UDC 623.4

V. Pashchenko **O. Bilenko**

THE IMPACT OF THE WEIGHT OF THE EMPLOYEE'S COMBAT EQUIPMENT SECURITY FORCES ON ITS MANOEUVRABILITY

The article investigates the influence of the weight of combat equipment of a security officer on his/her manoeuvrability. It has been established that an increase in the weight of combat equipment negatively affects the time of performance of tactical actions by a security officer, which are associated with the need for manoeuvring and rapid movement in space. The dependencies of the time of performance of some tactical actions by a security officer on the weight of combat equipment are obtained. The obtained results allow rationally determining the quantitative indicators of tasks related to the need for manoeuvring and rapid movement in space, and can also be used to optimise the distribution of physical activity to individual security forces personnel of one unit in order to increase the efficiency of the unit's performance of its tasks as a whole.

Keywords: *combat survivability, efficiency of task performance, manoeuvrability, combat equipment, tactical actions, physical activity, security forces officer.*

Statement of the problem. Ensuring a high level of survivability of security forces personnel (SFP) while performing assigned tasks is a prerequisite for preserving their lives and combat capability [1, 2]. The survivability of the SFP depends on a combination of certain properties of the employee, in particular manoeuvring.

Manoeuvrability should be understood as the ability to change one's position in space or movement parameters (speed, direction) within a certain period of time [3].

The manoeuvrability of the SFP during the performance of assigned tasks increases the chances of avoiding visual or fire contact with the enemy, and, if necessary, initiating such contact on their own terms. The manoeuvrability properties of a SFP affect the time a worker takes to leave the danger zone and the accuracy of enemy fire [1, 4], and thus its survivability in combat. The need to increase the manoeuvrability of security forces personnel is also evidenced by the ongoing work to improve the efficiency of fire missions by operators of various weapons [5] and the accuracy of weapons firing [6, 7]. In addition, the manoeuvrability of the SFP affects the time of the task, which is associated with the need to move in space.

Thus, improving the manoeuvrability of security forces personnel has a positive impact on the effectiveness of their assigned tasks.

An analysis of the factors affecting the manoeuvrability of the SFP allows us to conclude that it depends on the endurance, agility and speed of the employee. In addition, an important factor that affects physiological parameters and physical qualities of the SFP, and therefore manoeuvrability, is mass characteristics of combat equipment (CE) elements. In this regard, in order to ensure the required manoeuvrability of security forces personnel, it is necessary to have data on the impact of the mass characteristics of combat equipment on the physical qualities of the SFP during the performance of assigned tasks.

Analysis of recent research and publications. The scientific interest in researching the impact of exercise on the physiological parameters and physical qualities of military personnel has increased significantly worldwide.

For example, [8] published the results of research on the impact of combat load on the mobility of servicemen during an eight-hour march and showed the dependence of the distance travelled by a serviceman on the weight of the combat load. Thesis [9] examines the impact of the load on the performance of individual servicemen, where performance is understood as the speed estimated by a mathematical model. This model calculates the speed considering a number of factors, including body weight, load, and terrain characteristics.

The scientific article [10] presents the results of a study on the effect of external load on people while they are performing a stair-climbing exercise. These studies were based on measuring the amount of oxygen absorbed, heart rate, and metabolic rate, and their results showed a decrease in performance in the scenario with additional load. The effect of the weight of a loaded US Army backpack on the physiological parameters of servicemen during its carrying is given in [11]. The results of the study illustrate and quantify the sharp decline in walking speed when soldiers have to carry heavy loads in modern backpacks.

A systematic review of scientific sources was conducted in [12], which raised the issue of the impact of body armour on the performance of tasks by law enforcement agencies. It was determined that wearing body armour affects shooting accuracy and various physiological parameters, but the characteristics of this effect are still uncertain and deserve further research. It has also been found that body armour does have a significant biomechanical and physical impact on law enforcement officers, including: reduced performance, increased time to perform functional tasks, reduced balance and stability, and increased body temperature. The impact of bulletproof vests on the service and combat activities of police officers of the National Police of Ukraine is discussed in the article [13]. The research has established the impact of body armour on the performance of employees of the Ministry of Internal Affairs, especially during dynamic actions, as well as the main characteristics of personal protective equipment that can significantly affect the effectiveness of the tasks.

However, none of the works provides data on the impact of the weight and size characteristics of the SFP on the time indicators of performing the tasks assigned to the SFP. Therefore, there is a need to determine this influence in order to ensure the necessary manoeuvrability of the SFP in conditions of danger of enemy fire, as well as to develop practical recommendations for the rational formation of a set of combat equipment by security forces and tasking.

The purpose of the article is to obtain dependencies of time of performance of tasks assigned by a security forces officer on the weight of combat equipment.

Summary of the main material. Combat equipment of a security forces officer provides individual protection of the officer, defeating targets, controlling personnel during the performance of assigned tasks, power supply of power-consuming means of combat equipment, etc. but at the cost of some reduction in the functional characteristics of the combat equipment.

The combat equipment of security forces personnel can be heavy, bulky and not sufficiently ergonomic, which negatively affects the manoeuvrability of the SFP due to an increase in overall weight, restriction of joint mobility, and difficulty in moving in confined spaces, in particular in vehicles. Taken together, the mass, volume and thermal load of the BE increase the fatigue of a security officer and reduce his or her physical and cognitive abilities, and therefore increase the time required to perform the task intended by the SFP.

In order to obtain numerical characteristics of the degree of influence of the mass of a worker's combat equipment on the time of performing tactical actions associated with movement, full-scale experimental studies were conducted. The main task of this study was to determine the time SFP of performing the same tactical actions by an employee in different weight SFP combat equipment.

Considering that the time of performing tasks depends on many factors, including the characteristics of equipment (weight, position of the centre of mass, ergonomics, etc.) and the peculiarities of motor tasks (length of the path, body position during movement, presence of various obstacles), the experimental studies used typical elements of combat equipment and the most characteristic ways of moving in the conditions of enemy fire.

The study involved two groups of employees (cadets), each consisting of 25 people. Group 1 consisted of cadets trained in special purpose groups, and Group 2 included cadets from regular training groups. The research was conducted in the field on rough terrain and on an obstacle course. During the experiment, each employee performed three exercises that corresponded to certain tactical actions (Table 1).

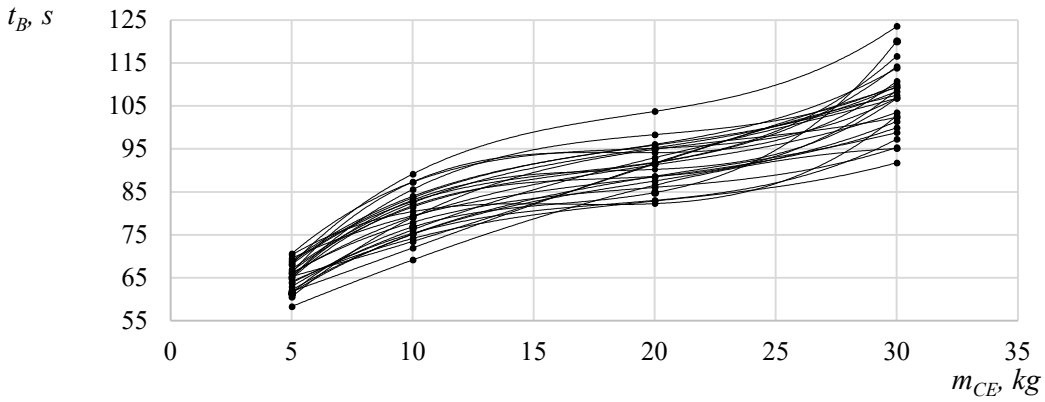
Within each exercise, the following levels of BE mass were set: 5 kg [small arms (5.45 mm AK-74 rifle), ballistic helmet]; 10 kg [small arms (5.45 mm AK-74 rifle), ballistic helmet, plate carrier], 20 kg [small arms (5.45 mm AK-74 rifle), ballistic helmet, body armour, belt and shoulder load bearing system]; 30 kg [small arms (5.45 mm AK-74 rifle), ballistic helmet, body armour with additional ballistic protection, shoulder strap and shoulder load-bearing system].

To restore the physical condition of a person, a period of at least 48 hours was allowed between exercises and series of experiments. The time for performing a tactical action was recorded from the beginning of the first element of the relevant actions to the end of the last.

As a result of the experiments, 25 values for each load level for three exercises and two groups were obtained, which are shown in Figures. 1, 2, 3. For clarity, time values belonging to one person are connected by lines.

Table 1 – List of tactical actions and the content of the corresponding physical exercises

No. of pars.	Tactical action	Distance, m	The content of the exercise
1	Getting closer to the enemy for effective fire	100	The movement is carried out by running from cover to cover (40 m), then taking the prone shooting position and covering 20 m by crawling in the Plast way, the rest of the distance (40 m) is covered by running
2	Quick approach to the object (position) after rushing from the equipment	600	Movement is carried out by intensive running from the boundary of haste to the object (position)
3	Pursuit on foot of an offender (enemy) on rough terrain and in a destroyed settlement	1000	Movement is carried out by running with overcoming obstacles in the form of fences and destroyed walls 1.1 m high (10 pieces on the course)



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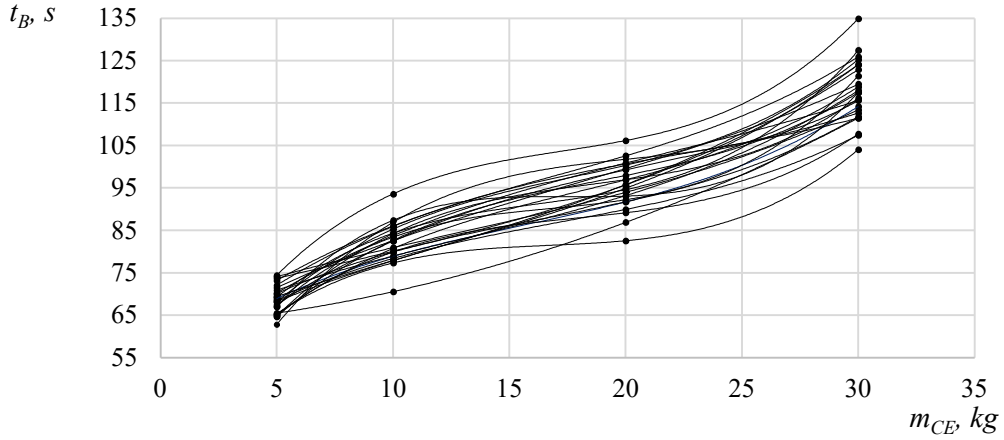

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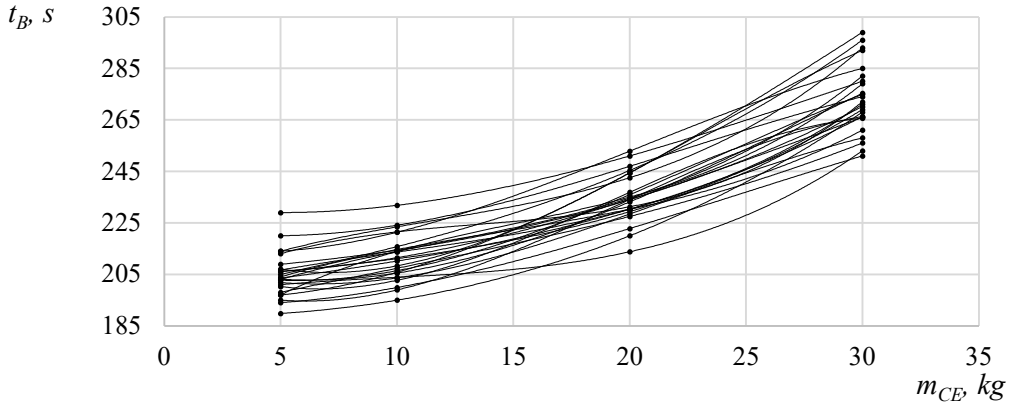
Figure 1 – Time dependence of tactical actions by a security officer the weight of its combat equipment during the approach to the enemy (exercise No. 1) for individuals: *a* – group No. 1; *b* – group No. 2



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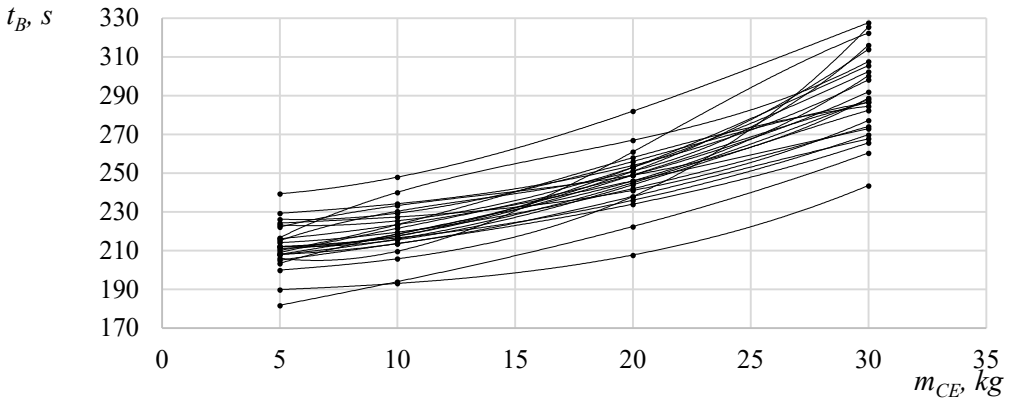

b

Figure 2 – Time dependence of tactical actions by a security officer on the weight of his combat equipment when approaching an object (position) after dismounting from equipment (physical exercise No. 2) for individuals: *a* – group No. 1; *b* – group No. 2

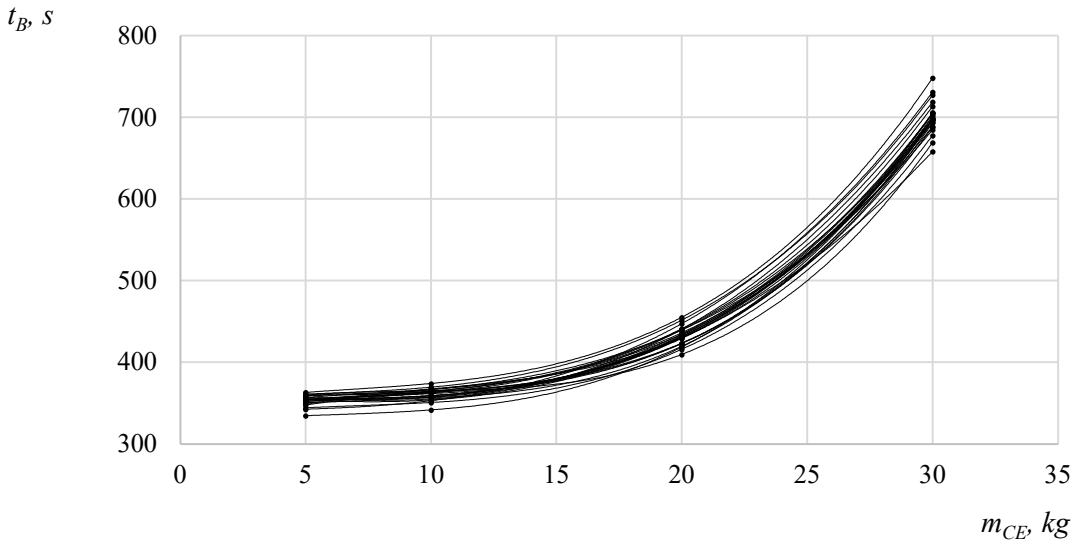

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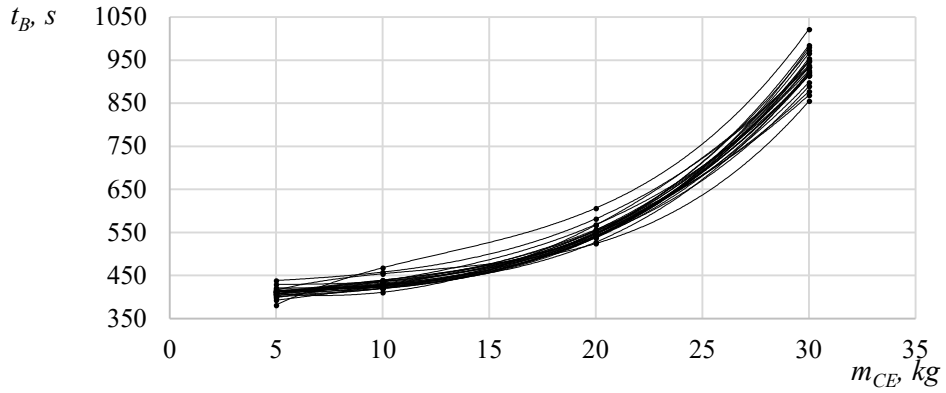
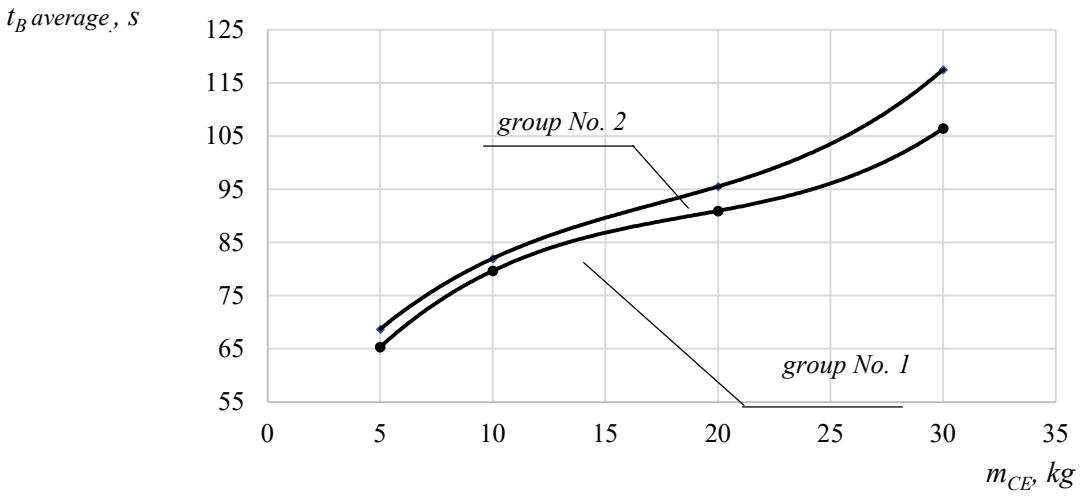
Figure 3 – Time dependence of tactical actions by a security officer on the weight of his/her combat equipment during the pursuit of the offender (enemy) on foot (physical exercise No. 3) for individuals: *a* – group No. 1



b

Figure 3 – Time dependence of tactical actions by a security officer on the weight of his/her combat equipment during the pursuit of the offender (enemy) on foot (physical exercise No. 3) for individuals: *b* – group No. 2

Figure 4 shows the results of processing the above data.



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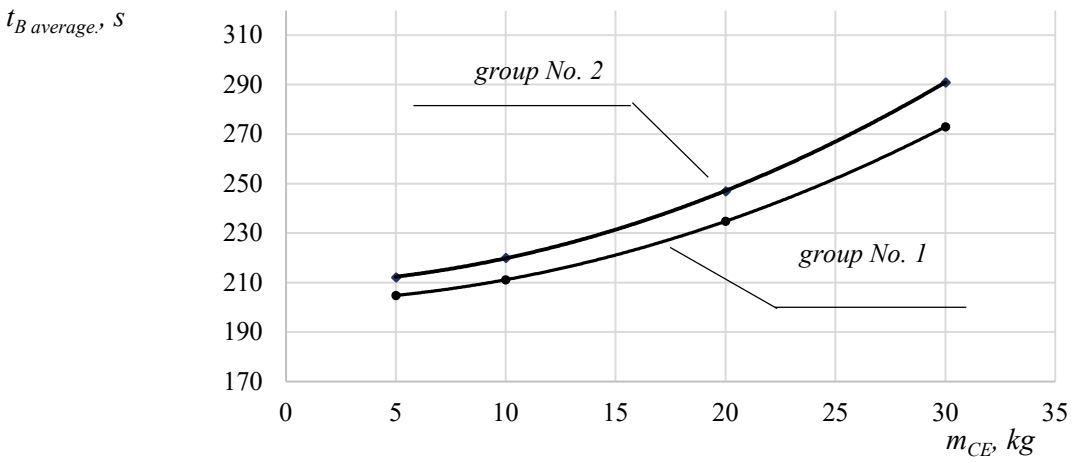

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Figure 4 – Dependence of the average time of tactical actions by an employee security forces from the weight of its combat equipment: *a* – physical exercise No. 1; *b* – physical exercise No. 2

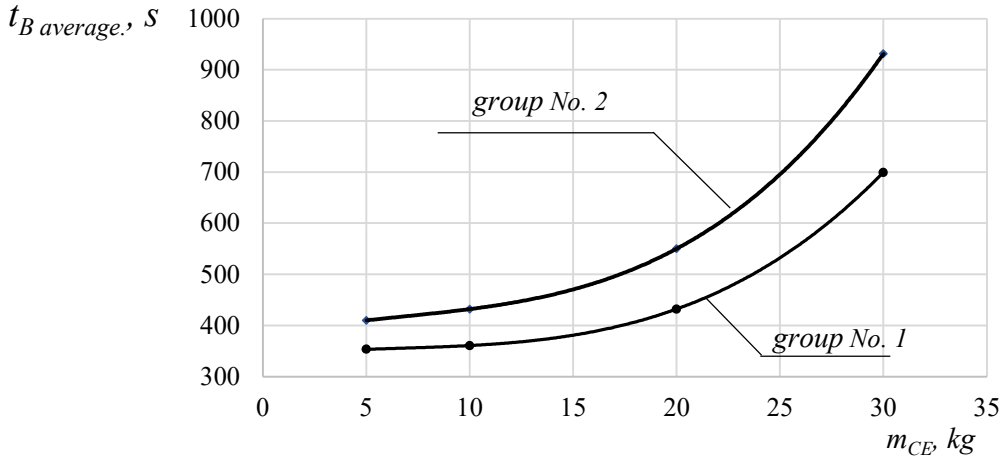

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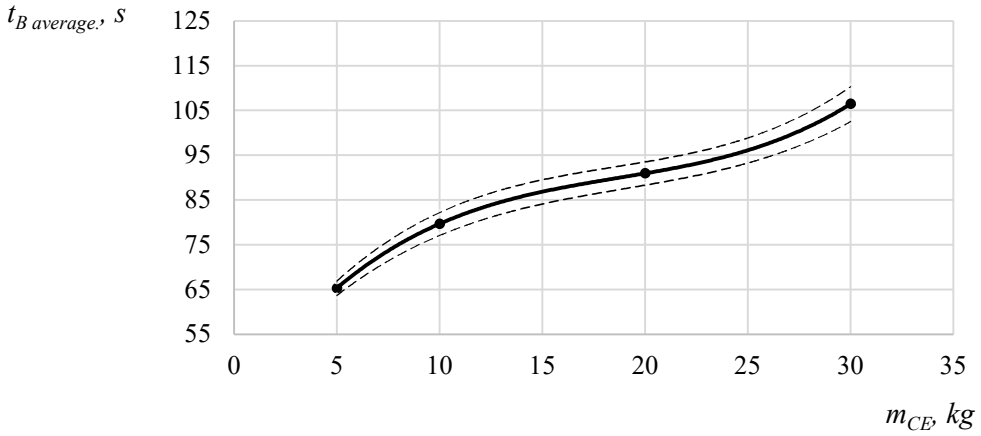
Figure 4 – Dependence of the average time of tactical actions by an employee security forces from the weight of its combat equipment: *c* – physical exercise No. 3

Figure 5 shows the dependencies for Group 1 with confidence intervals for a significance level of 0.02.



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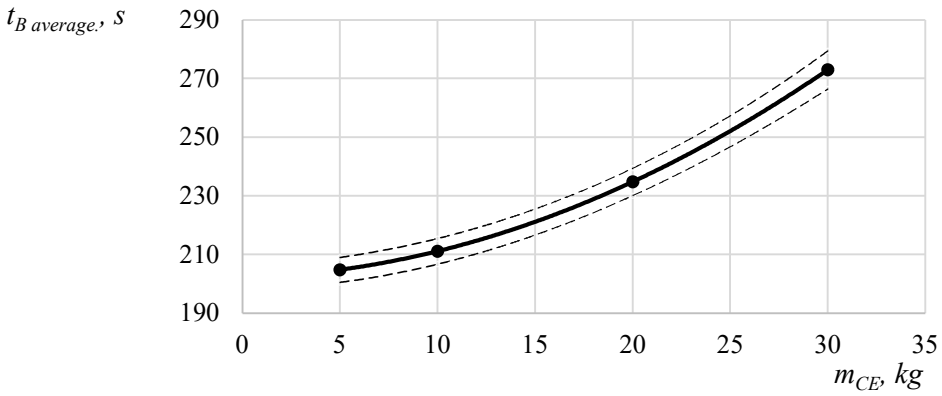

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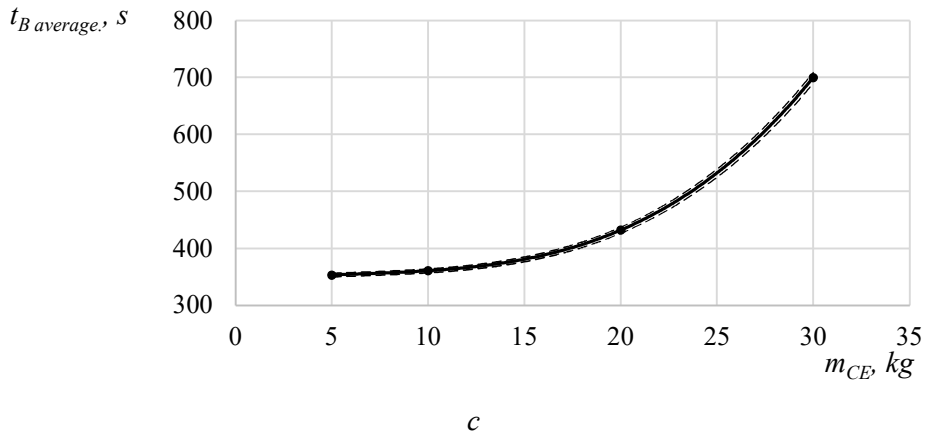
Figure 5 – Dependence of the average time of tactical actions by a member of the security forces of group No. 1, depending on the weight of his/her combat equipment with confidence intervals for the significance level of 0.02: *a* – physical exercise No. 1; *b* – physical exercise No. 2



c

Figure 5 – Dependence of the average time of tactical actions by a member of the security forces of group No. 1, depending on the weight of his/her combat equipment with confidence intervals for the significance level of 0.02: *c* – physical exercise No. 3

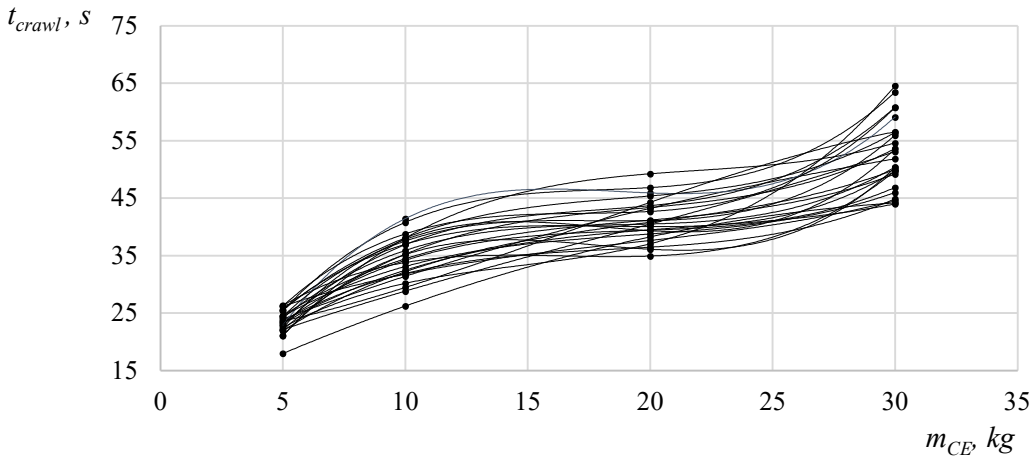


Figure 6 – Dependence of the time of the "crawl" element of physical exercise No. 1 by a member of the security forces of group No. 1 on the weight of combat equipment

The figures show that with increasing load, the time of exercise increases. At the same time, the curves have a concave shape, which is explained by an increase in the ratio of the mass of the BE to the mass of the SFP and a gradual approach to such a ratio when the movement of the SFP becomes impossible, i.e. the time tends to infinity. The S-shaped shape of the curves describing the dependencies for Exercise 1 is due to the specificity of the dependence of the time to overcome the section on the load during crawling (Figure 6), which requires further study. At the same time, the dependence of the time of overcoming the sections by jogging in exercise No. 1 does not differ in nature from the corresponding dependences obtained by the results of exercises No. 1 and No. 2.

The analysis of the dependencies shows that the same workload affects different employees in different ways. For example, during exercise No. 2, the relative difference in the time taken to perform tactical actions ranges from 22 % to 46 %. This variation may be due to individual differences in endurance under the same conditions and physical fitness of employees.

The obtained dependencies show that an increase in the mass of the UE negatively affects the time of tactical actions by the employee, and therefore the efficiency of performing the relevant tasks, which can be critical in some situations where the manoeuvrability and speed of the SFP are key.

It should be noted that the uneven impact of the mass of the BE on different workers is explained not only by the mass of the load, but also by other factors, including individual physiological characteristics of the body [14], the level of training to withstand physical exertion [15], the physical condition of the person at a certain time [16],

ergonomic characteristics of combat equipment, etc. However, the influence of these factors is not the subject of this study, and their random combination is considered by empirical dependencies and affects only the scattering of the response function values.

The obtained results suggest the need for an individual approach to both the training and equipping of the airborne combat equipment and the setting of specific tasks during the performance of assigned tasks. Such an approach will allow, based on the use of the obtained dependencies, to rationally determine the quantitative indicators of tasks related to the need for manoeuvring and rapid movement in space, as well as to optimise the distribution of physical activity on individual PSBs of one unit and increase their efficiency in performing assigned tasks.

Conclusions

1. It has been established that an increase in the weight of combat equipment negatively affects the time required for a security officer to perform tactical actions related to the need for manoeuvring and rapid movement in space.

2. The dependencies of the time of a tactical action by a security officer on the weight of combat equipment are obtained, which make it possible to rationally determine the quantitative indicators of tasks related to the need for manoeuvring and rapid movement in space. These dependencies can also be used to optimise the distribution of physical activity among individual security personnel of one unit in order to increase the efficiency of the unit's performance of its tasks.

The direction of further research is to determine the impact of the position of the centre of mass of combat equipment, as well as its ergonomic characteristics, on the manoeuvrability and speed of movement of a security force member while performing assigned tasks.

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В. В. Пащенко, О. І. Біленко

ВПЛИВ МАСИ БОЙОВОГО ЕКІПІРУВАННЯ ПРАЦІВНИКА СИЛ БЕЗПЕКИ НА ЙОГО МАНЕВРЕНІСТЬ

На основі аналізу наукових джерел установлено, що маневреність працівника сил безпеки залежить від його витривалості, спритності та швидкості, важливим чинником, який впливає на фізіологічні параметри та фізичні якості працівника сил безпеки, а отже, на маневреніст, є масові характеристики елементів бойового екіпірування.

Визначено вплив масогабаритних характеристик бойового екіпірування на часові показники виконання завдань за призначенням особовим складом сил безпеки з метою забезпечення їм необхідних показників маневреності в умовах вогневої небезпеки противника, а також обґрунтовано розроблення практичних рекомендацій щодо раціонального формування комплекту бойового екіпірування працівника сил безпеки та постановки завдань.

Досліджено вплив маси бойового екіпірування працівника сил безпеки на його маневреність. Установлено, що підвищення маси бойового екіпірування негативно впливає на час виконання працівником сил безпеки тактичних дій, що пов'язані з необхідністю маневрування та швидкого переміщення у просторі. Отримано залежності часу виконання деяких тактичних дій працівником сил безпеки від маси бойового екіпірування. Одержані результати дають змогу раціонально визначати кількісні показники завдань, які пов'язані з необхідністю маневрування та швидкого переміщення у просторі, а також можуть бути використані для оптимізації розподілу фізичного навантаження на окремих працівників сил безпеки одного підрозділу з метою підвищити ефективність виконання поставлених завдань підрозділом у цілому.

Ключові слова: *бойова живучість, оперативність виконання завдань, маневреність, бойове екіпірування, тактичні дії, фізичне навантаження, працівник сил безпеки.*

Pashchenko Viktor – Candidate of Technical Sciences, Doctoral Student of the National Academy of the National Guard of Ukraine
https://orcid.org/ 0000-0002-6859-0700

Bilenko Oleksandr – Doctor of Technical Sciences, Professor, Chief Researcher of the Research Center of the National Academy of the National Guard of Ukraine
https://orcid.org/ 0000-0001-6007-3330