and Methods of Athletics; Department of Theory and Methods of Athletics, the Faculty of Summer Olympic Sports, Lesgaft National State University of Physical Education, Sport and Health, RUSSIAN FEDERATION

⁵Candidate of Sciences (Pedagogy)s, Dean of the Faculty of Summer Olympic sports; Department of Theory and Methods of Athletics, Lesgaft National State University of Physical Culture, Sport and Health, RUSSIAN FEDERATION

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Abstract:

Athletics exercises, due to their accessibility and universality, are used in the training process in many sports. Athletics is used at training of football referees. At the same time, there is no methodological explanation for the effectiveness of using athletes' exercises for football referees. This was the actual research topic.

The information on the topic that can be found in the scientific and methodological literature is not systematized and is fragmentary. However, it can form the basis for developing a modern methodology to define the physical preparedness of football referees. This was the basis for the purpose of the study, which is to develop an effective method of physical training for football referees using athletics.

The theoretical review of the scientific and methodological literature, questionnaires, recording of load characteristics using the Polar M400 sports watch, timekeeping, pedagogical testing, and methods of mathematical statistics were used during the research. The principal method is observation and experiment.

The status of the question of the physical training of football referees was determined to fulfill the research goal; the properties of motor activity of football referees of various qualifications are revealed. The paper developed and experimentally tested the effectiveness of physical athletics-based training methods for football referees.

The practical and theoretical significance of the research is reflected in the results and conclusions of the work.

The practical significance of the research is in the development of the physical athletics-based training method of football referees. The situational control standard for football referees has been prepared and tested to determine the degree of physical readiness, considering the specificity of their motor activity.

The theoretical significance is in the following:

- The specification and addition of the latest theoretical data, the characteristics of the professional activity of football referees;
- The creation of theoretical provisions of the physical athletics-based training method of football referees;
- A highly informative benchmark is recommended that include the individual and distinctive features of the motor activity of the referees.

Key Words: Football; athletics; physical training; standards of physical fitness; football referees; means of athletics.

Introduction

Today's highly professional football is becoming more dynamic every year. Players in the arena do many movements and technical and tactical actions. The requirements for physical readiness of both players and football referees are increasing.

Numerous experts note that blunders made by referees during refereeing are often associated with a lack of preparedness (Spirin, 2003; Budogossky, 2008; Kulalaev, 2006; Turbin, 2009; Castagna, 2008; Schenk et al., 2018; Suarez-Arrones, et al., 2013; Emmonds, et al., 2015; Rebelo, 2011; Webb, 2014; Weston, 2007). The results show that referees mostly make mistakes in the closing minutes of each half of the game. This is

associated with accumulating physical fatigue, which leads to a decrease in the concentration of mindfulness and quick decision-making (Helsen, 2004; Dixon, 2014; Di Salvo, 2009; Hogarth et al., 2015; Put et al., 2014; Dell, 2016; Larkin, 2018).

Therefore, this indicates a lack of physical fitness of the referees during the refereeing. In recent years, various studies related to football refereeing have been conducted. The issues of training young referees and problems of organizing qualities necessary for the effective performance of work were considered: organizational and pedagogical aspects of professional training (Budogossky, 2008), specific skills formation (Turbin, 2009), professionally critical psychophysiological qualities formation (Soloviev, 2018). Besides, psychological aspects of refereeing were researched (Chopilko, 2014). Physical training in the conducted studies was considered exclusively fragmentary (Weston, 2007). The study by P.N. Kulalaev (2006) only touches on the problems of physical training for beginning referees.

At present, there is no scientifically substantiated methodology of physical preparation of football referees in the annual cycle. There are parts of the training plans and guidelines that do not have the necessary scientific explanation. Then it follows that the physical training of football referees is not classified and there is no theoretical basis for its organization. The scientific literature does not entirely present the information describing the motor activity of referees which is the basis for research of physical preparation of football referees. Benchmarks that are recommended for testing the degree of physical fitness of football referees do not characterize the peculiarity of their professional activity. Therefore, there is a need to develop and create a new benchmark for football referees, which would be able to display the specificity of the motor activity.

Hypothesis: it is expected that the decision to increase the physical fitness of football referees is possible by the application of:

- Scientifically-argued means of athletics, considering the signs of motor activity;
- Benchmarks for assessing the level of physical fitness, meeting the metrological conditions;
- Planning of the training process, considering the degree of preparedness of the football referees.

The following tasks were set to solve the purpose of the experiment:

- To establish the status of the issue of physical training of football referees;
- To reveal the specificity of the motor activity of football referees of various qualifications;
- To investigate and experimentally substantiate the application of the athletics-based training method of football referees.

The next section contains an overview of the scientific literature. Next, the procedure for the study is described. Then the results are shown. Then discussions and conclusions are presented with conclusions. The last section contains a list of references.

Literature review

Athletics, due to their availability, is used in different sports to improve the process of physical training of athletes (triathlon, orienteering, figure skating, etc.). Football referees, in turn, use athletics for physical training, but there is no scientific explanation for its effectiveness for referees. In order to carry out the transfer of athletics in the physical training of football referees, it is needed to integrate them with a specificity of motor activity. In sports games, in addition to football, questions related to refereeing were considered in hockey (Weisfeld, 1996), basketball (Dmitriev, 2015, 2016-3, Emma, 2006; Sampaio, 2006), rugby (Brightmore, et al., 2016, Emmonds, et al., 2015), and volleyball (Kurdyukov, 2004). In works on basketball and hockey, this topic is revealed to a greater extent. This is because, above all, of high demands on the level of physical preparedness of referees for the implementation of professional activities.

In recent years, football has become athletic, the degree of physical and functional preparedness of football players is continuously increasing, which allows for keeping the game at a high pace, participating in power combats. In this regard, in order to make decisions without error, while being at a reasonable distance from the game moment, the referee must continuously be in good physical shape (Pochinkin, 1997, Spirin, 2003, Weston, 2004, Chopilko 2012; Chopilko 2014; Manilo, 2014; Schenk, 2018). The increase in the proportion of playing time, in which the episodes of the game are continuous, requires a corresponding higher availability of the referees, especially in the physical plan (Hogarth, 2015). E.A. Turbin (2009) found that during the game over time, referees are more likely to make mistakes at the end of each half, and the distance from which they make a decision increases. Yu.V. Manilo writes: "The magnitude of motor activity during football games in professional referees may be different. It depends on their physical fitness, championship (competitions), League, team level, the character of game intensity" (Manilo, 2014). In general, research of the motor activity of football referees was conducted at the initial training of referees, and data on the work of professional football referees are presented only fragmentarily (Bangsbo 1994; Castagna 2008; Di Salvo 2009; Helsen 2004; Weston 2007).

A.D. Budogossky disagrees with this opinion: "Modern methodological recommendations concerning the training of football referees are mainly intended for highly qualified referees serving professional teams, in which the initial training of referees is considered only fragmentarily" (Budogossky, 2008).

Referees are currently using various tests approved by FIFA to test physical fitness (Soloviev, 2016). Tests approved by FIFA reflect physical fitness level, which is associated with the manifestation of high-speed

abilities (sprints) and limited endurance (interval test, Yo-Yo test). Both main referees and their assistants can use Yo-Yo tests as additional tests. These tests were designed to evaluate the limited endurance of Jens Bangsbo (Bangsbo, 1994). The reliability of the Yo-Yo test has been tested by researchers (Krustrup et al., 2003; Krustrup et al., 2006; Krustrup, 2012).

The modern football game is characterized by the high game dynamics, constant movement of players across the field, a lot of various game situations. This complicates the work of the referees, and they make mistakes when making individual decisions related to the evaluation of the game episodes. T.G. Chopilko believes that: “the consequence of the irrationally planned training process is the increase in the number of erroneous decisions of the referees during the game associated with insufficient motor activity” (Chopilko, 2014). Other experts agree with this (D’Ottavio, 2001, Spirin, 2004, Kulalayev, 2006, Turbin, 2009). They note that most of the errors are due to the insufficient level of preparedness of the referees.

This indicates the need to resolve this problem. The studies that exist at present address these issues only in a fragmented manner. The authors mainly dealt with problems of initial training of superior referees. Little attention is paid to the physical training of highly qualified referees. The literature mainly presents fragments of training micro-cycles, and special exercises recommended for physical training and not having sufficient scientific justification for their application. The basic principles of making up training are not considered. There is no connection between general and special physical training at all stages of training. Little attention is paid to many years of physical training and planning.

Material & methods

In order to solve the tasks in the city of St. Petersburg and the Leningrad region, an indirect questioning of football referees of various qualifications (n = 39) was conducted. The questionnaires are distributed by the distribution method, and the respondents respond to them at a convenient time. The questionnaire had three parts: introductory, basic and demographic. The four referees from FIFA were invited as experts. The questionnaire aimed to study the most critical professional qualities of football referees and to identify the features of physical training for referee of various qualifications. During the refereeing of the various competitions, the motor activity of the football referees was monitored. 93 games of different levels (in 49 games, control was conducted for the main referees and 44 for assistants) were analyzed. During the games, the load characteristics were recorded: modes of movement, the amount of movement (m) and heart rate (bpm). The volume of movements was presented in general and in different speed ranges (m/s). The received heart rate values were presented in different pulse zones as a percentage of the total operating time. Polar M400 sports watches were used for measurements. This model, shown in Figure 1, is equipped with a pulse meter and a GPS-sensor. Using sports watches with a heart rate monitor and a GPS sensor during refereeing games allows for objective evaluation of the load. This allows for more accurate analyzing the work during the games and adjusting the training process to improve physical fitness.



Fig. 1 – Polar M400 sports watches

The computer program Polar Flow was used to analyze the data. The obtained results were processed using mathematical statistics methods and computer software product STATGRAPHICS Plus 5.0. A comparative evaluation of the results was carried out using the t-Student test and the Mann-Whitney criterion. Differences in indices were considered at significance level of $P < 0.05$, which is recognized as reliable in pedagogical studies. Next, a situational control standard and a method for the physical training of referees with the use of athletics were developed (Soloviev, 2018). The execution, shown in Figure 2, reflects the motor activity more during the refereeing of football games. The situation control standard is carried out on a football field. A regular hexagon with equal sides of 25 meters is marked. A chip of a particular color or cone with a numeral designation is installed in each vertex.

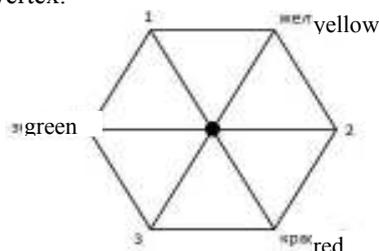


Fig. 2 - Scheme of the implementation of the situation control standard

The main distinguishing feature of this control standard is its situationality. The subject continually has to navigate in space and choose the direction of movement under the task. The situational control standard largely reflects the performance of the referee on the football field during the refereeing games.

A pedagogical experiment was conducted to substantiate the proposed methodology. Two groups of 14 and 15 people (age 23-28 years) were formed. They included referees as chief referees and their assistants. Subjects of the experimental group carried out a training process with the use of athletics. The basis was taken athletics and methods of physical training athletes, who specialize in running for endurance. Among these means are Aerobic running at a uniform and variable pace; running on segments in a mixed mode of the power supply; tempo running; special running and jumping exercises, strength exercises; running on stretches in anaerobic mode; sprinting. In the control group, the referees engaged in the typical program and prepared for the surrender of standards. The training process of the experimental and control group was carried out by the Academy of FC "Zenith," in track and field athletics arena, in forest parks in St. Petersburg.

Results

As a result of the survey, all interviewed respondents noted the need to develop a methodology for physical training of referees, which would allow the body of the referee to prepare for the workload associated with professional activities. The majority of respondents (90%) believe that the most important physical quality is endurance. At the same time (53%) is engaged in self-training. Most referees (59%) pay attention to physical training: they refer to the services of physical training trainers (47%) or engage themselves (53%) on the recommendations of the specialized literature on the physical training of referees. They also lack a specific training system (67%). They pay little attention to planning the training process, building training cycles (55%). All the interviewed respondents note the need to develop a methodology for physical training of arbitrators, which would allow the body of the referee to prepare for the stresses associated with his professional activities. In the course of the monitoring, the movement activity of football referees of various qualifications was analyzed. Referees, who work in games of professional football clubs, overcome a greater distance than their colleagues serving competitions of a lower level. Tables 1 and 2 show the results of monitoring referees working in games in St. Petersburg. The amount of movement with different speed of referees serving the competitions of non-professional (amateur) football clubs is shown in Table 1. These results were obtained using a Polar M400 sports watch equipped with a heart rate monitor and GPS-sensor.

Table 1 - The amount of movement with different speed of the referees serving competitions of non-professional (amateur) football clubs (n = 50)

		Referee (n=24)	Assistant (n=26)
Movement (m) per game $\bar{x} \pm S_x$		7541,2 ± 562,6	3159,6 ± 312,3
Amount of movement (m) $\bar{x} \pm S_x$ with different speed (m/s)	0 - 2,22	3482,1 ± 283,3	1358,9 ± 144,5
	2,22 - 3	2876,6 ± 328,4	1324,6 ± 221,6
	3 - 4,16	924,2 ± 139,6	366,5 ± 60,9
	4,16 - 5	148,3 ± 37,9	75,0 ± 18,6
	> 5	110,0 ± 37,8	34,6 ± 18,2

At the same time, most of the heart rate of the main referee serving competitions of amateur football clubs, varies in the range of 131-150 bpm (35.2 ± 4.1%), and in the area from 150 to 170 bpm (25.8 ± 5.1%). The maximum heart rate values (176.8 ± 5.2 bpm) are in the area of 171-180 bpm, where referees have to work only 3.5 ± 1.9% of the total time, and for some referees included in the sample, the maximum heart rate was in the range of 181 to 190 bpm. The assistants of the main referees have 51.4 ± 6.3% of the playing time of the heart rate in the zone from 111 to 130 bpm. Less time falls within 131-150 bpm (29.7 ± 5.6%), and only 6.6 ± 2.6% are within 151-170 bpm. The maximum pulse is 174.8 ± 4.9 bpm falls within 171-180 bpm (2.1 ± 1.3%). As for the main referees and assistants, the time of the heart rate was varied in the zone over 180 bpm.

Referees, who work in games of professional football clubs, overcome a greater distance than their colleagues serving competitions of a lower level. This data is shown in Table 2.

Table 2 - The amount of movement at different speeds of referees serving professional football clubs (n = 43)

		Referee (n=25)	Assistant (n=18)
Movement (m) per game $\bar{x} \pm S_x$		8670,8 ± 648,6	3864,4 ± 289,7
Amount of movement (m) $\bar{x} \pm S_x$ with different speed (m/s)	0 - 2,22	3653,6 ± 304,1	1812,8 ± 174,9
	2,22 - 3	3378,4 ± 308,3	1290,6 ± 154,8
	3 - 4,16	1239,2 ± 215,9	592,7 ± 105,2
	4,16 - 5	210,4 ± 65,3	104,4 ± 22,8
	> 5	189,2 ± 63,2	63,9 ± 29,1

Thus, the heart rate of the referees during the main time of the game for is in the zones of 131-150 bpm ($35.2 \pm 6.1\%$) and 151-170 bpm ($40,4 \pm 7,9\%$), the maximum heart rate is on average $177,4 \pm 5,0$ bpm. Assistants to the chief referees during the main time of the game, which is $38.1 \pm 6.2\%$ and $35.9 \pm 3.7\%$, work within 111-130 bpm and 131-150 bpm respectively. The maximum pulse is 175.7 ± 4.6 bpm is mainly in the area of 171-180 bpm ($5.3 \pm 2.7\%$) and a small number of referees >181 bpm. The use of the method of physical training of football referees based on the use of athletics was justified in the course of the monitoring.

Running in aerobic mode should be performed using a uniform (heart rate of 130-150 bpm) and alternating method of training, and during variable running no more than 165 bpm. The running speed should correspond to the pace from five to four and a half minutes per kilometer, during variable running - up to four minutes.

Tempo running is performed at a uniform pace. The heart rate varies approximately at the level of 160-170 bpm and can reach the level of 175-180 bpm at the finish line. The running speed corresponds to a tempo of about four minutes per kilometer. The running is from 2 to 4 km.

Running in the mixed mode of the power supply is carried out on different segments (from 150 m to 1000 m) using the interval training method. The heart rate varies in the 80-85% of the maximum (165-175 bpm) and may reach higher values at the end of the training sessions. An excellent example of such training is an interval test, which until recently was handled by many referees. Running on stretches of 150 m (30 seconds) through 50 meters of rest (30 seconds) can be an excellent training tool. The amount of rest the speed of running and the number of segments must be adequate to the level of preparedness of each referee.

Running in anaerobic mode should be performed on small stretches (150-300 m) using the interval and repeat training method. The heart rate is at the level of over 180 bpm. Sprinting starts only after a sufficient amount of jumping, power, and special running exercises. Running is performed on segments of 20 to 80 meters at maximum speed.

In performing professional duties, a football referee must continuously solve diverse and complex visual tasks (Budogosky, 2008, Kulalayev, 2006; Soloviev, 2018; Castagna, 2008). The proposed situational control standard largely reflects the specifics of the professional activities of football referees (Soloviev, 2018). The effectiveness of the application of these exercises was assessed by two indicators: in the change in the number of comments and the volume of the distance covered without comment. Based on the content of the situational control standard, an evaluation scale was determined by the number of comments received during its implementation for the referees of initial training and the referees of professional football. This scale is presented in Table 3. If the subject has overcome the segments in the wrong sequence or without considering the task, then the latter get a remark. The number of comments at the end of the control standard reflects the ability of a referee to exercise the necessary psycho-physiological qualities in conditions of physical fatigue.

Table 3 - Evaluation scale by the number of comments received during the implementation of the situation control standard

	Referees working for amateur competitions	Referees working for professional competitions
Excellent	≤ 5	≤ 3
Good	6 – 9	4 – 6
Fair	$10 \leq$	$7 \leq$

The pedagogical experiment tested the control and experimental groups. The results of testing determined the effectiveness of the training process. Evaluation of the methodology used in the second preparatory period was conducted using a new specially designed situational control standard for football referees. Testing was conducted before the beginning of the first week of the second preparatory period and at the end of the last (recovery) week. The results of the testing are presented in Table 4. At this stage of the study, the approbation of the situational control standard was carried out. There were no significant differences between the groups before and after testing in the situational control standard by the number of comments ($P > 0.05$), while the incremental increase in this indicator in each group separately had significant differences ($P \leq 0.05$). Such changes are associated with the use of modeling the motor activity of referees in the preparatory period of situational exercises, which provide a comprehensive development of the necessary psycho-physiological qualities.

Table 4 - Test results in the situational control standard (number of comments)

	The control group (n=14)	The experimental group (n=15)	Reliability of differences
The number of remarks $\bar{x} \pm S_x$ (qty)			
Initial research	5,6±2,5	6,0±2,5	$P > 0,05$
Final study	4,14±2,4	4,7±2,2	$P > 0,05$
Reliability of differences	$P \leq 0,05$	$P \leq 0,05$	

The general trend of the results of the initial study of the situational control standard in control and experimental groups is at level 1 ($P > 0.05$).

Considering the results of the initial and the last testing of the situational control standard, we will see an increase in the results for overcoming the distance, approximately for all subjects, both in control and experimental groups. However, the parameters of the experimental group are higher. The results are presented in Table 5.

Table 5 - Test results in the situational control standard (change the distance traveled)

	The control group (n=14)	The experimental group (n=15)	Reliability of differences
$\bar{x} \pm S_x$ Traveled distance (m)			
Initial research	3171,4±270,1	3130,7±215,4	$P > 0,05$
Final study	3321,4±222,5	3693,3±157,9	$P \leq 0,05$
Reliability of differences	$P \leq 0,05$	$P \leq 0,05$	

Such an improvement in results is not an accidental process. This is due to the use of an innovative factor in training. Therefore, the physical preparedness of football referees, planned with the use of athletics and taking into account the specifics of professional activity, makes it possible to improve the level of physical fitness. Based on the results of the pedagogical experiment, the effectiveness of using the physical training method for football referees with athletics in the annual cycle of training was confirmed.

Discussion

The value of the experiment results is in the expansion of knowledge about the peculiarities of professional motor activity of football referees, as well as in obtaining the latest thoughts about their physical preparation (Chopilko, 2014; Soloviev, 2018; Dell, 2016). The totality of physical training methods for football referees with the use of athletics means is recommended for use in the training process for initial training of referees and referees serving professional teams competitions (Soloviev, 2018; Castagna, 2008; Dell, 2016)

The necessary conditions for practical application of the methodology in the annual cycle are:

- Drawing up a training plan for an extended period, considering individual characteristics and the level of physical preparedness at the initial stage;
- Load planning is carried out taking into account the motor activity of football referees;
- Fulfillment of the requirements for the organization of the training process under the individual training plan for this method.

It is possible to use the method by which the properties of the motor activity of the referees during the refereeing to assess the motor activity of referees of different qualifications during the refereeing (Soloviev, 2018). The method of physical training of football referees based on athletics, planned considering the properties of motor activity, was developed and tested by experience during the research. The characteristics of the motor activity of the referees are supplemented with new data that will allow more accurate determination of the basic parameters of training loads (volume and intensity).

The methods allow for increasing the degree of physical fitness of referees. A control test for football referees has also been developed and tested. As a control exercise that determines the degree of physical preparedness for refereeing competitions and passing tests, it is recommended to use a situational control standard Soloviev (2018). The method of physical training of football referees with the use of athletics is recommended for use in the training process to the referees of initial training and referees serving professional football clubs.

Conclusions

Existing studies raise the questions on the peculiarities of professional motor activity of football referees only in a fragmented manner (Budogosky, 2008; Bangsbo 1994; Castagna 2008; Di Salvo 2009; Helsen 2004; Weston 2007).

The authors mainly dealt with problems of initial training of superior referees. Little attention is paid to the physical training of highly qualified referees. The first literature presents fragments of training microcycles and special exercises recommended for physical training and not having sufficient scientific justification for their application (Kulalayev, 2006, Turbin, 2009, Bangsbo, 1994, Weston 2004). The basic principles of training making up are not considered. There is no connection between general and special physical training at all stages of training (Kurdyukov, 2004, Chopilko, 2014). Little attention is paid to many years of physical training and planning (Di Salvo, 2009; Soloviev, 2018)

As a result of theoretical analysis and generalization of unique and scientific and methodological literature (Spirin, 2003; Budogosky, 2008; Kulalaevev, 2006; Turbin, 2009; Castagna, 2008; Schenk, et al., 2018; Suarez-Arrones, et al., 2013; Emmonds, et al., 2015; Rebelo, 2011; Webb, 2014; Weston, 2004; 2007), it was found out that:

- Many of the mistakes that referees make during the refereeing of games are associated with a lack of physical fitness;
- Physical training of football referees in the annual cycle is not systematized, the methods and means used by the referees do not have sufficient scientific justification;
- The benchmarks recommended for football referees do not adequately reflect the specifics of the motor activity;
- The characteristics of the motor activity of football referees are presented only in fragmented form.

As a result of monitoring the motor activity of football referees of various qualifications, it was established (Soloviev, 2018) that during the games, the heart rate varies in different pulse zones with varying power of work. The main referees serving games of professional football clubs most of the game operate in the aerobic developing zone and a mixed aerobic-anaerobic zone. Assistants perform their duties with the load in the aerobic regenerative and aerobic development zones.

The results of the studying the load indicators during control standards establish the following:

- The test subject performs in the mixed aerobic-anaerobic zone during the primary game time. This requires the manifestation of extraordinary endurance, aerobic and anaerobic-glycolytic capabilities of the body.
- These tests do not require the manifestation of psycho-physiological qualities that are necessary for the referees to perform their professional activities.

This confirms the need to study an entirely new control test, which takes into account the specificity of the motor activity of football referees. A situational target for football referees has been developed, which considers the peculiarities of work and the specificity of their motor activities. Its reliability and informativeness were confirmed. The test requires the predominant manifestation of not only individual endurance, but also the psycho-physiological qualities necessary for the football referee (Soloviev, 2018, Krustup, 2003, 2006, 2012). The method of physical training of football referees of various qualifications with the use of athletics in the annual cycle is developed. The volume, intensity, and structure of the training loads carried out were planned during each period of preparation, considering the characteristics of the motor activity of the football referees. The method is more aimed at developing individual endurance, aerobic and anaerobic-glycolytic capabilities of the body.

During the pedagogical experiment, the effectiveness of using the method of physical training of football referees with the introduction of athletics in the annual cycle of training football referees was proved.

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