THE EFFECT OF PHYSICAL COMPOSITION ON PHYSICAL EDUCATION GIRLS USING CIRCUIT TRAINING AND PLYOMETRIC PROGRAM

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ABSTRACT

The purpose of this study aimed to analyze the effect of a circuit training and plyometric program, applied for 12 weeks per 120 minutes, during the warm-up phase of practical physical fitness classes, and to verify the resulting effects on the analyzed variables. Twenty-five women students participated in the study. Their results were applied to the analysis before and after the training program. The results indicated that the application of the training program induced positive effects in the skeletal muscle mass (SMM), body fat mass (BFM), percentage of body fat (PBF), and basal metabolic rate (BMR). This study also concluded a viable alternative for warming up in the physical education class. The skeletal muscle mass (SMM) ranged from 21.0 to 30.1 for pre-program and from 21.6 to 31.6 for post-program. SMM was higher after the program (M = 21.40±2.40) than before (M = 24.56±2.05), and there was a statistically significant difference (t = -4.447, p<.001). The amount of body fat (BFM) ranged from 8.3 to 26.2 for pre-program and from 8.1 to 24.7 for post-program. BFM was higher after the program (M = 16.19±4.43) than before (M = 16.83±4.17), and there was statistically significant difference (p<.001). The body mass index (BMI) ranged from 18.9 to 26.6 for pre-program and from 18.4 to 26.8 for post-program. This study was showed the existence of a positive association between the practice of training circuit and plyometric program.

Keywords: body mass index, circuit training, plyometric program, skeletal muscle mass.

INTRODUCTION

Physical activity is defined as any bodily movement produced by skeletal muscles that results in energy expenditure (WHO, 2022). Physical activity reduces the risk for heart disease, diabetes mellitus, osteoporosis, high blood pressure, obesity, and metabolic syndrome; improves various other aspects of health and fitness, including aerobic capacity, muscle and bone strength, flexibility, insulin sensitivity, and lipid profiles; and reduces stress, anxiety, and depression (Hallal et al., 2006).

Exercise prescription is obviously complex and involves numerous variables that can be manipulated, as evidenced by detailed reviews that have characterized interval training from the perspective of performance enhancement (Seiler,2010; Tschakert & Hofmann,2013; Buchheit & Laursen,2013a,b; MacInnis & Gibala, 2017). For simplicity and consistency, this review will employ the nomenclature put forward by Westonet al. (2014). They reported that high-intensity interval training was superior to moderate-intensity continuous training in improving Cardiorespiratory fitness.

There are as many strength and conditioning programs as there are physical education programs developing the individual physical body. This type of training program is conducted through interval training and consists of several stations that involve work on strength, balance, resistance, and coordination, depending on the objectives (Ribeiro & Martins, 2014). The stretch-induced force enhancement is accompanied by an increased relaxation time during regular contractions (Rassier and Herzog, 2005).

Circuit training is a structure of training that is interval-like in nature or a continuous change in the exercises you happen to be doing. Circuit training is also a workout that involves rotating through various exercises targeting different parts of the body. Focusing on different muscle groups in a short amount of time is an effective exercise that can be incorporated into a healthy lifestyle. it can help build strength, improve heart health, and help you lose weight. Circuit training became an important device in conditioning girls for participation in track and field activities as well as in other sports activities (Drummond et al., 2021).

Plyometrics on the other hands is a type of exercise or more specifically an exercise that creates a certain muscle contraction that triggers the stretch-shortening cycle (AKA stretch reflex). Plyometric training (PT) is a very popular form of physical conditioning of healthy individuals that has been extensively studied over the last decades (Slimani et al. 2016). Plyometrics facilitates the production of maximal force in the shortest amount of time (Davies et al. 2015). The data gathered here show that sprint performance improvements are significantly greater when plyometrics are combined with other types of exercises such as sprint and jump training (Marques et al., 2013).

Body composition is alsoconsidered as a component of fitness. Body compositioncan be expressed as the relative percentage of body mass that is fat and fat-free tissue.
The results of this study showed that circuit resistance training and plyometric training groups have significantlly differed on muscular strength when compared to non-training group (condition), but between the training groups significant differencewas not found.

METHODOLOGY

Subjects

A group of 30 girl students belong to the Department of Physical Education at D University in Busan Metropolitan City, the Repbulic of Korea. Before the study began, students underwent a physical examination by the Public Health Center of D University, and each was considered free from any disorder that would prevent full participation in the investigation. They agreed to use the data for this study. They participated in a 12-week physical education class in the second semester of 2022. They targeted students who actively participated in two hours and a total of 120 minutes of classes once a week as students. Of these, 25 students participated in the preliminary in-body measurement but did not participate in the in-body measurement after class, except for five students, absentees at least once in class.

Limitations of the study

The subjects of this study were limited to adult women enrolled in the physical education department of the university, and there was no control over physical activity outside of class time among the test participants. And the nutritional, psychological, and genetic factors of the participants in the experiment were not taken into account.

Research Design and Circuit Training

In this study, 25 women students were subjected to 12 weeks of circuit and weight training and plyometric training in physical education classes (Table 1). These were evaluated in 2 distinct phases: before the application of the training program (i.e. pre-test) and after the application of the training program (i.e. post-test).

Circuit training and plyometric program were performed according to the protocol described in Figure 1 and Tables 2 and 3.

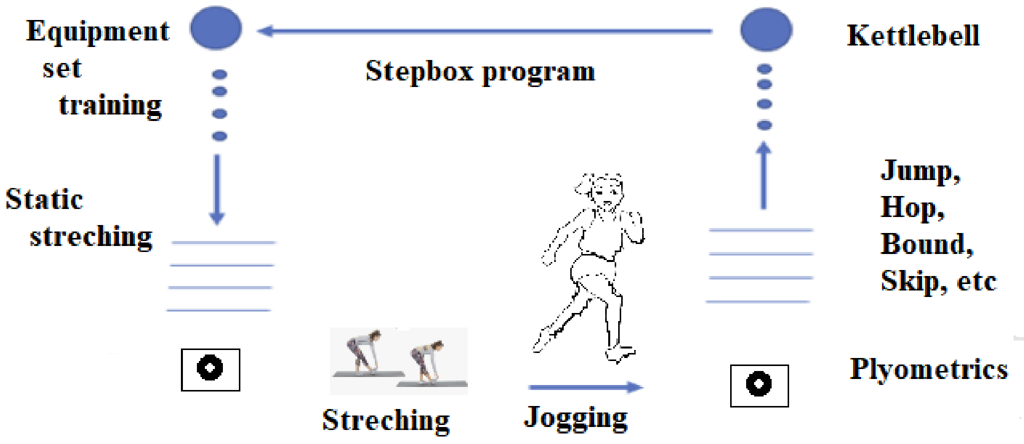

Figure 1. Training course for women students in this study.

Table 1. 12 week training program content for girl students

No.	Month (period: weeks)		
	September (4 weeks)	October (4 weeks)	November (4 weeks)
1	Power clear: speed and strength can be applied or the rate at which force can be developed	Power clear: speed and strength can be applied or the rate at which force can be developed	Running machine: speed is 8 km
2	Bench press: weight upwards while lying on aweight training bench	Cable crossover: hest exercise	Lying dumbbell press: 2 kg
3	Seated machine press: targeting the chest muscles	Side lateral raise: dumbbell	Barbell push press: empty bar
4	High lat pull-down: Cable pulley machine	Seated row: cable machine	Hyper extension: hip hinge movement
5	Lying triceps extension: Lift the dumbbells back up and repeat the exercise	Barbell curl: empty bar	Wrist roller: concentric and eccentric portions
6	Squat: front squat, hack squat, overhead squat	Leg extension: level machine	Barbell dead lift: empty bar

Table 2. 12-week circuit training program guide

Athletic section	Warm-up exercise	Main exercise	Organizing exercise
Program	1) A light jog 2) Streching	1) Flyometric Program 2) Kettlebell program 3) Stepbox Program	Static stretching
Note	Slowly raise your body temperature and heart rate, stretching muscles, tendons, ligaments, etc	4 weeks each: 1) → 2) → 3)	
Time (min.)	5	40 → 10(rest) → 40	5

Statistical analyses

The calculation of means, standard deviations, and 95%, 99% confidence intervals (95% and 99% CI) was performed using standardized statistical methods. All data from this study were calculated using the Window SPSS 18.0 statistical program to calculate the mean and standard deviation through descriptive statistical analysis of the population. To compare the physiological variables at rest in the two assessment sessions and to compare responses to the exercises, the paired t-test and non-parametric correspondent, the Wilcoxin test, was used.

RESULTS

We examined 25 participants at the Busan in Republic of Korea. Their In-Body measurement results before circuit training and after circuit training are shown in Table 3 and Table 4, respectively. Table 5 shows the results of the paired sample t-verification to find out the pre- and post effects of the circuit training program conducted for 12 weeks. The height (H) of women body ranged from 156.5 to 171.8 for pre-program and from 157.3 to 172.5 for post-program. H was higher after (mean, M = 164.70±3.94) than before (M = 164.10±4.31), and there was a statistically significant difference (t = -2.731, p<.001). Weight ranged from 52.1 to 73.7 for pre-program and from 50.8 to 74.5 for post-program. Weight was lower after the program (M = 61.40±6.05) than before the program (M = 61.33±6.13), and there was no statistically significant difference (t = -0.196, p>.05). The skeletal muscle mass (SMM) ranged from 21.0 to 30.1 for pre-program and from 21.6 to 31.6 for post-program. SMM was higher after the program (M = 21.40±2.40) than before (M = 24.56±2.05), and there was a statistically significant difference (t = -4.447, p<.001). The amount of body fat (BFM) ranged from 8.3 to 26.2 for pre-program and from 8.1 to 24.7 for post-program. BFM was higher after the program (M = 16.19±4.43) than before (M = 16.83±4.17), and there was statistically significant difference (p<.001). The body mass index (BMI) ranged from 18.9 to 26.6 for pre-program and from 18.4 to 26.8 for post-program. BMI showed lower post-the program (M = 22.78±2.07) than before (M = 22.64±2.11), and there was no statistically significant difference (p>.05). The percentage of body fat (PBF) ranged from 15.9 to 36.4 for pre-program and from 14.2 to 36.2 for post-program. PBF was lower after (M = 25.71±5.44) than before (M = 27.05±4.74), and there was a statistically significant difference (p<.001). The basal metabolic rate (BMR) ranged from 1201 to 1530 for pre-program and from 1231 to 1582 for post-program. BMR was higher after (M = 1354.88±79.77) than before (M = 1332.88±74.75), and there was a statistically significant difference (p<.001).

Table 3. In-Body measurement results before circuit training

No.	H (㎝)	Weight (㎏)	SMM (㎏)	BFM (㎏)	BMI (㎏/㎡)	PBF	BMR (㎉)
1	156.5	60.0	21.4	22.5	25.3	36.4	1222
2	170.0	67.9	26.4	20.1	23.5	29.6	1403
3	164.3	54.2	22.8	12.5	20.1	23.0	1272
4	157.6	65.8	26.1	18.7	26.5	28.5	1387
5	158.9	56.7	23.2	14.2	22.5	25.1	1287
6	163.4	60.1	24.8	15.2	22.5	25.3	1340
7	160.8	56.9	22.5	15.5	22.0	27.2	1264
8	159.5	66.1	24.8	21.0	26.0	31.8	1343

9	167.5	64.1	24.5	19.2	22.8	29.9	1340
10	170.3	61.7	25.9	16.6	21.3	24.3	1379
11	169.7	67.5	28.4	16.3	23.4	24.2	1476
12	166.1	52.1	24.4	8.3	18.9	15.9	1317
13	160.2	59.9	23.4	17.4	23.3	29.1	1287
14	160.3	52.5	21.0	14.0	20.4	26.7	1201
15	162.1	53.9	23.4	11.5	20.5	21.4	1286
16	166.4	73.7	26.5	26.2	26.6	35.6	1396
17	169.7	63.3	24.1	19.4	22.0	30.6	1318
18	165.7	60.9	25.5	14.9	22.2	24.5	1362
19	163.7	60.5	23.8	16.9	22.8	27.9	1312
20	165.6	68.3	30.1	14.6	24.9	21.3	1530
21	171.8	72.6	26.3	24.6	24.6	33.8	1407
22	162.3	58.6	24.1	15,4	22.2	26.2	1304
23	164.6	66.4	24.5	20.1	24.0	30.9	1340
24	166.2	55.7	23.5	12.7	20.0	22.8	1298
25	159.2	53.8	22.6	13.0	21.2	24.2	1251

SMM: skeletal muscle mass, BFM: body fat mass, BMI: Body mass index, PBF: percentage of body fat, BMR: basal metabolic rate.

Table 4. In-Body measurement results after circuit training

No.	H (㎝)	Weight (㎏)	SMM (㎏)	BFM (㎏)	BMI (㎏/㎡)	PBF	BMR (㎉)
1	157.3	63.8	23.1	22.0	25.8	34.4	1273
2	171.0	66.4	26.7	18.2	22.7	27.5	1410
3	166.1	57.5	24.7	12.4	20.8	21.5	1345
4	161.0	66.7	28.0	17.0	25.7	25.4	1444
5	160.1	56.9	24.2	13.1	22.2	23.0	1316
6	163.3	62.3	25.6	16.5	23.4	26.4	1359
7	162.0	59.4	21.6	19.5	22.6	32.8	1231
8	159.8	68.3	23.8	24.7	26.8	36.2	1311
9	167.2	63.6	24.8	18.2	22.1	28.7	1349
10	170.3	60.1	26.3	15.0	20.7	21.8	1382
11	169.4	66.1	27.7	16.2	23.0	24.4	1448
12	166.3	50.8	25.3	8.1	18.4	14.2	1331

13	161.6	59.8	25.1	14.7	22.9	24.6	1343
14	161.2	51.0	23.3	12.6	20.0	23.2	1231
15	162.1	52.8	22.7	11.8	20.1	22.3	1256
16	167.2	70.1	31.3	23.8	25.1	32.5	1442
17	169.6	60.6	24.8	15.6	21.1	25.7	1343
18	164.9	61.9	26.3	14.8	22.8	23.9	1388
19	163.5	60.9	24.7	15.9	22.8	26.1	1342
20	166.4	67.7	31.6	11.5	24.5	17.1	1582
21	172.5	74.5	28.1	23.7	25.0	31.8	1468
22	163.7	60.3	24.6	16.1	22.5	26.7	1325
23	165.3	65.0	25.2	20.9	24.0	31.4	1353
24	165.4	53.0	24.1	9.1	19.4	17.3	1317
25	160.2	55.6	23.6	13.3	21.7	23.9	1283

SMM, PBF, and BBMR were shown in Table 3.

Table 5. Pair sample *t*-verification for body composition and basal metabolic rate

Variable	Training	Mean	SD	*t*	*p*
H (㎝)	Before	164.10	4.31	-2.731	<0.01
	After	164.70	3.94		
Weight (㎏)	Before	61.33	6.13	-0.196	>0.05
	After	61.40	6.05		
SMM (㎏)	Before	24.56	2.05	-4.447	<0.001
	After	25.40	2.40		
BFM (㎏)	Before	16.83	4.17	1.477	>0.05
	After	16.19	4.43		
BMI (㎏/㎡)	Before	22.78	2.07	0.935	>0.05
	After	22.64	2.11		
PBF	Before	27.05	4.74	2.198	<0.01
	After	25.71	5.44		
BMR (㎉)	Before	1332.88	74.75	-3.107	<0.01
	After	1354.88	79.77		

The critical values of t (0.05, 2, 24) = 2.064, t (0.01, 2, 24) = 2.797, t (0.001, 2, 24) = 3.745. SMM, PBF, and BBMR were shown in Table 3.

DISCUSSION

Physical education classes need to be fun and engaging for students, and circuit training is a good way to achieve that. Circuit training is a great way to maximize activity time in physical education and train a variety of muscles. The simple circuit (60 seconds on, 10 second rest) has students working on their cardio as well as strengthening the core, lower body and upper body. Circuits can be tailored to any type of fitness level, and they are a great way for students to get moving in a gym or classroom. An important part of creating a circuit is to have a variety of movements that target different muscle groups and address different components of fitness. We modified physical education circuits as Fig. 1 and Table 1. Unlike children, middle and high school students, and general students, even the same exercise consisted of programs with enhanced training intensity in terms of content.

We also conducted a study of male students. The height of boy student's body was higher after (mean, M = 177.4±3.83) than before (M = 177.7±3.76), and there was a statistically significant difference (t = -3.54, p<.001) (data not shown). Their weight was lower after the program (M = 77.99±5.86) than before the program (M = 77.82±6.21), and there was no statistically significant difference (t=-0.35, p>.05). Their skeletal muscle mass (SMM) was higher after the program (M = 38.31±2.51) than before (M = 37.26±2.51), and there was a statistically significant difference (t = -4.98, p<.001). The amount of men body fat (BFM) was higher after the program (M = 11.72±3.30) than before (M = 12.79±4.57), and there was statistically significant difference (p<.001). BMI showed lower post-the program (M = 24.67±1.85) than before (M = 24.71±2.06), and there was no statistically significant difference (p>.05). The percentage of men body fat (PBF) was lower after (M = 14.76±3.41) than before (M = 16.28±3.57), and there was a statistically significant difference (p<.001). The basal metabolic rate (BMR) was higher after (M = 1807.0±81.91) than before (M = 1773.04±88.18), and there was a statistically significant difference (p<.001). The results of this study of female students were also similar to those of male students. Ferraz et al (2020) also analyzed the effect of a training circuit, applied for 3 weeks, during the warm-up phase of practical physical education classes, and to verify the resulting effects on the analyzed variables. Twenty-five students participated in their study (mean ± age = 15.67 ± 1.02), weight (67.31 ± 9.29 kg), height (1.72 ± 0.08 m). Wiium & Säfvenbom (2019) assessed associations between participation in the two activity types and several demographics along with developmental factors (e.g., body mass index (BMI)). Their data was from a representative sample of 2060 students attending 38 schools in Norway (mean age (M_{age}) = 15.29, standard deviation (SD) = 1.51; 52% females). Kim et al (2018) investigated the effect of a 12-week circuit training program on health-related physical fitness and metabolic syndrome risk factors in obese female college students. Women' body composition component examination showed that the body weight, body fat percentage and waist measurement showed differences that were statistically significant (Yun et al., 2016). Resistance circuit-based training is an effective training method to decrease total body fat and increase muscle mass in adults (Ramos-Campo et al., 2021).
In conclusion, circuit training and plyometric program were a relatively more important component of total weekly activity on physical education for female students in Busan City. Circuit training is very time efficient helping to develop strength and stamina in a physical education class.

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