Proceeding

*Supplementary Issue: Winter Conferences of Sports Science. Costa Blanca Sports Science Events, 24 April 2020. Alicante, Spain.*

# Individual system of self-monitoring of the daily motor activity of athletes

ROMAN SERGEEVICH NAGOVITSYN[1] , ALEKSANDER YURIEVICH OSIPOV[2], DENIS VASILEVICH LOGINOV[3], DMITRY SERGEEVICH PRIKHODOV[4], ANNA VLADIMIROVNA VAPAEVA[5]

*[1]Glazov State Pedagogical University, Glazov, Russian Federation*
*[2]Department of Physical Culture, Siberian Federal University, Krasnoyarsk State Medical University named after professor V.F. Voyno-Yasenetsky, Siberian Law Institute of the Ministry of Internal Affair of Russia, Russian Federation*
*[3]Department of Physical Culture, Siberian Federal University, Krasnoyarsk State Medical University named after professor V.F. Voyno-Yasenetsky, Reshetnev Siberian State University Science and Technology, Krasnoyarsk State Pedagogical University named after V.P. Astafyev, Russian Federation*
*[4]Department of Physical Culture, Siberian Federal University, Krasnoyarsk State Medical University named after professor V.F. Voyno-Yasenetsky, Reshetnev Siberian State University Science and Technology, Russian Federation*
*[5]Department of Physical Culture, Siberian Federal University, Russian Federation*

## ABSTRACT

Background: The implementation of daily and weekly self-control of individual motor activity, consisting of various speed modes, is not a systematically studied issue. The aim of the study was to develop an individually-differentiated system of self-monitoring of daily physical activity of athletes to increase their motor regime and prove its effectiveness by increasing the level of physical development and health of participants in the experiment. Study participants: Thirty-two subjects from 18 to 25 years of age, engaged for 12 weeks at the Sports Club "Progress"(Glazov, Russia). Interventions: self-monitoring by the participants of this research on a ranking system for diverse types of physical exercises by their correlation to one ordinary step or author's motor unit. Main outcome measures: the author's self-monitoring system contributes to lowering the body mass index of athletes and developing their endurance. However, its implementation is effective in increasing the level of physical health only among athletes, stably, systematically and without significant deviations in the level of weekly physical activity performing physical activity. The results of the study. the implementation of daily monitoring of motor activity of young people in various motor modes stimulates respondents to increase their motor daily, weekly and monthly activity. Findings. The author's recommendations for the implementation of continuous self-monitoring will provide feedback to the user of the programme, increase motivation for setting individual goals of amateur athletes and strategies for their further achievement.
**Keywords**: Motor activity; Self-monitoring; Physical development; Health.

**Cite this article as:**
Nagovitsyn, R.S., Osipov, A.Y., Loginov, D.V., Prikhodov, D.S. & Vapaeva, A.V. (2020). Individual system of self-monitoring of the daily motor activity of athletes. *Journal of Human Sport and Exercise, 15*(2proc), S118-S128. doi:https://doi.org/10.14198/jhse.2020.15.Proc2.01

**Corresponding author.** *Glazov State Pedagogical University, Glazov, Russian Federation. http://orcid.org/0000-0003-4471-0875*
E-mail: gto18@mail.ru
Supplementary Issue: Winter Conferences of Sports Science. Costa Blanca Sports Science Events, 24 April 2020. Alicante, Spain.
JOURNAL OF HUMAN SPORT & EXERCISE ISSN 1988-5202

**doi:10.14198/jhse.2020.15.Proc2.01**

## INTRODUCTION

Recently, there has been a persistent trend towards a deterioration in the physical and functional development of youth (Lo Cascio et al., 2017). Socio-economic instability, an increase in psycho-emotional stress significantly increase the requirements for the level of physical health of students, which is the main resource potential of any state (Brown et al., 2003; Troiano et al., 2012; Nagovitsyn et al., 2019).

One of the main directions in solving this urgent problem is the implementation of group and independent physical education and sports, which are the basis in the systematization of motor activity of the population (Haskell et al., 2007; Wennman et al., 2019). Physical exercises are represented in various directions: from simple types of walking and running (Eakin et al., 2007; Plotnikoff & Karunamuni, 2011), to non-traditional types of physical activity (Sallis & Saelens, 2000; Nagovitsyn et al. 2019). However, one of the most accessible types of motor activity and nature-like forms of manifestation of a physical culture lifestyle are aerobic types of physical exercises or cyclic types of physical culture and sports (Vuori, 1998; Cupples et al., 2013). Which, according to some authors (Liu et al., 2012; Troiano et al., 2014), have the highest level in terms of popularity of classes (Brown et al., 2003; Nagovitsyn et al., 2018), the most significant healing effect of all areas of physical education and sports (Vuori, 1998; Kraus et al., 2019), as well as the opportunity to optimize the level of daily physical activity of youth in the shortest possible time (Sallis & Saelens, 2000; Warburton et al., 2006).

In the process of analysing numerous studies to optimize daily and weekly physical activity of youth, the most effective forms and methods of aerobic exercise were identified (Helsel et al., 2007; Dyrstad et al., 2014). Authors mark (Sallis & Saelens, 2000; Buckley et al., 2019), that various types of aerobic sports in their diverse forms and varieties can actively influence not only the state of health, the level of physical fitness and the functional state of the body, but also the mental and professional-applied working capacity of young people (Namba et al., 2016; Kirwan et al., 2012).

In turn, the growing implementation of various mobile technologies every year (Troiano et al., 2014; Nagovitsyn et al., 2018) in the training process on cyclic types of physical exercises allowed to identify a separate scientific direction (Tsai et al., 2007; Yang & Hsu, 2010). In a number of works in this field, studies aimed at studying the effects of specific motor modes have gained particular relevance (Freedson & Miller, 2000; Harvey-Berino et al., 2004), in particular, the daily number of steps taken by participants in various experiments on specific systems of the male or female body (Wennman et al., 2019). For example, special pedometers for studying locomotor individual daily activity of people (Plotnikoff & Karunamuni, 2011), in weekly or monthly cycles (Eakin et al., 2007; Dyrstad et al., 2014). At the same time, a systemically studied issue is the development of a complex of daily monitoring of youth physical activity in various motor modes and its impact on the physical health of the population through an increase in their physical activity.

The insufficient development of the methodological foundations for the design of motor activity of the population determined the aim of the study - to develop an individually differentiated system of self-monitoring of daily physical activity of athletes to increase their motor regime and to prove its effectiveness by increasing the level of physical development and health of the participants in the experiment.

## MATERIAL AND METHODS

### *Participants*

The study was conducted on the basis of the sports club "Progress" in Glazov for 12 weeks. Thirty two subjects from 18 to 25 years old participated, regardless of gender. All participants in the experiment performed daily and weekly self-monitoring of individual motor activity, consisting of various speed modes, during the study period of 12 weeks. The implementation of the experimental work was focused on targeted stimulation of the participants in the experiment to independent, systematic, optimal physical activity to maintain the body's health. The main goal set before the participants of the study before the experiment was to realize physical activity during the day according to the principle of “at least 10000 steps per day” (Eakin et al., 2007; Kirwan et al., 2012) daily and weekly cycles. During the experiment, participants in the study had to score at least 840000 steps or proprietary motor units in 12 weeks. Before the start of the study, all participants in the experiment had the experience of self-study with low and medium intensity of physical activity, at least 2-3 times a week.

At the end of the study, the groups were divided into experimental (n = 12) and control (n = 20) groups. Respondents who were able to fulfil the basic condition of the experiment within 12 weeks were enrolled in the experimental group (EG). The implementation of this condition included daily physical activity in various motor modes, equal to the generally recognized formula of “10,000 steps per day” (Eakin et al., 2007; Kirwan et al., 2012). Participants who were unable to implement such a daily or weekly motor regimen during the designated time were enrolled in the control group (CG).

### *Research methods*

To determine the impact of the study on the body through an analysis of the cardiovascular system of the respondents, an express assessment was used to determine the level of physical health (HS) according to the method of V.I. Lyakh. $PH = 0.011*HR + 0.014*Aps + 0.008*Apd + 0.014*A + 0.009*W - 0.009*G - 0.27$, where HR - heart rate per minute at rest, APs - arterial systolic pressure, APd - arterial diystolic pressure, A - age in years, W - body weight in kilograms, G - body growth, cm. High level = $PH < 2.4$, average level = $2.4 \leq PH < 2.8$, low level = $2.8 \leq PH < 3.2$, critical level = $3.2 \leq PH$ (Lyakh,1998).

To analyse the effect of the experiment on the body through monitoring the total metabolism in the respondents' body, an express assessment was used to determine the level of body mass index (BMI). BMI = weight in kilograms / height in meters squared. High level (optimal weight) = $19 \leq BMI < 25$, average level (overweight) = $25 \leq BMI < 30$, low level (obesity) = $30 \leq BMI < 35$, critical level (morbid obesity) = $35 \leq BMI$

Monitoring the level of physical development through determining the level of endurance (LE) of the body was carried out using testing on the steps of the Russian physical culture and sports complex “Ready for work and defence”: VI level - running for boys 3000 meters (min., sec.) or running for girls 2000 meters (min., sec.). Testing performance was ranked by the following levels (boys/girls): high level (golden sign) = LE ≤ 12.30/10.30; average level (silver sign) = 12.30/10.30 < LE ≤ 13.30/11.15; low level (bronze sign) = 13.30/11.15 < LE ≤ 14.00/11.35; critical level (unsigned) = 14.00/11.35 < LE.

### *Organization of the study*

Based on the analysis of a detailed study of special scientific literature on the energy consumption of respondents for motor activity at different speeds and under different conditions (Kurpad et al., 2006; Tsai et al., 2007) special recommendations were created. The author's development included the ranking of various types of physical exercises in various speed modes according to their correlation measurement to one ordinary step of the respondent or motor unit.[8] As a result, differentiated coefficients were proposed for the actual types of physical exercises and an individually-differentiated system of self-monitoring of daily motor activity of athletes was developed (Table 1).

Table 1. Individually-differentiated system of self-monitoring of daily motor activity of athletes.

| Coefficient | Exercise characteristic |
|---|---|
| 60X | Walking (2.5-3 km/h); bike simulator (0.5-0.6 Wat/kg); step exercise (f * h = 9.5-12) |
| 75X | Walking (3-3.5 km/h); bicycle (7-8 km/h); bike simulator (0.6-0.7 Wat/kg); step exercise (f * h = 12-14.5) |
| 90X | Walking (3.5-4 km/h); bicycle (8-8.5 km/h); rowing (50-55 m/min); swimming (10 m/min); bike simulator (0.7-0.8 Wat/kg); step exercise (f * h = 14.5-17) |
| 120X | Walking (4.5-5 km/h); bicycle (8.5-10 km/h); swimming (15 m/min); rowing (55-60 m/min); bike simulator (0.9-1 Wat/kg); step exercise (f * h = 17-19.5) |
| 150X | Walking or slow running (5.5-6 km/h); bicycle (10-15 km/h); rowing (60-70 m/min); swimming (15-20 m/min); bike simulator (1.1-1.2 Wat/kg); skates or rollers (8-10 km/h); step exercise (f * h = 19.5-22) |
| 180X | Running (6-6.5 km/h); bicycle (15-16 km/h); rowing (70-80 m/min); skiing (5.5-6 km/h); skates or rollers (13-15 km/h); swimming (25-30 m/min); bike simulator (1.3-1.5 Wat/kg) |
| 210X | Running (6.5-7 km/h); bicycle (16.5-17.5 km/h); skiing (6-6.5 km/h); rowing (80-90 m/min), swimming (30-35 m/min), bike simulator (1.6-1.7 Wat/kg); skates or rollers (15-16 km/h) |
| 240X | Running (7-8 km/h); bicycle (17.5-20 km/h); rowing (90-100 m/min); swimming (35-40 m/min); skiing (6.5-7 km/h); bike simulator (1.8-2 Wat/kg) |
| 300X | Running (9-10 km/h); bicycle (20-21 km/h); skiing (7-8 km/h); kayaking (45-50 m/min); swimming (40-50 m/min); bike simulator (2.1-2.2 Wat/kg) |
| 360X | Running (10-11 km/h); bicycle (21-22 km/h); skiing (8-8.5 km/h); rowing (100-110 m/min); swimming (50-52 m/min); bike simulator (2.2-2.3 Wat/kg) |
| 420X | Running (11-12 km/h); bicycle (21.5-22 km/h); skiing (9-10 km/h); bike simulator (2.3-2.5 Wat/kg); rowing (more than 110 m/min); swimming (52-55 m/min) |

**X - Duration of the performance of motor activity in minutes; step exercise: f - Rise frequency in 1 minute, h - Projectile height in meters.*

Using the presented differentiation of motor activity (Table 1), the study participants calculated the individual daily regimen in motor units. For the starting value, a coefficient of 60X was taken. He, in turn, corresponded to the implementation of the following physical exercises performed in 60 seconds: 60 steps per minute with an average walking speed of 2.5-3 km / h, exercise on a stationary bike with a load of 0.5-0.6 Wat/kg or step exercise. If a participant in this group could not withstand the basic condition of the experiment (at least 10,000 motor units per day), he was offered the opportunity to perform a step exercise at home. This physical activity included climbing a special projectile of height - h (step, bench, cube, etc.). The subject became facing the projectile. He independently began the exercise according to the Harvard step test system: put one leg on the shell; then another and straighten up; after that, immediately lower the leg with which the exercise began, in front of the projectile, then the second and return to its original position. The exercise had to be repeated continuously (f - rise frequency in 1 minute), but not more than 30 minutes.

It should be noted that all the presented types of physical activity by various intensity levels in (Table 1) were ranked by coefficients that were differentiated based on the level of energy expenditure by the body on oxygen consumption in 1 min for their implementation (Namba et al., 2016).

For the convenience of the experiment, the respondents of both focus groups were asked to implement self-control of walking, running and other types of physical exercises using the proposed author's system and special mobile devices: fitness trackers, fitness watches, pedometers and smartphones. Participants in the experiment, implementing self-diagnosis without the use of mobile equipment, used a sports stopwatch and terrain maps.

### *Statistical analysis*

Mathematical and statistical processing of the obtained results before the experiment and after its implementation was carried out by Chi-square at $p < .05$. The choice of this criterion for mathematical-statistical processing is due to the fact that its application is possible when the results of the EG and CG according to the state of the studied property, attribute are distributed into more than two categories. In our experiment, there are four levels: high, average, low and critical (Kirwan et al., 2012). Before the start of the experiment, mathematical and statistical uncertainty of the differences between the EG and the CG at $p > .05$ by the level of physical health of V. I. Lyakh, an express assessment of determining the level of body mass index and monitoring the level of physical development by endurance was recorded.

## RESULTS

### *Effects of the intervention for daily and weekly motor stability*

To study the stability of the daily and weekly motor conditions of the participants in the EG study, as a positive guide for all the studied, the weekly standard deviations σ of each athlete of the EG were studied. On their basis, EG was divided into two equal groups of EG1 (n = 6) and EG2 (n = 6). The first group included study participants for whom the standard weekly deviation σ < 500 was recorded, and the second group for which σ > 500.

In Figure 1 shows weekly indicators for the number of motor units of all participants in the EG1 study for each of the 12 weeks of the experiment on a weekly motor activity scale (on average for 7 days), as well as the average indicator of motor activity during the experiment:

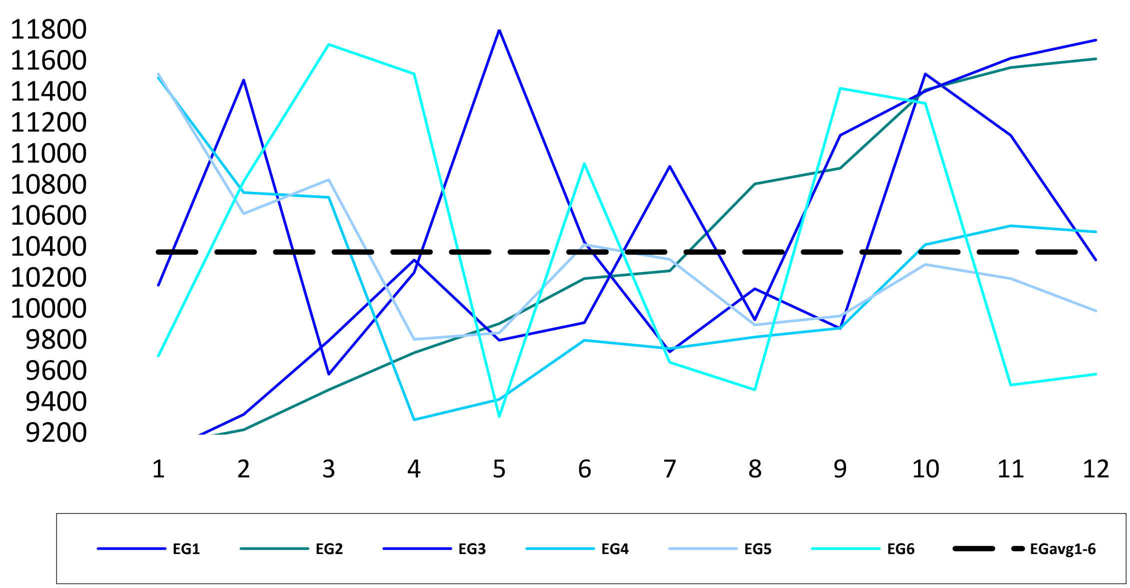


Figure 1. Weekly indicators of motor units EG1 (σ > 500) for 12 weeks.

 

In Figure 2 shows the weekly indicators for the number of relative steps of all participants in the EG2 study on the weekly motor activity scale (on average per week), as well as the average indicator of motor activity for 12 weeks:

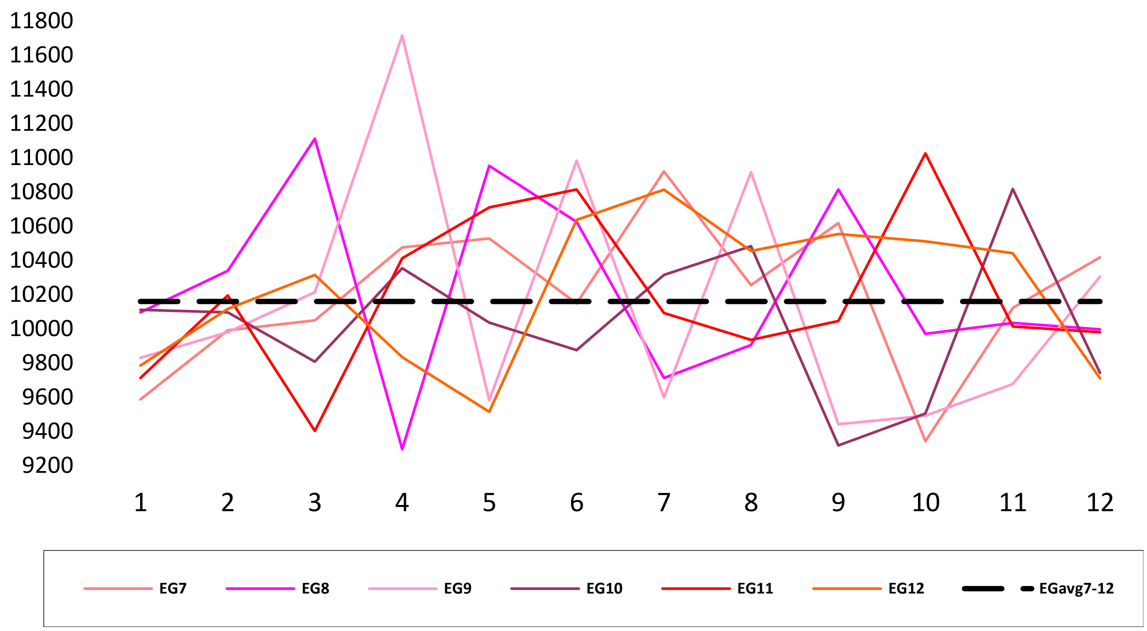


Figure 2. Weekly indicators of motor units EG2 (σ < 500) for 12 weeks.

As a result of a visual study of the presented diagrams (Figures 1, 2), it is possible to identify the stability of the motor activity of the participants in the EG2 study compared with the respondents in the EG1 during the implementation of the experimental work. In unison with the mathematical and statistical study of average indicators, it was found that the average level in EG1 (Egavg1-6 = 10336) is significantly higher than in EG2 (Egavg7-12 = 10160). However, the result of deviations from the average level for weekly motor modes for 12 weeks in the focus groups recorded the opposite. For EG1 study participants, this indicator is significantly higher (σ > 500), compared with EG2 respondents (σ < 500). Which, in turn, proves the comparative stability of the latter group in their daily and weekly physical activity.

***Reliability***

Continuing the comparative analysis, at the end of the study, the obtained results were analysed in EG1, EG2 and CG according to the method of the level of physical health of V.I. Lyakh, the express method of determining the level of body mass index and the level of development of endurance of the body using testing on the steps of the Russian Physical-Sports complex “Ready for Work and Defence.”

As shown in Table 2, the number of participants in the EG and CG in the percentage for the four level groups after the experiment is significantly different at a confidence level of $p < .01$, according to the methods used in the study, which indicates a positive effect of the experiment:

Table 2. Results of the comparison of groups that implemented the experiment at different levels of motor activity, after the experiment.

| Group % | High | Average | Low | Critical | Statistical Processing | High | Average | Low | Critical | Group % |
|---|---|---|---|---|---|---|---|---|---|---|
| **Method of V. I. Lyakh (HS)** | | | | | | | | | | |
| EG1 | 0 | 50 | 50 | 0 | p > .05 | 0 | 40 | 55 | 5 | CG |
| EG2 | 17 | 83 | 0 | 0 | p < .05 | | | | | |
| | | p < .05 | | | | | | | | |
| **Body mass index (BMI)** | | | | | | | | | | |
| EG1 | 17 | 66 | 17 | 0 | p < .05 | 5 | 35 | 55 | 5 | CG |
| EG2 | 17 | 50 | 33 | 0 | p < .05 | | | | | |
| | | p > .05 | | | | | | | | |
| **Russian Physical-Sports complex "Ready for work and defence" (LE)** | | | | | | | | | | |
| EG1 | 17 | 66 | 17 | 0 | p < .05 | 5 | 20 | 55 | 15 | CG |
| EG2 | 33 | 67 | 0 | 0 | p < .05 | | | | | |
| | | p > .05 | | | | | | | | |

***Data analysis***

Logistic regression analysis in mathematical-statistical processing showed (Table 2) that the use of the author's individually-differentiated program for self-monitoring of daily motor activity significantly affects the performance of athletes. The implemented express methodology for determining the level of body mass index of focus groups after the experiment revealed positive dynamics in the respondents EG1 and EG2, compared with the CG ($p < .05$). In turn, testing the participants of the experiment on the level of endurance development in the "Ready for Work and Defence" package showed the reliability of the positive effect by fixing the statistical differences between EG1 and EG2 on the one hand and CG on the other ($p < .05$). However, the analysis of the data of the study participants obtained as a result of monitoring by the method of V.I. Lyakh, showed no significance of the difference between EG1 and EG ($p > .05$) and a statistical significance of the inequality between EG1 and EG2 ($p < .05$). As a result, the obtained data proved that the experiment helps to reduce the level of body mass index of athletes and the development of their endurance. However, its implementation is effective in increasing the level of physical health only in athletes, stably, systematically and without significant deviations in the level of weekly physical activity performing physical activity during weekly training cycles.

## DISCUSSION

This study was carried out within 12 weeks of the training process by athletes according to the author's program of an individually-differentiated system of self-monitoring of daily motor activity (motor units per minute). This period is justified by the optimality of the experimental period to obtain reliable results (Buckley et al., 2019). It was within 3 months in the study that a reliable result was obtained in improving the physical and functional development of athletes.

The dosed load used in the study showed statistically significant changes in the decrease in body weight of the subjects. The increase in daily and weekly physical activity, measured in various aspects, such as Kcal or motor steps, allows you to get a positive dynamic (Helsel et al., 2007; Tsai et al., 2007). The originality of our study lies in the fact that the study created special recommendations on the expenditure of energy expenditures of respondents for motor activity at different speeds and under different conditions.

 

The implementation of the experimental work is consistent with studies proving that the positive effect of physical activity can only be in daily motor activity equal to at least 10,000 steps per day (Eakin et al., 2007; Kirwan et al., 2012). In turn, the author's study differentiates different types of aerobic exercise from walking to cycling in relative units. Each type of physical activity in various intensity formats is assigned an individual coefficient that determines its physical value in comparison with one step of the study participant.

Numerous studies suggest and experimentally substantiate various approaches to monitoring the motor activity of athletes: from the use of special formulas (Liu et al., 2012; Sallis & Saelens, 2000) before applying mobile technology (Nagovitsyn et al., 2018; Tsai et al., 2007), such as pedometers, fitness trackers and various types of accelerometers (Dyrstad et al., 2014; Troiano et al., 2014). However, as shown by the results of our study, only the implementation of self-monitoring through the systematization and classification of the most accessible for youth various physical exercises of a cyclic nature, allows to achieve a positive result.

Continuing the discussion, it should be noted that many studies have experimentally proven the positive impact of the implementation of self-monitoring of motor activity of athletes of different ages (Sallis & Saelens, 2000; Wennman et al., 2019), to various body systems (Helsel et al., 2007; Warburton et al., 2006), including athlete's cardiovascular system (Freedson & Miller, 2000; Kurpad et al., 2006). However, in a number of studies (Nagovitsyn et al., 2018; Troiano et al., 2012) and in the present study, a detailed analysis of the obtained data after the completion of the experiment revealed the ambiguity of the positive results. In particular, by assessing the level of physical health of respondents, mainly on the basis of studying the functioning of their cardiovascular system. An analysis of the average deviation in the weekly physical activity of athletes of the experimental group showed that athletes who perform physical activity stably receive higher rates in terms of their health. As the mathematical and statistical processing of the research results in EG athletes shows, the fulfilment of a high volume of weekly and monthly loads does not correlate with a positive increase in physical health indicators. However, this correlation is fixed in improving the overall metabolism, expressed in lowering the body weight of athletes, and increasing indicators of physical development, in particular endurance, as the main physical quality necessary to perform aerobic exercise.

## CONCLUSIONS

The study proved that the implementation of daily and weekly self-monitoring of motor activity of youth in various motor modes stimulates respondents to increase their motor daily, weekly and monthly activity. The obtained research data showed that the impact of motor activity has a significantly greater effect on the decrease in body weight of respondents and the physical development of athletes. The study proved on the basis of mathematical and statistical processing of the results that an active lifestyle in a stable motor mode, including daily systematic physical activity of an aerobic nature, increases the level of physical health and functionality of athletes. Ultimately, the implementation of the author's programme of an individually-differentiated system of self-monitoring of daily motor activity reliably stimulates the participants in the experiment to independent, systematic, optimal for maintaining the body's health of motor activity.

### *Perspectives*

The study will be useful to a wide range of specialists in the field of physical education and sports, fitness trainers, as well as athletes who are independently engaged in aerobic exercise. The author's recommendations for the implementation of continuous self-monitoring will provide feedback to the user of the programme, increase motivation to set individual goals for athletes - amateurs and strategies for their further achievement. Further research will be aimed at studying the influence of the author's programme of self-monitoring of motor activity on different age and gender categories. Non-traditional motor regimes will be studied at various levels of energy intensity. An experimental study will cover a larger sample of subjects with different individual capabilities and needs for the implementation of motor activity.

## CONFLICT OF INTEREST

There were no conflicts of interest.

## REFERENCES

Brown, W., Eakin, E., Mummery, W.K., & Trost, S. (2003). 10,000 Steps Rockhampton: establishing a multi-strategy physical activity promotion in a community. Health Promot J, 14(2), 95-100. https://doi.org/10.1071/he03095

Buckley, B.J.R., Thijssen, D.H.J., Murphy, R.C., Graves, L.E.F., Whyte, G., Gillison, F., Crone, D., Wilson, P.M., Hindley, D., & Watson, P.M. (2019). Preliminary effects and acceptability of a co-produced physical activity referral intervention. Health Education Journal, 78(8), 869-884. https://doi.org/10.1177/0017896919853322

Cupples, M., Dean, A., Tully, M.A., Taggart, M., Mccorkell, G., O'Neill, S., & Coates, V. (2013). Using pedometer step-count goals to promote physical activity in cardiac rehabilitation: a feasibility study of a controlled trial. Int J Phys Med Rehabil, 1, 157-166. https://doi.org/10.4172/2329-9096.1000157

Dyrstad, S.M., Hansen, B.H., Holme, I.M., & Anderssen, S.A. (2014). Comparison of self-reported versus accelerometer-measured physical activity. Medicine and Science in Sports and Exercise, 46(1), 99-106. https://doi.org/10.1249/mss.0b013e3182a0595f

Eakin, E.G., Mummery, K., & Reeves, M.M. (2007). Correlates of pedometer use: results from a community-based physical activity intervention trial (10,000 Steps Rockhampton). Int J Behav Nutr Phys Act, 4, 31-39. https://doi.org/10.1186/1479-5868-4-31

Freedson, P.S., & Miller, K. (2000). Objective monitoring of physical activity using motion sensors and heart rate. Res Q Exerc Sport, 71(2 Suppl), 21–9. https://doi.org/10.1080/02701367.2000.11082782

Harvey-Berino, J., Pintauro, S., Buzzell, P., & Gold, E.C. (2004). Effect of internet support on the long-term maintenance of weight loss. Obes Res, 12(2), 320-329. https://doi.org/10.1038/oby.2004.40

Haskell, W.L., Lee, I.M., Pate, R.R., Powell, K.E., Blair, S.N., Franklin, B.A, Macera, C.A., & Bauman, A. (2007). Physical activity and public health: Updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. Circulation, 116 (9), 1081-1093. https://doi.org/10.1161/circulationaha.107.185649

Helsel, D.L., Jakicic, J.M., & Otto, A.D. (2007). Comparison of techniques for self-monitoring eating and exercise behaviors on weight loss in a correspondence-based intervention. J Am Diet Assoc, 107(10), 1807-1810. https://doi.org/10.1016/j.jada.2007.07.014

Kirwan, M., Duncan, M.J., Vandelanotte, C., & Mummery, W.K. (2012). Using smartphone technology to monitor physical activity in the 10,000 Steps program: a matched case-control trial. J Med Internet Res, 14, e55. https://doi.org/10.2196/jmir.1950

Kraus, W.E., Janz, K.F., Powell, K.E., Campbell, W.W., Jakicic, J.M., Troiano, R.P., Sprow, K., Torres A, & Piercy, K.L. (2019). Daily Step Counts for Measuring Physical Activity Exposure and Its Relation to Health. Medicine and Science in Sports and Exercise, 51(6), 1206-1212. https://doi.org/10.1249/mss.0000000000001932

Kurpad, A.V., Raj, R., Maruthy, K.N., & Vaz, M. (2006). A simple method of measuring total daily energy expenditure and physical activity level from the heart rate in adult men. Eur J Clin Nutr, 60(1), 32-40. https://doi.org/10.1038/sj.ejcn.1602264

 

Liu, S., Gao, R.X., & Freedson, P.S. (2012). Computational methods for estimating energy expenditure in human physical activities. Medicine and Science in Sports and Exercise, 44(11), 2138-2146. https://doi.org/10.1249/mss.0b013e31825e825a

Lo Cascio, C.M, Quante, M., Hoffman, E.A., Bertoni, A.G., Aaron, C.P., Schwartz, J.E., Avdalovic, M.V., Fan, V.S., Lovasi, G.S., Kawut, S.M., Austin, J.H.M., Redline, S., & Barr, R.G. (2017). Percent Emphysema and Daily Motor Activity Levels in the General Population: Multi-Ethnic Study of Atherosclerosis. Chest, 151(5), 1039-1050. https://doi.org/10.1016/j.chest.2016.11.033

Lyakh, V.I. (1988). Tests in the physical education of schoolchildren. Moscow: Ast, 272.

Nagovitsyn, R.S., Bartosh, D.K., Ratsimor, A.Y., & Neverova, N.V. (2019). Modernization of Regional Continuing Pedagogical Education in the "School-College-Institute. European journal of contemporary education, 8(1), 144-156. https://doi.org/10.13187/ejced.2019.1.144

Nagovitsyn, R.S., Miroshnichenko, A.A., & Senator, S.Yu. (2018). Implementation of mobile pedagogy during continuous education of physical culture teachers. Integration of Education, 22(1), 107-119. https://doi.org/10.15507/1991-9468.090.022.201801.107-119

Nagovitsyn, R.S., Tutolmin, A.V., Maksimov, Y.G., Dimova, I.A., Karoyan, A.A., Skryabina, D.Y., Volkov, S.A. (2019). Motivation for physical activity of people of different ages. Gazzetta Medica Italiana - Archivio per le Scienze Mediche, 178(10), 799-806. https://doi.org/10.23736/s0393-3660.18.03965-7

Nagovitsyn, R.S., Zekrin, F.H., Fendel', T.V., & Zubkov, D.A. (2019). Sports selection in martial arts based on the harmonic stability of results at competitions. Journal of Human Sport and Exercise, 14(4proc), S867-S876. https://doi.org/10.14198/jhse.2019.14.proc4.49

Nagovitsyn, R.S., Zekrin, F.H., Fendel', T.V., Zubkov, D.A., & Osipov, A.Y. (2019). Favourite music as an increasing factor of the result in the control running of athletes. Journal of Human Sport and Exercise, 14(5proc), S1829-S1841. https://doi.org/10.14198/jhse.2019.14.proc5.02

Namba, H., Kurosaka, Y., Shionoya, Y., & Minato, K. (2016). Relationship between estimated maximum oxygen intake, past sports experience and physical activity in female university students. Wayo Women's. Univ. Bull, 56, 99-111.

Plotnikoff, R.C., & Karunamuni, N. (2011). Steps towards permanently increasing physical activity in the population. Curr Opin Psychiatry, 24(2), 162-167. https://doi.org/10.1097/yco.0b013e3283438107

Sallis, J.F., & Saelens, B.E. (2000). Assessment of physical activity by self-report: Status, limitations, and future directions. Research Quarterly for Exercise and Sport, 71, 1-14. https://doi.org/10.1080/02701367.2000.11082780

Troiano, R.P., McClain, J.J., Brychta, R.J., & Chen, K.Y. (2014). Evolution of accelerometer methods for physical activity research. British Journal of Sports Medicine, 48(13), 1019-1023. https://doi.org/10.1136/bjsports-2014-093546

Troiano, R.P., Pettee, G., Welk, G.J., Owen, N., & Sternfeld, B. (2012). Reported physical activity and sedentary behavior: why do you ask? Journal of physical activity & health, 9(1), 68-75. https://doi.org/10.1123/jpah.9.s1.s68

Tsai, C., Lee, G., Raab, F., Norman, G., Sohn, T., & Griswold, W. (2007). Usability and feasibility of PmEB: a mobile phone application for monitoring real time caloric balance. Mob Netw, 12(2), 173-184. https://doi.org/10.1109/pcthealth.2006.361659

Vuori, I. (1998). Does physical activity enhance health? Patient Education and Counseling, 33(1), S95-S103. https://doi.org/10.1016/s0738-3991(98)00014-7

Warburton, D.E., Nicol, C.W., & Bredin, SS. (2006). Health benefits of physical activity: the evidence. CMAJ, 174, 801–9.

Wennman, H., Pietilä, A, Rissanen, H,Valkeinen, H, Partonen, T, Mäki-Opas, T, & Borodulin, K. (2019). Gender, age and socioeconomic variation in 24-hour physical activity by wrist-worn accelerometers:

the FinHealth 2017 Survey. Scientific Reports. 9(1), 6534. https://doi.org/10.1038/s41598-019-43007-x

Yang, C.C., & Hsu, Y.L. (2010). A review of accelerometry-based wearable motion detectors for physical activity monitoring. Sensors (Basel), 10, 7772–88. https://doi.org/10.3390/s100807772