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Individual Rate of Motor Activity as a Criterion for Assessment of Students' Physical Health

Indywidualny wskaźnik aktywności ruchowej jako kryterium oceny zdrowia fizycznego studentów

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SUMMARY

Aim: To develop a methodology for determining the individual rate of motor activity of students in the process of physical education on the basis of indicators of their physical well-being.

Materials and Methods: The research involved 82 first year students aged from 17 to 19 (38 – male students, 44 – female students). Research methods: analysis and generalization of literature, modelling, anthropometry and physiometry, pedagogical testing, experiment, methods of mathematical statistics.

Results: Low existing level of physical development and physical fitness of students both male and female was revealed due to their low motor activity and passive lifestyle. The relationship between the indicators of students' physical well-being and their motor activity were established, the closest connection of motor activity was revealed with the indicators of the Ruffier index. Regression equations were developed, which are the content of the methodology for determining the individual rate of motor activity of students in the process of their physical education.

Conclusions: The obtained results testify to the need for wide introduction of the methodology for determining the individual rate of motor activity of students on the basis of indicators of their physical well-being in the process of physical education. This will allow students to receive information about the appropriate level of physical well-being in accordance with their indicators of physical development, physical fitness and daily motor activity.

Key words: individual rate, motor activity, students, physical well-being, health

Słowa kluczowe: stawka indywidualna, aktywność ruchowa, studenci, samopoczucie fizyczne, zdrowie

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INTRODUCTION

Adequate motor activity is one of the main factors that determine the level of physical health of the population [1]. The strong physical health of young people is one of the most important criteria for the development potential of modern society and indicators of the formation of a personality culture. At the same time, the insufficient level of motor activity of student youth is a factor in the emergence and development of various diseases [2].

According to the World Health Organization [3], the weekly rate of motor activity of a person in the age from 17 to 64 should make at least 150-300 minutes of moderate-intensity aerobic physical activity, or at least 75-150 minutes

of high-intensity aerobic physical activity, or an equivalent combination of physical activity of moderate and high intensity.

According to the scientists [4-6], a person should take an average of 10 000 steps a day. However, the above rates of motor activity are statistically average and do not take into account the individual characteristics of those involved. Given that the rate of motor activity of modern youth is a value that fully meets the biological needs of movements, accounts the functional capabilities of the organism, promotes its physical development and health, so one of the most important scientific tasks of this problem is to develop a methodology for determining individual daily rates of motor

activity of students of higher educational institutions (HEI) in the process of physical education, taking into account their physical well-being.

AIM

The aim is to develop a methodology for determining the individual rate of motor activity of students in the process of physical education on the basis of indicators of their physical well-being.

MATERIALS AND METHODS

We identified the following *tasks* to achieve the aim of the research: to investigate the current level of indicators of physical well-being (physical development, physical fitness and motor activity) of students of HEI; to study the relationship between the indicators of students' physical well-being and their motor activity; to develop a methodology for determining the individual rate of motor activity of students in the process of their physical education.

The research was conducted in 2019-2022 at the National Pedagogical Dragomanov University (Kyiv, Ukraine). The research involved 82 1st year students aged from 17 to 19 (38 – male students, 44 – female students).

Research methods: *theoretical* (analysis and generalization of literature, conceptual and comparative as well as structural and system analysis – to clarify modern approaches to determining motor activity of student youth; modelling – to develop the authors' methodology for determining individual rate of motor activity of students in the process of their physical education); *empirical* (anthropometry and physiometry – to determine the indicators of students' physical development; pedagogical testing – to determine the indicators of physical fitness of students; the Fremmenham technique – to assess the level of motor activity of students); *ascertaining pedagogical experiment* – to assess the indicators of physical well-being of students and determine its relationship with the level of their motor activity; *methods of mathematical statistics* – to carry out qualitative and quantitative analysis and process research results.

Physical development of students was assessed by indicators of height, body mass, vital capacity of the lungs, heart rate at rest and after standard load and hand strength. The following indices were determined on the basis of these indicators: body mass index, vital index, strength index and the Ruffier index. Physical fitness of students was assessed by the following tests: the Romberg test (balance), 30 m run (speed), standing long jump (speed and strength qualities), 4x9 m shuttle run (agility), pull-ups on the horizontal bar (strength, man), push-ups (strength, women), lifting the torso from the prone lying position (strength endurance), torso tilt (flexibility) and swimming for 12 min (endurance). The Framingham method was used to determine the motor activity of students. It allows you to quantify and qualitatively determine the motor activity of the student on the basis of the time tracking of daily activities of various kinds with the registration of the intensity of each type of physical effort. The value of these measurements is presented in the form

of a digital value of the index of physical activity according to time tracking, which records all activities that take more than 5 minutes. The day is described from the moment when the student woke up after a night's sleep to the time when he/she fell asleep.

This research was conducted in accordance with the requirements of the Code of Ethics of the National Pedagogical Dragomanov University. Informed consent was received from all students who took part in this research.

RESULTS

It was found that the indicators of physical development and physical fitness of students were in the range from low to average, which is associated with low motor activity and passive lifestyle. The following indicators of physical well-being for boys were established: heart rate – 81.0 ± 14.0 beats/min, age – 18.0 ± 1.0 years, body mass – 74.0 ± 9.5 kg, body length – 181.5 ± 6.6 cm; for girls: heart rate – 89.2 ± 4.4 beats/min, age – 18.0 ± 0.5 years, body mass – 61.1 ± 8.6 kg, body length – 164.0 ± 6.2 cm. Relevant students' indices were calculated. Thus, the average value of the body mass index for boys was 22.8 ± 2.5 kg/m², for girls – 22.9 ± 2.1 kg/m². The results obtained indicated the average level. According to the results of the research, the vital index for boys was low (47.2 ± 14.4 ml/kg), and for girls – average (48.2 ± 5.4 ml/kg). The indicators of the strength index for both male students ($60.8 \pm 13.1\%$) and female students ($39.0 \pm 6.6\%$) were within low levels. According to the results of the Ruffier index, the level of functional reserve of the heart and adaptation of the body to physical loads for girls was 11.0 ± 3.5 c.u., which was below the average level, for boys – 9.5 ± 4.0 c.u., which was the average level.

The results of testing the level of physical fitness of students showed that the level of endurance for boys on the test of swimming for 12 min made 468.0 ± 102.0 m, for girls – 338.5 ± 58.7 m. The level of strength in the test of push-ups for boys was 10.0 ± 6.9 times, for girls according to the push-ups test – 9.3 ± 5.5 times. The level of strength endurance on the test of lifting the torso for 1 min for boys was 40.6 ± 7.8 times and for girls – 36.1 ± 8.3 times. The level of manifestation of speed and strength abilities according to the results of long jump for boys was 207.0 ± 17.0 cm and for girls – 184.3 ± 22.1 cm. The level of manifestation of speed in the time of overcoming the distance of 30 m was 5.2 ± 0.1 s for boys and 6.5 ± 0.7 s for girls. The level of agility according to the results of the 4x9 m shuttle run was $10.20.8$ s for boys and 11.1 ± 0.9 s for girls. The level of flexibility in the test of torso tilt forward from a sitting position was 5.2 ± 3.6 cm for boys and 15.2 ± 3.8 cm for girls.

The results of the Framingham method for assessing daily physical activity according to 5 levels (basic, sedentary, small, average and high) showed that the level of boys' physical activity was 8.0 ± 1.9 hours at the basic level, which included sleep, and rest in the lying position. Students spend 4.0 ± 1.4 hours at a sedentary level of physical activity (moving in transport, rest in the sitting position and eating). Analysis of the time tracking of daily motor activity of students

showed that most of them had a low level of physical activity (preparation for classes, personal hygiene, walking and training sessions), the duration of which made 9.1 ± 2.6 hours for boys. The indicators of average and high levels of motor activity were the lowest. Thus, the average level of motor activity, which includes housework, walking and morning exercises made 2.6 ± 2.0 hours for boys. The baseline level of motor activity was 8.7 ± 1.6 hours for girls. The girls spent 4.2 ± 1.3 hours at a sedentary level of motor activity. The duration of the low level made 10.8 ± 1.8 hours, the average – 2.6 ± 2.0 hours.

In percentage terms, more than 80% of daily motor activity for boys made at the basic, sedentary and low levels (basic – 31.9%, sedentary – 15.7%, small – 36.5%); for girls – about 90% (basic – 33.4%, sedentary – 16.1%, small – 39.2%). The high level of motor activity included specially organized physical exercises and sports, moving and sports games. It made 5.6% for boys and 3.4% for girls in terms of daily motor activity.

The index of physical activity (IPA) according to the results of the Framingham method application made 25.4 ± 1.5 points for boys and 26.8 ± 2.9 points for girls. Given that the optimal IPA indicator was a value that corresponds to 42 points, which provides eight-hour duration at the basic level, eight-hour duration at the sedentary, two-hour duration in terms of the low-level physical activity and three-hour duration of the high-level activity; such an indicator was not recorded in any student as a result of the research, which confirms the low level of their motor activity.

We conducted the correlation analysis, which established the dependence of the indicators of physical development and physical fitness of students on the level of their motor activity in order to determine the presence and nature of the relationship between motor activity and indicators of physical well-being of students. Only the volume of high level, i.e. the time directly spent on exercise was considered as an indicator of motor activity.

During the correlation analysis the girls revealed a reliable ($p \leq 0.05$) direct relationship between motor activity and indicators of physical well-being: endurance ($r=0.60$), hand strength ($r=0.64$), strength endurance ($r=0.65$), speed and strength qualities ($r=0.45$) and balance ($r=0.52$). They also showed the inverse correlation coefficients between motor activity and the Ruffier index ($r=-0.79$). Motor activity revealed significant ($p \leq 0.05$) correlation relationships with endurance ($r=0.63$), strength endurance ($r=0.59$), speed and strength qualities ($r=0.52$), speed ($r=-0.66$), the Ruffier index ($r=-0.80$), agility ($r=-0.50$) and mass index ($r=-0.50$) for boys.

The research showed that the level of health depends on the indicators of physical well-being and motor activity. Accordingly, a person needs to determine the required rate of motor activity in order to maintain the state of health at the adequate level. The research substantiates the need to develop a methodology for determining individual motor activity of students in the process of their physical education.

The basis of the proposed author's methodology is the process of creating mathematical models in the form of regression equations, where the indices of physical development and physical fitness are used as variables. The parameters included in the independent variables of the mathematical model allow to influence the level of physical well-being of students. In addition, taking into account the real level of physical well-being of students allows them to operate with indicators of their physical well-being and to determine the appropriate level of motor activity, based on their own data.

Independent variables include the most informative parameters that have the most significant relationship with the level of motor activity. Thus, the regression equation rightly includes variable indicators of physical development and physical fitness, which can be purposefully influenced by the performance of regular physical activity in the process of motor activity, as well as the daily level of individual motor activity directly related to exercise. Given the above, the dependent variable Y is chosen integral value, which depends on the indicators of physical development, motor fitness, functional capabilities, and the daily level of motor activity, namely the Ruffier index, as this indicator is the most informative one of physical well-being for girls and boys and has the closest correlation relationship with motor activity of all the studied parameters. This indicator is conditionally called the level of health.

Thus, to develop the methodology for determining the individual motor activity of students in the process of their physical education, we calculated multiple regression equations to determine the dependence of the integrated indicator of physical well-being on the most important parameters of physical development, physical fitness and motor activity of students. The mathematical model of the appropriate level of physical well-being for female students is as follows: $Y = 19.38 - 0.02x_1 - 0.25x_2 + 0.035x_3 - 0.1x_4 + 4.0x_5 - 0.13x_6$, where Y is the Ruffier index, x_1 is endurance, x_2 is strength, x_3 is strength endurance, x_4 is speed and strength qualities, x_5 is balance and x_6 is motor activity. The mathematical model of the appropriate level of physical well-being for male students is as follows: $Y = -19.8545 - 1.1795x_1 + 0.00743x_2 - 0.0056x_3 + 0.0465x_4 - 0.9583x_5 + 5.5792x_6 - 0.1112x_7$, where Y is the Ruffier index, x_1 is body mass index, x_2 is endurance, x_3 is strength endurance, x_4 is speed and strength qualities, x_5 is speed, x_6 is agility and x_7 is motor activity.

We slightly modified the rated scale and the assessment of the Ruffier index for the convenience of using the mathematical model i.e. the integrated health indicator was combined into 3 levels: high, average, satisfactory. We can determine the appropriate level of health of an individual student by substituting informatively significant individual indicators of physical development, physical fitness, as well as real indicators of physical activity in the formula that corresponds to a particular age and sex (Table 1).

The appropriate rates of individual daily motor activity depending on the level of health of students were calculated upon determination of the appropriate level of health and

Table 1. Appropriate levels of students' health, c.u.

| Levels | Girls/Boys |
|--------------|------------|
| High | ≤6 |
| Average | 7-9 |
| Satisfactory | 10-14 |

Table 2. Appropriate rates of daily motor activity of average intensity of students, according to the level of health, min

| Levels of health | Girls | Boys |
|------------------|----------|----------|
| Satisfactory | below 25 | below 70 |
| Average | 26-50 | 71-105 |
| High | ≤51 | ≤106 |

the indicators of physical fitness, i.e. the time required for moderate-intensity exercise to maintain proper health was determined (Table 2), by formulas: for girls: $x_6 = (Y + 19.38 + 0.02x_1 + 0.25x_2 - 0.035x_3 + 0.1x_4 - 4.0x_5) / -0.13$; for boys: $x_7 = (Y + 19.8545 + 1.1795x_1 - 0.00743x_2 + 0.0056x_3 - 0.0465x_4 + 0.9583x_5 - 5.5792x_6) / -0.1112$.

It is assumed that students actively involved in exercising can consciously improve their health since motor activity, which depends on motivational factors, is the most variable indicator. It is important to note that the level of motor activity is determined not so much by the time of exercise as by intensity, i.e. the greater the intensity of an exercise, the less time it takes to perform it, and vice versa.

The peculiarity of our methodology is to determine the individual rates of motor activity of different aerobic efficiency, taking into account the indicators of physical development and physical fitness of those involved. The rates of aerobic efficiency were determined according to the methodology for determining the rates in physical education and sports: if $x < x - 0.5\delta$, it is a low level of aerobic efficiency; if $x - 0.5\delta \leq x \leq x + 0.5\delta$, then this is an average level of aerobic efficiency; if $x > x + 0.5\delta$, then this is a high level of aerobic efficiency.

The low level of aerobic efficiency include the following sports and exercises: bowling, judo, static yoga, stretching exercises and weight training exercises. The average level includes badminton, volleyball, football, basketball, ice skating, table tennis and slow dancing. The high level includes walking from 3.8 to 7.2 km/h, swimming, rollerblading, cycling and running from 8.8 to 16 km/h.

Therefore, having determined the student's level of health and the required rate of motor activity, the student can determine the level of aerobic efficiency and choose the appropriate type of exercise. This calculation makes it possible to set the pace of a particular type of physical activity to achieve the desired level of health.

DISCUSSION

The analysis of the scientific and methodological literature [7, 8] confirms the importance of pedagogical control in the physical education of HEI students not only

in theoretical but also in practical terms. It is established that the issue of developing and implementing a system of control and evaluation of motor activity, which would meet modern requirements of the educational process and have an effective impact on improving the status of physical education and attracting young people to exercise is still acute nowadays [9, 10].

The work of many scientists [11, 12] states that modern student youth is characterized by a low level of responsibility for their own health, the prevalence of health risk factors (smoking, alcohol and drugs abuse, etc.). Urgent socio-pedagogical as well as treatment-and-prophylactic measures are needed to preserve and strengthen the health of modern youth. In this regard, the process of physical education in the HEI should be aimed primarily at developing a healthy lifestyle, an active mode of behaviour in students, by increasing motor activity.

The analysis of the literature sources [2, 13, 14] showed that the low level of motor activity contradicts the biological laws of human development and leads to negative changes in the body, which are manifested in reduced functional activity of organs and systems; in violation of the processes of nervous and humoral regulation; in the appearance of trophic and degenerative changes of the musculoskeletal system, its neuromuscular and skeletal components; in violation of metabolic processes; in increasing the volume of adipose tissue. The importance of motor activity is especially growing in modern conditions of society, when due to the rapid development of scientific and technological progress, as well as mass computerization, there is hypodynamia in children, adolescents and students.

Physical education of students in the conditions of use of modern information technologies should be based on specially developed computer programs, realization of programs-complexes of physical exercises in various forms of training sessions. The use of modern information technology will allow to predict, control the dynamics of changes in physical well-being, choose individual loads, determine the individual level of motor activity necessary for standard functioning of the body, and timely assess somatic health in the process of physical education.

The analysis of the scientific literature on the researched problem [8, 15] revealed the availability of methodologies for determining the individual rate of motor activity of students, developed on the basis of modern information and computer technologies. However, there are not enough methodologies that take into account the indicators of physical well-being, i. e. indicators of physical development and physical fitness of those involved, which determined the choice of the research. It is worth noting that in today's world; most young people have fitness bracelets that can be used in any sport. Most of all the models look quite simple and are identical to each other, but there are many different fitness programs for each gadget. Fitness bracelet software is a specialized utility that allows you to synchronize various information from fitness bracelets to smartphones via a wireless connection. However, these programs are

multifunctional, with most of them related to determining the state of health, the level of physical development and physical fitness of those who go into sports. At the same time, insufficient programs have been developed to determine the individual level of motor activity of students taking into account their physical well-being (anthropometric indicators, physical fitness and morphofunctional indices). Therefore, we have developed the author's methodology for determining the individual rate of motor activity of students in the process of physical education on the basis of indicators of their physical well-being. Multiple regression equations, which constitute the content of the author's methodology, allow students to obtain information about the appropriate level of physical well-being in accordance with their indicators of physical development, motor fitness and daily motor activity. Based on this methodology, we have developed a computer program named "Activity for health", which reflects the process of determining individual motor activity, creating an individual program of training, analysis and adjustment of practical results. Our results complement and expand the findings of many scientists [16-18].

CONCLUSIONS

1. The analysis and generalization of the scientific and methodological literature revealed that the priority of improving the system of physical education is the formation of young people's caring attitude to their own health, sustainable needs and habits of motor activity not only during physical education training sessions, but also in everyday life. This is especially true today, during the pandemic, when students in many countries around the world are forced to study remotely and exercise independently during quarantine.
2. The current level of physical development and physical fitness of the HEI students has been studied. It was found that the studied indicators are in the range from low to average, which is associated with low motor activity and passive lifestyle.
3. As a result of the correlation analysis, the existence of a close relationship between the indicators of physical well-being and the level of their motor activity was established.
4. The methodology for determining the individual motor activity of students in the process of their physical education was developed based on multiple regression equations, which provide information about the appropriate level of physical well-being of students, according to the indicators of their physical development, physical fitness and motor activity. The Rufier index was found to be an integral indicator of students' physical well-being, as it was proved to be most closely related to motor activity.
5. The peculiarity of the developed methodology is the determination of the individual rate of motor activity of different aerobic efficiency, taking into account the indicators of physical development and physical fitness of students. The student can independently choose the level of aerobic efficiency and the appropriate type of physical activity having determined the level of his/her physical well-being and the required rate of motor activity.

Prospects for further research are to investigate the influence of the methodology for determining the individual rate of motor activity of students on the quality of their life.

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