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Original research papers

EFFECT OF AEROBIC DANCE VS STATIC CYCLING ON ANTHROPOMETRIC MEASURES, CHOLESTEROL, AND BLOOD GLUCOSE IN TYPE 2 DIABETES MELLITUS: A RANDOMIZED CONTROLLED TRIAL

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Abstract

Introduction. Aerobic dance (AD) has grown as a popular aerobic exercise treating metabolic diseases. However, its beneficial effects on type 2 diabetes mellitus (T2DM) compared with other types of aerobic exercise have not been known. This study aimed to compare the influence of AD and static cycling (SC) on anthropometric measures, systolic blood pressure (SBP), blood glucose, and total cholesterol. ***Material and Methods.*** The design of this study was a randomized controlled study (RCT). Thirty T2DM subjects were assigned to three groups, i.e. control (C), aerobic dance exercise (AD), and static cycling exercise (SC), ten subjects in each group. AD and SC were performed three times a week for eight weeks. On the follow-up, four subjects were withdrawn. Waist and hip circumference (WC and HC), BMI, and blood pressure (BP) were measured. Blood glucose (fasting (FBG) and 2 hours postprandial (2-h PPBG)) and total cholesterol were checked using a simple, instant blood examination device. A paired t-test, Anova and Tamhane's T2 post hoc test were applied. Significance was set at $p < 0.05$. ***Results.*** Student's t-test showed that post-exercise waist circumference was significantly increased in the control group (92.7 ± 13.5 cm, $p = 0.04$), while post-exercise FBG and 2-h PPBG were significantly reduced in the SC group (112.5 ± 12.0 mg/dL, $p = 0.04$ and 155.0 ± 45.3 mg/dL, $p = 0.02$, respectively). Tamhane's T2 post hoc indicates that 2-h PPBG in SC was lower than in the case of AD (155.0 ± 45.3 vs 171.3 ± 19.7 mg/dL, $p = 0.04$) and SC vs control (155.0 ± 45.3 vs 183.0 ± 24.1 mg/dL, $p = 0.02$). Systolic was significantly reduced in SC compared to the control group (126.9 ± 7.5 vs. 143.3 ± 17.5 mmHg, $p = 0.04$). The magnitude of reduced (Δ) in 2-h PPBG in SC was significantly different from control (Δ-18.75 ± 10.9 vs. Δ2.75 ± 12.4, $p = 0.04$) and AD (Δ-18.75 ± 10.9 vs. Δ6.37 ± 11.8, $p = 0.02$). ***Conclusions.*** Static cycling exercise improved 2-hour postprandial blood glucose and systolic blood pressure significantly more than aerobic dance in T2DM.

Key words: diabetes mellitus, older people, aerobic dance, aerobic cycling, anthropometric measures, blood glucose, blood glucose and cholesterol

Introduction

The prevalence of non-communicable diseases (NCD) has increased dramatically for decades. Such diseases affect about 67% of people globally [1]. The diseases affect almost all age groups but mostly the elderly. One of the main types of NCDs is type 2 diabetes mellitus (T2DM), with more than 500 million prevalent cases of T2DM in 2018 around the world [2]. Asia is experiencing the fastest growth of T2DM, mainly in China and India [3]. In South-East Asia, the prevalence increased from 4.1% in 1980 to 8.6% in 2014 [1]. It was estimated that there are around 72 million people with DM. This number will increase to exceed 123 million in 2035 [4]. NCD's main risk factors are unhealthy dietary patterns, smoking, sedentary lifestyle, obesity, and alcoholism [1]. Thus, modifying the risk factors is the best strategy for reducing morbidity and mortality.

Type 2 DM is usually accompanied by dyslipidemia. An increase would consequently follow the increased epidemiology of T2DM in the epidemiology of dyslipidemia [5]. Typical forms of dyslipidemia are hypertriglyceridemia, high low-density lipoprotein cholesterol (LDL-C), and low high-density lipoprotein cholesterol (HDL-C). Dyslipidemia increases the risk of heart diseases and stroke. The risk of developing heart diseases is doubled, while one-third of strokes are attributed to hyperlipidemia [6, 7]. Decreased cholesterol levels reduce the risk of illness. In men aged 40, a 50% reduction in heart disease within five years has been associated with a 10% reduction in cholesterol, whereas in men aged 70, the same cholesterol reduction results in an average 20% reduction [7]. Hypertension is a condition that is also often found in T2DM patients. The presence of dyslipidemia and hypertension in T2DM can develop into metabolic syndrome, increasing the incidence and mortality of cardiovascular diseases [8].

Improving physical activity has been used as a strategy in managing T2DM. The benefits of exercise have been well documented. Physical activity improves blood glucose, enhances insulin sensitivity, and improves the plasma lipoprotein profile [9]. Prior studies reported that regular exercise reduced blood glucose and triglycerides [10, 11]. However, the effect of exercise on cholesterol is less consistent. A study by Aggarwala et al. [11] and Chen et al. [12] observed that cholesterol decreased but not significantly. Also, a significant effect of exercise on anthropometric measurements such as weight and waist circumference has been observed [13].

Aerobic exercise is considered the most suitable for T2DM and other NCDs among exercise types. Aerobic activities such as brisk walking, jogging, and running are feasible and straightforward. Therefore, these exercises are more commonly prescribed

to patients than other types of exercise. The fight against NCDs, especially T2DM, has been developed in Indonesia through the Chronic Diseases Management Program. This program focuses on enhancing a good lifestyle, including physical activity.

Aerobic dance is one of the most favorite and popular forms of exercise, especially for women. It is performed with specific choreography under the guidance of an instructor and usually follows rhythmic pieces of music. Communities or health institutions develop types of aerobic dance for disease, e.g., aerobic dance for osteoporosis, aerobic dance for heart disease, etc. This exercise is prevalent and is preferred by older women in Indonesia due to its entertainment and fun. However, very few studies compare the benefits of aerobic dance with common aerobic exercises such as jogging, running, static cycling, etc. [14, 15]. The beneficial effect of aerobic dance on diabetes mellitus has lacked evidence. Therefore, this study aims to compare the impact of aerobic dance for T2DM and static cycling exercise on anthropometric measures, blood glucose, and cholesterol in the T2DM elderly.

Material and Methods

Subjects

Patients with T2DM (n = 30) aged 60-70 years (all women) who dwelled in two nursing homes were eligible for this intervention study (14 subjects in nursing home A, and 16 subjects in nursing home B). With three group interventions, the subject number for each group was rounded to ten. They were allocated into three groups according to the intervention: controls (C), static cycling exercise (SC), and aerobic dance exercise group (AD). There were four controls, five aerobic dance, and five static cycling participants in nursing home A. There were six controls, five aerobic dance, and five static cycling participants in nursing home B.

The T2DM was diagnosed according to their medical record or currently undergoing oral T2DM treatment. Inclusion criteria were T2DM with oral antidiabetic treatment, aged 60-70 years old and no participation in exercise within the last three months. Subjects with comorbidities such as cardiovascu-

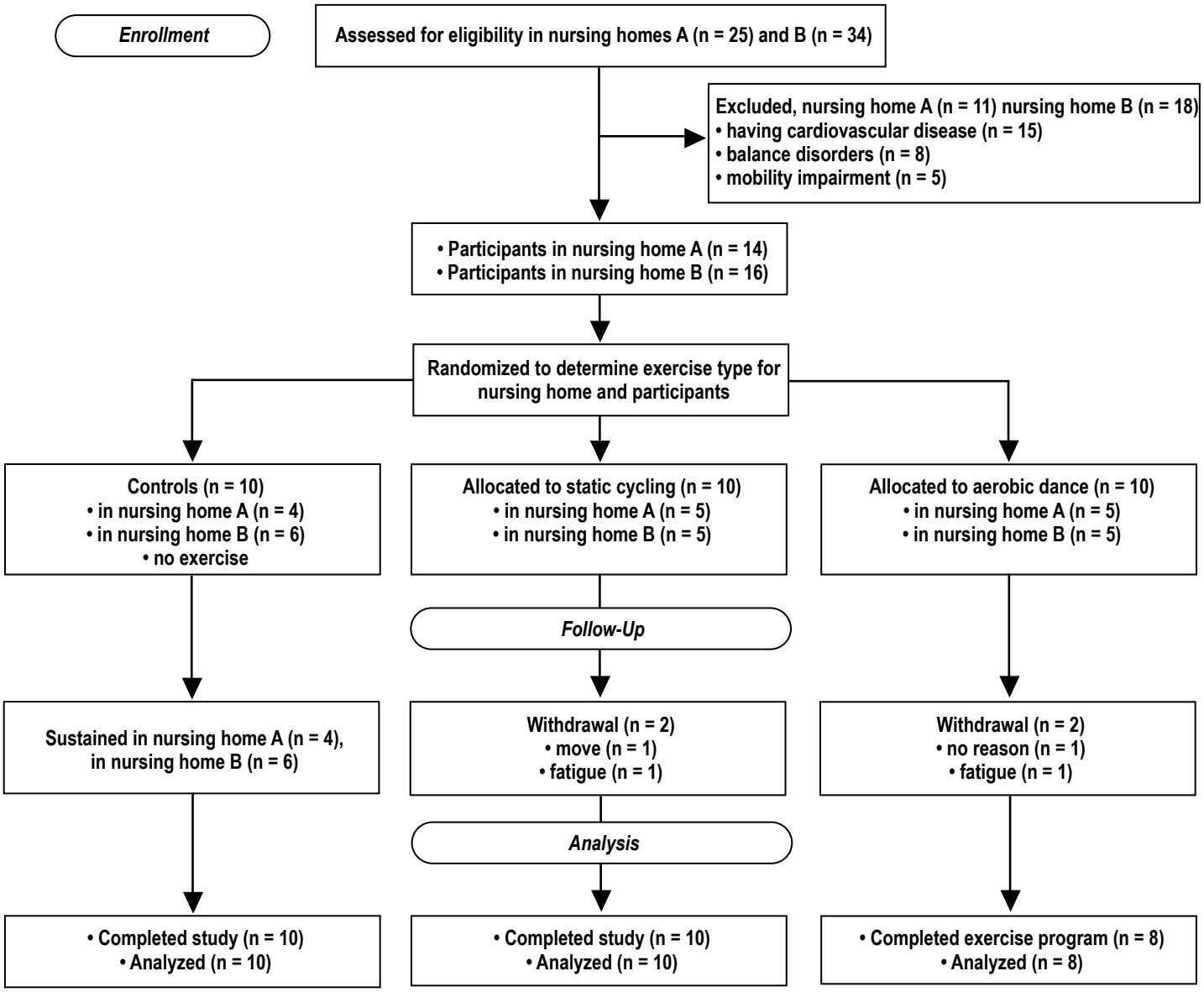


Figure 1. Flow diagram of the participants in the study

lar disease, systolic blood pressure ≥160 mmHg, diastolic blood pressure ≥100 mmHg, metabolic and endocrine disorders, musculoskeletal and balance disorders, and insulin-treated T2DM were excluded. The assignments of the subjects were randomized. The head of the nursing homes granted the study permit. Subjects gave consent independently.

Ethical consideration

The Ethics Commission of the School of Medicine and Health Sciences approved the study at Atma Jaya Catholic University of Indonesia (No. 04/01/KEP-FKUAJ/2019). All procedures were performed in the nursing homes. This study was conducted in early 2019.

Pre-participation Examination

The pre-participation examination was performed several days before the exercise program and aimed to verify inclusion-exclusion criteria and physical readiness to undergo an exercise program. Personal data were asked through a questionnaire. Anthropometric measures such as weight, height, waist & hip circumferences were performed using standard equipment & methods. Height was measured barefoot in a standing position using a stadiometer. Weight was measured with minimal clothes using a digital scale (Robust 813, Seca, Germany). Body mass index (BMI) was calculated using a standard formula. BMI for Asian people was employed [16, 17]. The waist and hip circumferences were measured using elastic tape with standard methods. Posture and gait were analyzed simply using a posture rating scale and visually with the naked eyes. Medical history was evaluated and confirmed with the medical record. Blood pressure was examined using a digital blood pressure monitor (Omron, HEM-8712, Tokyo, Japan). Twelve lead electrocardiograms were applied using an ECG (FX-7102, Fukuda Denshi, Japan), and a cardiologist interpreted the results.

Exercise Protocol

The exercises were performed three times a week with fifteen minutes for eight weeks. According to the Karvonen formula, the exercise intensity was light-moderate (40-59% above heart rate reserve – HRR) [18].

Static cycling exercise was conducted using Kettler Ergometer EL1 Super (Ense, Germany) equipped with a pulse monitor to monitor heart rate. Subjects tried a static cycling trial for customization before the exercise program. This trial also aimed to determine the subjects' heart rate, which matched target exercise intensity. The intensity was maintained by adjusting the cycle pedal frequency at 40 rpm using a metronome, while the resistance load was gradually increased to meet exercise intensity. The static cycling exercise was scheduled every Monday, Wednesday and Friday.

The aerobic dance exercise was implemented with a similar frequency, duration, and intensity as the cycling exercise (three times a week with 15 min for eight weeks with light-moderate intensity). An instructor guided the participants in performing the aerobic dance choreography while following dance music from the CD player to maintain the intensity. This exercise consisted of fifteen minutes of primary exercise. The aerobic dance was performed every Tuesday, Thursday and Saturday.

A doctor supervised the daily exercise and checked the weight and blood pressure before and after exercise; blood glucose was checked only before exercise in each nursing home. The heart rate of the aerobic dance group was monitored using a smartwatch (Mi Band 3, Xiaomi, China). All subjects received their regular medication adjusted with the exercise time. Rescue devices, medicines, and emergency call numbers were provided in an emergency.

Blood Examination

Blood glucose was examined to monitor hypoglycemia before doing exercise and see the change as an effect of the exercise in each group. Hypoglycemia was monitored by testing random blood glucose every day or before the exercise started. The change of blood glucose as a function of the exercise was evaluated by checking fasting plasma glucose (FPG) and 2-hour postprandial plasma glucose (2-h PPPG). Total blood cholesterol was tested twice: pre-and post-study. Blood glucose and cholesterol were checked using EasyTouch® GCU (Bioptik Technology Inc, Taiwan). The test methods were applied according to the standard procedure in the user guide and according to the professional recommendations [19, 20, 21].

Follow-up

Four subjects dropped out: two from each exercise group. The reasons were that three participants refused a blood examination, while one subject was exhausted. They decided to withdraw in the third to fifth weeks. Thus, eight subjects in each exercise group and ten subjects in the control group completed the study (Fig. 1).

Statistical analysis

One-way ANOVA was applied to compare post-exercise value and magnitude of the difference in the variables between the three groups. Pre and post-exercise values of the variables were analyzed using a student's paired t-test. The significance was defined as $p < 0.05$. The SPSS v.19 was used for statistical analysis.

Results

Table 1 compares the characteristics between groups. One-way ANOVA indicated no significant difference in group characteristics (all $p > 0.05$). Mean systolic pressure demonstrated in all groups was above normal, while mean diastolic pressure was normal. Mean BMI indicated that the control and SC group participants were obese, while the AD group was overweight. Mean blood glucose levels confirmed that all subjects suffered from diabetes mellitus. Mean cholesterol level was average in all groups.

Table 2 shows variables' values after the intervention. The student's paired T was applied to evaluate the effect of the intervention within groups. Post-intervention values were compared to pre-intervention values. In the control group, except FBG, all post-intervention variables were increased, but only the waist circumference was significantly increased (92.7 ± 13.5 cm, $p = 0.04$). In the SC group, five variables were reduced but only post-intervention FBG and 2-h PPBG were significantly reduced (122.5 ± 12.0 mg/dL, $p = 0.04$ and 155.0 ± 45.3 mg/dL, $p = 0.02$, respectively). In the AD group, most variables were increased. Post-intervention cholesterol and systolic pressure were reduced but not significantly (195.8 ± 37.5 mg/dL, $p = 0.83$ and 130.1 ± 9.6 mg/dL, $p = 0.29$).

Table 2 also demonstrated one-way ANOVA, which compared post-exercise variables between three groups. The results showed that only two variables, 2-h PPBG and systolic, were significantly different between groups ($p = 0.033$ and 0.016). Post hoc analysis using Tamhane's T2 indicates that a difference in 2-h PPBG was found between SC vs. AD (155.0 ± 45.3 vs. 171.3 ± 19.7 mg/dL, $p = 0.04$) and SC vs. control (155.0 ± 45.3 vs. 183.0 ± 24.1 mg/dL, $p = 0.02$), and no significant difference

Table 1. Differences in the characteristics between groups

Variables	Control (n = 10)	SC group (n = 8)	AD group (n = 8)	p
Age (years)	72.3 ± 3.7	70.4 ± 8.9	74.0 ± 6.8	0.580
Height (cm)	149.6 ± 10.3	150.9 ± 8.4	154.0 ± 8.6	0.622
Weight (kg)	57.8 ± 13.6	57.3 ± 6.3	56.9 ± 9.8	0.984
BMI (kg/m^2)	25.5 ± 4.7	25.2 ± 1.4	23.4 ± 2.0	0.346
Waist Circumference (cm)	92.0 ± 10.8	95.6 ± 3.7	96.1 ± 10.8	0.705
Hip Circumference (cm)	98.9 ± 10.8	99.6 ± 3.7	98.4 ± 8.5	0.958
FBG (mg/dL)	116.4 ± 10.9	118.6 ± 13.7	120.8 ± 10.7	0.801
2-h PPBG (mg/dL)	180.3 ± 25.4	173.8 ± 3.3	164.9 ± 12.6	0.745
Cholesterol (mg/dL)	220.3 ± 27.1	192.9 ± 18.9	198.5 ± 27.8	0.249
Systolic pressure (mmHg)	140.7 ± 14.0	130.0 ± 10.4	133.3 ± 12.1	0.260
Diastolic pressure (mmHg)	75.3 ± 11.3	76.3 ± 5.2	76.4 ± 9.8	0.972

Abbreviations: AD – aerobic dance; SC – static cycling; BMI – body mass index; FBG – fasting blood glucose; 2-h PPBG – 2-hour postprandial blood glucose.

Table 2. Comparison of variables after the intervention within and between groups

Variables	Control (n = 10)	SC group (n = 8)	AD group (n = 8)
Weight (kg)	58.4 ± 13.7	57.6 ± 6.8	57.3 ± 10.3
BMI (kg/m^2)	25.7 ± 4.8	25.2 ± 1.1	24.0 ± 2.8
WC (cm)	92.7 ± 13.5*	95.9 ± 2.4	96.3 ± 11.6
HC (cm)	99.0 ± 11.7	99.4 ± 3.7	98.9 ± 8.4
FBG (mg/dL)	112.5 ± 9.2	112.5 ± 12.0*	123.1 ± 11.9
2-h PPBG (mg/dL)	183.0 ± 24.1	155.0 ± 45.3*	171.3 ± 19.7§
Cholesterol (mg/dL)	229.4 ± 30.7	176.4 ± 34.4	195.8 ± 37.5
Systolic (mmHg)	143.3 ± 17.5	126.9 ± 7.5	130.1 ± 9.6§
Diastolic (mmHg)	80.9 ± 13.8	77.5 ± 5.3	77.9 ± 8.5

* – $p < 0.05$, significant differences between pre- and post-intervention were detected using the student's t-test, pre-intervention values were presented in table 1; § – $p < 0.05$, significant differences between the groups in post-intervention were detected using one-way analysis of variance (ANOVA). Abbreviations: AD – aerobic dance; S.C. – static cycling; BMI – body mass index; WC – waist circumference; HC – hip circumference; FBG – fasting blood glucose; 2-h PPBG – 2-hour postprandial blood glucose.

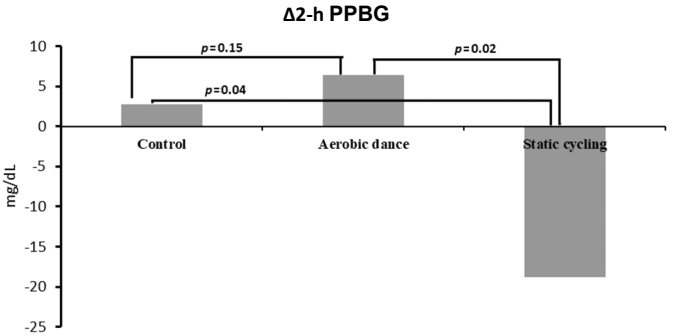
was observed between the AD group and control (171.3 ± 19.7 vs. 183.0 ± 24.1 mg/dL, p = 0.38). Systolic pressure was significantly different between SC and control (126.9 ± 7.5 vs. 143.3 ± 17.5 mmHg, p = 0.04), while there was no significant difference between other groups.

Table 3 shows one-way ANOVA of the magnitude of the change (Δ) of the variables. The only magnitude of change (Δ) in 2-h PPBG was significantly different between groups (p = 0.009). Using Tamhane's T2 post hoc analysis, the differences in systolic were found between the SC group vs. AD group (Δ-18.75 vs. Δ6.37 mmHg, p = 0.02) and between the SC group vs. control group (Δ-18.75 ± 10.9 vs. Δ2.75 ± 12.4 mmHg, p = 0.04). There was no significant difference between the control vs. AD group (Δ2.75 ± 12.4 vs. Δ6.37 ± 11.8, p = 0.15) (Fig. 2).

Table 3. The comparison of the magnitude of changes in variables between groups with one-way ANOVA.

Variables	Control (n = 10)	SC group (n = 8)	AD group (n = 8)	p
Δweight (kg)	0.58 ± 1.0	0.30 ± 1.4	0.39 ± 1.3	0.903
ΔBMI (kg/m^2)	0.28 ± 0.4	0.08 ± 1.7	0.63 ± 1.4	0.501
ΔWaist circumference (cm)	0.75 ± 0.9	0.25 ± 1.6	0.13 ± 1.2	0.622
ΔHip circumference (cm)	0.13 ± 2.7	-0.25 ± 2.8	0.50 ± 1.4	0.333
ΔFBG (mg/dL)	-3.87 ± 5.7	-6.12 ± 8.8	2.37 ± 10.3	0.202
Δ2-h PPBG (mg/dL)	2.75 ± 12.4	-18.75 ± 10.9	6.37 ± 11.8	0.009*
Δcholesterol (mg/dL)	9.12 ± 16.3	-16.5 ± 7.1	-2.75 ± 3.5	0.469
ΔSystolic BP (mmHg)	2.50 ± 10.7	-3.12 ± 11.4	-3.12 ± 9.6	0.296
ΔDiastolic BP (mmHg)	5.00 ± 9.2	1.25 ± 10.3	1.50 ± 11.5	0.545

Abbreviations: AD – aerobic dance; SC – static cycling; BMI – body mass index; FBG – fasting blood glucose; 2-h PPBG – 2-hour postprandial blood glucose.



Abbreviation: PPBG – postprandial blood glucose.

Figure 2. The post hoc comparison of the magnitude of change in two-hour postprandial blood glucose

Discussion

The beneficial effect of aerobic exercise on BMI, BP, plasma glucose, and lipid profile is recognized. Aerobic dance is one of the most popular aerobic exercises in Indonesia. However, only a few studies have reported differences in beneficial effects between aerobic dance and other types of aerobic exercises. This study compared the effects of aerobic dance and static cycling on obesity anthropometric parameters, blood pressure, cholesterol, and blood glucose parameters. Our study found that FBG and 2-hour postprandial blood glucose (2-h PPBG) were improved after static cycling exercise, while no variables improved significantly following aerobic dance exercise.

The beneficial effects of aerobic dance exercise have been reported. William & Morton reported that aerobic dance could reduce resting heart rate (HR) and body fat as well as increase maximal oxygen uptake (VO2 max), endurance capacity, and lean body mass [22]. Aerobic dance was also found to improve cardiovascular function and capacity [23]. Another study demonstrated that aerobic dance improved resting HR and the Cooper test for cardiac endurance [24]. A study by Ahmad and Rosli [25] also supported those results. They reported that aerobic dance increased their subjects' cardiovascular fitness

and reduced weight [25]. In addition, Na Ayutthaya reported that aerobic dance diminished bone resorption and improved bone health [26]. Some previous studies reported the effect of aerobic dance on cognitive function. The two previous studies reported that cognitive improvement was found following aerobic dance exercise [27, 28].

Although studies on the benefits of aerobic dance have been widely reported, only a few studies have compared aerobic dance with other types of aerobic exercise. Milburn and Butts [14] compared aerobic dance and jogging with similar training volume (four days/week, 30 min/day, for seven weeks). They found that aerobic dance was as effective as jogging in increasing VO_2max, endurance, and heart rate maximal [14]. Another study compared the influence of aerobic dance and stepped aerobic exercise on triglyceride and lipoprotein profiles in college-aged female students [15]. Step aerobic exercise was more effective than aerobic dance in modifying lipid and lipoprotein profiles [15]. Our study compared the effects of aerobic dance and static cycling on BMI, blood pressure, blood glucose, and total cholesterol. We found that static cycling effectively reduced blood glucose, but aerobic dance did not. The non-significant results of aerobic dance might relate to inadequate duration and intensity.

Besides, aerobic dance has some limitations. The choreography of the dance is sometimes not feasible for people with joint disorders or limited range of motion. The choreography sometimes contains movements prohibited for osteoporosis patients due to inducing fracture. Also, the progressivity of the aerobic dance is less manageable due to music dance controlling the speed of movements, and aerobic dance intensity is unchangeable.

The training effect of exercises is closely related to exercise duration and intensity. In general, fifteen minutes of exercise duration was sufficient for static cycling to improve blood glucose but not for aerobic dance to improve the variables. This might be aggravated with exercise intensity. The exercise duration and intensity in our study was suitable for older diabetics. However, aerobic dance was significant for achieving the desired intensity. The intensity of aerobic dance is less controlled than static cycling. Participants must follow the dance choreography and music from the CD player. However, when participants feel the intensity is harder, they can lower their exercise persistence. The aerobic dance could attain the desired intensity when performed correctly because it could maximally expend 10-11 kcal/minutes or oxygen requirements of about 30 ml/kg/min [29, 30, 31]. A study reported the influence of controlled vs. uncontrolled intensity on the exercise results [32]. The controlled intensity in aerobic dance boosted VO_2max twice as much as uncontrolled intensity [32]. Controlling intensity in static cycling was simpler than aerobic dance. Cycle pedal frequency was adjusted with a metronome. This assured that the desired intensity could be maintained.

We noted some limitations in our study. First, the exercise intensity in the AD group was less controlled; thus, the intensity of the exercise was less adequate and could lead to weaker response and no significant results. Second, a small sample size within groups could affect the significance of the results. Third, a short observation period and the total exercise duration within a week. Eight weeks of training might be less sufficient to elicit more significant results. Also, the total exercise time of 45 minutes a week was not according to the recommendation of at least 150 min/week aerobic exercise [33]. However, many variables improved, even though less significantly. Fourth, blood glucose and cholesterol were checked using a simple device with less accuracy than a laboratory examination.

Our study had some advantages, including recruiting T2DM subjects, examining some variables associated with metabolic syndrome, and a prospective study with RCT design.

Conclusions

Aerobic dance exercise for 15 minutes with low-moderate intensity for eight weeks could not significantly improve anthropometric measures, blood glucose, cholesterol, and blood pressure. Static cycling can reduce FBG and 2-h PPBG significantly. Static cycling or aerobic dance with light-moderate intensity for eight weeks had little effect on anthropometric measures, blood pressure, and cholesterol. Generalizing and interpreting these results should be done carefully due to study limitations. Our findings have implications for aerobic dance as exercise therapy for metabolic and non-communicable diseases. The result of this study is expected to change people's exercise habits and choices to improve DM.

Acknowledgment

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