A method for tracking and evaluating students' physical activity using wearable devices

UDC 796.015.62

PhD **A.A. Kovalev**
Immanuel Kant Baltic Federal University, Kaliningrad

Corresponding author: sheynin@mail.ru

Received by the editorial office on 29.04.2025

Abstract

Objective of the study is to scientifically substantiate a system of pedagogical control of motor activity based on data from wearable devices.

Methods and structure of the study. The work involved: theoretical analysis, generalization of data from scientific publications, statistical and rank analysis.

Results and conclusions. The system, developed for monitoring and assessing the motor activity (MA) of those engaged in health-improving physical culture (HPE), is closely integrated with the process of setting physical activity standards. The key component is the information and analytical complex (IACOM), which includes a heart rate (HR) database, tools for analysis and visualization, and a user interface. Elements of the system of pedagogical control of motor activity (SPKDA) are built into each stage of standardization. The main activities for monitoring and assessing MA are shown in the figure. This system of pedagogical control expands the possibilities of personalized standardization of physical activity, providing the feedback necessary for effective management of the motor activity of those engaged in HPE.

Keywords: *monitoring, assessment, physical activity, health-improving physical culture, heart rate, HR, pedagogical control system, physical activity regulation, feedback, physical activity management.*

Introduction. The realities of scientific and technological progress determine the modernization of all spheres of society, including the sphere of health-improving physical education (HPE) [1]. Pedagogical control (PC) is an important part of HPE, which is understood as the process of obtaining information about the physical condition of those involved in HPE in order to improve the effectiveness of physical education and health-improving activities (PEH). It is based on monitoring the volume and intensity of physical activity in accordance with the physical and functional state of the person involved. It is carried out in the form of preliminary, current, operational, stage-by-stage and final control of the DA of those involved in HPE. It can be carried out both with the help of a teacher and independently through self-control.

Objective of the study is to scientifically substantiate a system of pedagogical control of motor activity based on data from wearable devices.

Methods and structure of the study. The work involved: theoretical analysis, generalization of data from scientific publications, statistical and rank analysis.

Results and conclusions. In order to improve the systematicity, individualization and digitalization of physical education, a system of pedagogical control of motor activity (SPKDA) was developed, which represents a set of measures for monitoring and assessing the activity of those involved in general physical education, as well as an information and analytical complex (IACOM), which includes a heart rate (HR) database, calculation and graphic modules and a user interface. Elements of the SPKDA are integrated into each stage of the physical activity standardization technology. The main PC activities for monitoring and assessing the activity of those involved are shown in Figure 1 [2-4].

The first stage of the technology includes comprehensive diagnostics, collecting heart rate data using smart

watches [1, 5] and preliminary PC. Preliminary control extends to the first three stages of the technology: diagnostic, standardization and design. At the second stage of the technology, a system of daily heart rate measurement data is formed, components of the standardization methodology are implemented [2, 3], procedures for ranking heart rate data analysis are carried out, personalized physical activity standards are developed, and indices of optimal physical activity for those involved in general physical fitness are calculated (Table 1) [6].

The third design stage should help those involved in general physical fitness develop a physical fitness strategy that allows them to fulfill the developed personalized physical activity standards [1, 4].

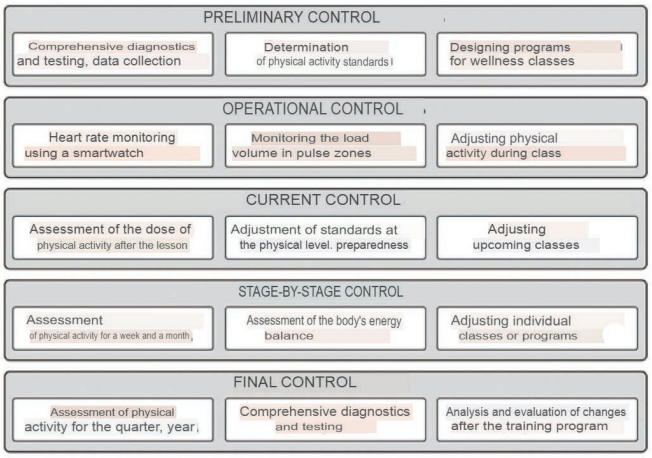

Fig. 1. *Complex of pedagogical control measures for monitoring and assessing the physical activity of those involved*

At the fourth stage, in which the designed physical fitness program is implemented, operational, current and staged PC is carried out. Within the framework of the methodology [2, 3], operational control is carried out according to the indicator of temporary stay in the heart rate training zones. The operational control data allow regulating the dynamics of the load in the process of physical fitness, as well as assessing the received dose by comparing it with personalized standards (Fig. 2) [5].

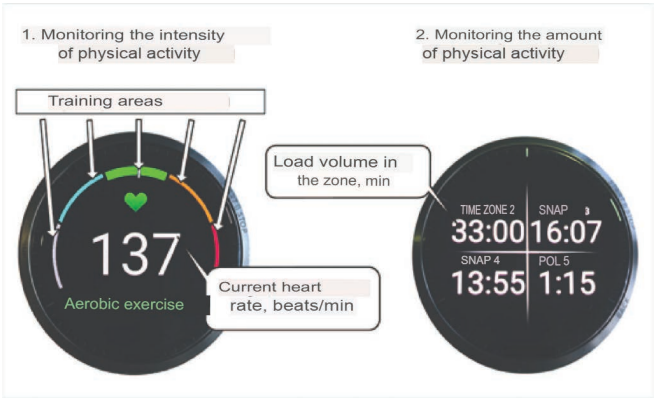

Fig. 2. *Monitoring the intensity and volume of physical activity*

Current monitoring is carried out to determine the reaction of the body of those involved in the load after the physical training program, as well as to assess the fulfillment of the personalized norm of physical activity. For this, the time volume of being in the training zones of the heart rate is compared with the planned for the fulfillment of a certain personalized norm (Table 2).

Stage-by-stage control is carried out to obtain information on the cumulative (total) training effect that has arisen over the period under consideration (week, month). Within the framework of the developed standardization methodology [2, 3], this information is formed in the form of an index of optimal physical activity [6], which allows monitoring and evaluation of daily and weekly and DA (Table 3) [6].

The fifth stage includes checking and evaluating the effectiveness of the physical activity program, as well as the implementation of the final PC. The purpose of the final control is to evaluate the degree of implementation of the physical activity program, identify the results of the completed physical activity program. An example of accounting for the optimal physical activity index for the year is shown in Table 4 [6].

The SPKDA complements the IACOM, which includes a heart rate database, calculation and

Table 1. Personalized norm of physical activity and index of optimal physical activity for one of the involved

Heart rate zone name	Zone range, bpm	Time spent in zones depending on the level of physical fitness, min		
		Short	Average	High
Maximum	166 – 184	0	3	8
Anaerobic	147 – 165	1	4	9
Aerobic	129 – 146	4	9	13
Fitness zone	110 – 128	10	19	25
Total time, min	–	15	35	55
Index value (low, optimal, high), points	–	27	64	100

Table 2. Examples of assessing the dose of physical activity after the session

Example number	Example 1		Example 2		Example 3	
Zone ranges, bpm	Lower limit norm	Received dose	Average limit norm	Received dose	Upper limit norm	Received dose
168 – 185	1	0	4	1	8	6
149 – 167	1	0	4	3	7	25
131 – 148	4	3	7	10	12	33
111 – 130	9	10	22	26	31	25
Time, min	15	13	37	40	58	89
Grade	Low dose		Optimal dose		Increased dose	

Note: The intensity ranges of the zones are calculated for a 35-year-old subject.

Table 3. Accounting for the index of optimal physical activity for a month

Indicator	Week of the month				Average value of the index and its assessment
	1st	2st	3st	4st	
Index value	30	17	35	72	38,5
Rating YES	Optimal	Low	Optimal	Increased	Optimal

Note: The optimal activity values in this example range from 26 to 64 points.

Table 4. Accounting for the optimal physical activity index for the year

Indicator	Month of the year												Average value of the index and its assessment
	1	2	3	4	5	6	7	8	9	10	11	12	
Index value	7	12	17	27	43	67	30	22	70	35	20	10	30
Rating YES	L	L	L	O	O	P	O	L	P	O	L	L	Optimal

Note: The values of optimal activity in this example range from 26 to 64 points, where L is low activity, O is optimal, and P is high.

graphic modules, and a user interface. Fig. 3 shows the structure of the information and analytical complex of the SPKDA. Within the framework of the creation of the information and analytical complex of the SPKDA, a database [7] and computer programs [8-11] were developed. Thus, the SPKDA was developed, which performs the main function – the implementation of feedback in the management of the activity of those engaged in OFC. In this case, the means of preliminary, operational and current control is a personalized norm, and the stage and control - an index of optimal physical activity. The SPKDA includes two complexes: a set of measures for monitoring and assessing the activity of those engaged in OFC and the IACOM.

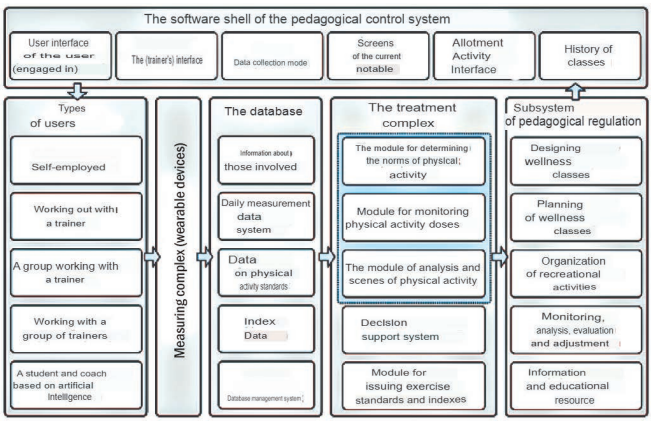

Fig. 3. Information and analytical complex of the system of pedagogical control of motor activity

Conclusion. The need of society to increase the level of systematicity, individualization and digitalization of health-improving activities for those involved requires the improvement of the PC system in OFK. The proposed SPKDA of those involved in OFK will ensure the proper implementation of personalized standards of physical activity, improve the indicators of the psychophysical state of those involved, increase their level of motivation and actualize the need for systematic physical exercise.

References

1. Kovalev A.A. Normirovanie fizicheskoy nagruzki na osnove cifrovyh dannyh nosimyh ustroystv. Teoriya i praktika fizicheskoy kultury. 2024. No. 4. Pp. 62-64.

2. Kovalev A.A. Metodologiya normirovaniya fizicheskoy nagruzki v ozdorovitelnoy fizicheskoy kulture posredstvom cifrovyh tekhnologiy. Uchenye zapiski universiteta im. P.F. Lesgafta. 2024. No. 3 (229). Pp. 126-131.
3. Kovalev A.A. Metodologiya normirovaniya fizicheskoy nagruzki studentov SMG. Adaptivnaya fizicheskaya kultura. 2024. No. 1 (97). Pp. 29-31.
4. Kovalev A.A. Tekhnologiya normirovaniya fizicheskoy nagruzki v OFK. Nauka i sport: sovremennye tendencii. 2024. Vol. 12. No. 1. Pp. 144-152.
5. Kovalev A.A. Cifrovoy monitoring CHSS zanimayushchegosya kak instrument opredeleniya personificirovannyh norm fizicheskoy nagruzki. Fizicheskaya kultura: vospitanie, obrazovanie, trenirovka. 2024. No. 2. Pp. 47-49.
6. Kovalev A.A., Gnatyuk V.I., Kivchun O.R., Zaitsev A.A. Razrabotka indeksa optimalnoy fizicheskoy aktivnosti dlya morskih specialistov. Morskie intellektualnye tekhnologii. 2022. No. 4-3 (58). Pp. 100-104.
7. Svidetelstvo o gosudarstvennoy registracii bazy dannyh №2025620060. Baza dannyh CHSS dlya normirovaniya fizicheskoy nagruzki. V.I. Gnatyuk, A.A. Zaytsev, A.A. Kovalev, P.V. Kozlov, D.V. Lepekho – Application No. 2024625995. Date of receipt: December 10, 2024. Registered in the Database Registry on January 10, 2025.
8. Svidetelstvo o gosudarstvennoy registracii programmy dlya EHVM № 2025610213. Programma preobrazovaniya sekundnyh izmereniy CHSS v minutnye. V.I. Gnatyuk, A.A. Zaytsev, A.A. Kovalev, P.V. Kozlov, D.V. Lepekho – Application No. 2024690328. Date of receipt: December 10, 2024. Registered in the Register of Computer Programs: January 10, 2025.
9. Svidetelstvo o gosudarstvennoy registracii programmy dlya EHVM № 2024691507. Programma normirovaniya fizicheskoy nagruzki dlya zanimayushhihsya OFK. V.I. Gnatyuk, A.A. Zaitsev, A.A. Kovalev, P.V. Kozlov, D.V. Lepekho – Application No. 2024690023. Date of receipt 12/9/2024. Registered in the Register of computer programs on 12/23/2024.
10. Svidetelstvo o gosudarstvennoy registracii programmy dlya EHVM № 2025619708. Programma rascheta indeksa optimalnoy fizicheskoy aktivnosti dlya zanimayushhikhsya OFK. V.I. Gnatyuk, A.A. Zaitsev, A.A. Kovalev, P.V. Kozlov – Application No. 2025617204. Date of receipt 03/31/2025. Registered in the Register of computer programs on 04.07.2025.
11. Svidetelstvo o gosudarstvennoy registracii programmy dlya EHVM№ 2013611936. Optimalnyy kompleks fizicheskih uprazhneniy. A.A. Sheinin, M.V. Sheynina, V.I. Gnatyuk, A.A. Merkulov – Application No. 2012661160. Date of receipt: December 14, 2012. Registered in the Registry of Computer Programs: February 8, 2013.