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APPLYING OF INFORMATIONAL MODEL OF NUTRITION RATION CALCULATION FOR COMPENSATION OF ENERGY LOSSES OF THE UKRAINIAN ARMED FORCES SERVICEMEN

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Abstract. Applying of informational model of nutrition ration calculation for compensation of energy losses of the Ukrainian Armed Forces servicemen. Deputat Yu.M., Gulich M.P., Savytskyi V.L., Ivanko O.M., Levit Yo.R., Bogomolets O.V. *The article is devoted to the research of the problem of compensation of energy losses of servicemen doing qualification course of the UAF Special Operations Forces as well as development of the method of promp response of the officials of food service on changing of energy losses of servicemen at different phases of qualification course by corresponding correction of their daily nutrition ration. The aim of work was directed at*

development and substantiation of informational model of nutrition ration calculation for compensation of energy losses of the Ukrainian Armed Forces servicemen. Time and tabular method of energy losses calculations, calculations of ration composition, instrumental estimations, laboratory and statistics assessments were used as methods of research. Calculations of informational model were done in Microsoft Excel 2007 functional environment. The description of informational polyparametrical model of the computational system of nutrients composition and energy value of servicemen daily nutrition ration depending on revealed energy losses doing qualification course of UAF Special Operations Forces has been presented. The model is meant for operative calculations of nutrients composition and energy value for compensation of corresponding energy losses of servicemen doing different phases of qualification course. Informational model got approval and was implemented in the UAF Special Operations Forces activities.

Реферат. Применение информационной модели расчета рациона питания для компенсации энергетических затрат военнослужащих Вооруженных сил Украины. Депутат Ю.Н., Гулич М.П., Савицкий В.Л., Иванько О.М., Левит И.Р., Богомолец О.В. *Публикация посвящена изучению проблемы компенсации энергетических затрат военнослужащих во время пребывания на квалификационном курсе Сил специальных операций Вооруженных сил Украины, а также созданию метода для оперативного реагирования должностных лиц продовольственной службы на изменения величины энергозатрат курсантов при различных фазах подготовки путем внесения соответствующих корректив в их рацион питания. Цель работы заключалась в разработке и обосновании информационной модели расчета суточного рациона питания для обеспечения адекватной компенсации фактических энергозатрат военнослужащих. Применены хронометражно-табличный, инструментальный, расчетный, лабораторный и статистический методы исследований. Расчеты информационной модели выполнялись с использованием функций табличного редактора Microsoft Excel 2007. В статье приводится описание разработанной информационной полипараметрической модели вычислительной системы формирования нутриентного состава и энергетической ценности суточного рациона военнослужащих в зависимости от выявленных величин энергозатрат при выполнении задач по программе квалификационного курса Сил специальных операций Вооруженных сил Украины. Модель предназначена оперативно рассчитывать нутриентный и энергетический состав рациона питания для адекватной компенсации соответствующих энергетических затрат военнослужащих на различных фазах подготовки. Информационная модель прошла тестирование и внедрена в практическую деятельность ССО.*

With the establishment of the Special Operations Forces (SOF) as a separate type of troops of the Ukrainian Armed Forces (UAF) in 2016 in accordance with the program of the Joint Multinational Group (USA, Lithuania, Latvia, Estonia) a qualification course for Special Operations Forces of the Armed Forces of Ukraine (hereinafter – Q-course) according to the adapted training program of NATO special forces was launched.

The command of the SOF of the Ukrainian Armed Forces was faced with an urgent issue regarding the organization of food for members of Q-course in accordance with their metabolic costs. However, during the independence, research on establishing the real metabolic costs of servicemen of the Ukrainian Armed Forces in various types of professional training and combat training was not conducted in our country. Accordingly, the food and energy needs of various categories of servicemen, including the SOF, remained unexplored, and the formation of current nutrition standards for personnel of the Ukrainian Armed Forces was based on the stereotypes of the Soviet Union.

According to studies of foreign authors [7, 6], physical and psycho-emotional stress of SOF servicemen, as well as their energy needs to ensure the energy balance of the body are higher than those of the average serviceman (not special forces soldier) due to high energy expenditures during,

training activities of the SOF in particular, which is characterized by high levels of physical activity. It was found that the level of physical activity during training exceeds the accepted upper limit of the coefficient of physical activity (>2.5) [5] and can lead to weight loss and reduced physical performance [9].

In this regard, in 2018-2019, planned research work commissioned by the command of the SOF of the Armed Forces of Ukraine was carried out, the results of which showed that the actual ration does not provide energy balance in the body of Q-course servicemen [8]. One of the reasons for this was the lack of a mechanism for rapid response of food service officials to changes in the amount of energy consumption of Q-course servicemen at different stages of training. It is this fact that prompted the development of a method of adjusting the diet to achieve energy balance of the body with in variability of indicator of metabolic costs of servicemen at different phases of Q-course training.

The aim is to develop and substantiate an information model for calculating the daily ration to ensure adequate compensation for the actual metabolic costs of Q-course servicemen.

MATERIALS AND METHODS OF RESEARCH

The study involved 85 Q-servicemen. Determination of the actual metabolic costs of servicemen during

the selection and training phases at the Q-course was carried out using the timing-table method [3].

Age and anthropometric data (height, body weight) were recorded, calculations of general metabolism, body mass index, body structure were performed [2, 3].

Estimation of energy and nutritional value of the actual ration was performed by calculation (analysis of weekly menu boards using reference tables of chemical composition of food) [4] and laboratory research methods.

The study was conducted in accordance with the principles of bioethics set out in the Helsinki Declaration on Ethical Principles for Human-Based Medical Research and the Universal Declaration on Bioethics and Human Rights (UNESCO).

The analysis of the obtained results was carried out with the help of traditional methods of statistical processing: descriptive statistics, analysis of variance, comparison of samples by statistical criteria, graphical and regression analysis [1] using statistical analysis applications "Statistica 10.0 for Windows" (Portable - version).

Calculations of the information model for calculating the nutrient and energy expenditures of the daily ration were performed using the functions of the spreadsheet editor MS Excel 2007.

RESULTS AND DISCUSSION

It has been established that according to the training program, the Q-course is a 23-week training period, which, depending on the learning objectives, is divided into five phases. These phases differ in both duration and complexity of the tasks. Accordingly, the energy expenditures of Q-course servicemen at different phases of training is also different.

Thus, during the research, the highest average daily metabolic costs of Q-course servicemen were recorded by us during the first two-week selection phase and amounted to 6853±963.9 kCal. At the same time, the energy value of the actual ration did not significantly ($p < 0.001$) correspond to metabolic costs, i.e. did not compensate for them in this period, and averaged 4015.6±231.7 kCal per day (Fig. 1).
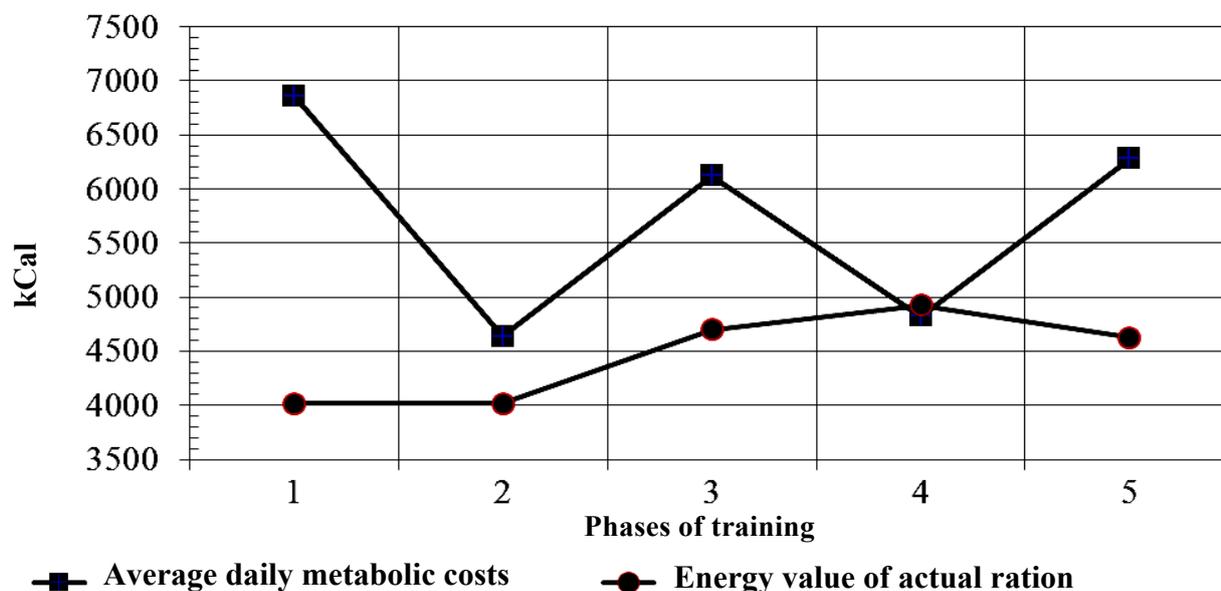

Fig. 1. Comparison of average daily energy expenditures of servicemen with the energy value of the actual ration during the various phases of the Q-course

The indicators of average daily metabolic costs during the second (4635±385.4 kCal), third (6120±627.3 kCal) and fifth (6277±837.2 kCal) phases significantly ($p < 0.001$) exceeded the energy value of ration of servicemen (4015.6±231.7, 4927.3±314.4 and 4628±251.2 kCal, respectively).

Only in the fourth phase of training, the average daily metabolic costs of the body

(4824±541.3 kCal) had no statistical discrepancy with the consumed with food calories in members of Q-course, which testified to the ability of the actual ration to compensate for metabolic costs of servicemen during this period.

The above data indicate the inability of the actual diet of servicemen to adequately compensate for the real metabolic costs of their body during training

activities in the Q-course, which can lead to exhaustion, reduced efficiency and premature disqualification at different stages of training.

According to the training program, training complexes of physical activity have a multi-vector character and consist of exercises that are related to various sports and the corresponding metabolic costs. According to the principles of rational nutrition, these metabolic costs must be compensated by the energy that comes with food [2].

Therefore, to ensure the energy balance in the body of members of Q-course, preserve their health and increase efficiency, we have developed an information model for calculating the daily ration to ensure adequate compensation for the actual metabolic costs of Q-course servicemen.

This model is based on the task of determining the quantitative composition of products for the diet, which is able to compensate for the established or projected specific amount of

metabolic costs at different types of complexity of physical activity during the selection and preparation for special force units.

During the selection for the Q-course, servicemen perform tasks of various physical complexity. To optimize the process of ensuring nutrition and more accurate reproduction of quantitative and qualitative nutritional composition of the ration, in the timing of daily activities, all loads were grouped by physical activity, namely: light, moderate, intense and heavy.

At the same time, the daily metabolic costs of servicemen under different types of loads is the initial data for calculating the components of the daily ration and is based on certain ratios of essential nutrients (proteins, fats, carbohydrates) and their contribution to total caloric content.

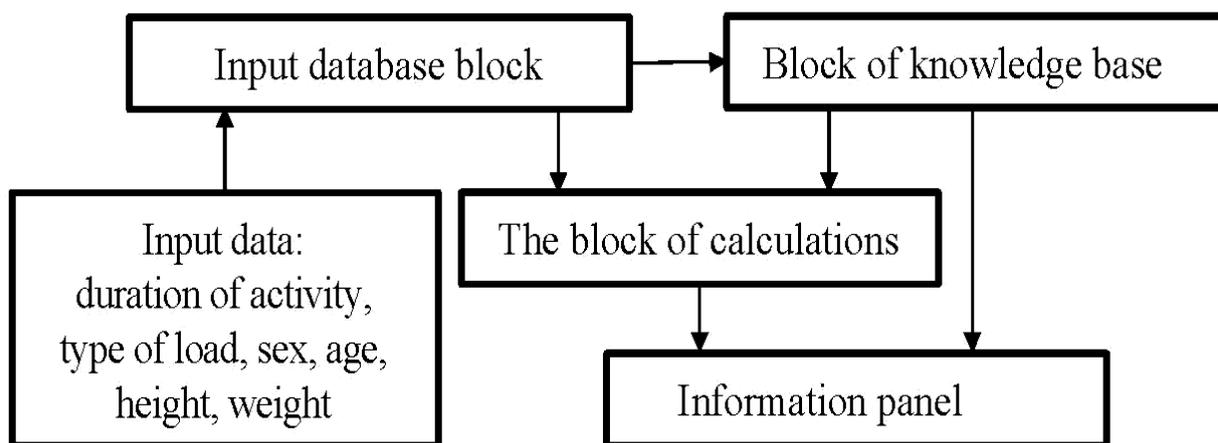The structure of the information model is presented in Figure 2.

Fig. 2. Structure of informstion model

The block of the input database includes the input indicators of the group of servicemen: age, sex and anthropometric parameters (body weight, height) to determine the basic metabolism, timing of all types of daily physical activity, as well as tabular value of the coefficient of physical activity (CFA) corresponding to each of these activities.

The block of knowledge pool (Fig. 3) contains information about the coefficients of physical activity of certain groups of physical activity exercises according to the selection program to the SOF, the rational ratio of nutrients and their contribution (in%) to the total caloric content of the daily ration, loads of servicemen with relevant sports

[2], tabular data of chemical composition (by macro- and micronutrients) in 100 g of food and their energy value in kilocalories (kCal) [4], as well as the value of specific basic exchange (e) depending on the age and sex of the person. When determining the components of the daily ration of servicemen according to the information model, the compliance with the generally accepted quantitative and qualitative characteristics of the nutritional composition of diets according to the formula of balanced nutrition (FBN) is checked [3].

According to WHO recommendations [3], basic exchange per day is calculated by the the data of age, body mass and height.
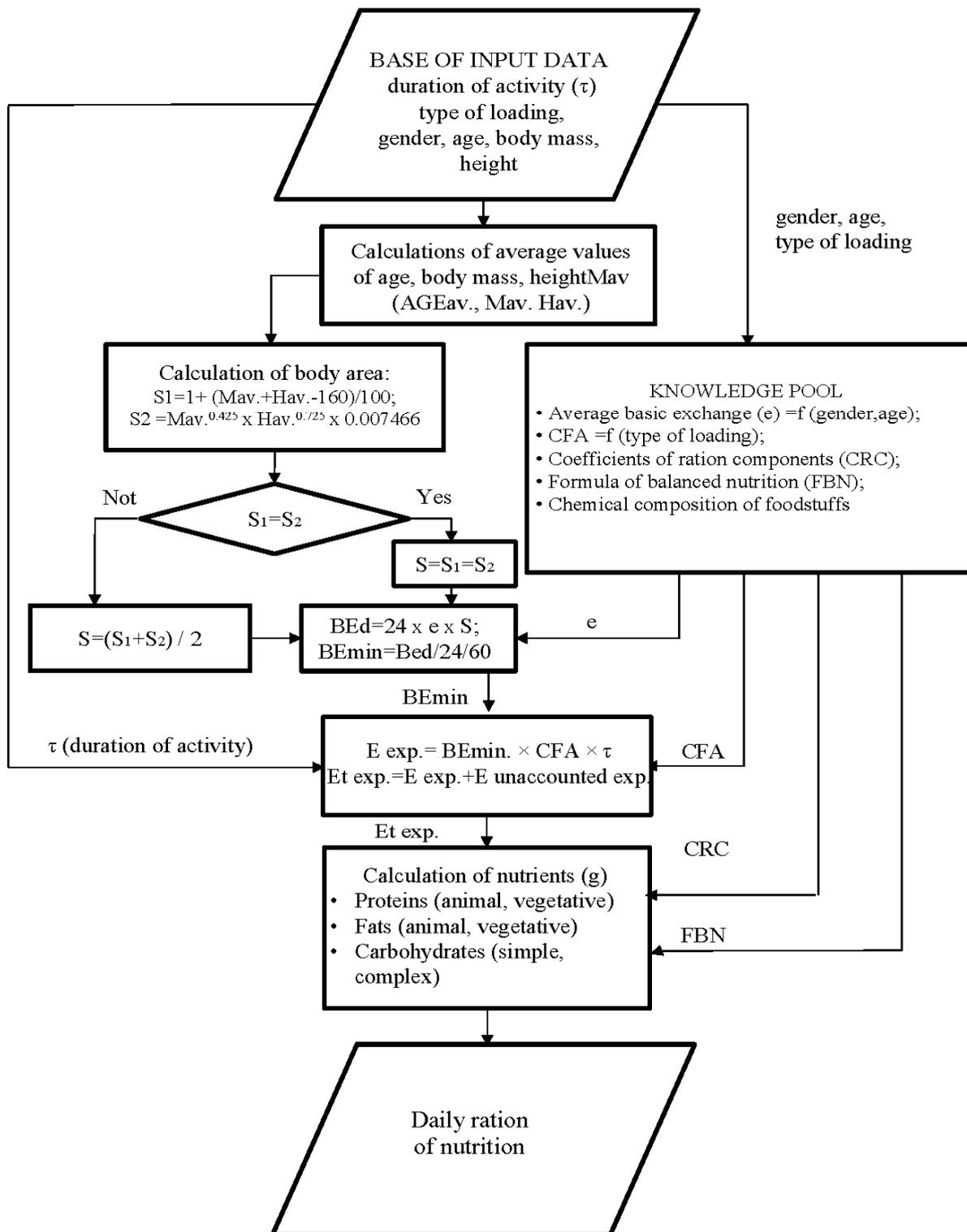
BASE OF INPUT DATA
duration of activity (τ)
type of loading,
gender, age, body mass,
height

gender, age,
type of loading

Calculations of average values
of age, body mass, heightMav
(AGEav., Mav. Hav.)

Calculation of body area:
$S1 = 1 + (Mav. + Hav. - 160)/100$;
$S2 = Mav.^{0.425} \times Hav.^{0.725} \times 0.007466$

KNOWLEDGE POOL
• Average basic exchange (e) $= f$ (gender, age);
• CFA $= f$ (type of loading);
• Coefficients of ration components (CRC);
• Formula of balanced nutrition (FBN);
• Chemical composition of foodstuffs

Not $S_1 = S_2$ Yes

$S = S_1 = S_2$

$S = (S_1 + S_2) / 2$

$BEd = 24 \times e \times S$;
$BEmin = Bed/24/60$

e

BEmin

τ (duration of activity)

E exp. $= BEmin. \times CFA \times \tau$
Et exp. $= E$ exp. $+ E$ unaccounted exp.

CFA

Et exp.

CRC

Calculation of nutrients (g)
• Proteins (animal, vegetative)
• Fats (animal, vegetative)
• Carbohydrates (simple, complex)

FBN

Daily ration
of nutrition

Fig. 3. Operation algorithm of information model

To more accurately determine the rate of basic metabolism one should take into account the area of the body. Therefore, the developed information model uses the calculation of body area using the value of specific basic exchange (e), which determines the rate of total exchange per day.

According to anthropometric data of servicemen, the block of calculations determines the values of the basic exchange per day (BEd) and per 1 minute (BEmin.). According to the timing data of the duration of exercise (τ) and the corresponding

coefficients of physical activity (CFA), the regulated energy expenditures (E exp.) is determined.

Total daily energy expenditures (Et exp.) is the sum of the indicators of calculated regulated energy expenditures (E exp.) (for physical work performance), unregulated (for basic exchange), energy expenditures for specific dynamic action of food and various unaccounted expenditures for energy (E unaccounted exp.) (including psycho-emotional stress). The value of unaccounted energy expenditures (E unaccounted exp.) was taken as 15% of energy expenditures for physical work.

According to the value of Et exp., the bulk quantity of basic nutrients is calculated using the load-bearing coefficients of the balanced ration (CBR).

The components of the daily ration are calculated according to the calculated values of total metabolic costs and the relevant data of the knowledge pool, which include the features of the quantitative ratios of basic nutrients (proteins, fats, carbohydrates) for certain types of physical activity.

The information panel displays the data by which the necessary calculations are performed, the results of calculations and determined quantitative and qualitative indicators of the main nutrients that should be included in the ration at the appropriate average daily metabolic costs.

According to the determined data of the optimal content of proteins, fats, carbohydrates and added into the knowledge pool of tables of chemical composition of food, a quantitative (in grams) set of basic products of the daily ration is calculated which has to provide main components of food in the balanced amount and to adequately compensate for energy expenditures at different phases of the Q-course.

Checking the effectiveness of the information model showed that the energy value of the calculated daily ration corresponded to the energy needs of Q-course servicemen at all phases of the Q-course and had a close correlation with their average daily metabolic costs (r=0.997 at p<0.001) .

The results of analysis of variance showed that the ration calculated according to the model significantly (p<0.001) differed in terms of energy value at different stages of preparation. This gave grounds to check the equality of the average values of the energy value of the calculated ration with the metabolic costs of servicemen according to the Student's t-test separately, in each of the phases. As a result, no significant discrepancies between these studied parameters at any of the preparation phases was found, which proves the effectiveness of calculations using our model.

The ratio of the energy value of the actual and calculated by the information model of rations to the average daily metabolic costs of the Q-course servicemen are presented in Figure 4.
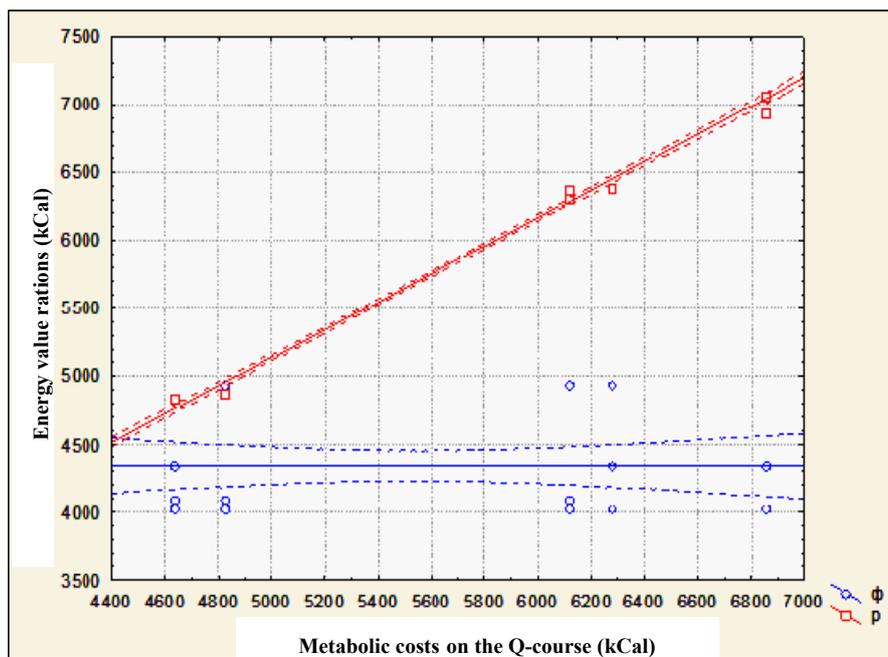

Fig. 4. Indicators of energy value of actual (A) and calculated (C) rations in relation to the established average daily energy expenditures

In Figure 4, the regression model of the energy content of the actual rtion (A) of nutrition is described by the function E=4348 (±406)-0.001 (±0.07) in the absence of its compliance with the registered metabolic costs in the Q-course (r=0.003 at p>0.05).

Instead, the regression model of the energy content of the calculated ration (R) is described by the function E=1.027 (±0.002) P and fully corresponds to the metabolic costs of servicemen (r=0.0999, p<0.001) during training in the Q-course.

This information model formed the basis for the development of Organizational and methodological guidelines for nutrition of servicemen of the Special Operations Forces of the Armed Forces of Ukraine, which were approved and put into effect by the order of the commander of the SOF No. 534 dated 2020.11.11.

After development the information model was sent over to the military unit A2772 for a 5-months' testing during the next Q-course. According to the test results, the model was adopted by the commission and implemented in the practice of the SOF of the Armed Forces of Ukraine as a way to determine the composition of the ration of servicemen to compensate for actual metabolic costs (implementation act dated 2020.12.30).

CONCLUSIONS

1. It was found that the indicators of average daily metabolic costs of Q-course servicemen differ significantly from the energy value of the actual ration during phases I, II, III and V (p<0.001) of training and are not fully compensated by the food provided.

2. The inability of the actual ration to adequately compensate for the real metabolic costs of servicemen can lead to exhaustion of the body, reduced efficiency and premature disqualification at various stages of the Q-course.

3. The Information Model developed and implemented in the practice of SOF can serve as a tool for operational calculation of the bulk of basic foodstuffs in the amount that will ensure adequate energy consumption, rational amount and optimal ratio of proteins, fats and carbohydrates in food with appropriate energy expenditures.

4. The ration calculated according to the information model fully corresponds to the metabolic costs of servicemen (r=0.0999, p<0.001) and is able to adequately compensate for them during the training in the Q-course.

Conflict of interests. The authors declare no conflict of interest.

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