



Increasing the level of cardiorespiratory and strength endurance of female students by means of mixed training (Kangoo-jumps fitness and resistance training)

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Abstract

Background. Experts note the low level of physical fitness of female students. Fitness programs that balance the development of cardiorespiratory and strength fitness level are necessary in the physical education practice of students. The purpose of this study is to compare effectiveness of two exercise programs in terms of strength endurance and cardiorespiratory of female students in physical education. **Material and Methods.** Female students ($n=36$) practicing fitness-aerobics (G-1) and resistance training (G-2) participated in the research. All students participated in 52 training sessions. The students (G-1) practiced step aerobics with strength training combination. The students (G-2) practiced resistance training with Kangoo-Jumps fitness combination. The level of cardiorespiratory and strength fitness was studied using tests: VC, Stange test, Step test (PWC_{170}), Running test, Push-Up test and others. **Results.** Students (G-1) had a reliable advantage in test results: VC, Stange test, Step test (PWC_{170}), Running test, at the research beginning. Students (G-2) showed significantly better results in tests: Burpee test, Push-Up test and Stange test at the end of research. Reliable differences in tests: Plank test and Heart Rate in favor of female students (G-2) were revealed. The results of other functional tests did not differ significantly. **Conclusions.** The possible effectiveness of aerobic fitness training Kangoo-Jumps in resistance training of female students was discovered. A significant increase in the indicators of strength endurance and cardiorespiratory fitness of young women was revealed.

Keywords: Students' health, physical fitness, Burpee test, aerobic fitness training, mixed training programs.

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INTRODUCTION

Physical inactivity has been identified as the fourth main risk factor to mortality worldwide. Researches showed that the prevalence of sedentary behavior among undergraduate students ranges from 70 to 90% today [1]. The current system of organization of physical education (PE) in higher educational institutions in the countries of the former USSR is not effective and needs to be updated. Experts point to the lack of physical health of students who practice standard programs of PE [2]. The level of regular physical activity (PA) of female students is significantly lower than male students [3]. The lack of regular PA negatively affects the level of physical fitness profile of female students [4]. Overweight and development of obesity is significant phenomena for female students [5]. Experts point out that low level of muscle and cardiorespiratory fitness in young female students are associated with risks of developing cardiovascular diseases [6], arterial hypertension and increasing the abdominal fat [7]. Scientists have identified a significant relationship between cardiorespiratory fitness and activity-related healthy lifestyle practices in modern youth: children, adolescents [8], and students [9].

Various types of health and sports fitness are used in the practice of PE of students today [10]. The students' attitude to various health-improvement fitness technologies is characterized by positive motivation; the interest in them is growing significantly due to the modification of exercises and possibility to change their intensity and orientation [11]. Health-improving fitness means have impact positive effects on the level of the physical condition of students [12]. Modern female students prefer fitness aerobics and dance when choosing a type of PE [13]. Females believe that the practice of fitness aerobics and dancing will have a significant impact on the correction of the figure and body mass dynamic. The positive impact of aerobic training on improving the dynamics of weight loss is confirmed by scientists [14]. Aerobic and dance training programs had positive effects on body composition values, functional fitness and dynamic balance parameters of female students with a high BMI [15]. Experts suggest using some types of aerobic fitness (fitball aerobics) in the practice of PE of female students with various functional state deviations [16]. Effective programs of PE should be based on evidence-based methods and provide the necessary level of PA to maintain a high level of health. Scientists suggest using Kangoo-Jumps fitness in the practice of PE of female students [17]. Researches show that the practice of Kangoo-Jumps helps to increase the level of cardiorespiratory and strength fitness of female students [18]. There is evidence of a high positive effect in the development of dynamic balance of the body and strength of the leg muscles for individuals using Kangoo-Jumps fitness [19]. The positive effect of using Kangoo-Jumps fitness in the practice of body mass control of female students was revealed [20]. Experts points out higher impact effectiveness of Kangoo-Jumps fitness in the practice of reducing the BMI of female students compared to other types of aerobic fitness training [21].

Some experts consider step aerobics combined with strength training and stretching to be the basis of aerobic training for female students. Astafyev et al., claim that a successful implementation of fitness technologies in the practice of PE of female students includes the integrated use of step aerobics, fitball aerobics and stretching. This combination is necessary to ensure the uniform distribution of physical loads on the main muscle groups, as well as to increase the emotionality in the training process and promote interest in fitness training [11]. Some scientists give a significant preference to aerobic fitness at the expense of strength fitness of female students. Avdeeva et al., point out the advantage of using step aerobics compared to athletic strength training in the practice of PE of female students [22]. Experts states out that aerobic training is preferable to other types of PA in the practice of increasing cardiorespiratory fitness level of students. The analysis of scientific data indicates the predominance of the concept of using aerobic fitness training in the PE practice of young women. Wilson, et al., indicate the preference of female students to perform aerobic PA over muscle strengthening. Scientists express some concern because muscle building activities are important for the physical and mental health of youth [23]. Prontenko et al., emphasize that significant correlations between the level of physical fitness and health indicators of female students are determined due to the results in the endurance and power exercises [2]. Scientists emphasize the importance of including weight-lifting exercises in the practice of aerobic training of modern youth. It is proved that the combination of aerobic training and resistance training has a positive effect on the health of youth,

including youth with overweight [24]. Symonik et al. [25], point to the need to use power blocks exercises in the fitness aerobics practice in female students of non-sporting specialties.

Scientists point out the effectiveness of using both intensive aerobic training and a reasonable combination of aerobic and strength training in the practice of reducing body mass and improving physical fitness in young women. A combination of strength and aerobic training is a more appropriate method for improving women's muscle strength and aerobic fitness [26]. Carneiro et al. [27], note that intensive interval training helps to improve body composition and increase muscle mass of young women. Combined workouts (combinations of aerobic and strength exercises with weights up to 70% of the maximum for single repetition) have a positive effect on increasing the strength of the muscles of the body of young women. It was found that resistance and mixed (aerobic + resistance) training is more effective than aerobic training in reducing circulating myostatin levels at young females [28].

A scientific data review showed the positive impact of aerobic and strength training in the physical fitness profile of female students. Many experts prefer various types of aerobic fitness in PE practice today. A short volume of strength exercise is used in aerobic training. Experts point out the lack of cardiorespiratory endurance in female students practicing resistance training. A date review identified the main problems of our research: the lack of strength training in the PE practice of female students and the low level of cardiorespiratory and strength endurance of females who practice resistance training.

The hypothesis of the research: the authors suggested that the use of Kangoo-Jumps fitness in the practice of resistance training of female students will more positive impact of cardiorespiratory fitness and strength endurance level of young women than step aerobics with strength training combination. The purpose of this study is to compare effectiveness of two exercise programs in terms of strength endurance and cardiorespiratory of female students in physical education.

MATERIALS AND METHODS

Participants

Healthy female undergraduate students ($n=36$) studying at the Siberian Federal University. All females passed a medical examination and had access to PE classes. All female students participated in PE in selected sports specializations during the year. The average age of female students is 19.24 ± 0.13 years. The average growth of female students – 163.46 ± 6.59 cm. Mean values of body mass of female students – 56.38 ± 5.66 kg. All female students gave informed consent to participate in the research and publish the results.

The Research Design

The research took place at the Siberian Federal University. The research period was 8 months (October 2018 – May 2019). All female students had regular practice PE by types of sports specializations: fitness aerobics ($n=18$ – G-1) and strength athletic training ($n=18$ – G-2). All female students had 2 sessions of PE per week excluding the winter examination period. Number of PE sessions of each group includes 52 training sessions. The volume of each session PE was 90 minutes.

Female students engaged in fitness aerobics (G-1) practiced step aerobics (performing various steps and dance movements on step platforms – 15–20 cm high). The volume of such exercises was about 35–40 minutes per training. The structure of aerobic fitness classes included strength training (20–25 min) and stretching training (15–20 min). The warm-up took about 10–15 minutes. Total time for PE session – 90 minutes

Female students engaged in resistance training (G-2) practiced power training with weight (50–70% of the maximum level for their single repetition): deadlifts, back squats, bench press, push press, push-ups, planks and others (dumbbell bench press, dumbbell incline bench press, lower back extension, leg press, leg extension, dumbbell lunge, hanging leg raise). The volume of power training was 45–50 minutes per session PE. Females (G-2) also practiced warm-up (15–20 minutes) and stretching training (15–20 min). The students performed one basic exercise and 2–3 non-basic exercises at each power training. Females performed 5–6 sets (10–15 reps in each set). During the research period, the total volume of warm-up and strength training was reduced by 20 minutes. Kangoo-Jumps fitness was added to the practice of training female students (20 minutes per each

training). Kangoo-Jumps practice – performing jumps and dance moves in special boots (Kangoo-Jumps boots) to rhythmic music.

To calculate the Body Mass Index data, the formula of A. Quetelet was used. BMI indicators for female students were evaluated using the WHO classification (2015).

The functional state of the respiratory system of female students was studied by determining the vital capacity of the lungs (VC). We used a portable dry spirometer Acorn (China), to the generally accepted method. The heart rate of female students was measured after passive rest (5 minutes). We used a heart rate monitor Polar H10 (China).

We evaluated the cardiorespiratory and strength endurance fitness level of the students used tests: Stange test, Step test (PWC_{170}), Running test (2000 m), Burpee test, Push-Up test (60 sec) and Plank test.

Stange test. Test envisages breath pause after inhale and is to be fulfilled in sitting position. The tested shall make deep (but not maximal) inhale and keep pause as long as possible (pressing nostrils with fingers). The time of pause was recorded. For healthy untrained persons the range of pauses is: 50–60 seconds for male students and 40–50 seconds for female students.

Step test (PWC_{170}). Female students performed 2 physical step loads (5 minutes each load) with a rest interval of 3 minutes between loads. Students performed ascents to the step platform (height of step platform was 30 cm). The rate of ascent to the step platform is at least 20 ascents at the first step load and 30 ascents at the second step load. Heart rate parameters were determined within 10 seconds after each test load. Indicators of physical performance of female students were determined to the modified method of Karpman [29]. Evaluation of students' workability indicators was carried out using the recommendations of Graevskaya. The following Step test (PWC_{170}) indicators are proposed: 14 or less – low level, 15–16 – below average level, 17–18 – average level, 19–20 – above average level, 21–22 – high level of assessment [30].

Running test. The female students had to run a distance of 2000 meters without slowing down to stepping, walking or stopping before finish. The total running time was recorded.

Burpee test. Female students performed a 3-minute burpee test according to the method of Podstawski [31]. Students were instructed on how to perform the burpee test correctly. The test was preceded by an active warm-up (not less than 10 minutes). Students' strength endurance was evaluated based on the number of burpee cycles completed in 3 minutes.

Push-Up test. The Push-Up test was performed according to standard procedure. Students' torso was lowered by bending the elbow joints to 90 degrees of flexion in a continuous motion. Female students after pressed herself back up to full elbow extension. Students performed as many repetitions as possible using maximum speed throughout the test for muscular endurance. The testing time for female students is 60 seconds.

Plank test. For the plank position, students' feet were placed hip width apart, with the ankles at 90°, knees straight, and pelvis tilted into a neutral position to engage the core. The elbows were bent to 90° and placed directly below the shoulders with the back flat. Recorded total time that proper plank form was maintained.

Statistical analysis

Results was analyzed using Statistica 12. Significance level was determined between both groups before and after intervention, as well as for each group. One-way ANOVA test was used because results does not fit into normal distribution.

RESULTS

Initial tests before intervention in October 2018 reveals, that two tested groups differs significantly in vital capacity of the lungs (VC), Step test, Burpee test and Running test. Comparison of BMI, Heart Rate and other test did not reveal differences between those two groups (table 1). For the first group, comparing between before and after intervention test, significant improvement was revealed in Plank test (from mean of 1.43 seconds to 2.04 seconds), Push-up test (from mean of 18.44 to 20.39 repetitions), Burpee test (from mean of 43.56 to 51.17), Step test (from mean of 17.04 to 18.36), Stange test (from mean of 42.25 to 49.67) and decrease in rest heart rate (from mean of 75.67

to 70.06). Detailed results are presented in figure 1. For the second group, all tested indicators turns to have significant difference between before and after intervention period. Improvement was revealed in all indicators. Interpretation depends on whether increase or decrease in value was desirable. Detailed results are presented in figure 2. Results of after intervention tests, reveals that in the second group, there were significantly higher values in terms of BMI, Burpee test, Push-up Test and Plank test.

Table 1. Test results for two tested groups before intervention.

| Test | G1 | | G2 | |
|----------------------------------|-------|------|-------|------|
| | mean | SD | mean | SD |
| BMI | 21.14 | 0.03 | 21.16 | 0.02 |
| Heart Rate | 75.67 | 2.97 | 77.44 | 3.26 |
| VC (l)* | 3.43 | 0.10 | 3.32 | 0.08 |
| Stange test (sec) | 42.25 | 2.78 | 41.79 | 2.34 |
| Step test (PWC ₁₇₀)* | 17.04 | 0.16 | 16.73 | 0.11 |
| Burpee test (3 min)* | 43.56 | 1.15 | 42.33 | 1.28 |
| Running (min)* | 10.56 | 0.53 | 11.28 | 0.51 |
| Push-Up test | 18.44 | 2.55 | 18.56 | 2.73 |
| Plank test | 1.46 | 0.11 | 1.48 | 0.14 |

* - significance level of differences at p< 0.05

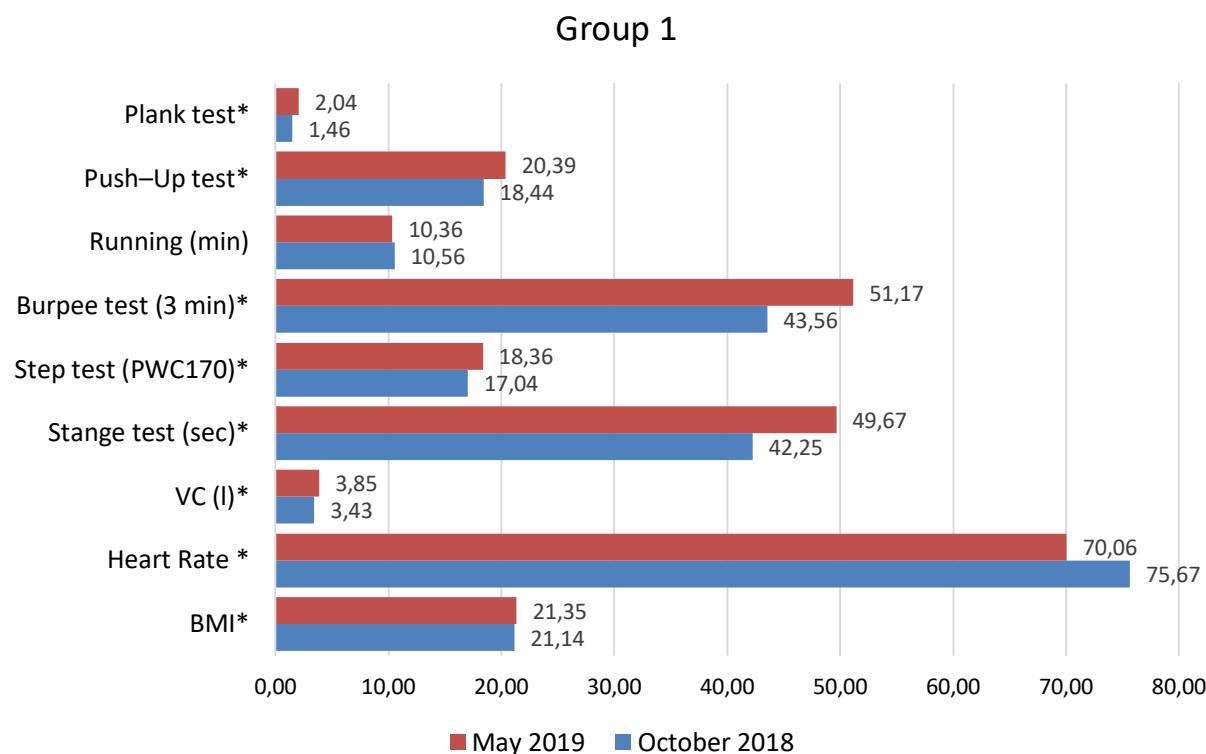


Figure 1. Results of conducted tests before and after intervention for participants from first group.
* - significance difference at p< 0.05.

Table 2. Test results for two tested groups after intervention.

| Test | G1 | | G2 | |
|---------------------------------|-------|------|-------|------|
| | mean | SD | mean | SD |
| BMI* | 21.35 | 0.05 | 20.86 | 0.04 |
| Heart Rate | 70.06 | 2.90 | 69.72 | 3.16 |
| VC (l) | 3.85 | 0.05 | 3.83 | 0.07 |
| Stange test (sec) | 49.67 | 3.01 | 51.02 | 2.68 |
| Step test (PWC ₁₇₀) | 18.36 | 0.31 | 18.34 | 0.18 |
| Burpee test (3 min)* | 51.17 | 1.29 | 53.22 | 1.35 |
| Running (min) | 10.36 | 0.16 | 10.35 | 0.14 |
| Push-Up test* | 20.39 | 2.48 | 22.83 | 2.75 |
| Plank test* | 2.04 | 0.21 | 2.18 | 0.17 |

* - significance level of differences at p< 0.05

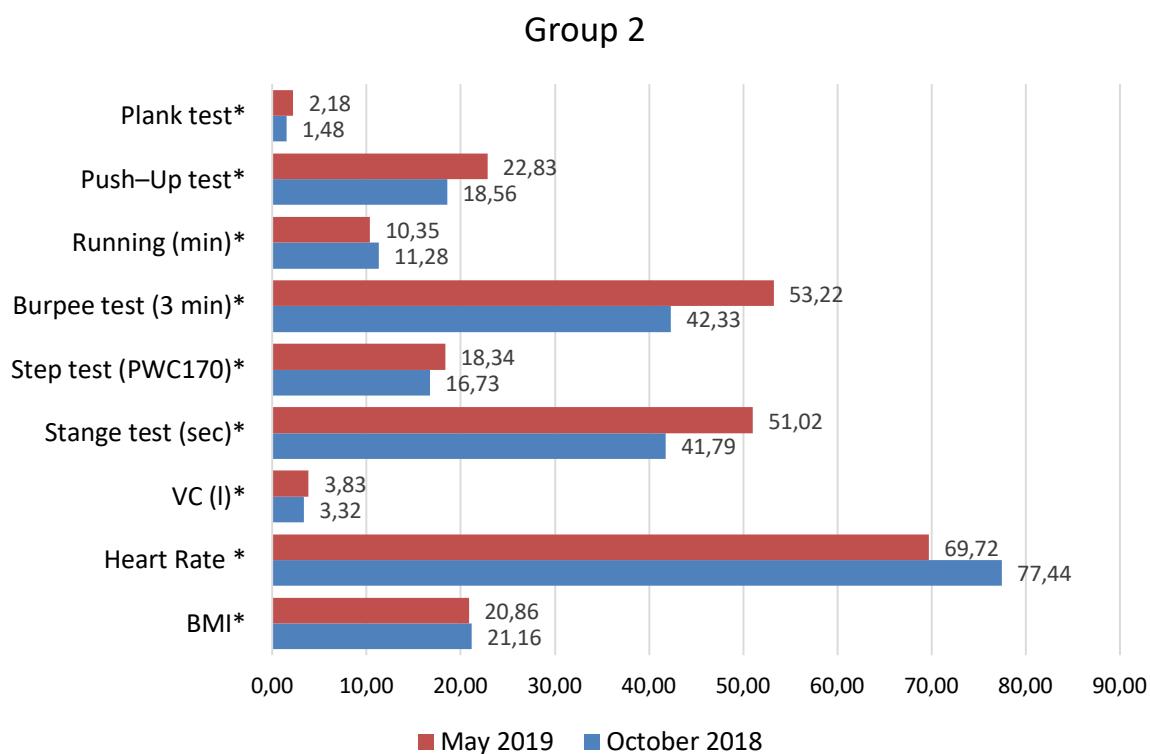


Figure 2. Results of conducted tests before and after intervention for participants from second group.
* - significance difference at p< 0.05

DISCUSSION

The scientific literature provides sufficient data on the benefits of aerobic fitness in the practice of improving cardiovascular and muscular endurance of young people [32]. Some experts highlight the advantage of aerobic fitness (step aerobics) over strength training in the practice of increasing of cardiorespiratory fitness level and body mass control of female students [22]. Other scientists allow the use of mixed aerobic and strength fitness training in the practice of PE of female students [1]. However, mixed training programs involve more aerobic training (about 60% of the total training time) and less (about 15–20%) strength training [33]. The possibility of the effective use of aerobic training of Kangoo-Jumps in the practice of resistance training of female students is substantiated in our research. The volume of resistance training was about 60%, and the volume of

Kangoo-Jumps fitness sessions was less than 25% of the total training time. Female students (G-2) were practicing similar training showed similar or significantly higher results in strength endurance and cardiorespiratory fitness tests (Push-Up test, Plank test and Burpee test), compared with students (G-1) were practicing more volume of aerobic fitness training (step aerobics).

Researches emphasizing the effectiveness of the use of mixed (aerobic + strength) training in the PE practice of female students are presented in the scientific literature [1,29,34]. Scientists point to a high level of effectiveness of using mixed training programs in the practice of combating overweight and obesity and increasing of physical fitness profile of young women. However, many mixed training programs have a limited intervention time of 8 to 12 weeks [1,34]. Such a short period of intervention does not allow obtaining complete and objective data on the effect of mixed training programs on the physical fitness profile of female students. A sufficiently large (8 months) time period of intervention in the PE practice of female students is presented in our research. Objective data on the possibility of a significant increase in strength endurance and cardiorespiratory fitness profile of young women who prefer resistance training (2 workouts per week) were obtained. Dynamics of changes in body mass of young women was studied. In particular, it was revealed that BMI indicators of female students practicing mixed aerobic and strength training programs demonstrate different dynamics: a BMI increase in students (G-1) and a BMI decrease in students (G-2). Our data is different from some experts. In particular, Mokrova et al., studied female students of similar age and BMI, who practiced strength and aerobic fitness training. Scientists have identified the dynamics of increasing body mass of all female students (practicing aerobic and strength fitness) [20]. We assume that the positive dynamics of a decrease in BMI in female students (G-2) in our studies is associated with the optimal distribution of the volume of resistance and aerobic fitness practices in mixed workouts.

Some scientists recommend using high-intensity aerobic fitness workouts to reduce body mass and correct BMI for students [1,20,33]. Ten Hoor et al., indicate the need for mandatory use of strength training (at least 2 workouts per week) in the practice of controlling body mass level and improving the body composition of young people. The volume of each strength training is about 15–30 minutes [35]. Female students (G-1) practiced aerobic (35–40 min) and strength (20–25 min) fitness training in our research. BMI indicators of female students (G-1) were reliable ($P<0.05$) higher compared to BMI of female students (G-2) practicing resistance training (45–50 min) and Kangoo-Jumps fitness (20 min). Our studies show the possibility of increasing the time of resistance practice in the total time of mixed training (aerobic fitness + strength training). At the same time, the positive dynamics of a decrease in the body mass of female students remains. Cosma et al., presented data on an impact reduction in body mass (about 2–3 kg) of female students practicing Kangoo-Jumps fitness once a week for 8 months [22]. Students (G-2) practiced Kangoo-Jumps fitness 2 times a week for 8 months in our research. BMI fluctuations were found in female students (G-2) were found (an average of 0.8 kg) during the period of research. Gayen et al., presented data on the significant positive effect of aerobic fitness training on the level of cardiorespiratory fitness and improving the BMI of female students. Students practiced aerobic fitness training at PE classes for at least 6 months. A significant ($p<0.05$) decrease in BMI in female students was recorded [10]. Our studies lasted 8 months. We found a significant ($p<0.05$) increase in BMI in female students (G-1) practicing fitness aerobics (October 2018 BMI – 21.14, May 2019 BMI – 21.35). A significant ($p<0.05$) decrease in BMI was found in female students (G-2) practicing mixed (aerobic + resistance) training (October 2018 BMI – 21.16, May 2019 BMI – 20.86).

Barantsev et al. [36], indicate the absence of positive dynamics of endurance indicators of female students practicing various PE programs at Russian universities. A significant ($p<0.05$) increase in endurance indicators of female students (G-1 and G-2) was recorded in our studies (test results: Step test (PWC₁₇₀), Burpee test). The positive dynamics of strength endurance and cardiorespiratory fitness indicators of young women indicates the significant impact of mixed training programs in the PE practice of female students. Mokrova et al., presented results on the dynamics of the level of functional fitness of female students practicing step aerobics and Kangoo-Jumps fitness at PE classes. Female students practiced aerobic fitness with strength training combination (aerobic fitness - 35-40 minutes, strength training – 15-20 minutes in each training session). The results of a running test (2000 m) indicate a significant (about 20-25 seconds) advantage in the speed of the female students practicing Kangoo-Jumps fitness with strength training combination [18]. Our studies did not reveal

significant correlations in the results of a running test (2000 m) in groups (G-1 and G-2) who practiced step aerobics (G-1) and Kangoo-Jumps (G-2) at PE classes. Perhaps this is due to the quality of the selection of participants in the study groups and a higher level of functional suitability of our participants. Podstawski et al., presented data on the assessment of the strength endurance of female students practiced standard PE programmes (3-minute Burpee test). Most of the students showed an average level of strength endurance by completing 36–50 burpee cycles [36]. Female students completed an average of 51.17 burpee cycles (G-1) and female students (G-2) completed 53.22 cycles in our studies. Similar results indicate the positive impact of the method of using Kangoo-Jumps in the practice of developing strength endurance in female students practicing resistance training.

Cosma et al., point to the relatively high cost of Kangoo-Jumps boots, as an obstacle to the massive expansion of the practice of Kangoo-Jumps fitness in the practice of PE of schoolchildren and students [21]. We used Kangoo-Jumps fitness series of 20 minutes in 90-minute training sessions for female students. Some of the females practiced Kangoo-Jumps at the beginning of the training session (before power training), while others practiced it at the end of the training session (after power training). This approach allowed more female students to use Kangoo-Jumps boots at the beginning and end of the each training session. Spiliopoulou et al., indicate that frequent (3 or more workouts per week) use of high-intensity interval aerobic training after power training practice negatively affects on muscle morphology and performance [37]. Students (G-2) used Kangoo-Jumps fitness no more than 2 times a week and showed positive results in tests of strength endurance and muscle performance (Burpee, Push-Up and Plank tests).

CONCLUSIONS

Main threats to the physical health of young women are an increase in overweight and a decrease in muscle and cardiorespiratory fitness. Modern students' PE programs should use effective methods of mixed aerobic and strength training. The effectiveness of the use of aerobic fitness training Kangoo-Jumps in the practice of resistance training of female students has been confirmed in our research. The regular practice of Kangoo-Jumps fitness (at least 2 workouts per week) contributes to a significant increase in the level of cardiorespiratory and strength endurance profile of young women practicing resistance training in higher education PE. Significant positive dynamics for a decrease in BMI for female students practicing mixed (resistance + Kangoo-Jumps fitness) training was found.

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