

# Morphofunctional and motor characteristics of Baikal region's students (Russia) with overweight

Kolokoltsev M.M.<sup>1</sup>, Iermakov S.S.<sup>2</sup>

<sup>1</sup>Department of the Physical Culture, Irkutsk National Research Technical University, Russia

<sup>2</sup>Department of Tourism and Recreation, Gdansk University of Physical Education and Sport, Poland

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## Abstract

**Purpose:** to study the morphofunctional and motor characteristics of the organism of students with overweight and obesity. To compare these data with data of students with normal weight.

**Material:** it was examined students (females – n=1937; males – n=1302) of 17-21 year-olds. (Baikal region, Russia). It was performed an anthropometrical and physiometric examination of students. It was determined the content of muscle and fat mass in the component structure of a body. It was determined the motor qualities of students.

**Results:** the indicators of anthropometrical and physiometric characteristics, results of motor action tests, the content of muscle and fat mass in a body of students with overweight and obesity are lower in comparison with the indicators of females and males with normal body weight ( $p < 0.05$ ). The integral criterion of physical fitness of students with overweight and obesity is lower in comparison with students with normal body weight ( $p < 0.05$ ). It is defined the direct dependence between the decrease in the level of physical fitness and increase in body weight of males and females. It was obtained data concerning interrelation of anthropometrical and functional characteristics with motor qualities of males and females with different body weight.

**Conclusions:** Results of the research allow correcting physical training classes of youth. Such classes are focused on the differentiated decrease in fat mass content and increase in muscle mass in the component structure of students' bodies.

**Keywords:** students, anthropometrical, physiometric, motor qualities, overweight.

## Introduction

According to World Health Organization (WHO) 39% of adult population of the world had overweight, and 13% had obesity in 2016 [1]. In European countries overweight had 50% of the population: among them 20% had obesity [2, 3]. There are a lot of people with overweight in a population of USA, Australia, Great Britain, China, South Korea, in the countries of Near East [4, 5]. WHO experts presuppose that the number of people in the world with obesity or overweight will double by 2025.

Overweight in youth strengths researchers to look for more effective ways to solve this problem:

- for New York students – consultations with healthcare providers [6];

- for Brazilian teenagers – control of obesity. It will allow decreasing the prevalence of hypertension in Northern region [7];

- for the youth of USA – it is the introduction of the monitoring system of risks behavior [8]. Six categories of health priority types among youth need the control: 1) behaviors that contribute to unintentional injuries and violence; 2) tobacco use; 3) alcohol and other drug use; 4) sexual behaviors related to unintended pregnancy and sexually transmitted infections (STIs), including human immunodeficiency virus (HIV) infection; 5) unhealthy dietary behaviors; and 6) physical inactivity [8];

- for Australian schoolchildren – it is the need to change habits concerning nutrition and to create healthy cultures in schools [9];

- for the youth of developing countries – the actions for obesity prevention which have to be innovative, concrete for the country and accepted from the cultural point of view [10];

- for Chinese youth – experts have to pay more attention to the prevalence of overweight and obesity in rural regions [11].

It is especially important to consider regional features in the prevention of obesity among youth. Such approach is in researches of regional features of Iran [12], Portugal [13], Sudan [14], Greece [15], Puerto Rico [16], Taiwan [17], Latin America [18], Ethiopia [19], Canada [20]; Republic of Belarus [21], Lithuania [22]. Authors confirm that the competence in the field of health care became an important part of the agenda in the field of healthcare and strengthening of health in recent years.

By results of a research (2012-2013) in 12 territorial subjects of Russian Federation, the prevalence of obesity among men was 26.9%, among women – 30.8% [23]. The annual growth of obesity cases in Russia is 0.4% in a year [2]. The overweight and obesity are widespread among students, especially after 20 year old [2]. Among students of the medical higher educational institution of Kemerovo (Russia), overweight have 10.7%, obesity have 4.8%, underweight have 9.7% [24]. In Tomsk (Russia) overweight have 18.6% of male-students [25].

Morphofunctional characteristics of the person are considered by researchers as information criteria of hormonal, growth and other metabolic processes; features of influence on the organism of climatic, ecological,

social and others factors [26, 27]. Therefore it is necessary to evaluate morphofunctional indicators of the population of different regions taking into consideration the regional anthropological features of persons.

The specialists of WHO emphasize the increase in a number of persons with overweight and obesity. It is especially widespread among city population. In this case process of urbanization is especially expressed, in comparison with rural population [1]. The Baikal region (Russia) is characterized by strongly continental climate. This region is also characterized by the adverse ecological situation connected with human impact [28]. Researchers point out regional features of body structure types of Baikal region's youth<sup>5</sup>. Authors determined incompleteness of body growth processes of Siberia youth (Russia) in comparison with students from the European part of Russia [29]. It is relevant the study of a regional feature of overweight and obesity prevalence among Baikal region's youth (Russia). The basis of such researches is made by motor action characteristics of students. These problems in this region haven't been studied yet.

The overweight and obesity promote the development of a serious noninfectious illness. It is diabetes of 2nd type, atherosclerosis, arterial hypertension, osteoarthritis, varicosity [30] violation of coronary and brain blood supply [31]. The risk of development of coronary heart disease in people with obesity increases in 2-3 times, strokes in 7 times [32]. People with the big body-weight index have violations of hormonal state [25]. Their working capacity [33, 34] and lifetime [35] decrease. The reason for an increase in the level of obesity is the availability of high-calorie foods against in a complex with a decrease in physical activity of population [36, 37].

The low physical activity has 39.8% of Russian population: 37.0% of men and 42.0% of women [23]. In researches of WHO [38] was emphasized the necessity to prevention and fight against obesity; normalization of population nutrition of various countries; to prevention addictions. The important role of people's physical activity is defined: increase in volumes and quality of physical training programs in educational institutions of different types [39, 40]; attraction to active sports activities and health-promoting activities [41, 42]; pedagogical control for physical loads [43, 44]. Training with students by a traditional technique (2-3 times a week) doesn't give the positive result concerning the decrease in body weight [40]. Therefore it is necessary to introduce the corrective classes in non-school hours [45].

The considerable decrease in overweight is promoted by application of health-promoting activities [46, 47, 48], physical exercises in a complex with a balanced diet and day regimen [49, 50]; corporal focused and dancing psychocorrection [51]; consideration of women's body features [52]; control of psychophysiological functions [53]. Other researches support the need of carrying out the fundamental and applied scientific researches in the field of primary population prevention of noninfectious diseases and formation of to a healthy lifestyle requirement [23] in population.

*Hypothesis.* The data concerning the interrelation of morphofunctional indicators with motor qualities of students with overweight and obesity will allow adding individual specific orientation of means and methods of carrying out physical training classes for university students.

*Purpose:* the comparative analysis of morphofunctional features and motor action characteristics of an organism of Baikal region's students (Russia) with overweight and obesity.

## Materials and Methods

### Participants

The university students (Irkutsk, Russia) were examined: females (n=1937), males (n=1302), 17-21 year-olds. All students belonged to the main medical group (have no deviations of health condition). The performed work doesn't violate the right and doesn't endanger the wellbeing of students in compliance with Ethical Principles for Medical Research Involving Human Subjects [54].

### Design of a research.

It is carried out the anthropometrical and physiometric examination of females and males with an application of standard techniques [55]. It is calculated weight-for-height Quetelet index II ( $BMI = \text{body mass/body height}^2$ ,  $\text{kg/m}^2$ ) [56]. According to WHO classification (1991) [57] students are devoted into 4 groups: group "N" with normal body weight (BMI is in the range of 18.5-24.99  $\text{kg/m}^2$ ); group "OV" with overweight (BMI=25-30  $\text{kg/m}^2$ ); group "OB" with obesity (BMI>30  $\text{kg/m}^2$ ); group "U" with underweight (BMI<18.5  $\text{kg/m}^2$ ). It was measured for the characteristic of morphofunctional indicators:

- body height, cm;
- body weight, kg;
- chest circumference (CC), cm;
- circumference of body parts, cm;
- skinfold thickness (caliperometry), mm;
- heart rate (HR) before load, b/10 s;
- HR after 20 squats in 30 s, b/10 s;
- HR recovery time after 20 squats, min;
- systolic arterial blood pressure (ABPs), mmHg;
- diastolic arterial blood pressure (ABPd), mmHg;
- vital capacity lung (VCL), l;
- hand-held dynamometry, kg.

It was calculated: Robinson [58] index ( $Rob_{\text{index}} = \text{HR} \times \text{ABPs} / 100$ , c.u.); vital index ( $VI = \text{VCL} / \text{body weight}$  [59], ml/kg); strong index ( $SI = \text{muscle strength of hand} / \text{body weight} \times 100\%$ ) [60]. It was defined the average value of absolute and percentage content in students' bodies of fat and muscular tissue according to the formulas [61]. It was applied the control tests included in the European and American tests of physical fitness [62, 63] to evaluate the physical fitness of students (high-speed qualities, endurance, strength, flexibility, dexterity). For females: 20 m run (s); 10x5 m shuttle run (s); 5 min run (min); hang (s); sit-ups (quantity of times); trunk bending (cm); long jump from the spot (cm). For males: 100 m run (s); 1000 m run (min); 10x5 m shuttle run (s); hang (quantity of

times); sit-ups (quantity of times); inclinations of a trunk (cm); long jump from the spot (cm). Results of control tests were expressed in metric units.

*Statistical analysis*

It was applied Statistica 7.0 programs (Stat Soft inc., USA). It was determined the arithmetic average mean of indicators (M), a standard deviation (SD). The significance of distinctions of average means of independent samples was estimated by parametrical methods by means of Student t-test. The differences between means of indicators are considered statistically significant at the level  $p < 0.05$ .

**Results**

Distribution of all students according to the indicator mean of BMI is presented in fig. 1, 2. Students of group “U” with underweight didn’t participate in further research.

The males have overweight in 1.7 times more often, and have obesity in 2.5 times more often than females, who have underweight in 36,1% times more often (in 1, 8 times).

The females of group “OV” and “OB” have increase in indicator mean of BMI (in 15.8%; in 29.8%) in comparison with group “N”. The majority of physiometrics are higher in students with a normal weight (tab. 1), than in females with overweight and obesity ( $p < 0.05$ ).

The females of group “OV” and “OB” (tab. 2) had

lower indicators means of all motor tests (except test “20 m run”), than females of group “N” ( $p < 0.05$ ). It was determined the difference in quantitative content of muscular (MM) and fat (FM) body mass in females of different groups (fig. 3).

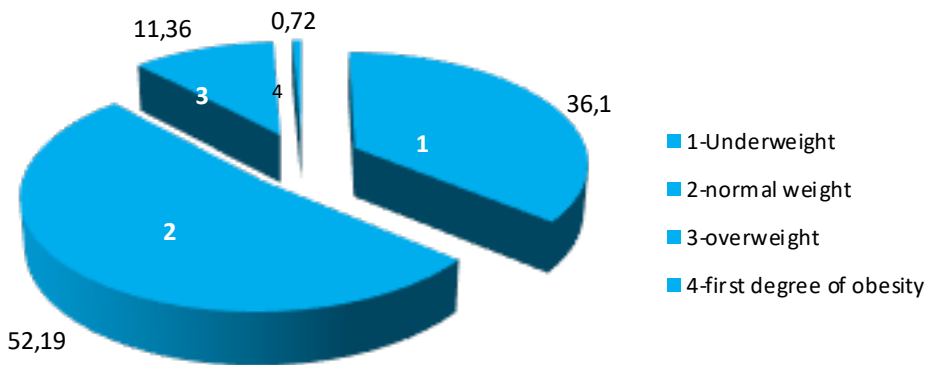
The females of group “OV” had: the content of muscle mass in component structure of a body in 9.7% less and fat mass in 12.2% more, than females of group “N”. Females of group “OB” had: less content of muscle mass in component structure of body in 22.1% and more in 25.2% of fat mass, than females of group “N”.

The males of groups “OV” and “OB” had higher means of BMI (in 16.58%; in 30.7%) in comparison with group “N”. The majority of cardiovascular system indicators and all indexes in males of group “N” (tab. 3) were higher, than in males with overweight and obesity ( $p < 0.05$ ).

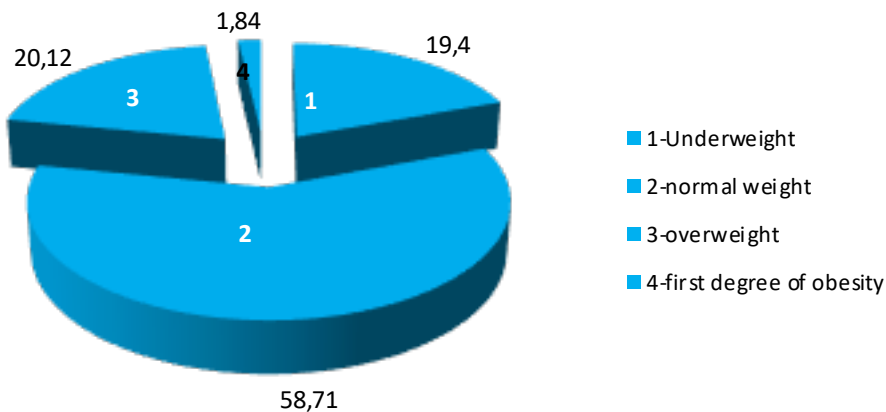
The males of groups “OV” and “OB” had the lowest indicators in five of seven motor tests (shuttle run, 100 m run, 1000 m run, pull-ups, long jump), in comparison with males of group “N”.

According to the results of a research was determined the difference in quantitative content of muscular (MM) and fat (FM) body mass in males of different groups (fig. 4).

The males of group “OV” had the content of muscle mass in 13, 7% less and the fat mass in 17.1% more, than in males of group “N”. The males of group “OB” had



**Fig. 1.** Distribution of females according to BMI (in % to quantity of examined persons)



**Fig. 2.** Distribution of males according to BMI (in % to quantity of examined persons)

**Table 1.** The morphofunctional characteristics of females with different means of BMI (M±SD)

Indicators	Group «N» (n=1011)	Group «OV» (n=220)	Group «OB» (n=14)
<i>Somatometrics</i>			
Body height, cm	164.7±0.17	165.0±0.34	156.7±1.54* #
Body weight, kg	56.9±0.14	68.5±0.35*	73.4 ±1.74* #
Chest circumference, cm	87.3±0.12	90.8±0.33*	96.8±1.93* #
<i>Physiometrics</i>			
VCL, ml	2701.0±14.0	2712.0±30.0	2691.0±123.0
RHR, b/10 s	11.71±0.02	11.76±0.05	12.07±0.13* #
HR after 20 squats in 30 s, b/10 s	21.0±0.08	21.1±0.18	19.78±0.42
HR recovery time after 20 squats in 30 s, min	1.42±0.01	1.48±0.04	2.14±0.18* #
ABPs, mmHg	105.6±0.30	109.7±0.79*	116.0±1.92* #
ABPd, mmHg	69.12±0.17	69.4±0.39	70.2±0.39
Dynamometry of left hand, kg	23.1±0.17	23.2±0.41	22.7±0.86
Dynamometry of right hand, kg	24.1±0.17	23.5±0.44	23.1±1.64
<i>Indexes</i>			
Body weight index, kg/m <sup>2</sup>	21.2±0.13	25.2±0.43*	30.2±1.88* #
Robinson index, c.u.	74.13±0.21	77.4±0.40*	84.0±0.65* #
Vital index, ml/kg	47.4±0.11	39.5±0.37*	36.6±2.14*
Strong index of left hand,%	40.5±0.09	33.8±0.27*	30.9±1.70*
Strong index of right hand,%	42.3±0.10	34.3±0.29*	31.4±1.96*

Note –\* significant differences between indicators of groups: “N”, “OV” and “OB” (P<0,05); – # significant differences between indicators of groups “OV” and “OB” (P<0,05).

**Table 2.** the results of motor tests of females with different means of BMI (M±SD)

Tests	Group «N» (n=1011)	Group «OV» (n=220)	Group «OB» (n=14)
20 m run, s	3.98±0.05	3.94±0.09	3.93±0.34
10x5 m shuttle run, s	21.25±0.06	22.43±0.15*	23.55±0.39* #
5 min run, m	890.2±6.33	820.0±14.1*	762. 7±22.67* #
Hang, s	9.37±0.16	8.35±0.36*	5.19±1.36* #
Sit-ups, reps	23.5±0.22	21.3±0.37*	16.3±0.72* #
Trunk bending, cm	15.38±0.21	14.8±0.38	11.0±0.9* #
Long jump from the spot, cm	150.93±0.52	143.0±1.22*	131.0±4.51#
Integral criterion (points)	3.02±0.01	2.86±0.03*	2.18±0.09* #

Note –\* significant differences between indicators of groups “N”, “OV” and “OB” (P<0,05); – # significant differences between indicators of groups “OV” and “OB” (P<0,05).

**Table 3.** The morphofunctional characteristics of males with different means of BMI (M±SD)

Indicators	Group «N» (n=765)	Group «OV» (n=262)	Group «OB» (n=24)
1	2	3	4
<i>Somatometrics</i>			
Body height, cm	177.9±0.22	177.3±0.38	174.5±2.08
Body weight, kg	67.0±0.19	79.9±0.39*	93.2±2.0* #
Chest circumference, cm	93.81±0.19	98.54±0.36*	106.2±1.9* #
<i>Physiometrics</i>			
VCL, ml	4180.0±19.3	4207.5±32.2	4200.0±130.0
RHR, b/10 s	12.04±0.03	12.19±0.05*	12.57±0.25*

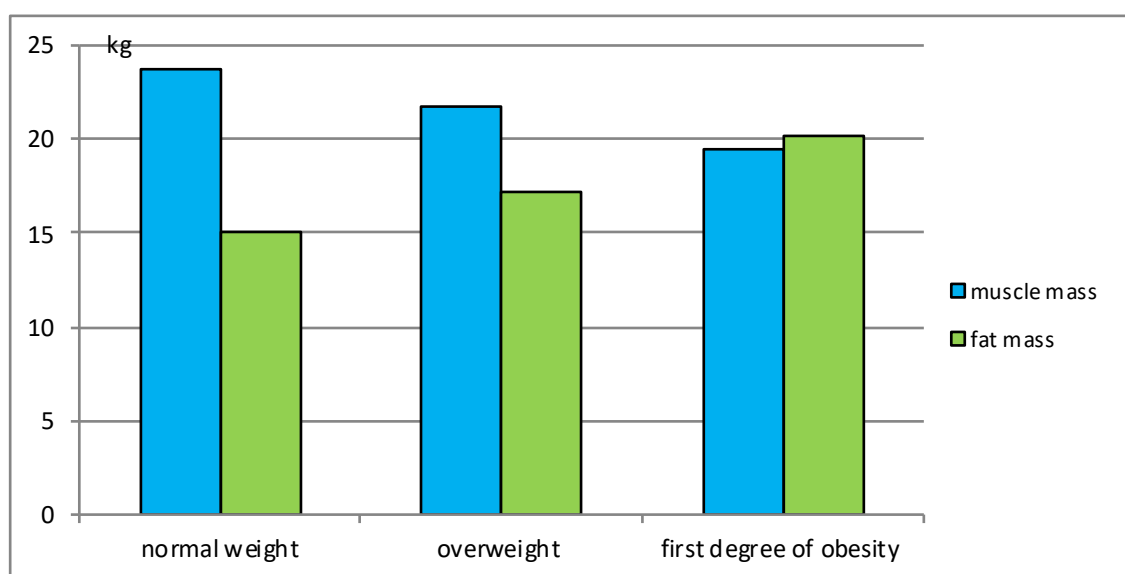
1	2	3	4
HR after 20 squats in 30 s, b/10 s	19.02±0.05	19.18±0.10	19.34± 0.49
HR recovery time after 20 squats in 30 s, min	0.93±0.01	1.04±0.01*	1.89 ± 0.06* #
ABPs, mmHg	114.0±0.27	115.5±0.40	116.8±1.5
ABPd, mmHg	72.9±0.24	74.0±0.41	74.5±1.12
Dynamometry of left hand, kg	43.0±0.12	43.8±0.21	42.8±1.34
Dynamometry of right hand, kg	44.9±0.23	44.8±0.28	43.3±1.45
Indexes			
Body weight index, kg/m <sup>2</sup>	21.2±0.06	25.4±0.18*	30.6±0.75* #
Robinson index, c.u.	82.3±0.27	84.4±0.64*	88.8±1.32* #
Vital index, ml/kg	62.3±0.18	52.6±0.32*	45.1±1.56* #
Strong index of left hand,%	64.2±0.19	54.8±0.41*	45.9±1.58* #
Strong index of right hand,%	67.8±0.20	56.1±0.44*	46.4±1.62* #

Note –\* significant differences between indicators of groups: “N”, “OV” and “OB” (P<0,05); – # significant differences between indicators of groups “OV” and “OB” (P<0,05).

**Table 4.** The results of motor tests of males with different BMI means (M±SD)

Tests	Group «N» (n=765)	Group «OV» (n=262)	Group «OB» (n=24)
10x5 m shuttle run, s	16.04±0.04	16.34±0.08*	16.58±0.28□
100 m run, s	13.84±0.35	15.23±0.08*	16.6±0.28* #
1000 m run, min	3:51.85±0:00.8	3:56.65±0:01.5□	4:05.69±0:06.7* #
Pull-ups, reps	11.08±0.15	9.92±0.27*	7.34±0.88□ #
Sit-ups, reps	29.3±0.20	29.5±0.28	29.1±0.76
Forward bend, cm	16.9±0.26	17.12±0.43	15.2±1.59
Long jump, cm	238.5±0.58	232.8±1.07*	216.6±3.88* #
Integral criterion (points)	3.23±0.01	2.92±0.02*	2.71±0.07* #

Note –\* significant differences between indicators of groups: “N”, “OV” and “OB” (P<0,05); – # significant differences between indicators of groups “OV” and “OB” (P<0,05).



**Fig. 3.** Muscular and fat content of body (kg) of females with different BMI means

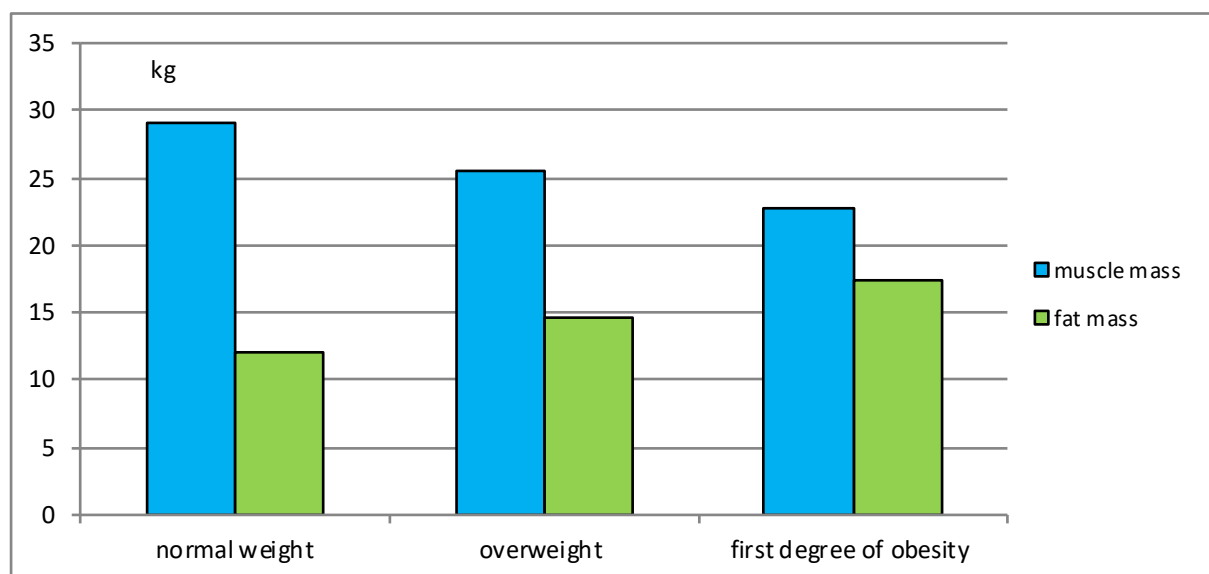


Fig. 4. Muscular and fat structure of body (kg) of males with different BMI means

the content of muscle mass in 27.6% less and fat mass in 30.4% more, than in group “N”.

#### Discussion

The overweight and obesity are risk factors for noninfectious diseases of human [33]. One of the reasons for such phenomenon is the inactive way of lifestyle of population [64, 65]. On a global scale, the physical activities are the fourth important factor, decreasing the risk of human death [25]. In Russian Federation, about 30% of the population suffers from overweight [51]. According to our data males from Baikal region have overweight and obesity more often than females. It will be coordinated with results of researches in other regions of Russia [66, 67]. Females are more motivated on asthenic constitution [68]. It is confirmed by the questioning of Romania students concerning the index of dissatisfaction with a constitution on The Beck Depression Inventory [69]. More than 41% of female students answered that it is possible to improve a body figure [69] by physical training and adhere healthy lifestyle. The analysis of results of the conducted research demonstrated the essential difference between anthropometrical and physiometric indicators in females and at the males with different BMI.

Anthropometrical indicators (body weight, CC) and physiometric characteristics [ $HR_{rest}$  and time of HR recovery after 20 squats; systolic arterial blood pressure (except males); Robinson index; vital and strong indexes] were better in group “N”, than all students in groups “OV” and “OB” ( $p < 0.05$ ). The lowest results of anthropometry and physiometry are revealed in males and females of group “OB” ( $p < 0.05$ ). The similar dependence of anthropometrical indicators of the person and overweight and obesity is noted by others researches [49, 70].

It is determined that the females of group “OV” and “OB” have high means of indicators of systolic arterial blood pressure, in comparison with females of group “N”. Results of our researches are confirmed by scientific

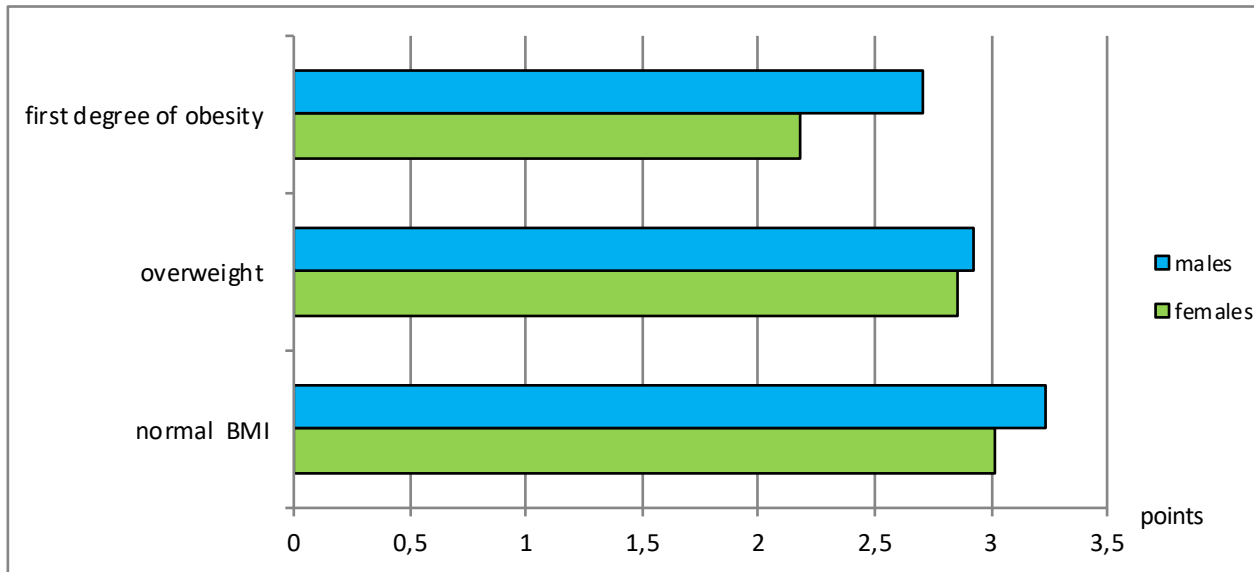
works in which were defined the interrelation between overweight, obesity and arterial hypertension [32, 33]. It can lead to heart attacks and brain strokes.

According to our data students with overweight and obesity have significant low indicators of cardiovascular system condition ( $HR_{rest}$  and HR recovery time after 20 squats), than students with normal body weight ( $p < 0.05$ ). It is confirmed with results of research devoted to the cardiorespiratory system in women of the first mature age in Ukraine [71].

The indicator of cardiovascular system activity is Robinson index. According to our data males and females of group “N” have a low mean of this index. The students of group “OV” and “OB” have significantly high Robinson index than students of groups “N”. It demonstrates the decrease in activity of cardiovascular system in students with overweight and obesity. However, our data differ from results of examination of females with overweight in the Tyva Republic (Russia) [72]. Authors determined low means of Robinson index and great reserve opportunities of an organism for physical activity.

According to our data, the physical fitness of females and males with overweight and obesity is much lower in comparison with results of testing of students with a normal weight. It is confirmed by researches of other authors [45, 73]. It was determined (tab. 2, 4) that females with overweight have significantly low results in five of seven motor tests. The males with overweight and obesity have low results in five tests ( $p < 0.05$ ). In comparison with students with normal weight, males and females (groups “OV” and “OB”) have the decrease in results in motor tests. It is confirmed by the integrated criterion of motor qualities tests (fig. 5).

The mean grade of integrated criterion of physical fitness (fig. 5) of females of group “OV” (with overweight) and females of group “OB” (with obesity of the I degree) was  $2.86 \pm 0.03$  and  $2.18 \pm 0.09$  points respectively. It was in 5, 3% and 27.8% lower than mean grade of female



**Fig. 5.** Integrated criterion of physical fitness level of females and males with different BMI means.

students with a normal weight ( $p < 0.05$ ). The mean grade of integrated criterion of physical fitness (fig. 5) of males of group “OV” (with overweight) and males of group “OB” (with first-degree obesity) was  $2.92 \pm 0.02$  and  $2.81 \pm 0.07$  points respectively. It was in 9.6% and 16.1% is lower than a mean grade of students with a normal weight ( $p < 0.05$ ). Low characteristics of motor qualities of males and females with overweight and obesity are caused by: weak heart function, insufficient content of muscular tissue, overage of fat tissue in component structure of body. The obtained data (fig. 3, 4) confirm the low content of muscle mass and considerable overage of fat mass in component structure of students bodies (with overweight and obesity) in comparison with students of group “N” ( $p < 0.05$ ). These data conform with researches of others authors [73, 74] and our previous researches<sup>75</sup>.

Overweight doesn't allow to develop speed and flexibility of students. The lack of a muscular component in all students' bodies (group “OV” and “OB”) decrease in results of motor tests for manifestation of strength, high-speed and general endurance. Characteristics of these motor qualities were lower, than in students with normal weight (group “N”,  $p < 0.05$ ).

We agree with ideas of other authors [76] concerning decrease in body weight and improvement of motor abilities of the person. It is recommended to apply moderated and long (more than 30 min) aerobic motor exercises for decrease in fat component in a body and

improvement of cardiovascular system activity. It is necessary to apply high-intensity physical activities which allow to intensify synthesis of protein in organism [77] for increase in muscle mass of a body.

### Conclusion

1. Female and male of 17-21-year-olds with overweight and obesity have lower anthropometrical and functional characteristics of organism and motor qualities, than students with a normal weight. Such students have less content of muscle mass in component structure of body, than students with normal weight. Also the content of fat mass is more, than in students with normal weight ( $p < 0.05$ ). It is determined the dependence between the quantity of body fat mass of males and females with the level of their physical fitness.

2. The obtained data concerning features and interrelation of anthropometrical, functional characteristics and motor qualities of females and males (with different body weight) allow to correct educational process of physical training of youth. The basis of such process is made by physical exercises which promote decrease in content of fat mass and to increase in muscle mass in component structure of students' bodies.

### Conflict of interest

The authors declare no conflict of interest.

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#### Information about the authors:

**Kolokoltsev M.M.** (Corresponding author); <http://orcid.org/0000-0001-6620-6296>; [mihm49@mail.ru](mailto:mihm49@mail.ru); Irkutsk National Research Technical University; ul. Lermontov 83, Irkutsk, 664074, Russia.

**Iermakov S.S.**; <http://orcid.org/0000-0002-5039-4517>; [sportart@gmail.com](mailto:sportart@gmail.com); Department of Tourism and Recreation, Gdansk University of Physical Education and Sport; Kazimierza Górskiego 1, 80-336 Gdańsk, Poland.

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