

**The Effect of Circuit Training and Body Mass Index on Aerobic Capacity, Body Fat and Body Circumference in Women Aged 20-45****Nurul Julinar^{1✉}, Setya Rahayu², Ipang Setiawan³**Sports Education Study Program, Graduate Program, Universitas Negeri Semarang, Indonesia¹²³**Article History**

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fat; Body circumference

Abstract

The purpose of this study was to analyze the effect of circuit training and body mass index on aerobic capacity, body fat and body circumference in women aged 20-45. The total sample was 30 women in Bumireso Village including experimental and control group. The research used purposive sampling with pretest and posttest. Data collection techniques used are questionnaires, food recall, daily activity record booklets, fat calculator software and documentation. The result data analyzed paired sample T-Test using IBM SPSS Statistic 25.00 for windows. The results obtained circuit training of trekking poles for normal group increasing in aerobic capacity of 7.92, decreased body fat of -1.68, decreased in arm circumference of -1, decreased in abdominal circumference by -3.2, and decreased in thigh circumference by -0.4 ($p = 0.000$). The trekking poles group for overweight group increased aerobic capacity by 4.8, a decreased in body fat of -2.58, a decreased in arm circumference of -1.2, a decreased in abdominal circumference of -2.8, and decreased in thigh circumference of -0.8 ($p = 0.000$). The group without trekking poles in the normal group increased in aerobic capacity of 3.2, a decreased in body fat of -1.58, a decreased in arm circumference of -0.4, decreased in abdominal circumference of -2.8, and a decreased in thigh circumference of -0.4 ($p = 0.000$). The group without trekking poles in the overweight group an increase in aerobic capacity of 2.6, decreased body fat of -2.64, a decreased in arm circumference of -1.2, a decreased in abdominal circumference of -2.8, and a decreased in thigh circumference of -0.6 ($p = 0.012$). Circuit training using trekking poles is better for increasing aerobic capacity, reducing body fat, and decreasing body circumferences.

How to Cite

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INTRODUCTION

The development of time continue to creating unlimited human mindset by constructing sustainable innovations in the form of modernity that will affecting the lifestyle. "Changes of lifestyle cause changes in knowledge, attitudes, behavior, eating patterns, as well as the selection of the type and amount of food consumed" (Octari, Liputo, & Edison, 2014:131). The influence of social life, technology and food consumption affect the pattern of life. "Economic growth has been accompanied by shifts in dietary intake patterns towards more westernised foods, characterized by increased consumption of saturated fat, salt and processed foods and diminishing fruits, vegetables, and fibre intake." (Agbozo, Bannerman, Klomegah, & Zotor, 2022:1).

Productive women who are generally of fertility and menopausal stages. Fertility women have reproductive organs that are still functioning properly between the ages of 20-45. (Rachmawati, 2012:10). Productive women have a life pattern with mobility from moderate to high along with sedentary activities and living in urban areas. According to Asyera br Sinulingga, Sri Andayani, & Lubis (2021:656) that sedentary behavior is a lifestyle, namely technological advances to facilitate all activities becomes faster, but the results is that humans becoming less productive.

Sedentary behavior causes weight gain, impairs cardiovascular function, impairs immune system response, and increases the risk of suffering from physiological disorders (eg: depression, psychological stress, and anxiety) (García-Suárez et al., 2022:1). Body mass index (BMI) values throughout childhood to adulthood have stabilized in many developed countries, although increasing in some parts of Asia (Id et al., 2021:2).

Wonosobo Regency is a regency of large city with increasing population and facilities with a Human Development Index value of 68.27, it is included in the medium category (Dinas Kesehatan Provinsi Jawa Tengah, 2019). Data obtained from Risesdas 2019 in the table of Prevalence of Nutritional Status Based on BMI Category in Adult Male and Female Population (Age > 18 Years) that BMI of women in Wonosobo Regency has a BMI rate of 6.15% in the underweight category, 46.71% in the normal category, 13.97% overweight category, and 33.18% obesity category (Dinas Kesehatan Provinsi Jawa Tengah, 2019).

Physical activity or sport is an important priority for every individual in achieving a level of fitness. "Sport is a regular and planned physical exercises to maintain life, im-

rove the quality of life, and achieve a level of physical ability (Elmando, Nasuka, & Sulaiman, 2020:115). The implementation of physical fitness training programs must be applied regularly to prevent degenerative diseases and balance physical activity for productive women with high mobility. The physical activity guidelines for each individual accumulate an accumulation of 150 to 300 minutes per week of moderate-intensity physical activity, 75 to 150 minutes of vigorous-intensity physical activity, or a combination of muscle-strengthening exercise on approximately 2 days per week (Scheer et al., 2021:284)

Physical activity programs to improving body fitness, one of which is Circuit Training. Circuit training is a form of body conditioning that involves resistance training, high-intensity aerobics, and exercises performed on a circuit, similar to high-intensity interval training" (Pratap, Shekhawat, & Chauhan, 2021:2). One of the treatment tests that distinguishes it from circuit training is by using tools or poles. Trekking Poles have hand grips and wrist straps, similar to single-point sticks or SPCs (Cohen, Huser, Barone, & Barone, 2021:136). Increasing metabolic response in the body with the use poles has an effect when walking on a treadmill and field track (Yong Bin Han et al., 2017:256).

The results of observations on 56 women in the Bumireso sub-district, Wonosobo district, with a normal BMI of 57%, a BMI in the overweight category of 41% and a class 1 obesity of 2%. Research on circuit training and body mass index to measure aerobic capacity, body fat and body circumference in women was used in previous studies, that circuit training can be used to increase VO₂max (Multazam, A., Chandra, A., Irawan, D. S., & Abdullah : 2013). Research related to lifestyle states that a high sedentary lifestyle is a determinant of weight gain among adult women in urban areas (Agrawal, Gupta, Mishra, & Agrawal : 2013). Using sticks for exercise was explained in previous research that using a stick would increase the strength of the hind legs and body flexibility (Permsirivanich et al.: 2016). There is an effect of physical activity (aerobic exercise) on BMI and blood pressure in obese women, but there is no effect of giving physical activity on the waist-to-hip ratio (RLPP)) (Fitri, Mulyani, Fitrianiingsih, & Suryana : 2016). There is a relationship between BMI and percent body fat and there is a relationship between BMI and viscelar fat (Susantini : 2021).

The problem in this study is "How are the differences in the effect of circuit training and body mass index on aerobic capacity, body fat and

body circumference of women aged 20-45". The purpose of the research is to analyze the difference in the effect of circuit training and body mass index on aerobic capacity, body fat and body circumference of women aged 20-45. The hypotheses in this study include a stick training system that will provide muscle strength, sustainable endurance with an aerobic system and improve body composition. Circuit training at low and moderate intensity for 30 minutes will burn fat, providing the difference between body fat (BF%), the ratio of arm, waist and thigh circumference. Circuit training in one month changes nutritional status based on body mass index (BMI) and systolic blood pressure /diastolic. The average increase in VO2max ability in the low BMI was higher than in the high BMI group.

METHODS

The study used quasi-experimental with Nonequivalent Control Group Pretest-Posttest Design. Aerobic capacity measurement was carried out using the Multi Stage Fitness Test, and body fat was measured using a skinfold caliper. Measuring body circumference with a waist ruler on the arm, stomach, and thighs. The provision of food recall and daily activity booklet for sample aims to record daily activities and food consumed during the study.

The collection of the population as many as 56 women aged 20-45. Screening of samples by filling out health questionnaires, informed consent and using inclusion, exclusion and drop out criteria by purposive sampling. The samples used were 30 women, 20 women in the experimental group (the trekking poles group in normal and overweight category, and the group without trekking poles in normal and overweight category), 10 control groups who participated in Bumireso Village, data carried on in a month, between June 4, 2022 to July 4, 2022.

The research procedure measures the level of aerobic capacity, body fat and body circumference with treatment using trekking poles and without trekking poles through 4 weeks of circuit training with a frequency of 3-4 times a week and the duration is 60 minutes. The number of exercise was 14 times including pretest and posttest. In the pretest and posttest, samples were measured heart rate, weight, height, body circumference, body fat and carried out the Multistage Fitness Test. The implementation of circuit training with 8 exercise posts, namely 30 seconds of

movement, 30 seconds of walking, 2 minutes of rest after finishing at the final post with 4 repetitions with FITT (Frequency, Intensity, Time and Type). Researcher also measured heart resting pulse, warm-up heart pulse, exercise heart pulse for every 5 minutes and cooling heart pulse.

Data were calculated as mean ± SD, normality test using Shapiro-Wilk with a significant level of 5%, homogeneity test using Levene's Test at p-value 0.05. Statistical analysis technique using Paired Sample T Test using IBM SPSS STATISTIC 25.00 with a significance level of 5%. The research flowchat can be seen in **Figure 1**.

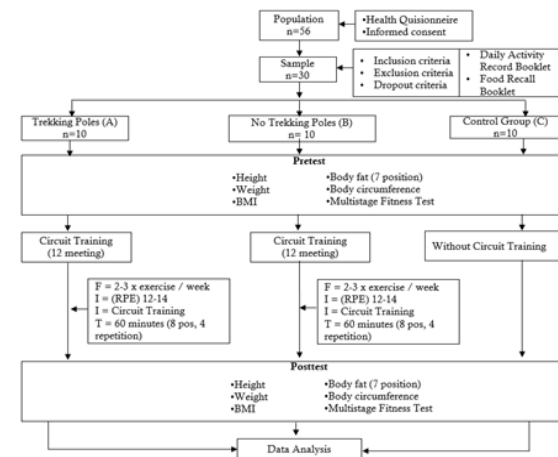


Figure 1. Research flowchat.

RESULTS AND DISCUSSION

Effect of Circuit Training and Body Mass Index on Aerobic Capacity of Women aged 20-45.

The Trekking Poles group in the normal category has an average pretest value of 22.16 and 30.08 for the posttest that increase in the average value of 7.92, in the Trekking Poles group in the overweight category, the average value of the pretest is 20.32, and the posttest 25.12 has an average value increase of 4.8. For group without using Trekking Poles for normal category, the average pretest score was 24.8 and the posttest 28 had an increase in the average value of 3.2, without Trekking Poles group for overweight category, the average pretest score was 21,6 and posttest 24.2 have an increase in the average value of 2.6. The process of comparative data for pretest and posttest (TP for Trekking Poles and NTP for No Trekking Poles group) can be seen in the following **Table 1** :

Table 1. Pretest and Posttest Result of Aerobic Capacity

Group	BMI	Mean ± SD Pretest	Mean ± SD Posttest
TP	Normal	22,16±0,92	30,08±3,11
	Overweight	20,32±0,769	25,12±1,179
NTP	Normal	24,8±1,09	28±0,707
	Overweight	21,6±1,51	24,2±1,09

This research also measuring of heart pulse every 5 minutes (resting heart pulse, after warming up, core exercise, and cooling down) for 12 meetings. It is shown in **Figure 2** and **Table 2** :

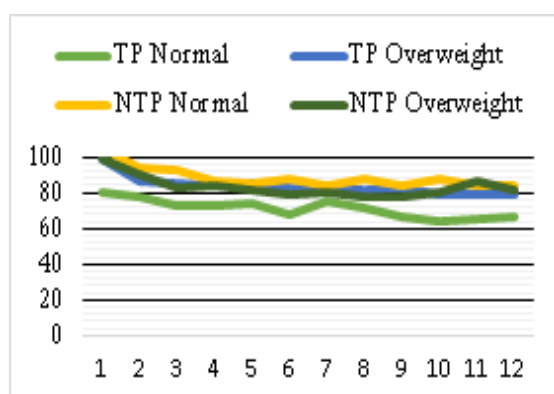


Figure 2. Heart Pulse Line Diagram for Circuit Training Exercise

Recording the pulse every 5 minutes having a purpose can perceive the condition of responden’s body when exercising, whether the adjustment of heart rate stability based from their age can be adapted in first exercise or the next exercise. It is important for the body to be able to adjust the environment and the cardiovascular performance on the body so as not over training.

Table 2. The Result of Heart Rate Exercise

Group	Category	Body Adjustment (day)	Mean (heart rate/minute)
TP	Normal	9-12	65,96-66,61
	Overweight	10-12	87,23-84,43
NTP	Normal	8-10	88,21-87,23
	Overweight	5-9	81,38 - 77,67

Hypothesis 1 used the paired sample T test, and obtained a significance value of 0.0001. The significance value is 0.0001 < 0.05, the hi states that ”difference in pretest and posttest between circuit training and body mass index exercises on aerobic capacity in productive women aged 20-45” is accepted. Circuit training using trekking

poles is better for aerobic capacity than circuit training without using trekking poles in productive women aged 20-45.

The Effect Of Circuit Training And Body Mass Index On Body Fat Women Aged 20-45

The Trekking poles group in normal category obtained an average score of 22.7 for the pretest and 21.02 for the posttest had a decrease in the value of 1.68, the Trekking Poles group in overweight category obtained an average score of 28 for the pretest and 25,42 for the posttest had a decrease in the value of 2.58. For group of No Trekking Poles in the normal category obtained an average score of 21.78 for the pretest and 20.2 for the posttest had a decrease in the value of 1.58, No Trekking poles in the overweight category obtained an average score of 28.96 for the pretest and 26.32 for the posttest had a decrease in the score 2.64. The process comparative data for pretest and posttest of body fat result can be seen in the following **Table 3** :

Table 3. Pretest and Posttest of Body Fat Result

Group	BMI Category	Mean ± SD Pretest	Mean ± SD Posttest
TP	Normal	22,7±3,22	21,02±3,23
	Overweight	28±3,11	25,42±2,75
NTP	Normal	21,78±4,66	20,2±4,26
	Overweight	28,96±3,536	26,32±3,532

Giving daily activity booklets to respondents aims to determine physical activity for a month, by taking 4 weekday data and 4 weekend data for each respondent, processed for MET-s analysis based on the results of working, moderate activity, leisure activities and activity using transportation. The reference for METs uses the 2011 Compendium of Physical Activities Reference List (Ainsworth et al., 2011). The results of the METs are aimed at whether the respondent is in an active or sedentary lifestyle. Low category if the amount of physical activity is < 600 MET-s minutes/week, moderate category if the amount of physical activity is > 600-1500 MET-s minutes/week, heavy category if the amount of physical activity is > 1500 MET-s minutes/week.

The average results obtained from respondents data in filling out food recalls and daily activities can be concluded that respondents living in a sedentary lifestyle with METs between 422-671 METs per week. The results of physical activity for the experimental group can be seen in **Table 4** :

Table 4. Physical Activity of Experimental Group

Group	BMI	n	Mean	SD	Min-Max (Mets/g)
TP	Normal	10	581,4	52,429	490-612
	Overweight	10	480,8	62,98968	422-550
NTP	Normal	10	592,4	52,28575	529-671
	Overweight	10	474	42,72002	425-529

Calculation of food recall 1 x 24 hours for a month, by taking 4 weekday data and 4 weekend data for each respondent, processed to analyze the macronutrient content of the food consumed by using NutriSurvey Software 2007 and LifeSum. The following is an overview of carbohydrate, protein and fat intake in the following **Table 5** for Carbohydrate Intake, **Table 6** for Protein Intake and **Table 7** for Fat Intake:

Table 5. Carbohydrate Intake

Group	BMI	n	Mean	SD	Min	Max
TP	Normal	10	1345,094	199,1037	1074,22	1524,1
	Overweight	10	1049,02	409,8562	651,8	1668,5
NTP	Normal	10	1424,66	222,0662	1229,6	1786,6
	Overweight	10	1265,28	112,5823	1132,6	1394,1

Table 6. Protein Intake

Group	BMI	n	Mean	SD	Min	Max
TP	Normal	10	395,468	68,43692	299,1	476,84
	Overweight	10	1049,02	409,8562	651,8	1668,5
NTP	Normal	10	503,244	106,8612	362,3	662,6
	Overweight	10	419,5	62,92793	346,8	498,74

Table 7. Fat Intake

Group	BMI	n	Mean	SD	Min	Max
TP	Normal	10	347,132	91,05689	218	437
	Overweight	10	341,42	125,2977	197,7	502,4
NTP	Normal	10	405,06	69,36323	340	519,6
	Overweight	10	363,0314	26,27615	327,5	394

Hypothesis 2 obtained a significance value of 0.0001. The significance value is $0.0001 < 0.05$, the HI states that "there is a difference between pretest and posttest on Circuit Training and Body Mass Index on body fat in productive women aged 20-45" is accepted. Trekking poles is more effective in reducing body fat than wit-

hout trekking poles. Overweight category is better at reducing fat than the normal category.

Effect of Circuit Training and Body Mass Index on Arm Circumference of Women aged 20-45

The decrease in arm circumference in the Trekking poles for normal category obtained an average value of pretest 27 and posttest 26 had an average decrease of -1 cm, Trekking Poles for overweight category obtained an average value of 33 pretest and 31.8 posttest had a decrease in average value -average of -1.2 cm. Meanwhile, in the circuit training group without Trekking poles for normal category, the average pretest score was 25.6 and the posttest 25.2 had an increase in the average value of -0.4 cm, in the group without Trekking poles for overweight category, the pretest average value was 32.6 and posttest 31.4 have a decrease in the average value of -1,2 cm. The results of arm circumference for the experimental group can be seen in **Table 8** :

Table 8. Pretest and Posttest Result of Arm Circumference

Group	BMI Category	Mean ± SD Pretest	Mean ± SD Posttest
TP	Normal	27±2,23	26±2
	Overweight	33±3,74	31,8±3,76
NTP	Normal	25,6±8,08	25,2±3,70
	Overweight	32,6±2,30	2,5±0,20

Hypothesis 3 used the Paired Sample T Test, and obtained a significance value of 0.0001. The significance value is $0.0001 < 0.05$, the HI states that "there is a difference between the pretest and posttest of Circuit Training and Body Mass Index on aerobic capacity in productive women aged 20-45" is accepted. Circuit training using trekking poles in the overweight category was better in reducing arm circumference in women aged 20-45

Effect of Circuit Training and Body Mass Index on Abdominal Circumference of Women aged 20-45

The decrease in abdominal circumference in Trekking Poles for normal category obtained an average value of 80.4 pretest and 77.2 posttest has a decrease in value of -3.2 cm, Trekking Poles group for overweight category obtained an average pretest value of 97.6 and posttest 94.8 has an average decrease of -2.8 cm. Meanwhile, in group without Trekking for normal category, the pretest average value was 81.8 and the posttest 79 had a decrease in the average value of -2.8 cm, in the group without Trekking poles for overweight category, the pretest average value was 95.6. and

posttest 92.8 had an average decrease of -2.8 cm. The results of arm circumference for the experimental group can be seen in **Table 9** :

Table 9. Pretest and Posttest Result of Abdominal Circumference

Group	BMI Category	Mean ± SD Pretest	Mean ± SD Posttest
TP	Normal	80,4±4,72	77,2±5,35
	Overweight	97,6±17,1	92,8±9,09
NTP	Normal	95,6±9,12	92,8±9,09
	Overweight	95,8±3,83	92,6±4,50

Hypothesis 4 was tested using the Paired Sample T Test, and obtained a significance value of 0.0001. The significance value is 0.0001 < 0.05, the HI states that "there is a difference between the pretest and posttest of Circuit Training and Body Mass Index on abdominal circumference in productive women aged 20-45 years" is accepted. The Trekking Poles group with normal category had a better reduction in abdominal circumference in women aged 20-45.

Effect of Circuit Training and Body Mass Index on Thigh Circumference for Women aged 20-45

The decrease in thigh circumference of Trekking poles for normal category obtained an average pretest value of 45.4 and posttest 45 had a decrease in the average value of -0.4 cm, in the Trekking Poles for overweight category obtained an average value of 56.2 pretest and posttest 55.4 has a mean decline of -0.8 cm. Meanwhile, in the group of without Trekking Poles for normal category, the average pretest value was 43.6 and the posttest was 43.2, which had a decrease in the average value of -0.4 cm, in the group without Trekking Poles for overweight category, the pretest average value was 56. and posttest 55.4 had an average decrease of -0.6 cm. The results of thigh circumference for the experimental group can be seen in **Table 10** :

Table 10. Pretest and Posttest Result of Thigh Circumference

Group	BMI Category	Mean ± SD Pretest	Mean ± SD Posttest
TP	Normal	45,4±2,40	45±1,8
	Overweight	56,2±3,83	55,4±3,20
NTP	Normal	43,6±4,277	43,2±5,06
	Overweight	56±4	55,4±4,72

Hypothesis 5 used the Paired Sample T

Test, and obtained a significance value of 0.0001. The significance value of 0.012 < 0.05 means that HI states that "there is a difference between pretest and posttest of Circuit Training and Body Mass Index on thigh circumference in productive women aged 20-45 years" is accepted. The Poles Trekking group with the overweight category had a better reduction in thigh circumference in women aged 20-45.

Based on the result circuit training in the pretest and posttest using trekking poles and without trekking poles giving a significant effect for normal and overweight categories for a month. In accordance with the research to be carried out that there is an effect on aerobic capacity, body fat, and body circumference for women aged 20-45.

Measurement of aerobic capacity with the Multistage Fitness Test for Trekking Poles group with the normal category is better. A low body mass index has a good aerobic capacity in exercise and using tool will provide a load and effort in maximizing flexibility. Giving a load to the exercise with a given intensity will increase work faster and improve cardio performance to work optimally and the body will adapt faster according to the FITT (Frequency, Intensity, Type, and Time). This is supported by research by Bahtra, Fahrozi, & Putra (2020) which states that extensive circuit training exercises are effective in increasing VO2Max.

Physical improvement 3 to 4 times a week will affect the burning of body fat and the process of energy expenditure and energy intake that takes place while body is moving. Daily activities as measured by METs, calorie needs, macro intake from carbohydrates, protein, to fat, as well as the adaptation of the Rating of Perceived Exertion (RPE) in the Original Borg Scale at levels 12 to 14 with a moderate level category. Moderate level circuit training during 30 minutes and at rest sessions given the movement of walking with a stick or without a stick for 30 seconds will certainly help to burn fat and glucose as an important role of energy when the body does exercise regularly.

Measurements of arm, abdominal and thigh circumference have a relationship with BMI to determine risk factors for cardiovascular disease. This is supported by the statement of Avisia, Kuswari, Nuzrina, Gifari, & Melani : (2021) which states that aerobic exercise will reduce muscle mass in the energy restriction phase in adults with high visceral fat found in the abdomen and have the effect on abdominal circumference. Abdominal circumference that is within normal

limits is associated with body fat and the risk of obesity, which will affect the body physically and psychologically. The thigh circumference has decrease in the proportion of fat or hypertrophy in muscle mass. Increased muscle hypertrophy should be focused on increasing macronutrients such as protein and fat as well as other nutritional compositions. Proper protein intake will increase muscle hypertrophy, while to reduce the proportion of fat in the limbs it is necessary to exercise 3 to 4 times a week with an intensity of 70-80% or at an aerobic level.

Nutritional intake and physical activity is important aspects for body circumference. If people not paying attention about those aspects, its will getting bigger and affect the muscle's ability to not withstand the weight of the upper body. The role of the lower body such as thighs and muscles must be balanced with individual active movements in maintaining body mass index and body percentage stage, the muscle performance can protect with other body components. Weight training and aerobics will build the body's hormones to process at catabolic and anabolic levels to provide a balanced nutritional intake.

CONCLUSION

Based on the analysis results, it was obtained that there were differences between pretest and posttest on the effect of circuit training on aerobic capacity, body fat, and body circumference. The posttest result are more better rather than pretest result. Suggestions for women who both working and not working can joining the activities are carried out regularly, improving physical fitness and socialization activities, and also physical activity have benefit to be more positive impact on mental and physical health.

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