



ORIGINAL SCIENTIFIC ARTICLE

THE EFFECT OF 12-WEEK CALISTHENICS EXERCISE ON PHYSICAL FITNESS AMONG OBESE FEMALE STUDENTS

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Abstract

Study purpose. The main purpose of this study was to determine the effect of calisthenics exercise on physical fitness. Materials and methods. 28 obese female students aged 20–30 with a BMI ranging between 30 kg/m² and 35 kg/m² were involved in this study. Participants were randomly divided into three groups which comprised a calisthenics exercise group, an aerobic calisthenics exercise and a control group. Sit and reach test (flexibility), sit up test (muscular endurance) and 20-meter shuttle run test (cardiovascular endurance) were measured as physical fitness parameters. All the tests were conducted before and after a 12-week intervention training program.

Results. The results of this study indicate that the calisthenics and aerobic calisthenics groups had significant ($p < 0.05$) improvement in the sit and reach test performance compared to the control group. The aerobic calisthenics group also showed significant ($p < 0.05$) improvement in the sit up and 20-metre shuttle run test performance compared to the calisthenics and control groups.

Conclusions. In conclusion, these study findings demonstrated that calisthenics exercise when combined with aerobic exercise was more effective to improve flexibility, muscular endurance and cardiovascular endurance among obese female students compared to calisthenics exercise only. Therefore, it is suggested that fitness trainers should consider combining calisthenics exercise with aerobics in the training program to improve flexibility, muscular and cardiovascular endurance.

Keywords: physical fitness, obesity, calisthenics exercise.

Introduction

Obesity can be defined as the accumulation of excess fat in the body. In Asian countries, Malaysia is one of the countries with the highest level of obesity (Ruiz Estrada et al., 2019). According to Mohd-Sidik et al. (2021), an obesity study based on demographic factors that have been conducted in Malaysia shows that demographic factors such as gender, marital status, age and level of education can affect the obesity level. Based on that study, obesity was higher among women than men. The rate of obesity was also higher among the married compared to the singles. In addition, middle-

aged adults have a higher obesity problem than other age groups and those with lower education (primary or secondary school) are more likely to show higher levels of obesity than those with higher levels of education (university).

Another a study by Wan Mohamed Radzi et al. (2019) found that the main factors contributing to the increase in obesity among university students in Malaysia were due to unbalanced dietary factors such as regular fast food and junk food intake, lack of involvement in physical activity and mental health issues such as stress. In the study by Tee et al. (2018), similar contributing factors (meal consumption, low level of physical activity and poor sleep quality) have also been stated as the main cause of the increasing obesity trend in Malaysian adolescents. Another study related to obesity knowledge by Ghazi et al. (2018) showed low knowledge regarding obesity among private university students in Malaysia. This indicates that the increase in obesity among

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university students may also be due to poor knowledge related to obesity.

Even though obesity problems can occur in all age groups such as the elderly, adolescents, adults and children. Increasing levels of obesity in a country especially among the young generation including university students can create a burden to the healthcare system and economy. Obesity has become one of the most severe health concerns worldwide because it can increase the risk of other chronic diseases such as diabetes, heart attack, cancer and hypertension (Smith et al., 2020), indirectly imposes a large burden on the health care system (Deng et al., 2016). In addition, excessive obesity can cause an individual's movement to be limited and reduce the quality of life, in turn leading to an increase in the unemployment rate and social disadvantages. These factors can lead to a reduction in socioeconomic productivity (Blüher, 2019). It is very important to overcome the problem of obesity among the young population such as university students.

Numerous studies have been conducted to identify the causes of obesity and it is well known that the best way to resolve the obesity problem is through a healthy diet and regular physical activity (Zouhal et al., 2020). The effectiveness of various types of exercise on obese populations has been demonstrated in past studies via weight training (Dias et al., 2015; Strasser & Schobersberger, 2011; Villareal et al., 2017), Circuit training (Kang et al., 2018; Kim et al., 2018; Seo et al., 2019), Aerobic training (Al Saif & Alsenany, 2015; Luo & Zheng, 2019; Shenbagavalli & Mary, 2008) and high-intensity interval training (Maillard et al., 2018; Wewege et al., 2017).

Other than that, calisthenics training is one of the effective training alternatives to increase the body's metabolism. The calisthenics training is an exercise that involves a variety of basic movements and can be performed by using bodyweight without the use of any equipment (Chaves et al., 2020). Based on the previous study, calisthenic training has been shown to be effective to improve fitness components such as reducing fat mass and increasing body mass (Cigerci & Genc, 2020), increasing aerobic capacity (Alsairawan et al., 2019), improved muscle strength (Kotarsky et al., 2018). However, most of these studies were conducted on athletes and the healthy population with normal weight. There is a lack of studies on the effect of calisthenic exercise among the obese population. Therefore, the purpose of this study was to investigate the effect of calisthenic exercise and aerobic calisthenic on physical fitness among obese female university students.

Methods and Materials

Participants

28 obese female university students were involved in this study voluntarily and have been informed that they were free to withdraw from the study at any time. Before the study was conducted, participants had completed the Physical Activity Readiness Questionnaire (PAR-Q) and informed consent. The selection criteria of participants for this study include; i) female students aged between 20 to 30 years, ii) BMI range between $30 \text{ kg}\cdot\text{m}^{-2}$ to $35 \text{ kg}\cdot\text{m}^{-2}$ and iii) did not have any history of chronic diseases. All participants were randomly divided into three groups, consisting of the aerobic calisthenic

group ($n = 9$), calisthenic group ($n = 9$) and control group ($n = 10$). Ethical approval for this study was obtained from the Committee of Sultan Idris Education University (Reference number: 2019-0034-01)

Instrument and Procedures

Participants in both aerobic calisthenics and calisthenics groups received the intervention for 12 weeks, which is 3 times of training per week. Pre- and post-tests were conducted to compare the effectiveness of both exercises on physical fitness levels among obese female students.

Measurements of Physical Fitness

Physical fitness parameters measured in this study during the pre-and post-tests for all participants in the three groups (aerobic calisthenic, calisthenic and control groups) were flexibility (sit and reach), muscular endurance (sit up) and cardiovascular endurance (20-meter shuttle run test).

For the sit and reach test, participants were asked to sit on the floor with straight legs without shoes and soles close to the sliding reach board (Trident, USA) with a scale marked at 23 cm. Participants' legs were apart and parallel to the shoulders and the hands were placed on top of the other hand. The position of the fingers will be the same on both hands. The participants were then instructed to slowly push forward on the scale marked with hands position facing down and legs remaining straight. 3 trials were given to each participant and the farthest distance would be taken for data analysis.

In the sit-up test, participants were instructed to lie on an exercise mattress with knees bent at 90° . The heels and feet were touching the floor and the feet were shoulder-width apart. The participant's hands are crossed on the chest and the palms hug the shoulders opposite. Participants sat up until they touched their knees on both elbows and then returned to the starting position. Participants were instructed to performed as many sit up repetitions as possible for 1 minute. The total number of correct completed sit up were counted and recorded for data analysis.

In the 20-meter shuttle run test, participants were instructed to continue running between the two lines, and turning when signalled by the recorded beeps. Participants have to cross a distance of 20 meters and wait until the "beep" sound to continue the run to and fro. A warning was given if the participants do not reach the line before the beep sounds for the first time, and were eliminated after the second warning. Participant's final score is the last level and shuttles they completed before missing a beep.

Training Programs

For the 12-week intervention training program, calisthenics training consists of eight exercise stations (high knee run, burpees, mountain climbers, planks, jumping jacks, Russian twits, squats and lunges) for one set. Each exercise was performed for 20 seconds (exercise training) with a 10 seconds rest between stations. The duration for 1 set of calisthenic exercises was 4 minutes.

For calisthenics training combined with the aerobic exercise group, the participants performed the same exercises

as the calisthenics group. However, after the 10 second rest period, the participants were required to perform the aerobic exercise (step box) for 60 seconds at each station. For the aerobic exercise, the participants need to step up where one foot on the top of box with one foot on the ground. The weight should be shifted into the heel of the foot that is on the box. Driving through that front heel, extend the leg completely straight before bringing the opposite foot onto the box. Repeat until the end of 1 minute. The duration of 1 set of aerobic calisthenic exercises was 12 minutes.

From week 1 to week 4, participants in both intervention groups performed 3 sets of the exercise, followed by 4 sets from week 5 to week 8 and lastly 5 sets from week 9 to week 12. Meanwhile, the control group did not receive any training intervention for 12 weeks and were only required to perform pre-and post-tests.

Data and statistical analyses

Mixed design MANOVA was used to compare physical fitness profiles (sit and reach, sit-up, 20-meter shuttle run test) between groups (aerobic calisthenic, calisthenic, control) during pre and post-tests among the obese students in UPSI. Table 1 shows the demographic and physical characteristics of the participants such as age, height and weight for all participants in the three groups.

Results

Table 1. Participants' demographic and physical characteristics

Category	Group	Mean±SD
Age (year)	Aerobic calisthenic	23.2±3.4
	Calisthenic	22.4±1.8
	Control	22.1±1.2
Height (cm)	Aerobic calisthenic	154.5±4.9
	Calisthenic	157.1±4.4
	Control	156.1±4.7
Weight (kg)	Aerobic calisthenic	73.2±10.2
	Calisthenic	77.7±6.2
	Control	83.6±9.4

Table 2. Multivariate values for physical fitness tests between a group

Effect	Wilks' Lambda value	F	Hypothesis df	Error df	Sig.	Partial Eta squared
Group	0.06	10.87	12	40	0.00	0.77

*Significant value was set at the level of $p < 0.05$

Result of the multivariate analysis in Table 2 showed there was significant main effect for group $F_{(12, 40)} = 10.87$, Wilk's $\lambda = 0.06$, $p = 0.00$, $\eta_p^2 = 0.7$.

Table 3 showed statistics descriptive of physical fitness scores between groups (aerobic calisthenic, calisthenic, and control) during pre and post-test.

Table 3. showed statistics descriptive of physical fitness scores between groups (aerobic calisthenic, calisthenic, and control) during pre and post-test.

Physical Fitness	Test	Aerobic calisthenic	Calisthenic	Control
Sit and Reach (cm)	Pre Test	25.1±4.9	27.8±4.5	22.2±4.7
	Post test	29.6±5.1c	29.6±4.6c	23.7±4.7ab
Sit up (repetitions)	Pre Test	18.9±2.2	16.0±3.3	16.2±3.3
	Post test	26.3±2.1bc	18.7±3.4a	16.4±3.4a
20-meter shuttle run test (Laps)	Pre Test	2.5±0.3	2.3±0.1	2.4±0.4
	Post test	3.4±0.2bc	2.6±0.2a	2.3±0.4a

a = significantly difference from aerobic calisthenic, $p < 0.05$; b = significantly difference from calisthenic, $p < 0.05$; c = significantly difference from control, $p < 0.05$

Table 4. Post hoc test for sit and reach score

	Test	Sum of Squares	df	Mean Square	F	Sig.
Sit and reach (cm)	Group	Pre	144.51	2	72.26	3.18
		Post	209.29	2	104.65	4.42
	Error	Pre	567.34	25	22.69	
		Post	591.96	25	23.68	

*Significant value was set at the level of $p < 0.05$

Table 4 showed, that there was significant interaction for sit and reach test $F_{(2,25)} = 4.42$, $p = 0.02$ between-group during post-test. Results of the Bonferroni Post hoc test showed, no significant difference ($p = 1.00$) between the aerobic calisthenic and calisthenic groups. However, both group aerobic calisthenic ($p = 0.05$) and calisthenic ($p = 0.05$) were significantly improve sit and reach scores compared to the control group during post-test as shown in Table 3.

Table 5. Post hoc test for sit up score

	Test	Sum of Squares	df	Mean Square	F	Sig.
Sit up (repetitions)	Group	Pre	50.22	2	25.11	2.77
		Post	509.84	2	254.92	27.72
	Error	Pre	226.46	25	9.06	
		Post	229.88	25	9.20	

*Significant value was set at the level of $p < 0.05$

Table 5 showed, that there was significant interaction for sit-up test $F_{(2,25)} = 22.72$, $p = 0.00$ between-group during post-test. The result of the Bonferroni Post hoc test showed there was a significant difference between aerobic calisthenic with calisthenic ($p = 0.00$) and the control group ($p = 0.00$) as shown in Table 3. There was no significant difference ($p = 0.35$) between the calisthenic and control groups. This finding proved that aerobic calisthenic was effective to improve the 1-minute sit-up repetition score, compared to calisthenic and control groups.

Table 6 showed, there was significant interaction for 20-meter shuttle run test $F_{(2, 25)} = 33.5$, $p = 0.00$ between-

Table 6. Post hoc test 20-meter shuttle run (Laps)

		Test	Sum of Squares	df	Mean Square	F	Sig.
20-meter shuttle run test (Laps)	Group	Pre	0.16	2	0.08	0.77	0.47
		Post	6.41	2	3.21	33.05	0.00
	Error	Pre	2.66	25	0.11		
		Post	2.43	25	0.10		

*Significant value was set at the level of $p < 0.05$

group during post-test. The result of the Bonferroni Post hoc test showed there was a significant difference between aerobic calisthenic with calisthenic ($p = 0.00$) and the control groups ($p = 0.00$) as shown in Table 3. There was no significant difference ($p = 0.16$) between the calisthenic and control groups. This finding showed that aerobic calisthenic was successful to improve the 20-meter shuttle run test, compared to the calisthenic and control group.

Discussion

The purpose of this study was to compare the effect of calisthenic and aerobic calisthenic exercise on physical fitness among obese female students. The results of this study showed that the training program for both aerobic calisthenics and calisthenics for 12 weeks improved the flexibility fitness component compared to the control group. However, only the aerobic calisthenics group showed improvements in muscular endurance and cardiovascular endurance performance compared to the calisthenic and control group.

In previous studies, calisthenics training has been shown to successfully improve fitness components such as flexibility in various ages and populations. Bayrakdar et al. (2019) found that 8-week calisthenics training improved flexibility among swimming athletes. Bayrakdar et al. (2019) also found that 8-week of calisthenics training was significantly increased the level of flexibility among junior high school boys. Similar to the effectiveness of calisthenics training in increasing flexibility among athletes as well as the general population, calisthenics and aerobic calisthenic training have also been shown in this study to be effective in increasing flexibility among obese peoples.

Other than that, this study found that muscular endurance and cardiovascular endurance in the calisthenic aerobic group were significantly better than in the calisthenic and control groups. This finding indicates that the combination of calisthenics with aerobics causes the training intensity to be higher following by increased the maximum oxygen uptake as most studies showing improvement in cardiovascular endurance performance after receiving high-intensity training (HIT) training (Türk et al., 2017). It is assumed that the calisthenics training group only induce training intensity at moderate or low level, thus it was insufficient to elicit significant increase in cardiovascular and muscular endurance performance.

Shaw et al. (2021), demonstrated that calisthenic training for 6 weeks improved lung capacity through peak expiratory flow (PEF) and maximal expiratory flow (MEF) test. In that study, the calisthenics training intervention provided aerobic exercise in the first 3 weeks followed by resistance training in the next three weeks. Thus, It was in line with

this study that included an aerobic element to increase the effectiveness of calisthenics training.

Kotarsky et al. (2018) indicated that calisthenic training was able to improve muscular strength. Thus, their finding it was contrary to the findings of this study that showed only aerobic calisthenic was able to increase muscle strength, but not in the calisthenic group. This result may be due to the limitations of this research which did not set the number of repetitions during calisthenic training. The participants in this study were only instructed to perform as many repetitions as possible in each type of exercise based on a pre-determined time. Therefore, it is likely that participants in the calisthenics group did not push themselves to perform the exercise with maximum effort, compared to the aerobic calisthenics group who may be able to perform more repetitions due to increased cardiovascular endurance.

Conclusion

In conclusion, combining calisthenics with aerobic exercise is more effective than calisthenics alone to increase the level of physical fitness such as flexibility, muscular endurance and cardiovascular endurance among female students with obesity problems. Therefore, it was recommended for fitness trainers to combine calisthenics with aerobic exercise in their training program.

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ВПЛИВ 12-ТИЖНЕВИХ ВІЛЬНИХ ГІМНАСТИЧНИХ ВПРАВ НА ФІЗИЧНУ ПІДГОТОВЛЕНІСТЬ СТУДЕНТОК З ОЖИРІННЯМ

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Мета дослідження. Основною метою цього дослідження було визначення впливу гімнастичних вправ на фізичну підготовленість.

Матеріали та методи. Учасницями цього дослідження стали 28 студенток з ожирінням віком від 20 до 30 років, у яких ІМТ коливався від 30 кг/м² до 35 кг/м². Учасниць розподілили методом випадкового відбору на три групи: група гімнастичних вправ, група аеробних гімнастичних вправ і контрольна група. Як параметри фізичної підготовки вимірювали показники тестів «Нахили тулуба вперед із положення сидячи» (гнучкість), «Піднімання тулуба з положення лежачи» (м'язова витривалість) та «Човниковий біг на 20 метрів» (серцево-судинна витривалість). Усі ці тести проводили до та після 12-тижневої експериментальної програми тренувань.

Результати. Результати цього дослідження вказують на те, що в групах гімнастичних вправ та аеробних гімнастичних вправ спостерігалось статистично значуще ($p < 0,05$) покращення показників виконання тесту «Нахили тулуба вперед із положення сидячи», порівняно з контрольною групою. У групі аеробних гімнастичних вправ також спостерігалось статистично значуще ($p < 0,05$) покращення показників виконання тестів «Піднімання тулуба з положення лежачи» та «Човниковий біг на 20 метрів», порівняно з групою гімнастичних вправ і контрольною групою.

Висновки. Отже, зазначені результати дослідження підтвердили, що гімнастичні вправи в поєднанні з аеробними вправами є ефективнішими для покращення показників гнучкості, м'язової витривалості та серцево-судинної витривалості у студенток з ожирінням, порівняно з лише гімнастичними вправами. Отже, тренерам із загальнофізичної підготовки рекомендується взяти до уваги можливість поєднання гімнастичних вправ та аеробіки в програмі тренувань для покращення показників гнучкості, м'язової та серцево-судинної витривалості.

Ключові слова: фізична підготовка, ожиріння, гімнастичні вправи.

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