

## Perception of academic load in physical education according to the Borg scale by female students with somatic diseases

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### Abstract:

*The purpose of the study* is to assess how female students of adolescence with somatic diseases percept physical activity during physical education lessons according to the Borg scale. *Research materials and methods.* 98 girls from a special medical group at PE classes, aged 18-19, studying at the Technical University of Irkutsk (Russia) in the 2019-2020 academic year took part at our research work. All students, according to their existing diseases, were divided into 6 groups. According to the Borg RPE scale (Borg, 1998), the girls evaluated the level of their muscle tension personal perception when performing physical exercises in a training session in the range from 6 points (very light level) to 20 (extremely heavy). The interrelation of the physical activity severity perception with the girls' functional characteristics of the cardiovascular and respiratory systems was studied. The indicators of the Robinson index and hypoxic samples of Stange and Genche (timed expiratory capacity) were calculated. The girls' physical fitness was studied using a battery of motor tests. *Research results.* It is established that the physical activity perception severity level depends on the type of somatic disease. Girls with cardiovascular and respiratory systems diseases perceive the dynamic load in PE classes as «hard», this fact is confirmed by the results of a questionnaire on Borg scale. They have significantly low indicators values of some functional characteristics of the cardiovascular system, motor qualities and hypoxic samples of Stange and Genche ( $p < 0,05$ ). *Conclusions.* The research work, carried out by us, showed that female students from the special medical group of the university perceive the volume and intensity of physical activity differently. For girls with digestive system, visual organs and genitourinary system diseases, physical activity corresponds to the aerobic load threshold (130-140 beats/min). In girls with respiratory organs and musculoskeletal system organs diseases, physical activity was at the upper limit of the aerobic load threshold (150-160 beats/min). In girls with a cardiovascular system disease, the load corresponded to an anaerobic regime of physical work (170-180 beats/min). Therefore, we recommend that PE teachers use Borg scale in their work for operational pedagogical control in the classroom and the curriculum correction for students with somatic diseases.

**Key Words:** girls, somatic diseases, Borg scale, functional and motor indicators, physical education

### Introduction

The modern scientific literature contains researchers' from different countries materials, who report low physical activity of the population and body diseases of hypodynamic genesis development (Chekhovska et. al., 2020; Bakiko et. al., 2020). In Russia (Golovin, & Romanova, 2017; Korolenko, 2020) and in other countries (Potop et.al., 2017; Zhang et.al., 2019) students have severe hypokinesia against the background of digital learning at the university (Hortigüela-Alcalá et. al., 2015) and eating disorders (Pop, 2018).

Studies note the fact that with insufficient physical exertion, emotional stress arises, affecting the indicators of heart rate variability (Krivobokova, 2020). New socially negative phenomena and habits are spreading among young people (Pengpid et al., 2019). All this reduces students' health indicators and their quality of life (Yang, Dong, 2017; Kolokoltsev, 2020).

Three methods are used to quantify a person's physical activity: chronometry, i.e. recording the time spent on various motor actions, indirect calorimetry and daily podometry (Kolpakova, 2018).

The physical load, performed by a person, has a quantitative characteristic in the form of intensity and volume, as well as an individual subjective assessment of the individual's motor impact perception. To determine

these parameters, G. Borg scale is used, allowing us to interpret a person's own assessment of his physical efforts severity (Borg, 1998). It is a simple, reliable and effective research and applied widely.

It is used to assess the perception of physical activity in work (Ardalan Shariat et al., 2018; Emma Sala et al., 2021), training process and sports competitions (Persiyanova-Dubrova et al., 2021), clinical practice after a stroke (Maxence Compagnat et al., 2018). RPE scale is valid for assessing physical activity intensity in patients with type 2 diabetes mellitus (Walter Rosales et al., 2016).

There are reports in the literature about motor activity volume perception in some population groups. For example, the use of Borg scale for a retrospective assessment of motor activity over the past 24 hours revealed the peculiarities of physical activity perception among men and women at different times of the day (Boaz Shulruf et al., 2020). According to these authors, such a research method can be used for mass monitoring of physical activity of different population groups.

Some authors (Shinichiro Morishita et al., 2021) established a correlation of Borg scale with a cardiopulmonary parameter and leg muscles oxygenation, which allowed them to correctly construct rehabilitation measures for adults.

The literature (Daiki Kasai et al., 2021) presents studies on physical activity assessment on RPE scale and physical deviations in health in active adult men and women. The authors also found a correlation between %  $VO_{2max}$  and Borg scale.

We consider it relevant and expedient to study the issues of assessing physical effort perceived severity on RPE scale in young female students with various somatic diseases. It will allow us to adjust the life program of motor activity and improve health quality of this group of young people.

**Research aim** is to assess young female students' with somatic diseases physical activity perception severity in PE classes according to Borg scale.

#### **Material & methods**

A screening research of girls was conducted at PE classes at the Technical University of Irkutsk (Russia) in 2019-2020 academic year. 98 female students from a special medical group aged 18-19, having physical activity restrictions associated with their somatic disease, were under observation. All students were divided into 6 groups: group 1 – girls with digestive organs pathology (n=13), group 2 – girls with visual organs pathology (n=19), group 3 – girls with genitourinary system pathology (n=15), group 4 – girls with musculoskeletal system pathology (n=14), group 5 – girls with respiratory organs pathology (n=20), group 6 – girls with cardiovascular system pathology (n=17).

According to the International Standards for Anthropometric Assessment (2001), the relationship between female students' physical activity severity perception and functional characteristics of their cardiovascular system was evaluated.

For this purpose, after the training session, a survey of female students was conducted on RPE scale (Borg, 1998). The girls were asked to evaluate on Borg scale the level of muscle tension personal perception when performing physical exercises in the range from 6 points (very light tension level) to 20 (extremely heavy tension). Each value of Borg scale digit corresponds to a certain heart rate, which characterizes the body's response to the physical activity performed. When multiplying by 10 the number marked in the answer by the students, the heart rate on Borg scale was obtained, corresponding to the physical activity of the girls at the observation time.

Additionally, the pulse was measured at rest, beats/10 s; the pulse after performing physical activity in the form of 20 squats for 30 s, beats/10 s; the pulse recovery time after 20 squats, s; systolic and diastolic blood pressure, mmHg. The nature of hemodynamics was estimated by the Robinson index:  $I_{Rob} = \text{heart rate} \times \text{SBP} : 100$ , relative units (Robinson, 1967). Hypoxic tests of Stange and Genche were performed to assess the respiratory system.

The physical fitness of the girls was studied using motor tests: 30 m run of the high start, s; 1000 m run, min, s; Cadence Push-Up Test, number of times; Eurofit Sit Up Test (for 60 s.), number of times, bending the trunk forward from sitting positions, cm; Standing long jump, cm. (PCFSN. The president's challenge: Physical fitness test, 2011).

PE classes were held in the gym 2 times a week for 90 minutes. The means, methods, intensity and volume of physical activity in the classroom were approximately the same for all groups of girls.

For statistical processing of the results, the programs Microsoft Excel 2010 and Statistica 10.0 were used. The reliability of the differences ( $p < 0.05$ ) was determined by the Student's t-criterion. The research followed the requirements of the WMA

Declaration of Helsinki-Ethical Principles for Medical Research Involving Human Subjects (2013).

## Results

The results of the survey of the screening research participants are shown in Table 1.

**Table 1. Physical activity severity perception assessment on Borg scale and cardiovascular system reaction in girls with different groups of diseases**

Groups of diseases	Physical activity severity perception in points on Borg scale (M± m)	The reference values boundaries perception of the load severity according to Borg (points)	Load assessment according to Borg	Heart rate (bpm)
1. Digestive organs diseases	12,25±0,65	11-12	Moderate	130-140
2. Visual organs diseases	12,78±0,21	11-12	Moderate	130-140
3. Genitourinary organs diseases	13,23±0,33	13-14	Moderate to heavy	130-140
4. Musculoskeletal organs diseases	15,07±0,35	15-16	Heavy	150-160
5. Respiratory organs diseases	15,83±0,75	15-16	Heavy	150-160
6. Cardiovascular organs diseases	17,34±0,19	17-18	Extremely heavy	170-180

It was found that girls with digestive system and visual organs diseases rated their physical activity severity at the training session as «moderate. Girls with genitourinary system diseases rated it as «moderate to heavy», girls with respiratory organs and musculoskeletal system organs diseases rated it as «heavy». For girls with cardiovascular system diseases, the physical load at the training session was «extremely heavy» and it was estimated on Borg scale of 17.34±0.19 points, which is significantly more than for girls with other diseases (p<0,05).

The heart rate indicators values determined by Borg method in girls with digestive system, visual organs and genitourinary system diseases, showed that the physical load in PE classes corresponds to the aerobic load threshold (130-140 beats/min). In girls with respiratory organs and musculoskeletal system organs diseases, physical activity was at the upper limit of the aerobic load threshold (150-160 beats/min). In girls with a cardiovascular system disease, the load corresponds to an anaerobic mode of physical work (170-180 beats/min). The reaction of the body of all the examined students showed that such physical activity is excessive for girls of group 6. In order to understand how the body of girls with different somatic diseases reacts to the educational physical activity perception severity we conducted a study of the girls' functional hemodynamic parameters (Table 2).

**Table 2. All the examined girls' hemodynamic indicators values (M± m)**

Hemodynamic indicators values	Girls' groups*					
	1	2	3	4	5	6
Systolic blood pressure, mmHg.	106,5±6,9	105,7±1,27	104,4±6,4	101,7±2,12	106,2±2,25	109,7±1,44
Diastolic blood pressure, mmHg.	82,5±4,24	83,7±2,36	76,0±3,15	76,1±2,05	75,3±2,6	77,5±2,28
Pulse at rest, beats/10 s	13,3±0,92	13,0±1,0	13,6±0,68	13,8±0,12	14,8±0,39	15,8±0,41
Pulse after performing physical activity (20 squats for 30 s), beats/10 s	23,6±0,15	20,0±3,5	23,8±0,41	23,2±0,76	24,5±0,51	26,8±0,70
Pulse recovery time after loading, s	90,0±4,40	91,1±4,29	90,0±3,7	96,9±5,24	99,2±4,13	126,0±5,1
Robinson index (IRob), relative units.	69,9±4,2	82,5±4,8	85,3±5,0	84,4±5,2	94,2±3,4	103,9±3,7

Note. \* 1- girls with digestive system pathology; 2- girls with visual organs pathology; 3 - girls with genitourinary system organs pathology; 4 - girls with musculoskeletal system organs pathology; 5 - girls with respiratory organs pathology; 6 - girls with cardiovascular system organs pathology.

The maximum value of the systolic blood pressure index was registered in girls with cardiovascular system diseases (109.7±1.44 mmHg), the minimum value in girls with musculoskeletal system diseases (101.7±2.12 mmHg). The maximum value of the diastolic blood pressure index was registered in girls with visual organ diseases (83.7±2.36 mmHg), the minimum value in girls with respiratory system diseases (75.3±2.6 mmHg).

An important functional characteristic of the circulatory system is the heart rate at rest and after physical loading (20 squats in 30 seconds), the pulse recovery time to the initial value and the Robinson index.

It was found that the maximum indicators of heart rate at rest and after exercise, pulse recovery time and Robinson index were registered in girls with cardiovascular system diseases (group 6), compared with the indicators of girls with other diseases (p<0.05). Girls of group 6 perceive dynamic load in PE classes as

«extremely heavy», which is confirmed by the results of the questionnaire and the indicators of their cardiovascular system study. The level of a person's physical health is determined by the state of his conditioning abilities. For our research, it was important to test the motor qualities of girls with different diseases (Table 3).

**Table 3. All the examined girls' motor tests indicators values (M± m)**

Test	Groups *					
	1	2	3	4	5	6
30 m run of the high start, s	5,42±0,07	5,44±0,04	5,37±0,11	5,49±0,06	5,84±0,14	5,97±0,14
1000 m run, min, s	5,82±0,11	6,33±0,08	6,25±0,15	6,14±0,13	6,83±0,15	6,87±0,13
Eurofit Sit Up Test (lifting the trunk) (for 60 s.) number of times	30,56±1,08	30,77±1,21	31,39±1,42	30,83±1,40	26,46±2,05	24,52±0,74
Cadence Push-Up Test (push-up from the floor), number of times	25,23±1,31	21,70±0,92	21,2±1,16	19,25±0,93	15,23±1,43	15,18±0,86
Standing long jump, cm.	153,4±2,45	152,8±1,81	159,3±3,23	151,7±2,40	136,5±4,20	138,2±4,14
Bending the trunk forward from sitting position, cm.	14,13±1,80	13,96±1,87	16,8±1,25	15,6±2,15	11,01±0,88	12,84±0,93

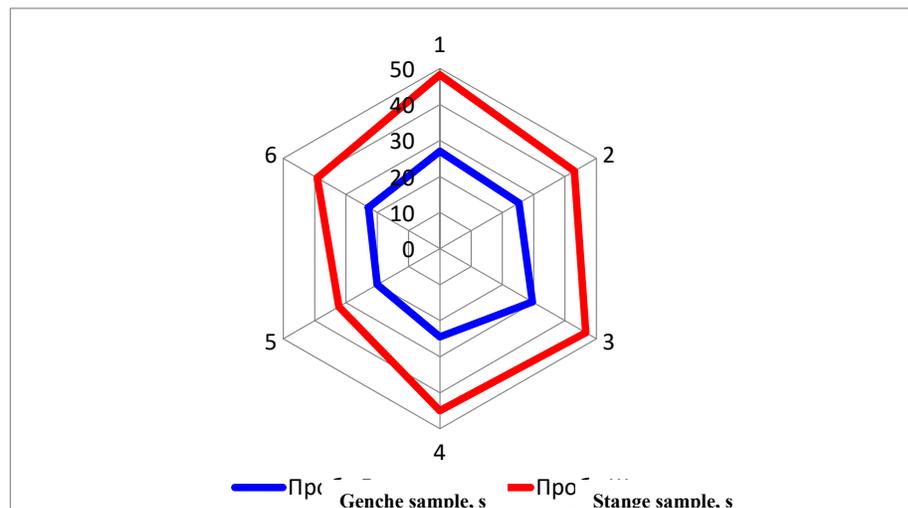
Note. \*1 - girls with digestive system pathology; 2- girls with visual organs pathology; 3 - girls with genitourinary system organs pathology; 4 - girls with musculoskeletal system organs pathology; 5 - girls with respiratory organs pathology; 6 - girls with cardiovascular system organs pathology.

Analysis of the students' physical fitness results showed that the indicators values in control exercises for speed, endurance, strength and strength endurance, dynamic strength of the muscles of the lower extremities were significantly higher in girls of groups 1-4, compared with girls with pathology of the respiratory (group 5) and cardiovascular systems (group 6),  $p < 0.05$ .

In the control test for spine and hip joints flexibility, there were no significant differences between the indicators values of girls from different groups ( $p > 0.05$ ).

In our opinion, the low results of motor tests in girls from group 6 indicate a decrease in the reserve capabilities of their cardiovascular system.

The results of the Stange and Genche hypoxic samples study showed that the lowest indicators values were reliably registered in the girls from group 5 with respiratory system pathology, compared with the indicators of girls from other groups (Fig.).



**Fig.1. The results of the Stange and Genche hypoxic samples of girls from different groups (s)**

Note. Numbers - of the group: 1- girls with digestive system pathology; 2- girls with visual organs pathology; 3 - girls with genitourinary system organs pathology; 4 - girls with musculoskeletal system organs pathology; 5 - girls with respiratory organs pathology; 6 - girls with cardiovascular system organs pathology.

The highest values of the Stange sample indicators were registered in girls of group 1 with digestive organs pathology (48.2 s). The maximum value of the Genche test parameters was registered in girls of group 3 with genitourinary system pathology (29.6 s). Girls of these two groups assessed the severity of physical activity

on Borg scale as «moderate», therefore, they effectively perform the program of the training session. High values of hypoxic tests are also observed in girls of group 2 with visual organs pathology and group 4 (musculoskeletal system diseases). However, they evaluate the physical activity severity perception on Borg scale differently. If the girls of the 2<sup>nd</sup> group consider the educational physical activity to be «moderate», then for the girls of the 4<sup>th</sup> group this physical work was «heavy».

In group 5 girls with respiratory system pathology, Stange sample results were 32.9% less than in students with digestive diseases. The Genche sample results were 32.4% less than in girls with genitourinary system pathology. The girls of group 5 rated the severity of physical activity on Borg scale as «heavy», which, with low values of hypoxic samples, causes them difficulty when performing physical exercises at a training session.

### **Dicussion**

Human motor activity consists of bodily movements using muscle strength and is accompanied by a level of energy consumption that is higher than the level of the body's metabolism at rest (Global Strategy on Diet, Physical Activity and Health, 2004). One of the important conditions for the harmonious physical, somatic and mental development of a person is his regular motor activity, especially in adolescence (Skead, Rogers, 2016).

The results of our Borg scale survey on the physical activity perception severity by girls with different pathologies of organs or systems allowed not only to get their subjective assessment of the load intensity, but also to understand the nature of differences in their responses. According to our data, the most severe perception of the physical activity intensity was observed in girls of group 6 with cardiovascular system diseases.

The correlation of Borg scale with cardiopulmonary parameters established by the authors (Shinichiro Morishita et al., 2021) complements the information about the relationship between the physical activity perception severity and the functional indicators of the circulatory organs. The low reserve capabilities of the cardiovascular system identified by us in the girls of group 6 minimize their performance and thereby increase physical activity, performed in an aerobic mode, perception severity. The research (Solodovnikova et al., 2017) showed that a person's low physical performance is interrelated with insufficient efficiency of the blood supply system, which is consistent with the results of our research works of pulse at rest and after 20 squats, recovery time after exercise and the Robinson index in girls with cardiovascular system diseases.

Human body reserve capabilities to perform physical labor do not always depend only on cardiovascular system pathology, but also on other factors. Earlier, we found that the results of low performance of female students' cardiovascular system are associated with a lack of body weight (Kolokoltsev et al., 2018).

Simplicity and accessibility of the research of the physical activity perception severity using Borg scale allow us to recommend this technique on a large scale (Boaz Shulruf et al., 2020; Daiki Daiki Kasai et al., 2021). This is very important for mass medical examinations of large groups of the population, especially in clinical practice. We believe that a positive characteristic of Borg scale is an operational assessment of the of physical activity perception severity in relation to the heart rate. It allows making quick changes in the process of performing physical activity by a person during sports, physical culture or medical rehabilitation and dose physical exercises.

Our analysis of the survey results of female students confirmed the opinion of other researchers (Lacombe et al., 2019) that the state of the human cardiorespiratory system reflects the quality of physical activity. According to our data, girls with cardiovascular and respiratory systems pathology have significantly the lowest values of indicators of all motor tests (with the exception of the flexibility test), compared with the indicators of girls with other diseases. This is confirmed by the results of control tests of girls for endurance and speed-power characteristics, which largely depend on their circulatory and respiratory organs efficiency. Girls of groups 5 and 6 have the lowest results of hypoxic Stange and Genche samples, compared with the results of girls with other somatic diseases.

### **Conclusions**

As a result of our research, it was found that the method of determining the physical activity perception severity on Borg scale (RPE) in female students with somatic diseases showed sufficient simplicity, accessibility and informational value.

The data on the difference in the nature of physical activity perception by girls with different groups of somatic diseases in PE classes were obtained. Girls with cardiovascular and respiratory systems diseases are most difficult to perceive the volume and intensity of motor loads than girls with digestive, visual, genitourinary and musculoskeletal systems diseases.

Significantly low indicators values of Stange and Genche hypoxic samples were found in girls with respiratory system diseases, compared with girls, having other diseases.

In girls with cardiorespiratory system pathology, low indicators of motor qualities were registered in all test tests (with the exception of the flexibility test). These girls should additionally independently perform aerobic physical activities: walking, light running, swimming, skiing and cycling.

Our research has shown that PE classes' curriculum in the special medical group of the university is perceived and performed by students in different ways. Therefore, we recommend that PE teachers use Borg scale in their work for operational pedagogical control in the classroom and their curriculum correction.

**Conflicts of interest.** The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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