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Prevention of Negative Effects of Nervous and Psychic Stress on the Driver's Cardio-Respiratory System[1]

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Abstract

Nervous and psychic stresses on the drivers' body as a result of intense analytical and synthesizing mental activity cause corresponding physiological responses and require a high level of functional preparedness. Investigating the frequency of cardiac contractions in the drivers - representatives of motor sport – during races show that its average (160-180 contraction/min.) and maximum (200-220 contraction/min.) values significantly exceed those calculated by oxygen consumption per minute, which indicates a high psychological pressure of a such kind of professional activity. One of the main causes of accidents is drivers' fatigue, which leads to a decrease in concentration of attention; therefore, the proper level of their functional readiness for nervous and psychic occupational stress can significantly increase the level of active traffic safety. The results of complex studies show that many years of professional activity of drivers leads to a significant decrease in a number of their motor function indices, which requires constant physical training aimed at the prevention of injuries and drivers' functional capabilities. The endurance necessary for drivers is recommended to be developed by non-stop and uniform running or jogging without rest, skiing, swimming, cycling or rowing for at least 30 minutes. However, considering the constant vertical overload on the drivers' spinal column, running along a hard track and riding a bike through rugged country are worth limiting in favor of swimming which combines the functional load on the cardio respiratory system and an even moderate load on all muscle groups with unloading and restoration of the spinal column.

To increase the level of the drivers' physical fitness, to prevent overweight and to treat obesity, we recommend a complex of simple exercises consisting of walking with the knees pressed to the chest, the torso of the trunk forward, touching the toes from the initial position standing legs apart, hands on hips, lifting of the trunk with bending forward from the initial position lying on the back and bending and unbending the arms lying down. Each exercise should be performed at a maximum pace for 30 seconds with a further 30-second rest. The daily performance of this complex significantly improves the functionality of the cardiovascular system. This complex is convenient to do during morning gymnastics, in terms of lack of time or in terms of limited opportunity for special physical training.

Keywords: nervous and psychic stress, a driver, cardio-respiratory system, negative influence, prevention

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Introduction

The specifics of drivers' modern professional activity consist in the sharp increase in the speeds of vehicles and their number on the roads, large amounts of information from the system "driver - car - road", which are processed by the driver in the conditions of time deficit and increased risk of accidents, cause significant nervous and psychic stresses on a driver's body that have a detrimental effect on the cardio respiratory system, and that pressure level can be compared with the mental loads of pilots, dispatchers, athletes and representatives of other types of extreme activity (Ryachinsky, 2001; Rybak, 2013). Stressed analytical and synthesized mental work requires a high level of the drivers' functional readiness to this type of overload and causes the corresponding physiological response of the organism (Rybak, 2002; Rybak, 2005).

The labor pressure as a harmful occupational factor often affects the employee in parallel with other factors (noise, vibration, microclimate, physical overload, etc.). Simultaneous influence of these factors enhances those adverse deviations of physiological and pathological nature, which arise under the influence of only the nervous and psychological load itself (Bus Drivers, 1996). The pressure during the labor process as a harmful occupational factor subjects to hygienic norm-setting. According to the authors' classification (Zanko, 2004), the mental pressure on the drivers as for the content of the work that is heuristic (creative) activity and requires solving algorithms of actions, individual control in complex situations, perception of signals and information with the following complex assessment of related parameters and a comprehensive assessment of all occupational activity – is referred to harmful working conditions (work under pressure) of the second degree. By the distribution of functions and the degree of a task complexity - the processing of a task, its performance and control over its performance are considered as harmful working conditions (work under pressure) of the first degree. Sensory loads over the duration of focused observation (over 75% of the work duration), as well as the hour density of signals and messages (over 300) - is a work in a time and information deficit, and increased responsibility for the final result. The number of points for simultaneous observation (11-25) is considered as work in a time deficit. Emotional pressure on drivers as the risk of their own life (possible), the degree of responsibility for the safety of others (the risk is possible) and the monotony of the stress (the number of techniques needed to complete a simple task - less than three) - taking into account the degree of responsibility for the final outcome of their own activity and significance of the error is the sole responsibility for the functional quality of the task, when there may be a danger to life. Therefore, professional activity of drivers can be attributed to the most stressful, which requires effective prevention of harmful nervous and psychological influences (Burlayev, 2010; Szczepaniak, 2015).

Method

Choosing out of all theoretical methods we applied in our research the following ones: analysis and generalization of special literature, WEB-pages of the Internet network, abstraction and idealization; classification and systematization of theoretical and experimental data; induction and deduction; specification of theoretical knowledge and forecasting.

We used such empirical methods of research as pedagogical observation of drivers' professional activity, method of rating, and experimental pulsometry.

According to many experts (Trofimets, 1977; Kuznetsov, 2007), the intensity of the drivers' actions can be objectively estimated by the value of his heart rate (HR) as an organism's response to the psychic stress.

The heart rate of professional drivers involved in our survey was recorded using the portable pulsometer "PC 800" made by SIGMA SPORT. This is a modern recording device, which consists of sensors, designed in a single block with an elastic breast strap, and a recording-set-up unit in the form of a wristwatch. The connection between the sensor unit and the recording unit is radio-telemetric (the maximum distance between them is 1.2 m). The pulsometer is activated and controlled by buttons located on the recording unit. The device allows real-time control of the visual average heart rate for the last 5 contractions of the myocardium, as well as to memorize the duration of training for 60 minutes in three zones of loading at the heart rate, which are given by the experimenter. The device is lightweight, convenient, powered by three batteries (48 hours of continuous operation).

Results

During training sessions of the top motor racers in the mode of minute oxygen consumption in the range of 2.0 l/min, their heart rate, which was supposed to be about 130 contraction/min, rose to 160-165 contraction/min. During the race on the same highway, their heart rate increased to 180 and more contraction/min. (Rybak, 2005), which can be explained by the high intensity of work (stress).

During the most intense automobile racing, the minute volume of oxygen consumption by qualified athletes is 0.5-0.6 l/min, which is 4-5 times less than in motocross. However, during the ring races, their average heart rate ranges from 160 to 170 contraction/min., and the maximum reaches 200-220 contraction/min. (Trofimets, 1990). Karters' heart rate before the control race start is 120-125 contraction/min. and reaches a maximum of 207-210 contraction/min. (Gradusov 2005) (at a simulator - up to 90 contractions per minute (Keller, 1980).

Examination of the heart rate of the representatives of motor and extreme sports (Ospinnikova, 2003; Singurindi, 1982) and drivers of special units of the Ministry of Internal Affairs during special operations (Zudin, 2004) made it possible to determine its average and maximum values (Table 1).

Table 1. Heart rate recorded among representatives of various kinds of extreme activities

№	Kind of activity, contingent	Heart rate (contraction/min.)		
		At start	Average	Maximum
1	Alpine skiers	120 – 140		170 – 180
2	Cross country motorcycle race, training races		160 – 165	
3	Cross country motorcycle race, competition races		over 180	
4	Ring motor races		160 – 170	200 – 220
5	Carting, at simulator		80 – 90	
6	Carting, control races	120 - 125		207 – 210
7	Cross country motorcycle race with a sidecar, driver		170 – 180	to 200
8	Cross country motorcycle with a sidecar race, passenger		180 – 190	to 200
9	Motorcycle football, field player-forward		170 – 180	to 200
10	Rally raid, pilot		140 – 150	183
11	Driving APC (extraordinary maneuvering)			to 200
12	Chauffeurs of diplomatic corps		136	

Discussion and Conclusion

The analysis of the results given in Table 1 shows that the hard work of drivers requires a high level of functional preparedness to negative influence of regular and extreme nervous and psychic stress on their cardio-respiratory system. The prevention to such type of stress can significantly increase the level of active traffic safety.

The drivers themselves recognize that one of the main causes of accidents is fatigue and due to the reduced concentration of attention, therefore, good health, proper level of physical and functional preparedness of the driver is the basis of traffic safety. However, the results of complex studies show that many years of professional activity of drivers of various vehicles cause a peculiar change in the functions of their organism. And if indices such as the ability to differentiate signal parameters, accuracy and speed of response, etc., increased three times, then some indices of motor functions significantly reduced. This requires compulsory physical activity, which could provide an adequate level of ability to overcome regular and extreme professional nervous and psychic stresses.

Physical training of professional drivers should primarily be aimed at preventing injuries by avoiding mistakes that can lead to accidents and, consequently, injuries (active safety). However, it should also increase their passive safety - the ability to overcome high mechanical and nervous and psychic professional overload on the body as at the regular and extreme situations, and quickly recover after occupational stresses, overload and possible injuries.

So, necessary drivers' stamina should be developed by such means of general physical training as uniform running, walking, cross, skiing, swimming, cycling or rowing. The load must be carried out continuously and without rest for 30 minutes or longer. However, taking into account the constant vertical professional load and overload on the drivers' spinal column, running along hard tracks and bike riding through country should be limited in favor of swimming, which combines the effect of the functional load on the cardio respiratory system and a uniform moderate load on all muscle groups on the one hand, and unloading and restoration of the spine column on the other.

The driver must be able to behave correctly – when he knows what to do, and is sure enough that he is physically prepared to withstand the load, more stable mentally, does not hesitate and panic at the last second before accident.

To improve the level of physical and functional preparedness of drivers, to prevent overweight and treat obesity, the complex of the simplest exercises designed by authors (Singurindi, 1982), is recommended to do (Figure 1).

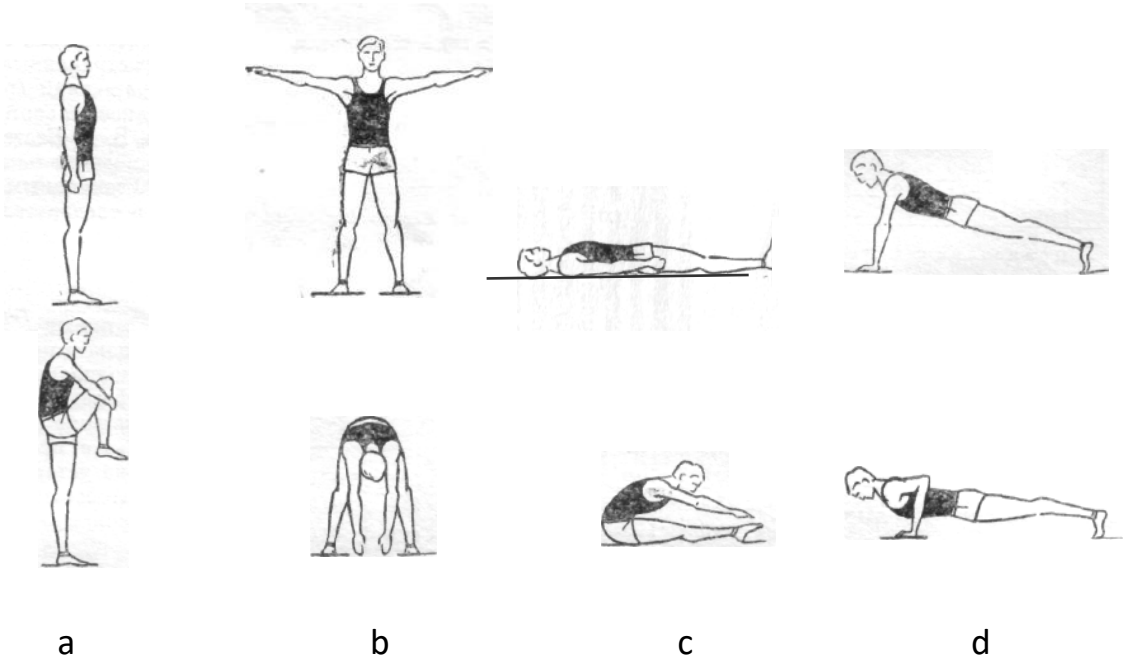

Figure 1. Complex of physical exercises recommended by physicians for increasing the level of physical fitness and prevention of excessive mass: a - walking with knees pressed to the chest; b – bending the torso of the trunk forward touching the toes from the initial position standing legs apart, hands on hips; c - lifting the trunk with bending forward from the initial position, lying on the back; d - bending and unbending the arms lying down (push-ups) (Singurindi, 1982, modified).

Each exercise is performed at a maximum pace for 30 seconds with a further thirty-second rest. It is advisable to establish such a sequence of their performance, so that the peak of the load was after the fourth exercise – bending and unbending the arms lying down.

Our tests showed that daily performance of this complex of exercises is not only a sufficient training load for the development of power and speed qualities, but also greatly improves the functionality of the cardiovascular system (heart rate after all four exercises reaches 150-180 contractions/min.) The described complex is very convenient to use in conditions of shortage

of time, or limited opportunities for special training. It can also be added to the morning exercises and to the individual physical training of individuals with a hypodynamic mode of activity. In this case, the complex must be performed at a rate of 60-80% out of the maximum.

The results obtained during the study indicate that:

a) the simultaneous influence of nervous and psychic professional stresses on the body of the drivers in parallel with other factors (noise, vibration, microclimate, physical overload, etc.), which increase the adverse deviations of the physiological and pathological nature, which arise under the influence of only the nervous and psychological load, create a harmful influence on their cardio-respiratory system;

b) the level of heart rate of drivers and representatives of other kinds of extreme activities significantly exceeds the calculated per minute oxygen consumption, which indicates the high pressure of their activities, and the performance of professional duties in such regimes is not feasible for untrained persons and requires special functional training;

c) prevention of the harmful effects of nervous and psychic stresses and overloads on the cardio-respiratory system of professional drivers is to maintain an adequate level of their functional preparedness by means of general physical training, such as continuous (for at least 30 minutes) uniform running, walking, cross-country skiing, cycling, rowing or swimming, which combines the effect of the functional load on the cardio respiratory system and a uniform moderate load on all muscle groups – on the one side, and unloading and restoration of the spine column - on the other;

d) daily exercising the complex of simple exercises, consisting of walking with knees pressed to the chest; bending the torso of the trunk forward touching the toes from the initial position standing legs apart, hands on hips; lifting the trunk with bending forward from the initial position, lying on the back; bending and unbending the arms lying down (push-ups), significantly improves the functionality of the cardiovascular system. Each exercise should be performed at a maximum pace for 30 seconds with a further 30-second rest.

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Conflict of Interest

The authors have not declared any conflicts of interest.

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