Chapter

Basic Tools and Techniques for Assessing Strength and General Endurance

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Abstract

The desire of more and more segments of the population for self-improvement and self-expression through amateur sports has acquired a global scale. The evaluation and analysis of the amateur athletes' achievements in the chosen physical activity become of practical importance for most amateur athletes and open up the possibility of developing innovative interventions to stimulate the engagement in physical activity of as much population as possible. For this purpose, we have developed an elementary methodology for monitoring the achieved level of strength and overall endurance of students, designed to monitor and motivate amateur athletes of various types of physical activity. The purpose of this research project was to conduct the targeted analysis of the array of physiological indicators of those engaged in physical activity, and also to justify and test technologies for collecting and interpreting objective indicators of performing elementary physical test exercises and calculating their dependence on objective indicators of the cardiovascular system. Subsequently, we planned to develop a simple methodology for collecting, evaluating, and interpreting test information. We suggest using this technique in the daily training sessions of amateur athletes of various qualifications.

Keywords: motor activity, physical activity, age-related changes, heart diseases, cardiovascular and respiratory systems, lifestyle, physical exercises, health promotion, physical training, physical fitness, functional state, working capacity, adaptive capabilities, cardiovascular system, regular physical activity, mobile services, endurance development, fitness level, healthy lifestyle

1. Introduction

This project began as an analytical review of the applied technologies used for periodically monitoring of the physical fitness levels of amateur athletes and then evaluate their practical results. Thereafter it was followed by methodological justification and technological development of methods for selecting and applying test exercises, methods for calculating functional indicators and methods for obtaining objective data. Then 6 months of testing for students who regularly engage in physical activity as part of the educational process [1]. Using the tools of this methodology, the initial (at the beginning of the semester), current (mid-semester) and final (end of the semester) types of monitoring of the strength levels and overall endurance of students were conducted. In total, 112 students and teachers of the Financial

University took part in the study. Analytical methods and a polystructural approach provided the collection and processing of reliable indicators of the physical fitness level of the examined individuals and indicators of their cardiovascular system.

1.1 Results

4 reliable ($p > 0.5$) test parameters characterizing features of male and female representatives were determined, as well as 4 objective indicators of the cardiovascular system and 1 integral indicator – the endurance coefficient, which shows the level of fitness of the individuals. The age range varied from 17 to 49 years. The methods of data collection used in the study and the point scales of indicators of strength development and general endurance allowed the individuals to form stable skills of control and self-control of indicators of physical fitness and indicators of the individual functional state. The body mass index ranged from 18.5 to 38.98, while 8 subjects were related to the "obese" category. During the training, 8 students were expelled due to poor progress in the development of the main curriculum. More than 80% of the subjects had previous experience of collecting blood pressure and heart rate indicators. More than 90% of the participants acquired the skills of organizing and controlling test physical exercises, which they did not have before. Only 72.2% of the subjects expressed complete satisfaction with the study of objective indicators of physical fitness and cardiovascular system and ways to assess them. The average score was 4.31 points out of 5.0. The presented indicators were obtained according to expert estimates [2, 3].

2. Elementary methodology for monitoring the achieved level of strength and overall endurance of students

Based on objective and subjective methods of assessing physical activity indicators, a method for monitoring the level of strength and overall endurance was developed and tested. The results and opinions obtained during the pedagogical experiment suggest that the proposed technology is suitable for periodic use, and user satisfaction is significantly high. It is proved that the application of the methodology is possible both for expanding the practical skills of university students, and for objective assessment of the physical activity of amateur athletes [4, 5].

The underwritten section discusses the patterns of aging of the human body, the decrease in the amount of physical activity due to the specifics of modern labor activity, and the mechanisms of its negative impact on the body. The correlation between physical activity and the risks of developing cardiovascular diseases is substantiated and shown. The methods of preventing the processes of age-related changes by elementary means of physical activity are given [6].

Modern European and Russian society has changed a large number of life priorities, which were symbols of the outgoing XX century. Over the past 20–25 years, many countries have experienced significant changes in many areas of life: politics, economy, education, medicine, etc. The worldview and world perception of both an individual and entire social groups of the population have changed. Both moral guidelines and life values have changed. In the most developed European countries, the emphasis in mass sports was placed in such a way as to involve the general population in regular classes in sports clubs and sections, and to fight hypodynamia and hypokinesia everywhere [7, 8].

As a universal and most common means of combating the above-mentioned risks, modern humanity recognizes such types of physical activity as running, Nordic walking and cycling. And although the number of participants in the most

popular running events in Europe in 2019 decreased by 13% and amounted to 7.9 million people compared to 2016 (then-9.1 million), they still remain the largest community of physical activity enthusiasts [9]. At the same time, in the countries of the Asian region and in Russia, the number of runners continues to grow to this day. There are more fans of running, but they have become slower to run their distances. To a greater extent, this applies to men. In 1986, the average finishing time for the marathon distance was 3:52:35. For today, this result is 4:32:49. The difference in the average finishing time increased by 40 minutes and 14 seconds. At the same time, the age of modern runners has also changed significantly. In 1986, their average age was 35.2 years, and in 2018–2039.3 years. The peculiarities of some running disciplines are that the amateur runners from Spain overcome marathon distance faster than other Europeans, and the Russians are the best at running half marathon distance. The Swiss and the Ukrainians are the leaders in the distances of 10 and 5 km, respectively. For the first time in history, the number of female runners exceeded the number of men. In 2018, the share of women accounted for 50.24% of all participants. In the last 5 years, there has been a steady growth trend in sports tourism. The motivation to participate in competitions has also changed. Now people are more concerned about physical, social, or psychological motivations rather than sporting achievements. This partly explains why people began to travel more, began to run more slowly. This is the answer to the question why the number of people who want to celebrate the achievement of a certain age milestone (30, 40, 50 years) participating in the marathon is less today than it was 15 and 30 years ago [10].

Consider as an example the Russian student population, as a quite significant social group, which in Soviet times, and today, is the object of close attention of specialists in various fields including doctors, psychologists, specialists in physical culture.

Over the past 25–30 years, an alarming pattern of deterioration in the health of young people and their overall physical development has been confirmed. This is due not only to the changes that have occurred in the economy, ecology, working conditions and everyday life of the Russian population, but also to the devaluation of the health and educational functions of physical culture in the society, which was reflected by the lack of harmonious personal development of many young men and women. The health of the nation still raises concerns due to the significant amounts of tobacco, alcohol, and drug use, as well as the lack of motor activity of young people. Positive changes are observed, but still not cardinal [1, 5, 11–13].

In 2018, students consumed 14.7% less alcohol than in 2019. According to the average data of official statistics and selective public opinion polls, 60.2% of young men and 21.7% of girls smoked about 10 cigarettes a day in 2018. In comparison with the beginning of the 2000s, the percentage of smokers among young students decreased from 62% to 60.5%, but in girls, on the contrary, an increase was recorded from 20% to 21.7%. A sociological survey conducted by RPORC (Russian public opinion research center) in August 2018 showed that 35% of the surveyed students living in megacities smoke in general. Surveys of the period 2013–2018 showed a stable share of smokers about 41% of the total number of students [3, 14].

If in 2016 only 39% of the surveyed students stated that they regularly play sports, then by the end of 2019, this figure reaches more than 52%. But at the same time, only 22% of them are engaged in physical culture every day.

As expected, the most active in this regard is the student youth living in megacities. More than 45% of the young people surveyed said that they regularly play sports. While only 26% of middle-aged people living in large cities turned out to be "regular" physical education students.

The most popular type of daily physical activity in Russia is fitness. 43% of respondents said that they do it, 15% of respondents said that they prefer athletics, 14% - swimming.

The main reason why residents of large cities do not engage in physical culture or sports is the lack of time. This was the response of 37% of respondents, 28% said that they do not need to exercise, and 22% said that they simply do not have the willpower to force themselves to exercise regularly.

Thus, over the past 8–10 years, the number of residents actively engaged in sports in Russia has significantly increased. And it is also important that only 30% of respondents believe that mass sports are poorly developed in Russia.

In modern society, the problems of forming the needs of university students in a healthy lifestyle occupy key positions, since students are the main reserve and a significant part of the labor resources of the national economy, and the state of health of students today is public health, the health of the nation in 10, 20, 30 years, as noted by a number of researchers, for example, by N. A. Aghajanyan, M. Ya. Vilensky, A. G. Shchedrina, etc. [1, 15].

These facts are extremely important for people to understand the most productive period of a person's life – a representative of middle age. Sociological research has shown that only 9% of respondents regularly engage in physical culture and sports, 17% of them do it on an occasional basis, and 18% - very rarely.

Physical activity is a multi-faceted and capacious concept. And one of the sharp edges of its implementation is the problem of building an optimal, individualized mode of physical activity, taking into account not the calendar, but the biological age. Otherwise, there is a great possibility of obtaining a negative effect and simply discrediting the principle itself.

With an overdose of physical activity in age-related individuals, overload manifests itself in an exacerbation of coronary insufficiency, blood pressure becomes unstable, and arrhythmia manifests itself. That is why medical, pedagogical and self-control should determine the individual dose of physical activity [6].

In countries with developed economies, the mortality rate from circulatory diseases by a large margin occupies a leading position among other causes of death and is 52%. Over the past half-century, this number has undergone a 5–6-fold increase.

As a result of large-scale studies conducted under the auspices of the World Health Organization (WHO) on large populations in different countries of the world, scientists have identified the main causes (risk factors) of the rapid growth of cardiovascular diseases and mortality from them. The factors were conditionally divided into two groups: primary, exogenous, depending on the lifestyle and environmental conditions; secondary, endogenous – pathological changes in the body that develop under the influence of external factors.

The leaders of the first group include: insufficient physical activity (inactivity) and excessive calorie intake (overeating). In the second: smoking, neuropsychiatric overexertion (stress) and alcohol abuse.

The predominant role of inactivity and overeating in the development of atherosclerosis and coronary heart disease (CHD) is confirmed by numerous studies conducted in different countries on different continents. It was found that in the countries of Africa and South-East Asia, where the population lacks food and the rhythm of life is characterized by relatively high physical activity, these diseases are almost not found [16]. For example, Ugandans, even in old age, are more likely to die from infectious diseases, but not from diseases of the respiratory system and blood circulation. A survey of representatives of the Maoban tribe in South Sudan showed that they do not have CHD at all, the blood pressure level is the same at 15 and 75 years old and is on average 115/70, the cholesterol content in the blood is low and averages about 3.47 mmol/l.

Mortality per 1000 people	A sedentary lifestyle	Moderate activity	High activity
General	20,6	10,6	—
From CHD	7,5	4,0	—

Source: compiled by the author on the basis of materials from international scientific research.

Table 1.
The relationship between physical activity during non-working hours and mortality per 1000 people, in %.

The role of lifestyle in the development of atherosclerosis confirms the following fact. As a result of emigration to economically prosperous countries, experiencing changes in the regime and structure of nutrition, changes in the mode of motor activity, representatives of the African continent are equally affected by diseases of the cardiovascular system, as well as the indigenous population. Moreover, for example, in the United States, the black population has the highest percentage of CHD among the rest of the American population.

A strong relation between physical activity during non-working hours and mortality is shown in the **Table 1**.

The table shows that among people with moderate physical activity, the mortality rate is 2 times lower than in people who lead a predominantly sedentary lifestyle, and in the group with high physical activity, there is no such relationship at all.

The 16-year follow-up of Harvard University graduates revealed that the mortality rate from CHD was 2 times lower in those graduates who were among those who regularly engaged in physical exercise and led an active lifestyle than in those whose life was characterized by a hypodynamic regime.

Dr. Ralph Paffenbarger, as a result of many years of research, has established an interesting fact: the preventive effect against CHD is most effectively provided by physical activity during non-working hours (intensity-7.5 kcal/min, energy consumption per week-at least 2000 kcal) [6].

When observing 36,000 people for 10 years, an American scientist found that only physical activity with an intensity higher than 7.5 kcal/min (long-distance running) had a protective effect, and the usual professional activity in modern production does not have such a protective anti-coronary effect. This fact allows us to conclude that only special wellness programs performed in their spare time are an effective preventive tool to combat atherosclerosis and coronary heart disease. The nature of the loads performed is also of great importance. These should be loads associated with the manifestation of general endurance and sufficiently long in time, the criterion of which is the value of the maximum oxygen consumption.

Thus, individually established modes of physical activity performed in their spare time (in the form of cyclic aerobic exercises aimed at developing overall endurance and increasing the level of maximum oxygen consumption) compensate for the lack of energy expenditure in most representatives of modern society. This avoids the negative effects of inactivity and is a natural, widely available means of promoting and maintaining health, as well as preventing cardiovascular diseases.

Mandatory elements of determining the regime of physical activity is the passage of medical and pedagogical control.

3. Basic assessment of the impact of aerobic exercise on the body ingaged in physical activity

This section substantiates and offers indicators and methods for assessing the level of endurance, functional state, adaptive capabilities and performance of the

body, allowing you to quickly and objectively assess the impact of physical activity on the body of people who regularly engage in physical culture [8].

The main indicators by which the effectiveness of the content and methods of physical training performed by modern students, as well as other amateurs of physical activity is judged are the level of endurance development, the functional state of the body, the adaptive capabilities and performance. Periodic evaluation of these indicators allows you to determine on the one hand – the degree of influence of physical training, on the other – to clarify the effectiveness of the tools and methods used.

The proposed method of monitoring the level of strength and general endurance of students is recommended to be carried out independently or in a group with a frequency of approximately once every 1 or 3 months using the following tests:

- pull-ups on the crossbar (for men);
- flexion and extension of the arms at the stop on a bench with a height of 0.4 m (for women);
- lifting the legs to the crossbar (for men);
- lifting the torso from the "lying on your back" position (for women);
- walking on a step with a height of 0.4 m (ascent and descent) for 3 minutes;
- running 1 km (for women);
- running 3 km (for men).

Walking on a step with a height of 0.4 m is estimated by the number of ascents in 3 minutes – the more ascents, the higher the level of physical endurance. At the same time, you should strictly observe the conditions for performing the test – completely straighten the torso and legs.

Indicators of the functional state are the characteristics of the cardiovascular system, the respiratory system, and the motor system.

The state of the cardiovascular system is assessed by the indicators of heart rate, systolic (SP), diastolic (DP), pulse pressure (PP), endurance coefficient (EC). Registration is carried out by generally accepted methods with metered physical activity of the step-test sample. The data obtained during the examination in the state of muscle rest, as a rule, do not allow us to fully assess the functional state of the body, in particular, the cardiovascular system and its reserve capabilities. Various load tests are used for this purpose.

The "step test" is a three-minute physical activity in the form of walking on a step with a height of 0.4 m at a pace of 30 steps per minute. In this case, the registration of indicators is carried out before the load (sitting at rest), at the 2nd, 3rd and 4th minutes of the recovery period.

Based on the obtained data, the endurance coefficient (EC) and the step test index (I) are determined.

The endurance coefficient is used to assess the fitness level of the cardiovascular system.

$$EC = \frac{CCR}{PP} \text{x} 10, \quad (1)$$

where.

CCR – cardiac contractions rate;

PP – pulse pressure.

An increase in the endurance coefficient associated with a decrease of PP indicates a detrained cardiovascular system.

The cardiovascular system has several levels of regulation. It is a functional system, the end result of which is to ensure the necessary level of functioning of the body. These facts give reason to consider the circulatory system as a universal indicator of the adaptive and accommodative activity of the entire organism. The state of the respiratory system allows you to evaluate breath-holding tests on the inhale (Shtange's test) and on the exhale (Gencha's test). The results of the tests are evaluated by the time of holding the breath.

The state of the motor system can be judged by the indicators of students' physical fitness. The study of the students' psychological state is carried out by observation, survey and using the questionnaire HAM (health – activity – mood) demonstrated in the **Table 2**. The HAM questionnaire is designed to characterize the emotional state of military personnel due to the influence of physical training. The task of the subject is to correlate subject's state with a number of polar assessments presented to one. There is a short version of the questionnaire below with seven gradations of states, which are evaluated by points from 3 to 0:

+3 – strong increase (decrease – 3);

+2 – distinct increase (decrease – 2);

+1 – small increase (decrease – 1).

Zero denotes unchanged from the original state.

On the questionnaire form, the subject writes his last name, initials, date and time of filling in. Then, against each of the seven points of the questionnaire, a circle is drawn around the score that, in his opinion, corresponds to his condition.

The points obtained for each of the seven indicators are summed up according to the **Table 3**, and the maximum possible test result is 49 points [16].

The adaptive capabilities of the body are judged by the results of physical tests. At the same time, for these purposes, we propose an integral indicator of the functional capabilities of the body.

For this purpose, two types of physical activity are used:

1. dosed, high-power with recording of heart rate and blood pressure parameters (BP);

2. activity with the maximum possible work capacity, such as running for 1 km or 3 km.

A three-minute step test is used as a metered activity. At the same time, the use of only this load does not allow us to fully identify the physiological reserves of body adaptation – for this it is necessary to make higher demands on the body.

So, K. Cooper, on the basis of experimental studies, showed that the distance that a person can overcome in 12 minutes is proportional to the value of one's maximum of oxygen consumption.

Similar results were obtained by WD McArdle and co-authors when evaluating the dynamics of human cardiorespiratory adaptation during exercise on a treadmill and cycling [17, 18].

Comparing the results of laboratory tests and running tests, it was found that the latter are as accurate in assessing functional capabilities as the results of complex laboratory experiments.

1.	Vigorous	+3	+2	+1	0	–1	–2	–3	Tired
2.	Interest in work	+3	+2	+1	0	–1	–2	–3	Indifference
3.	Attentive	+3	+2	+1	0	–1	–2	–3	Distracted
4.	Good mood	+3	+2	+1	0	–1	–2	–3	Bad mood
5.	Overall health is good	+3	+2	+1	0	–1	–2	–3	General health is poor
6.	Calm, balanced	+3	+2	+1	0	–1	–2	–3	Excited, tense
7.	Confident	+3	+2	+1	0	–1	–2	–3	Uncertain

Source: compiled by the author based on the results of his own research.

Table 2.
Self-assessment questionnaire

Rating on the scale	+3	+2	+1	0	–1	–2	–3
Rating in points	7	6	5	4	3	2	1

Source: compiled by the author based on the results of his own research.

Table 3.
Processing of completed questionnaires on a scale in points

The performance indicators of the two considered loads are combined in a single formula for assessing adaptive capabilities:

$$FI = \frac{I}{\text{T3}km}\text{x10}. \quad (2)$$

where.

FI-functional indicator of adaptive capabilities in relative units;

I – the index of the step test in relative units;

T3km – running time for 3 km, min.

The physiological meaning of the above formula is that it reflects, on the one hand, the cardiac cost of metered work, and on the other – the ability to maximize the mobilization of the body's reserves.

The step test index is determined by the generally accepted formula:

$$\text{I} = \frac{180x100}{\text{P2} + \text{P3} + \text{P4}.} \quad (3)$$

where

I – is the index of the step test;

P_2, P_3, P_4 – heart rate at the 2nd, 3rd, 4th minute of the recovery period after exercise.

The performance can be judged by many of the considered indicators, including tests for assessing physical fitness, adaptive capabilities of the body. The main indicator of human performance is considered to be the maximum oxygen consumption. The value of the maximum oxygen consumption (MOC) reflects the level of person's physical performance.

To determine the MOC, the step-test is convenient to use. The power of the work performed in this case, the heart rate and the nomogram to get the value of the MOC [16].

The most important information about the impact of physical training is the dynamics of the main body state indicators during the training process. Therefore, it is necessary to keep a strict record of the body state indicators obtained during monitoring and self-control.

For rapid assessment of the functional state, a step-test can be used, where after a three-minute load, the heart rate should be determined immediately after the work phase (CCR_w), at the 2nd, 3rd and 4th minutes of the recovery period. At the 4th minute, the blood pressure is measured: systolic (SP) and diastolic (DP).

The functional state of the body can be judged:

CCRw – the heart cost of work (HCW), the lower the indicator, the higher the functional capabilities of the body;

CE – the coefficient of endurance, its increase indicates the detrainment of the cardiovascular system;

I – the index of the step test, the higher the indicator, the higher the functional capabilities of the body.

CE and I are calculated using the above formulas.

An additional survey on the HAM questionnaire will allow to assess the well-being, activity, and mood of the students.

For a more complete assessment of the functionality, it is necessary to conduct races for 1 km or 3 km. The results obtained provide important information, since it is a high-power load and its performance is largely determined by the functional capabilities of the cardiovascular and respiratory systems.

Methods and scale scoring indicators of power and overall endurance development allow to quickly and objectively assess the functional state of students or amateurs of physical culture in the process of their physical perfection, and to determine the effectiveness of their tools and techniques of training, to ensure harmless and motivating process of physical activity, to minimize or eliminate the adverse impact of exercise on the body [19].

Nowadays, the issue of maintaining a healthy lifestyle in a consumer society and maintaining the public health of the population is relevant. According to Federal State Statistic Service, in 2019 only 12% of the Russian population considers themselves fully adhering to the principles of healthy lifestyle. This indicator is calculated based on several criteria. This includes smoking cessation, daily consumption of vegetables and fruits in an amount of at least 400 g, adequate physical activity (at least 150 minutes of moderate or 75 minutes of intense physical activity per week), etc.. To increase the attractiveness of the elements of healthy lifestyle for young people, incentives have been introduced for admission to higher educational institutions for passing the standards of the Civil Defense Squads (CDS) complex and other sports achievements. The article considers the XRF indicators of young people aged 18–24 years, substantiates the claims that the use of mobile services helps to achieve the desired physical fitness indicators.

For the purpose of the study, data from 50 Strava users of both sexes, who were randomly selected, systematically used the program's services and regularly, at least 3 times a week, shared the total results of all their physical activities – walking, running, cycling. The data obtained after mathematical processing are presented in **Table 4**, in which the average annual total indicators of 25 men and 25 women are calculated [12].

According to **Table 4**, the average speed of a man's regular physical activity is 2.33634 km/h lower than the target average speed in the "5 km run race" test. This indicates an insufficient level of men's endurance development of this sample. The actual average speed does not allow them to pass the CDS standard for the Golden Badge of Distinction, shown in the **Table 5**, without special direct training. To give a more complete degree assessment of physical fitness of the selected group of men,

let us compare their performance with the standards necessary for passing the CDS for the Golden Badge. As an example, consider cross-country running, because this type of physical activity is most similar to running on the street, which the subjects are engaged in.

When comparing the indicators, it is clear that the average mobile service user does not fit into the standard of the CDS, since its "endurance coefficient" (the ratio of time to distance) and the average speed are lower than the calculated ones. Thus, it should be concluded that the level of overall endurance of the examined men is insufficient. However, if we pay attention to the more individual data of each participant, we can note a different picture. The results of 7 out of 25 men are close to the coefficient required for successful completion of the CDS complex, which is 28% of the total number of subjects.

A similar situation is observed among women. According to the **Table 6**, it can be concluded that the average speed of women using the mobile service is lower than the estimated speed (**Table 7**). This fact shows an insufficient level of overall endurance in the category of women.

Comparing homogeneous indicators of "coefficient endurance" of the women, and the test of the CDS VI stage "3 km run race", it is clear that the rate in equal measure is not valid, as in the case with men.

When considering the individual indicators of the surveyed participants, it was found that 6 out of 25 women can pass cross-country running in accordance with the standard of the CDS, which corresponds to 24% of the total number of surveyed women.

Total time of physical activity (min)	Total distance (km)	Endurance coefficient (EC)	Actual average speed during physical activity (km/h)
7827,783	88454,10	0,088495	11,30002

Source: calculated by the authors in the course of the study.

Table 4.
Annual average total indicators of physical activity of the test subjects-users of the mobile service (men).

Age category (CDS stage)	Target indicators	Endurance coefficient(EC)		Actual average speed during race (km / h)	
		aim	fact	aim	fact
Men 18–24 y.o.	«Gold» Run race 5 km	0,073333	0,088495	13,63636	11,30002

Source: calculated by the authors in the course of the study.

Table 5.
Comparison of homogeneous numerical indicators (men).

Total time of physical activity (min)	Total distance (km)	Endurance coefficient (EC)	Actual average speed during physical activity (km / h)
6733,083333	62259,10	0,10814617	9,246744

Source: calculated by the authors in the course of the study.

Table 6.
Annual average total indicators of physical activity of the test subjects-users of the mobile service (women).

Age category (CDS stage)	Target indicators	Endurance coefficient (EC)		Actual average speed during race (km / h)	
		aim	fact	aim	fact
Women 18–24 y.o.	«Gold» 3 km run race	0,097222	0,10814617	10,28571	9,246744

Source: calculated by the authors in the course of the study.

Table 7.
Comparison of homogeneous numerical indicators (women).

Based on the performed analysis and data processing, it can be concluded that the level of overall endurance of mobile service users is not sufficient to pass the CDS test "from scratch", without specially directed training. Elementary calculations of the personal XRF and their comparison with the target indicators will help in planning the process of preparation for passing the standards of the CDS complex. The study showed that monitoring the personal results of the XRF has a motivating effect on users, contributes to the progress indicators, and makes this process interactive and interesting.

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