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The effect of 12-weeks brisk walking exercise duration on blood pressure and VO_{2max} on overweight and obese female students in Indonesia

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ABSTRACT

Background: Lack of physical activity is one of the causes of the increasing prevalence of overweight and obesity. Therefore, the strategy to overcome this is to increase the physical activity exercise program. The objective of this study was to evaluate the effect of 12 weeks of brisk walking exercise duration on blood pressure and VO_{2max} in overweight and obese female students in Indonesia

Methods: The quasi-experimental design of the pre and post-test involved 40 overweight and obese female students aged 20-30 years with a BMI of ≥ 25 kg/m2 who were non-randomly recruited and divided into two groups, namely BW-60 (n=19) and BW-40 (n=19). Both groups did exercise five times a week at 50%-75% of maximum heart rate for 12 weeks. Systolic, diastolic, and VO_{2max} were evaluated before and after the intervention. The data analysis was performed by SPSS 21.0 using the Shapiro-Wilk test, independent sample t-test, Paired sample t-test. $P<0.05$ was to set a level of significant significance.

Results: After 12-weeks of brisk walking, BW-60 groups increased more steps by 6635 steps than WE-40 only 3985 steps per day from the initial average steps. There was a significant increase in VO_{2max} after the intervention program for each group, namely, BW-60 ($P<0.001$), BW-40 ($P<0.001$). There was no significant effect on systolic and diastolic blood pressure in both groups ($P>0.05$)

Conclusion: Both BW-60 and BW-40 groups effectively increased VO_{2max}, but there was no significant change in blood pressure parameters. However, more research is needed with longer intervention times and different intensities and types of exercise to further optimize exercise doses for specific health benefits.

KEYWORDS

Brisk walking exercise, Blood pressure, Obesity, Female, VO_{2max}.

INTRODUCTION

Overweight and obesity cases have become a health problem almost everywhere around the world, and the number has increased rapidly over the past 35 years. Currently, women experience more of this problem than men[1,2]. A report from The Indonesian Basic Health Research (*RISKESDAS)* in 2018 stated the prevalence of overweight and obesity in adulthood was 13.6 % for overweight and 21.8 % for obesity[3]. Another study in Indonesia showed a prevalence of overweight and obesity between the age of 18 to 45 years old, which was found higher in women with the percentage of 42.8 % when compared to men with a percentage of 29.2 %[4].

Obesity contributes to various risk factors for cardiovascular diseases such as dyslipidemia, type 2 diabetes mellitus, hypertension and sleep disorder[5]. Lack of physical activity is considered a modifiable determinant often associated with an increasing prevalence of overweight and obesity, which tends to be higher for women than men in all age groups[6] One way to reduce the prevalence of overweight and obesity is to engage in regular physical activity by promoting a healthy lifestyle[7]. Brisk walking is one of the ideal programs

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for overweight and obese individuals to increase their physical activity because it can be done easily and inexpensively and does not require special equipment except for individuals with knee pain[8].

Aerobic exercise, such as brisk walking, involves many major muscle groups that can increase oxygen consumption in the body and result in physical fitness improvement. It also improves the overall quality of life and reduces all causes of death, including controlling blood pressure[9,10]. The American College of Sports Medicine (ACSM) recommends that people with hypertension perform 30-60 minutes of moderate physical activity per day 5-6 times per week with exercise types such as walking, jogging, cycling, and swimming, while resistance training is performed at least 2-3 times per week as a control of blood pressure[11]. A meta-analysis study reported a significant reduction in systolic blood pressure after participating in a brisk walking program[12]. Whereas another study found that doing a brisk walking program for 60 minutes 3 times a week at low to high intensity can reduce blood pressure and the risk of acute cardiovascular events in elderly patients with essential hypertension[13].

Brisk walking can also improve blood vessel function that can be used as an indicator of physical fitness[14]. The study results with a brisk walking intervention for eight weeks were proven to increase the VO_{2max} (volume oxygen maximum) from 28.3 to 33.5 ml/kg/minute in overweight and obese patients[15]. The physical activity levels such as volume and duration of exercise per session may be more relevant than the intensity of exercise in cardiometabolic health, especially in overweight adults when the days were spent in sitting activities[16]. Therefore, this study aimed to evaluate the effect of brisk walking based on duration on blood pressure and VO_{2max} on overweight and obese female students.

METHODS

Design and Participants

The present study was a quasi-experimental with a pre-test-post-test design. The participants were non-randomly recruited and resulted in 40 overweight and obese female students aged 20-30 years old who were willing to be interviewed. However, two participants were excluded from this study due to illness, so they could not finish it. Subsequently, the remaining 38 subjects were divided into two groups of 19 participants; each was named (1) the 60-minute brisk walking exercise group (BW-60) and (2) the 40-minute brisk walking exercise group (BW-40). In writing the report, all participants were informed about the study's objective, implementation, and risks associated with this investigation. There were two criteria for this study, (1) inclusion criteria: (a) 20-30 years old; (b) Body mass index (BMI) ≥25 kg/m^2; (c) having an inactive lifestyle based on an average daily step of < 5000 steps per day, and (2) the exclusion criteria: (a) pregnant; (b) taking drugs/dietary supplements; (c) diagnosed with a chronic disease; (d) following a strict diet; (e) doing other strenuous activities or sports such as the gym during the research period; (f) not willing to use a smartband during the study. Informed consent was obtained and signed by all participants before the intervention program. The location of the intervention program was carried out at IPB University, Indonesia. This study has received approval from the Human Subject Research Ethics (KEPMSM) under letter number 289/IT3. KEPMSM-IPB/SK/2020.

Intervention

Both groups were invited to attend an instructional session on implementing the intervention program and explained the use of the smartband. The intervention in this study will last 12 weeks. The BW-60 group did a brisk walking exercise with a duration of 60 minutes, while the BW-40 group did the exercise for 40 minutes. Both groups performed five times a week and participants were instructed to take a brisk walk with exercise intensity based on their zone of heart rate (50-75 % of maximum heart rate (HRM), which had previously had been calculated based on a formula of 220 age x target HR, or, with a rhythm > 100 steps per minute that is considered as a representative number of moderate intensity exercises[11,17].

The implementation time was in the morning at 06.00, but when the situation was not possible to do this activity in the morning, the implementation could be switched to the afternoon. The practise sessions were conducted outdoors and supervised by a research assistant. The brisk walking exercise began with a 10-minute warm-up to flex body muscles and improve blood circulation, followed by a heart rate measurement to determine the participants' readiness to do the brisk walking exercise and after the participants completed the training, a cooling down activity was performed to stabilize the heart rate for about 10 minutes. The heart rate was monitored procedure was carried out by the participants with the help of Miband smartband version 4.0 attached to their wrists (which was previously explained by the researchers).

Both groups were monitored to ensure each group performed a brisk walking to completion by a research assistant. A weekly examination of the training history was carried out using a downloaded application on each participant's smartphone and recorded on a prepared compliance sheet that had previously been set up by the researchers. The brisk walking data collection was gathered by Xiaomi Miband smartband version 4.0 (Xiaomi Communication Co., Ltd., China). As a research tool, a smartband is similar to a bracelet attached to the wrist during the participant's activities, except bathing. It

will be connected to Bluetooth to synchronize and record the walking exercise data or send the steps data either per day, weekly, or monthly, which can be reopened when necessary. The accuracy level of the smartband is equipped with a multi-sensor 3-axis accelerometer, a gyroscope, and a heart rate sensor with PPG (Photoplethysmograph) technology that uses infrared to penetrate the skin of a user and is able to send its reflection to determine the heartbeat speed. The use of the Xiaomi Miband 4.0 version has been investigated to the level of validation for the number of measurement precision compared to other brands[18,19].

Measurements

Anthropometric measurements were conducted in the laboratory of the Public Nutrition Department, IPB University, where participants were measured barefoot and wearing light clothing. The height of the participants was measured using a stadiometer with an accuracy of 0.1 cm, the body weight of the participants was measured by multifrequency BIA (bioelectrical impedance analysis) using InBody 270 (BIA Inbody 270, InBody Co., Ltd, Seoul, Korea), and the BMI of the participants was calculated by dividing body weight (kg) by height squared in meters (m).

Blood pressure measurement was performed employing an automatic sphygmomanometer (Omron Monitor HEM-7203). The measurement was taken in a relaxed sitting position, body upright, and feet on the floor after resting for 3-5 minutes before the measurement process occurred. The cuff is placed in the middle at the sternum level and then tightened about 75%-100% of the arm. Participants were not allowed to do excessive physical activity or consume caffeine substances at least 30 minutes before measurement.

The Cooper test with a 12-minute walk/run method was employed in this study to determine the level of cardiorespiratory fitness (VO_{2max}) by instructing all participants to run or to walk around at a 400-meter track for 12 minutes long at the same time on the cue to use a stopwatch to calculate the travel time and participants unallowed to stop before the time was up. Later, the measurement results are converted into the distance formula (meters) – 504.9 / 44.73[20].

Statistical analysis

All data were analyzed through IBM SPSS Statistics (Version 21 for Windows; IBM, Armonk, NY, USA), and all results were expressed as mean ± standard deviation (SD). For normality distribution, data were measured by the Shapiro-Wilk test. The differences in the two groups were performed using the independent sample t-test and to exemine the effect of the intervention program on the systolic, diastolic, and VO2max in each group before and after the intervention was used the paired sample t-test. The change (Δ) values are reported as adjusted mean values and a 95% lower-upper limit confidence interval (CI). The level of significance in this study was set to a value of $p<0.05$.

RESULTS

Table 1 presents the participants' general characteristics that describe the average age, weight, height, body mass index (BMI), and the average daily steps, which show no significant difference between the groups before the intervention program ($P>0.05$).

Table 1. Comparison of general characteristics before the intervention program

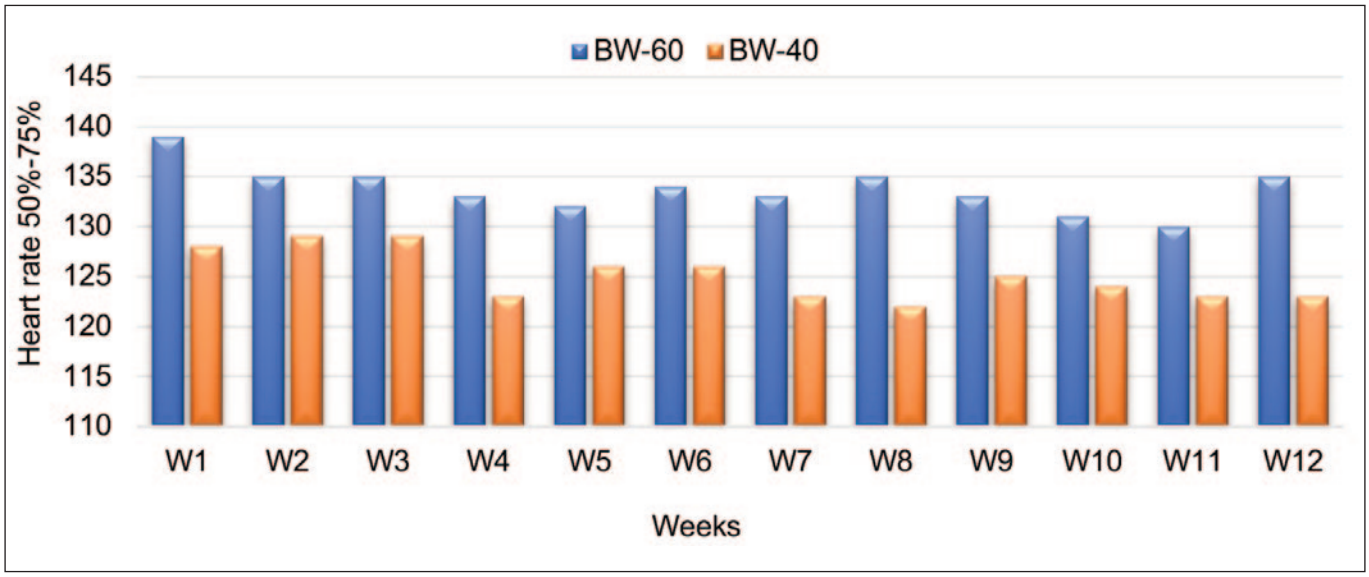
Variable	Group		*P* value[a]
	BW-60 (mean±SD)	BW-40 (mean±SD)	
Age (years)	24±1.87	23±2.40	0.16
Body height (cm)	154.17±6.01	156.27±4.53	0.23
Body weight (kg)	72.26±13.65	72.79±13.49	0.89
BMI (kg/m^2)	30.50±4.41	29.83±5.52	0.16
Average of daily steps	4508±1562	4089±1334	0.38

BW-60, Brisk walking 60-minutes; BW-40, Brisk walking 40-minutes; BMI, Body mass index, [a]Independet sample t-test; *(P<0.05).

The brisk walking heart rate (HR) for the 12-week intervention is reported in Figure 1. Brisk walking exercises based on a heart rate of 50%-75% of maximum HR showed that BW-60 exhibited an average heart rate of 134 beats per minute, i.e. 68% of its maximum heart rate (HRM), while BW-40 had an average heart rate of 125 beats per minute or were at 64% of their HRM. This proves that both groups have met the requirements for moderate-intensity exercise.

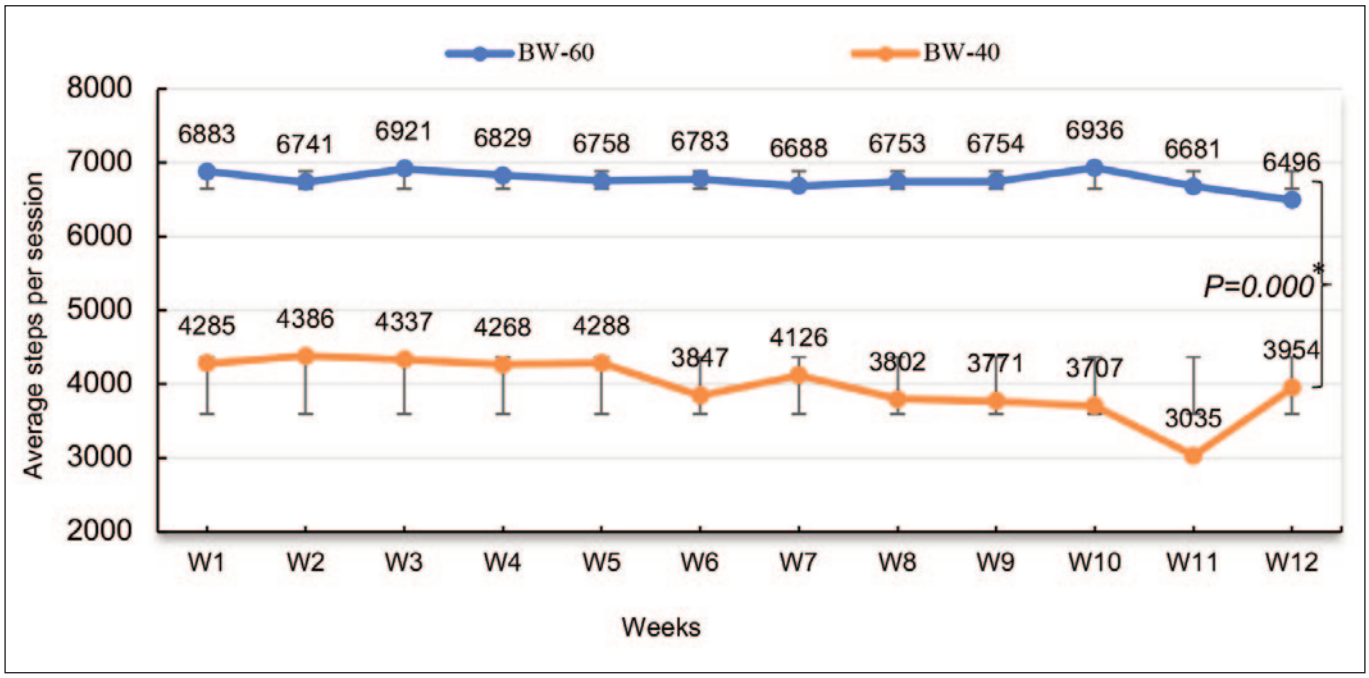
The brisk walking exercise program in this study was determined based on the duration. The brisk walking exercise based on the average number of steps per session during the 12 weeks of intervention is presented in Figure 2. The moderate-intensity walking exercise program in the WE-60 and WE-40 groups resulted in an average additional step of about 6635±794 and 3985±677 steps per session, respectively. Steps per session is the total number of steps taken in one training session. The results of statistical analysis showed that there was a significant difference between the two groups (P<0.001).

Figure 1. Brisk walking heart rate during12-week intervention



BW-60, Brisk walking 60-minutes; BW-40, Brisk walking 40-minutes.

Figure 2. Brisk walking exercise base on average number of steps per session during 12-week intrvention



BW-60, Brisk walking 60-minutes; BW-40, Brisk walking 40-minutes; Independet sample t-test (* P<0.05).

The outcomes of blood pressure measures are showed in Table 2. There were no significant difference changes (Δ) in systolic blood pressure between the two groups (P=0.907), but there was a tendency to decrease systolic blood pressure in both groups after the intervention, although not statistically significant. Diastolic blood pressure also did not significantly different between the two groups (P=0.291), but showed a decrease after the intervention program although the results were not statistically significant.

Table 3 shows the results of measures VO_{2max} during the 12-week intervention program. There was an increase in the VO_{2max} value in each group after 12 weeks of the intervention program, namely, BW-60 (P<0.001) and BW-40(P<0.001), respectively. However, when compared between the two groups, there was no significant difference (P>0.05).

Table 2. Blood pressure variables before and after intervention program

Variable	Before (mean±SD)	After (mean±SD)	ΔChange [95% CI]	*P* value[b]
Systolic (mmHg)				
BW-60	118.89±7.47	115.11±7.21	-3.78±9.61 [0.8, 8.4]	0.103
BW-40	120.74±10.40	117.58±8.07	-3.15±6.85 [0.1, 6.4]	0.060
P value[a]	0.535	0.326	0.907	
Diastolic (mmHg)				
BW-60	78.74±5.85	77.84±6.03	-0.89±8.83 [3.3, 5.1]	0.664
BW-40	83.21±9.61	79.27±6.21	-3.94±8.72 [0.2,8.1]	0.064
P value[a]	0.092	0.479	0.291	

BW-60, Brisk walking 60-minutes; BW-40, Brisk walking 40-minutes; [a]Independent sample t-test; [b]Paired sample t-test; *(P<0.05).

Table 3. VO_{2max} variable before and after intervention program

Variable	Before (mean±SD)	After (mean±SD)	ΔChange [95% CI]	*P* value[b]
VO_{2max} (ml/kg/min)				
BW-60	15.00±3.15	19.08±5.03	4.08±3.79 [2.2, 5.9]	0.000*
BW-40	13.39±3.70	16.40±3.54	3.00±1.73 [2.1, 3.8]	0.000*
P value[a]	0.158	0.065	0.272	

BW-60, Brisk walking 60-minutes; BW-40, Brisk walking 40-minutes; [a]Independent sample t-test; [b]Paired sample t-test; *(P<0.05).

DISCUSSION

Brisk walking is an ideal intervention to reduce blood pressure, which can occur through several mechanisms of neurohormonal adaptation, including decreased sympathetic nerve activity, decreased catecholamines, decreased cortisol hormone, increased baroreflex sensitivity, increased endothelial function that occurs due to increased physical exercise[21]. In this study showed that there was no significant difference between systolic and diastolic blood pressure of both groups. However, there was a tendency to decrease blood preassure in both groups after the intervention program, although the change was not significant. It was because most of the subjects of this study had a normal range of blood pressure before the intervention program. Another reason is that the subject is still young so his blood pressure is still stable. The results of China study showed that age as a risk factor for hypertension has an odds ratio (OR) of 2.7 times higher in individuals 45-59 years old and 6.9 times higher at the age of 60 years old when compared to the age group of 18-44 years old[22].

These results are in line with research that performed a 30-minute brisk walking intervention for five times a week and did not show changes in systolic and diastolic blood pressure for six months in overweight adults[23]. Other results also reported a 45-minute walk with four sessions per week for 12 weeks, which increased pulse rate and blood pressure in obese adults[24]. These results contrast with a study of hypertensive women who performed walking exercises with light to moderate intensity of 50% to 80% of maximum heart rate under 30 minutes duration per session three times per week that were able to reduce systolic and diastolic blood pressure by 4.5 mmHg and 2.5 mmHg, respectively, for six months[25]. Other results also reported that sedentary adults with a higher baseline of systolic blood pressure who finished the intervention of walking at a speed of 5 km per hour in 50-70 minutes time duration and conducted five times per week were able to reduce the systolic and diastolic blood pressure for six months[26]. Therefore, the results of this study indicated that providing regular brisk walking exercise with a longer duration of intervention on

blood pressure is more significant in individuals with a higher baseline blood pressure than normal.

The aerobic capacity (VO_{2max}) in overweight women is lower than that of normal weight women[27]. The study shows that excess fat in the body puts a significant burden on heart function and oxygen uptake to body muscles, so that an increase in BMI affects VO_{2max}, which will reduce a person's cardiovascular fitness[28]. Maximum oxygen consumption (VO_{2max}) is considered the primary indicator of physical fitness, directly related to cardiovascular health. In this study, participants were advised to exercise with a heart rate of 50%-75% of their maximum heart rate so that all participants had met the requirements for moderately intensity exercise, as shown in Figure 1. The Paired Sample T-Test showed that a significant increase in VO_{2max} for both groups after 12 weeks of the intervention program ($P<0.001$), where a tremendous increase was found in BW-60, but it did not show a significant difference between the two groups. The results indicated that the brisk walking exercise intervention in both groups was equally effective on increasing the VO_{2max} value; although the increase makes a small contribution, it can improve the subject's physical fitness.

These results are consistent with a 6-week study of sedentary subjects aged 18 to 28 years who received a 30-minute continuous treadmill walking program per session with a heart rate of 40%-60%, which also experienced increasing VO_{2max} values[29]. Other results also showed a brisk walking program three times a week with 60%-70% of the maximum heart rate significantly affecting changes in VO_{2max}[15]. In contrast, a study result found that giving an intervention program to walk for ten weeks has not increased VO_{2max} in sedentary employees[30].

The strength of this study is the use of a multisensory smartband to measure physical activity based on a series of measures that can give better results than a subjective questionnaire. The researchers realized that the limitation in this study is the total intervention time was only 12 weeks, so it was insufficient to increase VO_{2max} values and the lack of sample size.

CONCLUSION

The regular brisk walking program with an intensity of 50-75 % maximum heart rate, carried out in 60 minutes and 40 minutes duration, effectively results in an additional in the average number of steps and significantly increases the VO2max after the intervention and tended to decrease systolic and diastolic blood pressure, although it was not statistically significant. Therefore, more research with longer intervention times, different intensity of exercise, and various types of exercise is needed to optimize the exercise doses to gain specific health benefits. Despite the limitations, this study recommends using a measurable walking program as a strategy to develop an intervention program to increase daily physical activity. This walking exercise is easier to do and flexible for all ages, especially for those who have sedentary behavior

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