

# Physical health data control system for students at PE classes

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**Abstract** - Competency-based approach in education, changes in the nature of educational and future professional activities demand higher standards from the participants of education process. Recently, the decline in the physical health of the younger generation of Russia has become evident. This decline can be observed with both schoolchildren and university students. In order to analyse and control education process in terms of physical education, define urgent and long-term actions to prevent and eliminate its negative impact on the physical conditions of students, it is necessary to control it at PE classes. Nation's health is a universal social value, a basis of well-being and economic development of the country, a requirement of national security that defines its geopolitical prospects and resilience. That is why maintaining and improving younger generation's health is a priority in higher education management striving to procure the social service of professional socialization during the study term, alongside with educational process optimisation in complex modern information society conditions compacting the life space of the youths. All-Russian health assessment conducted by the Ministry of Health of Russia showed that disease rate among children aged under 11 has increased by 1.4 times over the last 10 years. The highest sickness rate increase can be found among teenagers between 15 and 17. According to official statistics, only 5 % of school graduates are apparently healthy, while 80% of them have some health condition [1]. Today, the problems of students' health, their motivation to improve their health, expanding body capabilities, value system, improving one's physical fitness are extremely pressing. The efficiency of physical training largely depends on the methodical basis of PE, the use of innovative forms, means, ways and methods of their introduction into education processes. It is obvious that most academic research must have the healthy human being as their subject matter, and the research must be aimed at the improvement and maintenance of the health of, primarily, children, teenagers and student youths. It is necessary to put research efforts into developing and defining indices, criteria of

healthy state [2]. Nowadays, the control of the physical health of schoolchildren and university students at PE classes is virtually absent. The only non-pharmaceutical and the most efficient way of maintaining and improving young people's health at the universities are PE classes and their physical health monitoring. This article analyses the dynamics of physical development changes and physical fitness of the girls studying at various courses in Irkutsk National Research Technical University (ISTU) and living in East Siberia.

**Keywords** – *health, physical health, control, monitoring, students.*

## I. INTRODUCTION

Modern society calls for healthy, socially adapted and active people, capable of providing for oneself and the family. To satisfy various people's needs, there are specialized systems in society that can solve respective problems. Health condition influences all areas of people's lives. The demand for good health is universal. National health in Russia is a public value, and the problem of its deterioration, especially among the younger generation, is a problem of national security [3].

The health system has five groups of indices: the three first ones are primary (physical development level, functional state of the body, immune protection and non-specific resistance levels), and the other two (diseases and development defects, moral, value and motivation standards) are secondary.

Physical health is the level of development and functional capabilities of body organs and systems. The material basis of it is the biological programme dominating the person at various stages of his or her individual development (ontogenesis). It is mediated by basic needs

and characterized by the ability to adapt to different environmental factors, the physical development level, physical and functional fitness of the body to workout [4].

The definitions of health and physical health in academic literature are quite vague; they often reflect the point of view of specialists in specific areas of knowledge and they do not deal with the factors that define these phenomena (especially the physical health), they do not focus on the ways and methods of researching it, which prevents the development of clear quantitative assessment criteria and standards.

New definitions of physical health appeared recently, and they show efficient ways for its study. Due to the deterioration of health of education process participants in schools and universities, there is a problem of objective and clear control of the physical health indices for school and university students.

Thus, physical health, as well as health in general, depends on four main factors: **1.** Genetics (heredity) (18–22 %). **2.** Healthcare system state (8–10 %). **3.** Environmental conditions (17–20 %). **4.** Lifestyle (49–53 %). The level of physical health is defined by the ability of a person to adapt to these factors.

Main criteria of physical health assessment are [5]:

1. Physical development level;
2. Physical fitness level;
3. Body's functional readiness to physical exercise;
4. The level and the ability to mobilize body's adaptation reserves to adapt to the environment.

Professor V. Yu. Lebedinsky [6] suggests a new definition of physical health: it is “genetically determined motorial capacity of a person (physical fitness) that changes significantly during the lifetime due to morphofunctional adaptation (physical development) to the shifting environment.”

The abovesaid translates into the main ways of studying and assessing physical health:

1. – physical development assessment, conducted using anthropometric and physiometric methods.
2. – motor skill test – physical fitness.

All the participants of the education process need to know these parameters in order to differentiate the means and methods of physical education, increase the objectivity of the education results, analyse the structure and the dynamics of pedagogic impact and the change trends in their effect.

Currently, the demand for training highly qualified specialists in higher education institutions is growing. The quality of their education is defined by not only the subject content of the pedagogic process but also the level of health and working efficiency of the student youths, which, in the end, influences the development of science and technology, as well as social and cultural progress. There was growing attention towards the healthy lifestyle of the students in recent years, which is connected with the concern of the society about the health of the specialists graduating from

higher education institutions, and with the increase in sickness rates in professional education and further reduction of working efficiency [7].

The terminology and the content of education are based on the provisions of laws and regulations of Russia, including the requirements for the results of principal education program acquisition results represented in the Federal educational standard.

The subject matter of PE in higher education is the motion activity and the general development of the students, which help improve the students' health, physical fitness, acquire certain motor actions, and develop their mind, creativity and self-sufficiency. The key requirements for a modern PE class include a differentiated and individual approach to students, taking into consideration their health levels, gender identity, physical fitness, motor fitness, their psychological development, observance of hygienic standards and monitoring of the abovementioned parameters [8].

Higher education period usually corresponds to the period of active formation of the body and its subsystems. This is when the key changes in lifestyle, culture, and psychology take place that predefines the professional, creative and social capacities of the future specialist. Physical education must preserve and improve students' health, propagate their need in a healthy lifestyle and physical improvement further in life, because their health is key to their personal fulfillment, education and professional activities, as well as longevity.

Therefore, key criteria of health saving technology efficiency in higher education institutions are developing new and expanding the existing recreation activities aimed at health improvement and disease prevention; introducing modern methods of instant diagnosis and complex health saving technologies; developing and maintaining labor capacities and professional longevity [9].

Over the last 10-15 years, students' health in Russia has considerably deteriorated - almost twice. They have low health level, and the amount of students belonging to the 3rd functional group and excused from attending PE classes is growing. During the period of study, their numbers do not fall but increase, and by graduation reach 60-70%.

The number of ISTU students belonging to the first functional group (apparently healthy) within 7 years of observations amounts to 50% (fluctuating between 48.2% and 57.2%). The amounts of students belonging to the second and the fourth functional groups have decreased (from 16.3% to 5.4% and from 11% to 6% respectively). There is also an increase in the number of examined third group students (from 37.8% to 67.6%).

In order to analyse and control physical education process, define urgent and long-term actions to prevent and eliminate its negative impact on students' physical conditions, it is necessary to monitor physical development and fitness of students. By monitoring we mean actions aimed at observation, prevention, control, adjustment and forecasting [10, 17].

Any sports training actively uses control methods for physical development and fitness parameters. The purpose

of this control is to improve the sport-training process based on objective assessment of various aspects of fitness. There are usually three types of control defined in sports: *stage control* – measuring and assessing various indices of competitive and training activity, exercise and result dynamics at competitions or arranged conditions at the end of the stage (period); *ongoing control* – assessing results of control competitions, exercise dynamics and proportions, recording and analysing daily changes of fitness level, technique and tactics development in training microcycles; and *real-time monitoring* – controlling immediate state, readiness for exercises and so on. The aim of the latter is to assess body reactions to training or competition loads, technique and combination quality assessment.

The planned content of training is monitored at its every stage through assessing various aspects of fitness (physical, technical and tactical).

Training success of the students is connected to testing their functional fitness, which can be evaluated via different control actions. Every higher education institution has specific types and terms of control actions for every specific type of sport (exercise sets). This helps to define methods and techniques to ensure the efficiency of training within a semester, school year or the entire period of study.

The PE process in all educational institutions of Russia use the following control methods: pedagogic - the process of acquiring information about the influence of physical exercise and sport on the body in order to increase the efficiency of training and education process; medical – systematic medical examinations (yearly and on health reasons), and self-check - controlling one's own health.

This sequence can be used when assessing the physical health of students. However, it shall have slightly different content. Stage control allows summarizing the results of the education process (1 time a year).

Ongoing control helps monitor the dynamics of individual condition indices between the current and the following training to assess the consequences and the time needed to recover working efficiency of students after different physical exercise in the semester in terms of their amount and focus.

Real-time monitoring shall be continuously conducted during every class [11].

However, there are almost no serious and significant works dedicated to PE class control to improve students' development and physical fitness based on an objective assessment of their various aspects. PE teachers do not have complete and objective information, allowing analyzing and control the physical education process, define urgent and long-term actions aimed at preventing and eliminating the negative impact of the education process on students' physical conditions. The solution to this problem lies in organising and conducting monitoring of physical development and fitness among the students of higher education [12].

All-Russia monitoring of nation's physical health, physical development of children, teenagers and youths (hereinafter - the monitoring) is a system of actions aimed at observation, analysis, assessment and forecasting nation's

physical health and the physical development of children, teenagers and youths.

Today we can speak about a certain perfection level in solving monitoring problems in PE and sports in terms of both theory and practice. In this case, the notion of monitoring is accepted by the majority of academics, and its status is enshrined in legislation [13, 16].

Therefore, within the scope of the decree no 916 of the Government of Russia of December 29th, 2001 On all-Russia monitoring of nation's physical health and development of children, teenagers and youths, students of ISTU are being examined to assess their basic physical development and fitness level, as well as compare the results of physical health of different student groups (group, year, institute, course of study, age, medical group) since 2007.

## II. MATERIALS AND METHODS (MODEL)

This research studies the physical health indices of girl students (1st, 2nd, 3rd and 4th years) in Irkutsk using monitoring technologies. Over 8,000 girls, studying in ISTU were examined. Physical development and fitness testing took place at the beginning and the end of every school year.

The main set of methods for this research was developed in the Federal target programme Youth of Russia. Physical education and health improvement for children, teenagers and youths in the Russian Federation (2000-2005) according to decree no. 916 of the Government of Russia of 29.12.2001; and the interagency agreement on The information impact of the Ministry of Healthcare, the State Committee for Sports and the Ministry of Education of Russia in social hygienic monitoring of 26.04.2002. It was also defined by the monitoring procedures.

The physical development level was defined using the methods of anthropometric standards, i.e. the system of objective average data about one's physical development gathered through examining a large number of people of the same gender, age and occupation. These include somatic indices, such as the length (height) and the mass (weight) of the body, chest circumference; physiometric (functional) indices, such as vital lung capacity (VLC), arterial tension (AT), hand muscle strength (dynamometry), and 20 squats.

The **height** is measured using the stadiometer. The student stands back to the plank, touching it with his or her heels, buttocks, shoulder blades and nape. The measurements are recorded to a precision of 0.5 cm.

**Body weight** is defined by medical scales and recorded to a precision of 50 grams. During the measurement, the student must stand still in the middle of the scale's platform.

**VLC** is the volume of air at the deepest exhale after a deepest inhale. It is measured with a spirometer. The student takes the mouthpiece and the rubber tube of the spirometer in her hands inhales deeply and then breathes the air out into the mouthpiece. It is recommended to stand straight during this test. The air must not escape through a student's nose.

**Chest circumference** is measured when the student breathes as usual. The student has to put her arms up. The measuring tape shall be placed under the lower angles of the shoulder blades on the back. On the chest, the tape shall be

placed directly above a woman's breasts. After the tape is placed, the student puts the hands down and the results are recorded.

**Hand dynamometry** is a method for the assessment of hand bending force with a dynamometer. The student takes the device with its scale towards the hand's inner part. Then the student stretches her arm to the shoulder level and squeezes the dynamometer, holding the result for 1-2 seconds. Then the second hand is tested. Any force index is always connected to the amount of muscles, and therefore with the body weight. Thus, when assessing the dynamometry results, it is necessary to take into consideration the absolute force alongside the relative force, referential of the body weight.

The circulatory response assessment is performed through the heart rate parameter. Heart rate is an intensive index of body shifts that show the exact level of physical exercise. It can be measured on the radial, temporal and carotid arteries, and in the cardiac impulse area. In order to measure the heart rate, a stopwatch or a watch with a second hand are used. The number of beats is counted from 10 seconds, and then they are multiplied by 6 to get the beats per minute. Palpatory pulsometry is accessible to everyone because any person can count his or her beats per minute.

Another important index, characterising the cardiovascular system is the level of **arterial tension**, measured with the blood pressure monitor.

**20 squats functional test** helps define the functional state of the cardiovascular system. The student measures her heart rate while sitting. Then she stands up (feet placed at the width of pelvis) and squats 20 times in 30 seconds. After the squats, the heart rate is measured for 10 seconds while sitting. Then, without stopping the stopwatch, the measurements are taken to find out the recovery time after exercise. They are taken from second 30 to 40 (before 1 minute has elapsed); from 1 minute to 1 minute 10 seconds (60 seconds), from 1 minute 50 to 2 minutes (120 seconds), from 2 minutes 50 to 3 minutes (180 seconds). If the heart rate is not back to normal within this time, we note "over 3 minutes" in the records. The time is recorded in seconds.

The students' fitness dynamics was assessed in two ways:

- serial section method;
- longitudinal exam.

The following method groups were used in the research:

- 1) testing motor skills, taking into consideration the guidelines for their use and performance;
- 2) statistical data processing.

The tests used in the programmes are quite simple in informative.

**Shuttle run test, 10×5 m** (to assess the speed endurance and agility, during the direction changes are interchanging acceleration and deceleration cycles).

In the gym (on the training grounds), two parallel lines are marked on the floor at a distance of 5 meters from each other. On "Ready" command, the student lines up at the

start. On "Set" command, the student leans forward (shifting the point of balance to the front leg) to take the starting position. The hand opposite to the front leg touches the line. The other hand, bent in elbow, is put back. On "Go" command, the students start running, gradually straightening up the body. The start push is achieved through quick steps. The student gradually increases the step length and maintains the leaning position.

The student starts from the first line, runs up to the second, crosses it, touching the floor with her hand, then turns around and runs back to the start. It is necessary to do five of such cycles at the maximum speed, while only turning to one side (the student must touch the lines nine times and cross them ten times).

Sidesteps, jumps, and turns in various directions are not allowed. The time is recorded to a precision of 0.1 seconds. The students must wear non-slip sport shoes. **Sit and reach test** (measuring the active flexibility of the spine and pelvic flexibility).

The student not wearing shoes takes the initial position: she sits with her legs apart and feet vertical so that the distance between the heels was 30 cm. She puts her hands forward, palms down, hands and fingers pressed together. A ruler placed between the student's feet and along her legs can be used for measurement.

The measurement starts from the point of the student's heels (it is considered zero). The student bends forward slowly three times (her palms must slide forward along the ruler). The fourth bend is measured. The student must hold for at least 2 seconds in the furthest position, her fingers must be pressed together and touching a point on the floor.

The best result (the maximum distance reached by the student) is recorded if the student can hold on the floor with the tips of her middle fingers. The precision of the measurement is 1.0 cm. The measurement is recorded with a plus (+) if the student could reach a point beyond her feet and with a minus (-), if she reached the point that is closer than her heels.

**Bent suspension test** (to assess the force and static endurance of the upper limb girdle muscles).

The student takes the initial position - hanging on a horizontal bar with the arms bent to the maximum, hand up at the width of the shoulders or a bit more, chin above the bar, not touching it. Having fixed the position, the teacher starts the stopwatch and waits until the student starts to unbend the arms.

The maximum bent suspension time is measured. The result is recorded to a precision of a hundredth of a second. It is necessary to keep the body from swaying during the test (with a hand).

**Standing long jump** (measuring the dynamic force of lower limb muscles). From the initial position (feet together or a little parted, forefoot to the startline), the student must jump forward as far as she can. There are 3 trials given. The best result is recorded. It corresponds to the farthest point reached by the student.

**Sit-ups in 30 seconds** (measuring speed and force endurance of the body flexor muscles). The initial position

is lying on the back, legs bent in knees at the angle of 90 degrees, feet on the floor, hands clasped behind the head, elbows outwards. A partner shall press the feet to the floor, holding them by hands (it is not allowed to sit on the feet or hold under knees).

On “Go” command, the student does the maximum number of energetic sit-ups in 30 seconds. Her elbows must touch the front of the thighs and return to the initial position, the lower back must touch the floor before the shoulder blades. The number of correctly performed sit-ups is recorded.

**20-meter run test** (measuring the speed). On an even surface, a 20-meter long area is chosen. A helper is placed on a zero line to give signals. On helper’s “Set” command – the student takes the standing start position, on “Go” command – the student starts running, reaching the top speed at the zero line. Upon reaching the zero line (the helper gives a signal), the student increases the speed and keeps in until the 20-meter line. The teacher starts the stopwatch after the helper’s signal and stops it after the student reaches the finish line. The result is recorded to a precision of a hundredth of a second.

**5-minute run test** (measuring general endurance). Performed on an even surface (in the gym) after the warm-up.

A distance of one kilometer is set (10 circles of 100 meters), and checkpoints are marked that must be reached. The test starts with the standing start position. On “Go” command, the stopwatch is on and students start running for 5 minutes. They have to run as long a distance as possible. Attention must be given to the breathing and running techniques.

Apart from the obligatory tests set out in the monitoring procedures in Russia, supplementary tests were used in ISTU to compare with the previous tests of students’ fitness, including:

**Abdominal crunch** (measuring the force endurance of the abs). The initial position is lying on the back, legs bent in knees and a little bit apart, feet on the floor, hands clasped behind the head (elbows outwards), lower edges of the shoulder blades are on the floor. On “Go” command from the teacher, the student lifts the upper part of the body (up to 1-2 cm), not pushing the elbows forward and not touching the floor with the blades when going down. The head must be kept straight, the chin not pressed to the chest. The maximum number of crunches without pauses and stops is recorded.

**Push-up test** (measuring the force endurance of the arms). Arms are bent and unbend from the initial position – the kneeling plank. The arms are bent until there is a right angle at elbows (shoulders and elbows must be on one level). The maximum number of push-ups without pauses and stops is recorded. Bending the head down (to the floor) is not allowed, as well as bending at the pelvis, lower back span, or touching the floor with thighs and stomach.

**Statistical methods.** In order to process the results, electronic tables of Microsoft Excel 7.1 were used. Multivariate statistic processing of the data received was performed in Statistica 6.1. Significance of the difference of

average values in independent samples was assessed with a parametric test on Student t-criterion where  $p < 0.05$  and non-parametric criteria of Wilcoxon-Mann-Whitney, depending on the value distribution type of the indices in question.

### III. RESULTS AND DISCUSSION

Several years’ experience of studying physical development and fitness indices among girl students allowed finding the following trends: their anthropometric features, being genetically determined, do not change significantly from the first to the fourth year of education, as evident from the data received from different year students. However, the height parameters change by 1-2 centimeters a year.

During the study period, 1st year students show weight loss due to the increase in physical activity, while the 2nd year students’ weight is stabilized. During the 3rd year, students’ weight increases a little, and during the 4th year, their weight decreases again.

Due to the increase in motor activity, girls of 1-3 years of education form a muscular core, which leads to steady growth of their chest circumference, and during the fourth year, this parameter decreases due to the weight loss.

Dynamometry result analysis shows that the strength of the 1st and 2nd-year students grows, while during the 3rd and 4th years it slightly reduces. It can be explained by the fact that in the first years of education there are PE classes two times per week, while on the senior years there is only one PE class per week, which leads to a lower level of physical activity and the reduction of functional parameters among the senior students.

The study of physical fitness parameters shows that first-year students by the end of the school year show real improvements in almost all of the test as compared with their results from the beginning of the school year.

Second-year students also show real improvements in virtually all tests as compared with the results of first-year students at the end of the school year.

Third-year students show the aggravation of their physical fitness as compared with the data from the 2nd year; however, these results are better in most cases than the results from the first year of education.

Fourth-year students have a significant decline in their physical fitness as compared with the first years of education.

Besides, the analysis of fitness dynamics among the technical university students shows the increase of students with average physical development levels due to the reduction of the amount of students with outstanding or poor development levels examined during the first two years. During the 3rd and the 4th years of education, the number of girls with average physical development decreases due to the increase in the amount of the students with good and poor development levels. This fact can be explained with the characteristic features of PE process in higher education institution because the subject programmes provide for two classes per week during the 1st and 2nd years, and one class per week during the 3rd and 4th years.

#### IV. CONCLUSION

Nowadays, educational institutions virtually lack a unified automated monitoring and control system to check the physical fitness of the students. Their achievement is accounted for in the mark system in the general pedagogic form of semester attestation. With any type of control (ongoing, stage, advanced medical examination), teachers shall take into consideration the physical health of their students, i.e. assess their morphofunctional health indices: physical development level, physical fitness level [14].

The authors of this article claim that the most efficient physical fitness control method for students is **complex monitoring**, which can be divided into subcategories according to their objectives:

1. Stage control shall provide for the assessment of the morphofunctional conditions and physical fitness during the PE course in schools and higher education institutions. It will help assess the selection and the use of various means, methods and amounts of exercise. This type of control can reveal basic trends in the physical education process at longer stages.

2. Ongoing control can help assess students' body condition within a semester and the dynamics of it within a school year. Students' current condition data can be used to plan the nearest classes in terms of their content and load (which defines their efficiency). Using this type of control, it is necessary to observe to the class structure: first stage is a warm-up, second stage - training, final stage - recovery.

3. Real-time control can help assess students' body condition at every PE class. Education efficiency and routine condition change are defined by both visual observations and using technical means for measuring heart rate and arterial tension.

During the ongoing and stage control, the range of research methods must be wider and include both physical development parameters and physical fitness indices for children, teenagers and students.

This complex control helps encourage correct PE class procedures for various age, gender and health groups, and it ensures higher recreational efficiency of the subject. It is necessary to develop guidelines, define rational means and methods of PE and assess teachers' work according to this approach.

Being a part of the all-Russia system for national health security, students' physical health monitoring and assessment in a technical university allows both planning and effectively organising the education process, and performing corrective actions to optimize it, while giving an objective evaluation of the PE teachers' work.

Introducing innovations into the health preservation system for students allows performing preventive actions in a timely manner, find efficient means of targeted prenosological correction, and change the interaction vector for the teacher and the student towards students' initiative and activity in forming their healthy lifestyle [15].

Over ten years of experience of monitoring at the higher education institution allowed individualizing PE classes, namely:

- assess the original physical and motor conditions of the students;
- adjust educational and training processes;
- assess the efficiency of motor skill training for students;
- compare the physical health of various groups of students (group, year, department, university) to define the indices and the logic for studying its parameters
- draw conclusions about the impact of various exercises on students' physical development and fitness;

The suggested control methods are necessary for a more objective evaluation of students' physical health, and they help assess the teachers' efficiency in terms of structuring the PE programme.

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