ORIGINAL ARTICLE

Effect of different training modes of strength exercises on a student's body

Alexander A. Fedyakin[ABCD], Zhanna G. Kortava[BCDE], Lidia K. Fedyakina[BCDE], Natalia Yu. Zaplatina[BCD]
Sochi State University, Russia

Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Fund Collection

Abstract

Purpose: Scientific-methodical literature underlined the importance of improving the effectiveness of physical education's tools and methods during the scheduled university lessons. Scientists point out the necessity to take into account every factor determining the training effect of lessons with strength exercises. The immediate training effect can be determined by measuring the heart rate during different modes of strength exercises and during recovery. The aim of this study is to analyse the strength exercises' immediate training effect on a student's body in the static mode and in the isotonic mode.

Material: In the study participated 47 freshman male students of the Sochi State University (Russia). The study took place in September-December 2019. Heart rate was measured with Sport Testers POLAR RS-400 during strength exercises and during recovery. The results were analysed in the computer programme SPSS Statistics v22.0. Statistical significance of the results was defined using non-parametric Wilcoxon test. Heart rate was analysed during four types of plank positions in static and isotonic modes.

Results: The study determined the effect of different training modes of strength exercises on a student's body. The immediate training effect of doing the bodyweight strength exercises in the isotonic mode compared to the static mode is characterised by a higher maximum heart rate at the end of doing the exercise ($p<0,05$); a higher average heart rate during the exercise and during rest until the next exercise ($p<0,05$); a higher combined heart rate ($p<0,05$).

Conclusions: The isotonic mode of the bodyweight strength exercises has a more prominent training effect than the static mode due to the specific nature of muscle contractions. Due to analysed heart rate values, the authors recommend taking into account the individual level of every student's physical fitness.

Keywords: students, strength exercises, static and isotonic modes; heart rate.

Introduction

The issue of effective use of physical education's different tools during the scheduled university lessons arises from the decline of students' physical fitness in Russia [1, 2] and in other countries [3]. There are no significant differences in physical fitness level between Russian students and students from other countries [3].

The amount of time that students spend on physical activity has a significant influence on the level of their physical fitness [4, 5, 6]. The implementation of the educational module "Physical education and sport" is regulated by the Federal State Educational Standard [7], and it provides not enough time for physical activity in a university, as noted [8]. That's why improving physical education teaching in universities should be accomplished by improving the methods of using physical education tools during the scheduled lessons. As indicated, during the scheduled lessons a positive effect is achieved as a result of cyclical aerobic exercises [9], shaping [10], sports and active games [11, 12], etc. A positive healthful training effect of the lessons with the strength exercises is established [13]. The implementation of the modern technologies [1], new and popular tools of physical education [14] warrant the evaluation of their training effect on a human body. Factors that define healthful training effect of physical exercises on a human body: the intensity of doing the exercise; the amount of work done; rest time between sets and between exercises; the mode of exercise [15, 16]. The intensity of doing a strength exercise can be calculated with a weight amount and a number of repetitions [17]. Under this approach, Pourrazi et al. [18] record the same training effect between groups that did the strength exercises with low (50%) and middle (75%) intensity. Maybe it stems from the authors' methodical approach in calculating the intensity of the exercise. A more perspective approach would be calculating the intensity based on the maximum weight of the load [19]. An easy measure of the internal intensity of the exercise is the heart rate. Khomiakov GK. [20, p. 182] notes that the circulatory system's functional condition is the leading factor limiting the amount of physical intensity. Physical fitness of students affects the training effectiveness of physical education's tools [21]. It can be acknowledged that strength exercises' distinctive effects on a human body need further study and specification. First of all, the effects of doing the exercises in different modes.

The aim of this study is to analyses the strength exercises' immediate training effect on a student's body in static and isotonic modes.

Materials and Methods

Participants. In the experimental study participated

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freshman male students of the Sochi State University (n=47). At the beginning of the experiment the participants' median age was 17,9±1,8 years old, the median weight – 74,1±2,4 kg, the median height – 175,1±3,3 cm. The entry criterion for participating in the study was a voluntary informed consent to participate. The study procedure complied with Ethical Committee standards.

Research Design.

The study's type was laboratory with cross comparisons. Cross comparisons were made in two stages. The participants of the experimental study were randomly divided into two groups. In the beginning of the lesson the participants did standard warm-up: 6 minutes of step aerobics, 12 minutes of slow running, 8 minutes of stretching and 6 minutes of special running exercises. During the first stage after the standard warm-up group A (n=24) did the bodyweight strength exercises in the static mode, and group B (n=23) did the bodyweight strength exercises in the isotonic mode. The second stage of the study was conducted one week after the first one at the same time. During the second stage after the standard warm-up group B (n=23) did the bodyweight strength exercises in the static mode, and group A (n=24) did the bodyweight strength exercises in the isotonic mode (during plank positions, the participants were slowly moving their pelvis without relaxing the involved muscles). Every participant did the exercise in two modes. The exercises began and ended on command. The time between exercises was two minutes. Each strength exercise was being done for 35 seconds; rest time amounted to 85 seconds. Every participant of the experiment did the bodyweight strength exercises in the static and in the isotonic mode, which improves the reliability of the collected data. Sport Testers Polar RS-400 were used to measure the heart rate. This allowed determining the circulatory system's reaction to the physical exercises with high accuracy. The heart rate was measured during the exercises and during recovery. The exercises were done lying down on polyurethane foam mats, which standardized the technique of the exercises. The only difference was in the mode of the exercises.

Statistical Analysis.

The collected data was analysed in the computer programmes Microsoft Excel 2010 and SPSS Statistics v22.0. Descriptive statistics parameters were calculated: arithmetic mean (M) and standard deviation (SD). The statistical significance of the results of the bodyweight strength exercises in static and isotonic modes was defined using non-parametric Wilcoxon test [22].

The assumption that there are no significant differences between the effects on a student's body from the bodyweight strength exercises in the static mode and in the isotonic mode was accepted as a null statistical hypothesis. The alternative hypothesis – doing the bodyweight strength exercises in the isotonic mode has a more prominent training effect (statistically significant) than doing the bodyweight strength exercises in the static mode. Acceptance or rejection of the null hypothesis was made using a significance level p = 0,05 (95%).

Results

The analysis of the heart rate deviations during the bodyweight strength exercises shows, that (Table):

- the maximum heart rate right after doing the exercises in the isotonic mode statistically differs from the heart

Table. Comparison of the strength exercises' training effect on a student's body in the static mode (top line) and in the isotonic mode (bottom line)

Exercises	Initial heart rate (BPM)	Maximum heart rate. (BPM)	Average heart rate (BPM)	Combined heart rate over two minutes (BPM)
Right-side forearm plank	105±12.7	135±10.1	118±11.6	252±30.6
	105±10.1	143±6.2	123±7.8	263±19.9
P_{1-2}	p>0.05	p<0.05	p<0.05	p<0.05
Left-side forearm plank	106±9.9	138±7.1	119±10.4	248±23.3
	105±13.2	143±11.7	124±11.2	261±25.9
P_{1-2}	p>0.05	p<0.05	p<0.05	p<0.05
Reverse forearm plank	103±11.1	131±7.0	117±8.3	241±19.4
	101±15.5	140±10.6	123±11.1	256±25.7
P_{1-2}	p>0.05	p<0.05	p<0.05	p<0.05
Forearm plank	107±10.8	133±9.4	121±6.2	247±10.3
	109±12.9	147±11.2	128±12.1	254±22.1
P_{1-2}	p>0.05	p<0.05	p<0.05	p<0.05

rate after doing the exercises in the static mode;

- the combined heart rate during the strength exercises in the isotonic mode statistically differs from the combined heart rate during the same exercises in the static mode;

- the average heart rate during the exercises done in the isotonic mode and during rest period until the next exercise (the average heart rate over two minutes) statistically differs from the same exercises done in the static mode.

Thus, during the study it was established that doing the bodyweight strength exercises in the isotonic mode has a more prominent training effect on a student's body than doing the exercises in the static mode.

The variations in the heart rate of the participants are explained by their level of physical fitness. Figures 1 and 2 demonstrate the combined heart rate during the strength exercises in the different modes of a fit student (Figure 1) and a physically weak student (Figure 2).

They show the specific effect on the human body from the different modes of doing strength exercises. Doing the bodyweight strength exercises in the isotonic mode has a more prominent training effect than doing the same exercises in the static mode. This is evident in the increased percentage of time of the higher heart rate during the strength exercises (Figures 1, 2).

A physically weak student has a heart rate of 131-150 BPM about 10% of the time during the exercise in the isotonic mode. This corresponds to the submaximal

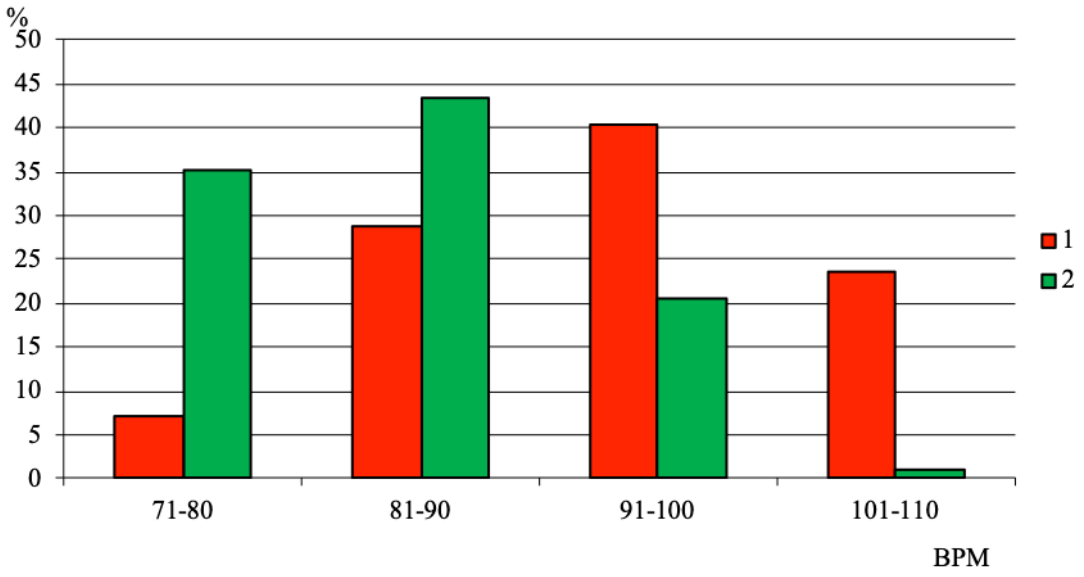

Figure 1. Combined heart rate of a fit student during the strength exercises (1 – in the isotonic mode, 2 – in the static mode)

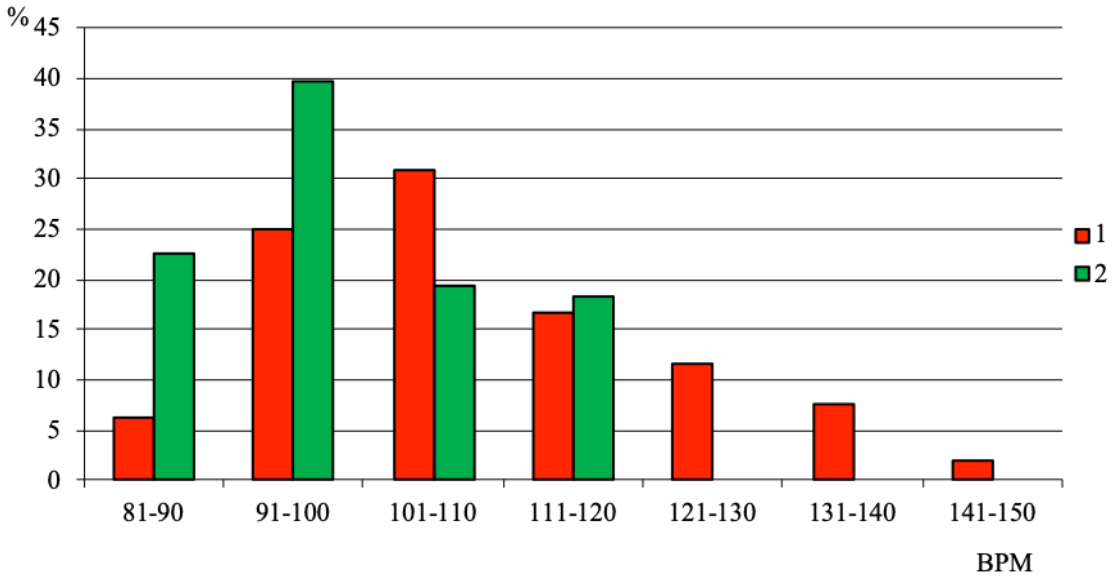

Figure 2. Combined heart rate of a physically weak student during the strength exercises (1 – in the isotonic mode, 2 – in the static mode)

intensity and the developing pulse zone [23]. During exercising in the static mode the heart rate doesn't go higher than 120 BPM.

A fit student's heart rate doesn't go higher than 110 BPM during the bodyweight strength exercises in the static mode as well as in the isotonic mode. By the time of the next exercise the heart rate becomes lower than 120 BPM in both cases, which indicates that enough recovery time has passed to begin the next exercise.

Discussion

The conducted study showed that there are statistically significant differences between the statistical hypotheses. The training effect on the bodies of students doing the strength exercises is more prominent in the isotonic mode. This is explained by the circulatory system's reactions and is related to the functionality of the students' specific muscle group. The isotonic mode of muscle contractions limits the blood flow to the working muscle because the muscle doesn't relax during the exercise. This allows the isotonic mode to be used with the hypoxic training, which has several benefits [24]. Doing strength exercises in isotonic mode enhances the strength and hypertrophies the working muscles. The revealed immediate effect of the strength exercises is prevalent if there is enough rest time between sets, since the amount of rest has a major influence on the body's response [16]. It is confirmed during the experiment of this study.

Recommendations to increase the amount of lessons [25] are suitable if the goal of the lessons is to reduce the body fat ratio and there are real possibilities to do that. It is impossible to do during scheduled lessons. Thus, the isotonic mode of doing the strength exercises can be viewed as one of the ways to improve the effectiveness of the scheduled physical education lessons. The study determined the immediate training effect on the students' bodies of the strength exercises done in static and isotonic modes. It is important to note that the intensity of the exercises should correspond to the fitness level of each student. Bodyweight strength exercises suit physically weak students. For the fit students the exercise's weight amount needs to be increased. Strength exercises should be done with additional weight, with maximum intensity according to every student's fitness level, as evidenced in sports training [26].

The intensity of the exercises should be analysed to determine the effectiveness of physical education's different tools on the students' performance. Step aerobics and athletic gymnastics enhance specific motor functions [27]. The mode of muscle contractions influences the intensity of the exercise. Quantitative data from this study shows that. Thus, the isotonic mode of doing the strength exercises is one of the factors that needs to be considered when determining the weight amount, as well as the intensity and the length of the exercise, and the isotonic mode should be used during the scheduled lessons.

Conclusion

The isotonic mode of doing the bodyweight strength exercises has a more prominent training effect due to the specific nature of the muscle contractions. Due to analysed heart rate values during the different modes of the strength exercises during the scheduled university lessons, the authors recommend taking into account the individual level of every student's physical fitness.

Conflicts of interest

The authors of the article declare that there is no conflict of interest.

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Information about the authors:

Alexander A. Fedyakin (Corresponding Author); Doctor of Pedagogical Sciences, Professor; http://orcid.org/0000-0001-8658-6724; faart@mail.ru; Sochi State University; Sochi, Russia.

Zhanna G. Kortava; https://orcid.org/0000-0003-4384-7642; zgkortava67@mail.ru; Sochi State University, Sochi, Russia.

Lidia K. Fedyakina; https://orcid.org/0000-0001-5557-208X; fedyakina.lidia@yandex.ru; Sochi State University; Sochi, Russia.

Natalia Yu. Zaplatina; https://orcid.org/0000-0002-5130-4106; zaplatinanata@yandex.ru; Sochi State University; Sochi, Russia.

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