

Rehabilitation of the physical condition of the motor vehicle driver by means of physical training

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Abstract. The article is intended for engineering and technological workers involved in the exploitation of road transport, for specialists of automobile enterprises who are responsible for organizing road safety. Prevention of diseases and increase of efficiency of drivers, development of such functions as attention, speed of reaction, perception of space and other professionally important psycho-physiological qualities, can be achieved only through purposeful and dosed application of specially designed complex sports and health-improving classes. The article presents the simplified methodology for determining the physical condition of the personnel of the car enterprise in order to design exercises and complexes based on it to achieve the goal. It also offers forms of physical education, which contributes to the optimal method of their organization and conduct. In addition, the frequency of classes is of great importance, which directly affects the speed of recovery of drivers. The purpose of this article was to determine the content, organizational and methodological features of complex physical exercises for drivers of vehicles. In the course of the research, the comprehensive program was designed to prevent fatigue, prevent occupational diseases and improve the efficiency of drivers. The following forms of physical exercises were included in the complex program: introductory gymnastics, physical culture minute, physical culture pause, self-massage, corrective exercises for the eyes, physical culture and health classes.

1 Introduction

According to the traffic police of the Russian Federation, in 2022, 70 thousand road accidents occurred in the country, 6.7 thousand people died, 90 thousand were injured. The Rostov region was in the top five with the highest accident rate on the roads. In 80% of cases, the perpetrators of the accident were men. More than 27% of accidents were committed by drivers aged 30-40 years, older drivers account for 18% of accidents. The main causes of accidents are non-compliance with the order of passage of intersections, inconsistency of speed with specific traffic conditions, the wrong choice of distance,

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driving into the oncoming traffic lane, violation of the rules for passing pedestrian crossings. But all these reasons are united by one common feature - this is increased fatigue and, as a result, making mistakes and not correct actions. According to statistics, drivers who work more than 12 hours cause 3.5 times more accidents and are 8 times more likely to fall asleep while driving than those who work 7 hours.

At the present stage of development of social production, the person operating the equipment is the most important link in the system "driver - car - road - environment". The labor activity of the driver is one of the most responsible and stressful forms of work. Certain stress factors affect the driver's activity: irregular working hours, unsatisfactory road conditions and poor traffic management; high intensity of the traffic flow; poor visibility and frequent changes in illumination; forced working position; poor visibility; high and low air temperatures; frequent temperature changes in the cabin of the car; changes in barometric pressure; neuro-emotional stress; noise; vibration, all this leads to a decrease in efficiency and, as a result, fatigue occurs.

Fatigue is a state of the body that occurs as a result of activity and is manifested by a temporary decrease in working capacity. Under the influence of fatigue in a person driving a vehicle, the perception of the route, coordination is disturbed, the accuracy and speed of movements are reduced, the driver can make gross mistakes that lead to a traffic accident. As a result, a sleepy state may occur, during which the thresholds of the visual and auditory analyzer increase, and the weakening of attention excludes the perception of signals coming through the analyzer systems. Violation of work and rest regimes, constant neuromuscular tension contributes to the development of diseases of the cardiovascular system, digestive organs, upper respiratory tract, central and peripheral nervous system. Based on this, there is a need to combat and prevent fatigue and overwork of car drivers, especially on long trips (more than 400 km one way). The most effective methods, in our opinion, is the observance of the regime of work and rest aimed at the prevention of fatigue.

From January 1, 2021, by order No. 424 on October 16, 2020 No. (amended on December, 01, 2022) "On the approval of the features of the regime of working hours and rest time, operating conditions for car drivers" The Ministry of Transport of Russia approved new features of the work and rest of car drivers, which include: lunch break (it is recommended to provide it in the middle of the working day not less than 30 minutes, but not more than 2 hours; special break for continuous driving (not later than after 4 hours 30 minutes of driving, duration not less than 45 minutes); other breaks (if the working day is more than 8 hours, two breaks are provided total duration of not more than 2 hours).

After analyzing scientific research, specialized literature, consultations with specialists, there were identified the main patterns of activity of transport drivers, informing us about the characteristics of the body in a direct way, depending on fatigue. High labor productivity, strengthening the health of the worker can be achieved by using the means of industrial physical culture, both in the sphere of working and non-working hours. The use of well-founded complexes of industrial physical culture reduces the impact of negative factors of production, working capacity is restored faster and more effectively, and contributes to the prevention of occupational diseases.

One of the main types of prevention of fatigue and diseases characteristic of motor transport drivers is exercise and self-massage both after working hours and on the way of the car.

The purpose of the study is to determine the content and organizational and methodological features of complex physical exercises for drivers of vehicles.

2 Organization and methodology of the research

When designing complex physical exercises, the principles of accessibility and individualization were taken into account. The material was offered in accordance with the capabilities of the students, the level of preliminary functional and psychophysical preparedness was taken into account. The following forms of physical exercise were included in the comprehensive research program: introductory gymnastics, physical culture minute, physical culture pause, physical culture and health classes.

In the process of collecting and processing information, the following methods of scientific research were used: analysis and generalization of scientific and methodological literature and the Internet, testing (before the start of the study and after three months), methods of mathematical processing. The processing of the obtained data was carried out using statistical methods used in pedagogy and sports using the Microsoft Excel program. The determination of the significance of differences in mean sample values was carried out according to Student's t-test, at a 5% significance level.

Testing of functional and psychophysical readiness took place at the beginning and end of the research, in the first half of the day, at the same time, after a preliminary warm-up, was determined by the following parameters:

- Strength (number of times) was determined by the number of press-ups performed from the floor.
- Speed-strength readiness (cm) was determined by long jump according to the generally accepted method. Two attempts were offered. The best result was taken into account.
- General endurance (m) was assessed by K. Cooper's 12-minute running test. The number of meters in 12 minutes' run was recorded.
- Flexibility test (cm), assessed by maximum forward torso tilt (cm) with straight legs on the step with a zero mark at the level of the feet. Touching the mark below the zero point with your fingers and maintaining this position for at least 2 seconds characterizes good mobility of the spinal column, muscles of the lower back and semitendinosus muscles. The test is carried out 3 times in a row (rest 5-10 s), the best result is counted;
- Static endurance (s). It was determined by the "Hang on the crossbar" test. The duration of the hang was recorded.
- Static coordination (s). It was determined by the complicated test (pose) of Romberg. The respondent stands legs in one line; the heel in front of the standing leg is adjacent to the toe (finger) behind the standing leg (foot). Eyes closed, arms extended forward, fingers slightly apart. If equilibrium is lost, the test is terminated. The respondent made 3 attempts every 30 seconds, the best result was taken into account. The stability time was recorded in (s) this position.
- Test to determine the development level of dexterity (s) – shuttle run 3×10 m, conducted according to the generally accepted methodology. Inventory was used: the stopwatch with a preliminary marking of the distance.
- Vital capacity (VC) was measured using a dry spirometer. Air volume was taken into account (l)
- The Stange test (c) was used as one of the criteria for assessing the general physical condition of the person. After 2-3 deep inhalations-exhalations, the respondent on a submaximal inhalation should hold his breath for the maximum possible time for him.
- Length (cm) and body weight (kg) were determined according to the generally accepted method.
- Pulsometry (bpm) and blood pressure measurement (BP_{diast} и BP_{syst} (mmHg.)) was carried out on the OMRON I-C10 tonometer.

– Determination of the level of physical condition (FCL) was carried out according to the method of E.A. Pirogov and others according to the formula (1), which allows identifying the state of the cardio-respiratory system in accordance with the data in Table 1.

$$FCL = \frac{700 - 3 \cdot HR - 2.5 \cdot BP_{av} - 2.7 \cdot A + 0.28 \cdot BM}{350 - 2.7 \cdot A + 0.21 \cdot P},$$

where $BP_{av} = BP_{diast} + \frac{HR}{3}$

- HR – resting heart rate;
- BP_{diast} – diastolic blood pressure, mm Hg;
- BP_{syst} – systolic blood pressure, mmHg;
- A – age, total number of years;
- BM – body mass, kg;
- P – body length, sm.

The assessment of the level of physical condition was carried out according to the scale presented in the Table

Table 1. Scale for assessing the physical condition.

Physical condition level	FCL value range (men)
Low	up to 0.375
Below the average	0.376 - 0.525
Average	0.526 - 0.675
Above average	0.676 - 0.825
High	more than 0.826

The time of the simple reaction was determined according to the test of I. Blok, the respondents were asked to find in order the numbers from 10 to 59, naming them aloud and showing them in a special test. The total time was determined by the stopwatch. The data were compared with the rating scale in Table 2.

Table 2. Estimated level of reaction time according to I. Blok.

Level	Time
Very good level	up to 140 s
Good level	140-150 s
Average level	150-160 s
Low level	more than 160s

The organization of small forms of training is presented in Table 3, taking into account the professional activities of drivers before and during work operations and included specially selected sets of exercises to relieve eye strain, to relieve fatigue from the muscles of the legs and back, to improve blood circulation, and normalize nervous excitation. Necessarily as the onset of general fatigue and fatigue of the eye muscles, self-massage was used.

Table 3. Forms of physical exercises.

Forms of physical exercises		Frequency of exercises	Applications of exercises
Small forms of physical training	introductory gymnastics	Before the start of the working day	Complexly coordinated exercises
	physical training breaks	At the onset of initial signs of fatigue	Sipping followed by muscle relaxation, bending, squatting, walking, prevention of

			fatigue of the visual analyzer
	physical training minutes	When the first sensations of fatigue appear	Exercises in stretching the musculoskeletal system, self-massage of the collar zone
Physical culture and health-improving exercises		2 times a week for 90 min	Sports games swimming

As part of the labor process, physical culture was represented mainly by industrial gymnastics, which included: introductory gymnastics, physical training breaks, and physical training minutes. The introductory gymnastics complex consisted of 6-8 specially selected exercises, lasting 5-7 minutes (Table 4). The purpose of introductory gymnastics is to activate the nervous system, improve blood supply to the main muscle groups, and increase concentration immediately before driving.

Table 4. Complex of introductory gymnastics.

No.	Physical exercises	Dosage	Guidelines
1	S.P. – main position, 1-4 - arms up, forward, sideways, down	30-40s in the morning shift; 20-30s in the evening shift	Breathing is even, the pace is fast
2	S.P. – main position, hands forward, 1-right leg swing forward, arms back - exhale; 2 - S.P., inhale; 3 - squat, hands behind the head - exhale; 4 - S.P., inhale; 5 - 8 - also with the left foot.	6-8 times in the morning shift, 4-6 times in the evening shift	Average pace
3	S.P. – main position, 1 - jumping legs apart, arms up, clap above the head; 2 - S.P.; 3-4 - repeat too	4-6 times in the morning shift, 2-4 times in the evening shift	The pace is average. After jumping, walking in place with deep breathing for 25-30s
4	S.P. – main position, 1 - left foot back on the toe, arms to the side; 2 - hands up, deep breath; 3 - put the left foot, tilt forward - exhale; 4 - S.P.; 5-8 also from the right foot	8-10 times in the morning shift, 6-8 in the evening shift	Average pace
5	S.P. – main position, 1 - tilt to the right, right leg to the side on the heel, right hand on the belt, left behind the head; 2 - S.P.; 3 - 4 the same in the other direction	6-8 times in the morning shift, 4-6 times in the evening shift	Breathing is even. Average pace
6	S.P. – stand legs apart, hands on the belt. 1 - turn the body to the left, arms to the sides; 2-3 - springy tilts back - inhale; 4 - S.P., exhale; 5 - 8 the same to the right	8-10 times in the morning shift, 6-8 in the evening shift	The pace is slow
7	S.P. – main position. 1 - tilt forward, arms relaxed up; 2 - straighten up, bend the left leg forward, arms back; 3 - left swoop back, arms up; 4 - S.P.; 5-8 - the same with the right foot.	6-8 times in the morning shift, 4-6 times in the evening shift	Breathing is arbitrary. Average pace
8	S.P. – main position. 1 - right hand forward; 2 - right hand to the side, left up; 3 - right hand up, left hand to the side; 4 - S.P.	8-10 times in the morning shift, 6-8 in the evening shift	Breathing is arbitrary. Start slowly, accelerate to a fast pace, finish on average

Physical education breaks were performed by drivers during the work shift during short stops when the first signs of fatigue appeared, for the prevention of occupational diseases.

Physical training minutes consisted of 5-7 exercises, providing switching activities to non-participating (little participating) muscle groups in the work, lasting 5-7 minutes (table 5).

Table 5. Complex of physical culture pause.

No.	Physical exercises	Dosage	Guidelines
1	S.P.– main position. 1 - 2 - arms to the sides, palms up; 3 - hands up - deep breath; 4 - S.P., exhale	8-10 times in the morning shift, 8-10 in the evening shift	The pace is slow
2	S.P.– main position. 1 - hands up, inhale; 2 - relaxing the muscles, "drop" the hands - exhale; 3 - tilt forward, shake with brushes - complete exhalation; 4 – S.P.	6-8 times in the morning shift, 4-6 times in the evening shift	Average pace
3	S.P.– stand legs apart, arms back, fingers interlaced. 1 - tilt to the left, arms to the right; 2 - S.P.; 3 - 4 - the same to the right	8-10 times in the morning shift, 6-8 times in the evening shift	The pace is fast. Breathing uniform
4	S.P.– main position, hands behind the back. 1-2 - squat, arms to the sides - exhale; 3 - 4 - S.P., inhale;	6-8 times in the morning shift, 8-10 times in the evening shift	The pace is average. After completing the exercise, walking in place for 25-30 seconds
5	S.P. – position legs apart. 1-3 - springy tilts back, hands behind the back - inhale; 4 - S.P. - exhale.	6-8 times in the morning shift, 8-10 times in the evening shift	Average pace
6	S.P.– semi-squat. 1 - straighten up, turn the body to the left, swing your arms to the sides - inhale; 2 - S.P., exhale; 3 - 4 - the same to the right.	8-10 times in the morning shift, 6-8 times in the evening shift	Average pace

In order to relax working muscle groups, activate the cardiovascular system and eliminate congestion in the body, a complex of physical exercises was performed - 2-3 exercises, lasting 1-3 minutes (Table 6).

Table 6. Complex of physical culture minute.

No.	Physical exercises	Dosage	Guidelines
1	S.P. – main position. 1 - hands forward; 2 - arms to the sides, palms up - inhale; 3 - hands up, rise on toes; 4 - S.P., exhale	2-4 times	Average pace
2	S.P. – main position. 1 – semi-squat, arms up - exhale; 2 - S.P.; 3 - emphasis crouching - exhalation; 4 - S.P., inhale	2-4 times	Average pace
3	S.P. – main position. Eyelid self-massage	15 s	

To improve blood circulation in the eye area, relieve tension from the eye muscles and prevent fatigue of the visual analyzer, complex of gymnastics for the development of resistance to fatigue and the prevention of eye diseases, self-massage of the eyelids was designed (Tables 7, 8).

Table 7. Eyelid self-massage exercises and their purposes.

No.	Massage zone	Eyelid self-massage techniques	Dosage	Purpose
1	Eye socket massage	Close your eyes, use your middle finger to massage the edges of the bone surrounding the eye, then move down to the bridge of your nose.	8-10 times	It improves blood circulation in facial tissues, saturates with oxygen and nutrients
2	Eyebrow and temple massage	Press on the points located just below the superciliary arches (the inner edge of the eyebrow), then press on the temples	Press each point for 3s	It stimulates various parts of the facial muscles responsible for squinting and blinking.
3	Massage between the eyes	With your thumbs, press and release on the area located just above the inner edge of the eye (the beginning of the crease of the eyelid).	5 times	It relieves tension from the tissues located between the eyes.
4	Temple massage	Massage the temples with your middle fingers, moving up and down, getting into a small depression in the temples.	1 minute	It relieves tension in the temples, headache caused by eye strain
5	Neck massage	Use the tips of your index fingers to massage the back of the head, located just behind the eyes. Don't press hard	1 minute	It relieves headaches, eye fatigue

Table 8. Corrective exercises for the eyes.

No.	Exercises	Dosage	Purpose
1	Close your eyes tightly for 3-5s, then open them for 3-5s	6-8 times	It helps improve blood circulation, relax the muscles of the eye
2	Fast blinking	1-2 min	It improves blood circulation
3	1- look straight ahead for 2-3 s; 2 - put your finger on the midline of the face at a distance of 25-30 cm from the eyes; 3- look at the end of the finger and look at it for 3-5s; 4- put your hand down	10-12 times	It reduces fatigue, facilitates visual work at close range
4	Look straight ahead for 2-3s, then look at the tip of the nose for 3-5s	6-8 times	It develops the ability to keep a look at close objects for a long time
5	Take your right hand to the side, slowly move the finger of the half-bent hand from right to left and left to right, without moving your head, follow your fingers with your eyes	10-12 times	It strengthens the muscles of the eyes of horizontal action, improves coordination
6	Raise the right hand up, slowly move the finger of the half-bent hand from top to bottom and from bottom to top, without moving the head, follow the finger	10-12 times	It strengthens vertical action eye muscles, improves coordination

7	Extend the half-bent arm forward and to the right, make slow circular movements clockwise with the hand at a distance of 40-50 cm from the eye, follow the fingertip with the eyes. Do the same with your left hand, making circular movements counterclockwise	3-6 times	It develops coordination of complex eye movements, helps to strengthen the vestibular apparatus
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The recommended set of corrective exercises for the eyes must be performed every 2-3 hours.

Drivers working on the morning shift performed introductory gymnastics exercises before leaving for the route and two physical culture breaks: the first after was performed 3.5-4 hours after the start of work, the second alert was performed after 6.5-7 hours. Physical training minutes were performed as fatigue set in. Drivers working in the evening: introductory gymnastics were performed before leaving the route, physical education was performed 1.5-2 hours after the start of work, the first physical training was performed after 5-5.5 hours from the start of work, subsequent ones were performed every 80-90 minutes, until the end of the work shift.

Outside the framework of the labor process, the employees were offered physical culture and health-improving classes in applied sports. Table 9 presents physical culture and recreation classes, in the form of a lesson, consisting of three parts of preparatory, main and final part, lasting 60-90 minutes.

Table 9. Components of physical culture and recreation classes and their purpose.

Components of the training	Duration	Purpose
Preparatory	10-15 min	Physical, functional preparation of the body, the musculoskeletal system for the upcoming load in the main part.
Main	40-60 min	Teaching the technique of any exercise (walking, running, playing basketball, volleyball, table tennis, etc.). Development of physical qualities (strength, speed, endurance, flexibility, agility)
Final	10-15 min	Gradual reduction in the load on the body, exercises to restore breathing, relaxation

In the process of training, the performance of high-intensity loads alternates with low-intensity loads or rest.

3 Results of the research and their discussion

As part of the research, the analysis was conducted on the psychophysical and morphological and functional readiness of drivers of the agricultural enterprise JSC "Grain educational farm". Testing was carried out on the basis of the Azovo-Chernomorskiy Engineering Institute, with the participation of 10 professional drivers of the agricultural enterprise. The obtained data were entered into individual cards. The study was carried out for three months. Informed consent was obtained from all respondents for participation in the research, and medical check-up was conducted to identify indications and contraindications for testing. For health reasons, employees are assigned to the first and second medical groups.

Table 10 presents the results of testing drivers at the beginning and at the end of the study.

Table 10. Physical readiness of drivers of the enterprise before and after the study.

Control tests	Results (n=10) M±m		t	p
	Indicators before test	Indicators after test		
Extension bending of the arms in the prone position (times)	11.6±1.51	16.2±1.31	8.83	< 0.05
Long jump (cm)	169.30±1.70	174.3±1.15	3.02	< 0.05
12 min. test run (m)	1341±49.21	1450±62.69	4.58	< 0.05
Hanging on the crossbar (s)	21.9±1.72	25.5±1.51	4.61	< 0.05
Shuttle run 3x10 (c)	11.49±1.28	9.94±0.26	0.2	> 0.05
Static equilibrium (Romberg test) (s)	18.5±0.8	23.3±0.5	6.31	< 0.05
Flexibility (cm)	-6.6±0.3	-4.3±0.2	4.23	< 0.05

The inclusion of complex physical exercises in the production process contributed to the significant increase in the level of physical fitness of workers. Comparing the data before and after the research, significant (at $p < 0.05$) differences are clearly visible for all the studied indicators (except for the shuttle run, $p > 0.05$). These differences are especially indicative in tests for general endurance of 109.1m (at $t = 4.58$ and $p < 0.05$); flexibility 2.3 cm (at $t = 4.23$ and $p < 0.05$); static balance for 5.8 s. (at $t = 6.31$ and $p < 0.05$), hanging on the crossbar (static endurance) for 3.6 s (at $t = 4.61$ and $p < 0.05$), extension and bending of the arms in the prone position for 4.6 times (at $t = 8.83$ and $p < 0.05$), speed-strength qualities by 5 cm (at $t = 3.02$ and $p < 0.05$). There were minor changes in the agility exercise (the increase was 11.5%), but the differences were not statistically significant at $p > 0.05$.

Table 11 shows the results of the functional state of drivers at the beginning and at the end of the pedagogical study

Table 11. Indicators of the morphofunctional state of the drivers of the enterprise before and after the research.

Indicators	Results (n=10) M±m		t	p
	Indicators before test	Indicators after test		
Body mass (kg)	82.53±6.12	81.37±4.93	0.11	> 0.05
Body length (sm)	177.12±5.32	177.19±5.29	0.79	> 0.05
Stange test (c)	35.9±7.72	43.9±8.35	2.11	< 0.05
Vital capacity (ml)	3600±26.26	4089±34.54	2.49	< 0.05
HR (bpm) at rest	80±3.77	73.2±2.25	8.46	< 0.05
BP _{syst} (mmHg)	135.2±1.0	126.1±0.8	8.4	< 0.05
BP _{diast} (mmHg)	80.4±1.4	74.6±0.7	4.3	< 0.05

Assessment of the functional state of the respondents revealed the following: the resting heart rate decreased by 6.8 beats/min, which amounted to 8.5% (at $t = 8.46$ and $p < 0.05$). Significant changes in blood pressure were recorded (BP_{syst} by 6.7%; BP_{diast} by 7.2%) during the research. In the group of respondents, diastolic blood pressure decreased from 80.4 ± 1.4 mmHg. by 7.2%, 5.8 mmHg and amounted to 74.6 ± 0.7 mmHg. (at $t = 4.3$ and $p < 0.05$), systolic blood pressure decreased from 135.2 ± 1.0 mmHg. by 9.1 mmHg, i.e. 9% and amounted to 126.1 ± 0.8 mm Hg. (at $t = 8.4$ and $p < 0.05$). The research revealed the increase in VC and the duration of breath holding on inspiration (Stange test) in respondents significantly and definitely (at $p < 0.05$) changed by 0.45 l (12%) and 14.7 s (25%), respectively.

Changes in the level of the physical condition of drivers at the beginning and at the end of the study are presented in Figures 1 and 2.

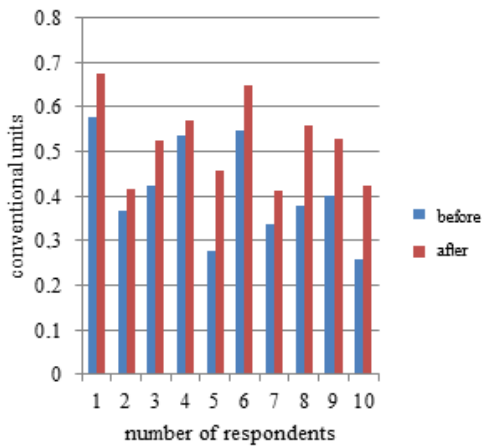


Fig. 1. Dynamics of changes in individual indicators of the level of physical condition of drivers of JSC «Grain educational farm».

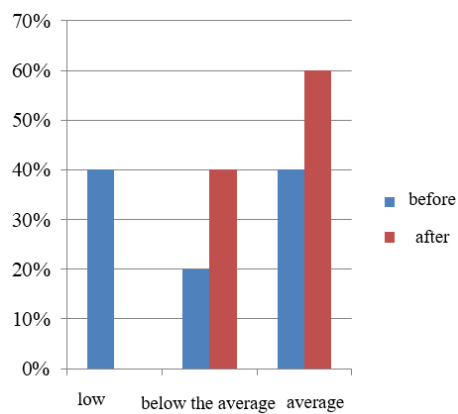


Fig. 2. Dynamics of changes in the average level of physical condition of drivers of JSC «Grain educational farm».

The level of physical condition of the drivers of JSC «Grain educational farm» at the beginning of the study showed that 20% of people have FCL below average , 40% of them have low FCL, 40% of them have average FCL. Most of the participants have a low level of physical condition, which indicates the functional stress of the body's mechanisms. As a result of the introduction of complex physical exercises into the production process, it contributed to the significant change in the indicators of drivers, the level of physical condition changed and amounted to 40% of respondents with below average FCL, 60% of respondents with average FCL (at $t = 2.28$, $p < 0.05$).

When comparing the average obtained values evaluating the reaction time with the evaluation scale of I. Blok, positive dynamics of the results is noted, when physical education means are included during working operations and after working hours in the form of small forms of classes and physical culture and recreation classes (Table 12).

Table 12. Comparative analysis of the reaction time of drivers of JSC «Grain educational farm».

Reaction time (points)	Before the research %	In 3 months %	Difference
Very good level (less than 140 sec)	-	40 %	40
Good level (140-150 sec)	-	30%	30
Medium level(150-160 sec)	10%	20%	10
Low level (more than 160sec)	90%	10%	80
Total	100%	100%	0

Analyzing the obtained results in the Table, it was revealed that the number of drivers with a low level of reaction time decreased, due to the transition to a higher quality level of their capabilities when performing a reaction time test, the very good level (40%) became dominant.

4 Conclusions

Based on the foregoing, it can be concluded with confidence that the performance and resistance to fatigue of vehicle drivers directly depends on their physical condition.

In addition, it should be noted that the physical condition can be influenced using specially designed sets of physical exercises, corrective exercises for the eyes and self-massage that affect the rehabilitation of muscle groups and organs most involved in the professional activities of drivers.

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