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Effect of skipping on body mass index, waist to hip ratio and muscle strength in overweight adolescent girls

Pengaruh skiping terhadap IMT/U, RLPP dan kekuatan otot pada remaja putri overweight

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Abstract

Overweight problems in adolescents tend to increase, with obese nutritional status prevalence for Indonesian teenagers in group aged–13-15 and 16-18 years respectively 11,2% and 9,5%. This study aimed to analyze the effect of skip training on body mass index for age z-score (BAZ), waist-to-hip ratio (WHR), and muscle strength in overweight adolescent girls. The method of this research was a quasi-experimental design using a subject study of 28 female students, who were divided into two groups: those age between 15-18 years old. This study was conducted at Senior High School 1 West Sumatra and Batipuh from October to December 2023. The skipping group received 4-8 minutes of exercise 3 times per week for 8 weeks of intervention. The statistical analysis employed a paired t-test and simple linear regression test. The results of this study revealed that the skipping intervention had a significant effect on the reduction of BAZ ($p<0,05$; $R2=0,286$) and WHR ($p<0,05$; $R2=0,174$) in the skipping group compared to the control group. There was no significant difference in the muscle strength between the skipping and control groups ($p>0,05$; $R2=0,049$). In conclusion, skipping for a duration–4-8 minutes was conducted three times a week for 8 weeks, which reduced the value of BAZ and WHR in adolescent girls.

Keywords: skipping, body mass index, muscle strength, overweight

Abstrak

Masalah kegemukan pada remaja cenderung mengalami peningkatan. Prevalensi status gizi gemuk pada remaja Indonesia usia 13-15 tahun dan usia 16-18 tahun berturut-turut 11,2% dan 9,5%. Penelitian bertujuan untuk menganalisis pengaruh latihan skiping terhadap Indeks Massa Tubuh menurut umur (IMT/U), Rasio Lingkar Pinggang Pinggul (RLPP) dan kekuatan otot pada remaja putri *overweight*. Metode penelitian menggunakan *quasi experimental design* dengan subjek 28 siswi *overweight* yang terdiri kelompok skiping 14 siswi dan kelompok kontrol 14 siswi usia 15-18 tahun dan bersedia mengikuti penelitian. Penelitian telah dilaksanakan di SMA 1 Sumatera Barat dan SMA 1 Batipuh pada Bulan Oktober-Desember 2023. Kelompok skiping melakukan latihan selama 4-8 menit sebanyak tiga kali per minggu selama delapan minggu intervensi. Analisis stasistik menggunakan uji *paired t-test* dan uji simpel regresi linier. Hasil, bahwa intervensi skiping berpengaruh signifikan terhadap penurunan z-*score* IMT/U ($p<0,05$; $R^2=0,286$) dan penurunan RLPP ($p<0,05$; $R^2=0,174$) dibandingkan kelompok kontrol. Tidak terdapat perbedaan pada kelompok skiping dibandingkan kontrol pada kekuatan otot ($p>0,05$; $R^2=0,049$). Kesimpulannya, skiping selama 4-8 menit sebanyak tiga kali seminggu selama delapan minggu menurunkan IMT/U dan RLPP remaja putri.

Kata Kunci: skiping, indeks massa tubuh, kekuatan otot, *overweight*

Introduction

Overweight cases are showing a higher rate worldwide, and Indonesia has become one of the countries that showed an increase in the prevalence of overweight and obesity in all age groups (Rachmi et al., 2017). The overweight prevalence in the age group of 5 – 19 years increased by 4 % in 1975 to 18 % in 2016 (World Health Organization, 2021). The prevalence of overweight increased in the 13-15 year age group and the 16-18 year age group from 2013 to 2018. Data from Nasional Basic Health Research 2013 showed that the overweight incidence among the age group of 13-15 years was 8,3 % and the age group of 16-18 years was 5,7 %. Meanwhile, in 2018, the prevalence of overweight among Indonesian adolescents within age group of 13-15 years of age was 11,2% and 16-18 years of age was 9,5 % based on a comparison of BMI-for-age (Kemenkes RI, 2018). In West Sumatra Province, the prevalence of overweight adolescents within the age group of 16-18 years old was 7,8 % (Riskesdas Sumatra Barat, 2018).

The incidence of overweight is increasing; therefore, efforts are required to address this problem. Weight loss efforts can be achieved through several ways such as physical exercise, diet, and psychological therapy. Physical exercise (sports) is a safe effort to reduce weight because it has a positive impact with a relatively low risk of health problems. Overweight children tend to be reluctant to move (lazy), and doing less physical activity results in the development of their physical fitness (Priyo & Priyanto, 2020). Low physical activity below the WHO recommendation for adolescents increased from 70% in 2018 to 81% in 2020 (World Health Organization, 2020). According to 2018 Nasional Basic Health Research data, the number of individuals aged ≥ 10 years who were less active in West Sumatra Province reached 39,4 %, while that in Padang Panjang City was 51,92 % (Riskesdas Sumatra Barat, 2018). Regular physical activity can burn fat and maintain a desired weight and body fat percentage to attain a slim and healthy figure. Therefore, a simple and applicable type of exercise should be performed anywhere so that it is expected to be performed regularly.

In relation to this, the results of the 2021 ASEAN Survey on Sports Participation research showed that one type of sport that ASEAN citizens are interested in is home-based exercise. It has become the preferred sports activity for adolescents and women (ASEAN Secretariat, 2021). One type of home-based exercise involves skipping. Skipping has the advantage of requiring only limited space, simple equipment, and moderate cost; therefore, it has great potential to promote physical exercise compliance in obese adolescents (Moghadam et al., 2021). Previous literature stated that there was a change in BMI after eight weeks of skipping intervention (Mullur & Jyoti, 2019). Other studies have reported that skipping training can improve WHR in adolescents with obesity (Eskandari et al., 2020). In addition, previous research has shown that three minutes of skipping training for nine weeks can improve adolescents' physical fitness, body fitness, blood circulation in the heart, flexibility, balance, muscle strength, coordination, speed, vertical jump, and rhythm (Frimpong et al., 2022). However, the weakness of the previous study was that skipping activity was carried out for the same duration every week (3 min) and without a control group for comparison. Therefore, this study aimed to optimize the duration of the intervention for 8 weeks with a schedule of 3 times per week with increased skipping duration for 4-8 minutes and by including a control group for comparison.

Body fat distribution is an important risk factor of obesity. Nutrition measurement by abdominal obesity measured by waist circumference and waist-hip ratio has a strong relationship with metabolic risk factors and cardiovascular disease (Wahyuni & Murbawani, 2016). Muscle strength is one of the body's fitness components that are important for health. The limb muscle strength is one of the muscle strengths that can provide the highest validity in assessing muscle strength throughout the body (Domitilla & Yani, 2020). Muscle fatigue when performing physical activity, especially exercise, causes a decrease in physical quality and quantity that leads to a decrease in accuracy and thoroughness in performing physical activities (Sjahriani & Ponanda, 2017).

To date, the type of suitable intervention for dealing with the increase in overweight incidence in adolescents is still being researched, and it is expected that skipping interventions as the focus of this study can be an effort to increase physical activity and reliably

be used as a reference to develop effective intervention strategies to overcome the problem of overweight. Therefore, this study aimed to analyze the effect of skipping training on BMI, WHR, and muscle strength in overweight adolescent girls.

Methods

This study employed a quasi-experimental design as the research design and involved two groups of studies: a skipping group and a control group. This quasi-experimental method was chosen based on the difficulty of controlling other variables, so that control of variables related to the research subject could not be carried out completely. The research subjects were students from two public senior high schools, Senior High School 1 West Sumatra and Senior High School 1 Batipuh, aged 15 to 18 years. This study was approved by the Ethics Commission of Airlangga University (approval number: 1123/HRECC). FODM/IX/2023. Before conducting the research, informed consent was given to the research subjects and an explanation was given regarding the confidentiality of participant data

Selection for the subject study was carried out using BMI-for-age screening. The screening participants were students who had a z-score >+1 SD or had an overweight nutritional status, met the inclusion and exclusion criteria, and were willing to take part in each stage of the research by signing an informed consent form. The sampling technique used purposive sampling with a minimum sample size determined by the equation from Lemeshow et al. (1997) as follows:

$$n = \frac{2\sigma^2\left(Z_{1-\alpha/2} + Z_{1-\beta}\right)^2}{(\mu_1 - \mu_2)^2}$$

n : Sample Size
σ : Deviation Standard (0,6) based on the BMI (Branco et al. 2018)
$Z_{1-\alpha}$: Confidence Level
$Z_{1-\beta}$: Strength of Study Testing
μ_1-μ_2 : Estimation of BMI value increase due to treatment (0,8) (Branco et al. 2018)

Based on the calculation result of the minimum sample size, 12 students were obtained as the minimum number of subjects with an anticipated dropout value of 10 %, so the number of respondents for this study was 14 students, with a total of 28 students since this study consisted of two groups: a skipping group and a control group. The inclusion criteria for this study were: 15-18 years old, had a z-score >+1 SD, did not experience complaints of pain, did not undergo a specific diet program, did not have a history of injury to the feet, and were willing to be a research subject. Exclusion criteria were metabolic diseases, taking drugs or weight loss supplements, undergoing other diets, and having injuries. The diagram for subject selection is shown in Figure 2.

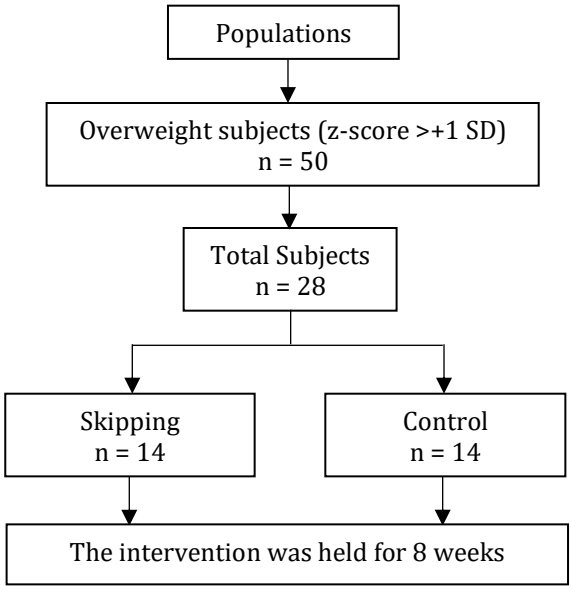

Figure 1. Subject grouping diagram

The intervention was held for eight weeks with a skipping frequency of three non-consecutive days carried out in one room by following the tutorial video. The tutorial video contained skipping movements, accompanied by the duration for which they were performed. During the exercise program, researchers monitor the research location directly so that compliance with the exercise program can be controlled. The exercise was performed for 3 days per week, with the exercise duration gradually increasing from 4 to 8 minutes every week refers to research (Camacho-Cardenosa et al., 2016). This strategy was chosen to increase the number of calories used at each exercise time until the end of the intervention. The first week of training was designated as the initial training period to prepare the body by

performing basic movements. For the second to the eighth weeks, the treatment group carried out skipping while the control group was not given any treatment but still had measurement of their Body Mass Index (BMI), Waist-Hip Ratio (WHR) and muscle strength which measured from the beginning to the end of the intervention. The skipping training consisted of high-intensity exercise for 20 s interspersed by active rest for 10 s with eight repetitions. Each training session began with a warm-up cardio and ended with a quick cooldown stretch. The control group did not receive treatment during the intervention period. The participants' physical activity was controlled by recalling the physical activity of the treatment group.

The data collected for this study were: (1) subject characteristics data, (2) daily physical activity data for 1 × 24 hours, (3) subject's BMI data including body weight (kg) and height (cm), (4) Hip Circumference Ratio (WHR) data including waist circumference (WC) and hip circumference, and (5) muscle strength data including the limb muscle strength obtained by the vertical jump method.

Subject characteristic data were collected through interviews by filling out questionnaires and direct measurements. The characteristic data included the age and the daily physical activity of the participants by filling out a questionnaire, while the direct measurement carried out on subjects included measurement of body weight using digital scales and height using a stature meter to calculate BMI-for-age with a cut-off z-score value, measurement of waist circumference and hip circumference to calculate the waist-to-hip ratio (WHR) using a measuring tape in centimeters, and measurement of the muscle strength by calculating the vertical jump value using the board used for jumping to obtain a vertical jump value.

Data processing in this study was conducted using Microsoft Excel 2019, while the differential test for subject characteristics (including data on age, height, weight, BMI-for-age, waist circumference, hip circumference, WHR muscle strength, physical activity data, and food intake) was measured using the Independent T-test for normally distributed data and the Mann-Whitney test for data not normally distributed. Normality tests were performed before statistical analysis to ensure that the data could be subjected to parametric or non-parametric statistical tests. Differences in the form of changes in result measurements (BMI, WHR, and muscle strength) before and after intervention among groups were analyzed by employing the paired sample t-test method to determine the average difference between two paired samples, while the effect of skipping on BMI, WHR, and muscle strength was tested using a simple linear regression test to determine the influence of the independent variable on the dependent variable. Data analysis was performed using the Statistical Package for the Social Sciences (SPSS) software version 26.0.

Result and Discussion

Data on the subjects' characteristics included age, height, body weight, body mass index (BMI), Waist Circumference (WC), hip circumference, waist-to-hip ratio (WHR), physical activity level, energy intake, protein intake, fat intake, energy intake level, protein intake level, and fat intake level (Table 1). The subjects of this study were female students of Senior High School 1 West Sumatra as the treatment group and female students of Senior High School 1 Batipuh as the control group. Total subject study were 28 female students with 15-18 years of age were divided into two groups: the skipping treatment group and the control group. Table 1 displays the mean age, height, body weight, body mass index (BMI), Waist Circumference (WC), hip circumference, and waist-to-hip ratio (WHR) before the intervention.

Data of subject characteristics started with adolescent age (15-18 years old) by average age from skipping group and control group stated as 16,46 ± 0,52 years and 15,80 ± 0,34 years. All subjects had a z-score (BMI-for-age) of >+1 SD. The average z-score value (BMI-for-age) for the skipping treatment group was 1,42 ± 0,64 SD while the average z-score value (BMI-for-age) for the control group was 1,35 ± 0,49 where according to the Indonesian Ministry of Health, BMI for both groups is included in the overweight category (Kemenkes RI, 2020). The average waist circumference (WC) of subjects in the skipping group was 84,21 ± 8,36 cm whereas that of the control group was 82,50 ± 7,30 cm. The subjects in both groups had an average waist circumference that was included into central obesity category because the measurement of waist circumference >80 cm

(Krisnanta Adnyana et al., 2021). The average value of WHR measurement for the skipping group was 0,79 ± 0,03 and 0,80 ± 0,04 for the control group. The WHR values for both groups were within the normal limit of WHR values in women under 0,85 (WHO, 2008).

The average value of physical activity from skipping group and control group expressed in number of 1,44 ± 0,05 and 1,42 ± 0,06, whereas the level of physical activity done by a subject within 24 hours is expressed in PAL (Physical Activity Level). Table 1 describes the average value of each group activity included in the mild category (1,40-1,69) (FAO/WHO/UNU, 2001). The energy intake of skipping group has average value of 1552,33 ± 416,56 kcal while the control group has average value of 1674,55 ± 510,87 kcal. The protein intake of skipping group has average value of 58,67 ± 17,15 g while the control group has average value of 61,84 ± 19,43 g. The fat intake of the skipping group had an average value of 57,52 ± 18,71 g while the control group had an average value of 57,66 ± 20,70 g. The energy adequacy level of skipping group has average value of 73,92 ± 19,83% while the control group has average value of 79,74 ± 24,32%. The average protein adequacy level of the skipping group has average of 97,79 ± 28,58% while that of the control group has average value of 103,06 ± 32,39%. The average fat sufficiency level of the skipping group has average value of 82,18 ± 26,73% while that of the control group has average value of 82,38 ± 29,57%. Subjects in the skipping group were categorized as having a moderate energy deficit, whereas those in the control group were categorized as having a mild energy deficit. The protein adequacy level in skipping and control groups was in the normal category, similar to the fat sufficiency level for both groups was in the more category. The categories of energy and protein adequacy levels were divided into five categories: (a) severe deficit (<70%), (b) moderate deficit (70-79%), (c) mild deficit (80-89%), (d) normal (90-119%), and (e) more (≥120%), whereas the category of fat sufficiency level was divided into (a) less (<20%), (b) normal (20-30%), and (c) more (>30 %) (Departemen Kesehatan Republik Indonesia, 2003).

The results of the differential test of respondent characteristics showed no significant differences (p>0,05) in height, weight, BMI for age, waist circumference, hip circumference, WHR, physical activity level, energy intake, protein intake, fat intake, energy intake level, protein intake level, or fat intake level.

Table 1. Subject characteristics

Subject Characteristics	Skipping (n=14)	Control (n=14)	p-value
	Mean ± SD	Mean ± SD	
Age (years)	16,46 ± 0,52	15,80 ± 0,34	0,001
Height (cm)	156,64 ± 7,94	157,15 ± 6,00	0,848
Weight (kg)	69,71 ± 13,79	70,26 ± 7,59	0,896
BMI-for-age	1,42 ± 0,64	1,35 ± 0,49	0,891
Waist circumference (cm)	84,21 ± 8,36	82,50 ± 7,30	0,568
Hip circumference (cm)	106,57 ± 10,10	103,36 ± 7,15	0,340
Waist to Hip Ratio	0,79 ± 0,03	0,80 ± 0,04	0,588
Physical activity level	1,44 ± 0,05	1,42 ± 0,06	0,241
Energy intake (kcal)	1552,33 ± 416,56	1674,55 ± 510,87	0,613
Protein intake (g)	58,67 ± 17,15	61,84 ± 19,43	0,713
Fat intake (g)	57,52 ± 18,71	57,66 ± 20,70	0,985
Energy intake level (%)	73,92 ± 19,83	79,74 ± 24,32	0,613
Protein intake level (%)	97,79 ± 28,58	103,06 ± 32,39	0,713
Fat intake level (%)	82,18 ± 26,73	82,38 ± 29,57	0,985

SD = Standard Deviation

Table 2 describes the average changes in the subjects' body weight (BW), BMI, waist circumference, WHR, and muscle strength before and after the intervention in both groups. There was a decrease in body weight for both groups where the body weight in the skipping treatment group decreased from 69,70 ± 13,79 kg to 67,50 ± 13,55 kg (ΔBB = -2,20 kg) whereas in the control group also decreased from 70,26 ± 7,59 kg to 69,97 ± 7,86 kg (ΔBB=-0,28 kg). Moreover, the

results of the differential test showed that exercise intervention had a significant effect on weight loss (p<0,05).

The results of this study are supported by previous research stating that there was a significant effect on body loss (p<0,05) after receiving a skipping intervention in overweight and obese teenagers (Zakavi et al., 2015). In line with this finding, previous research has reported that different exercise models have the same impact on weight loss(D'Amuri et al., 2021).

BMI changes occurred in the skipping treatment group. BMI was calculated using the BMI-for-age z-score index for adolescent subjects. BMI-for-age in the skipping treatment group decreased from 1,42 ± 0,64 to 0,78 ± 0,57 (Δ BMI-for-age = -0,64). The results of the differential test showed a significant difference between intervention and BMI-for-age (p<0,05). This result is also supported by previous research that stated that there was a significant difference in BMI after eight weeks of skipping intervention (Mullur & Jyoti, 2019). Furthermore, the results of this stu dy showed that skipping exercise was effective in increasing body mass index. In this study, the number of respondents who had an overweight nutritional status decreased after receiving treatment with skipping intervention.

Excessive abdominal fat is associated with an increased risk of cardiometabolic disease, and waist circumference is often used to determine the size of abdominal fat mass. Waist circumference can provide a simple measurement of central obesity (Yunieswati & Briawan, 2014). For women, waist circumference is categorized as normal when it stated <80 cm and it will be categorized as abdominal obesity when it reaches ≥80 cm.

Table 2. Difference test before and after intervention

Variables	Skipping	Control	p-*value*
Weight			
Before	69,70 ± 13,79	70,26 ± 7,59	
After	67,50 ± 13,55	69,97 ± 7,86	0,000*
Changes weight	-2,20 ± 0,83[a]	-0,28 ± 0,68[b]	
p-value	0,000*	0,143	
BMI-for-age			
Before	1,42 ± 0,64	1,35 ± 0,49	
After	0,78 ± 0,57	1,35 ± 0,49	0,004*
Changes BMI-for-age	-0,64 ± 0,63[a]	0,00 ± 0,39[b]	
p-value	0,007*	1,000	
Waist circumferences			
Before	84,21 ± 8,35	82,50 ± 7,30	
After	77,00 ± 9,19	83,50 ± 6,88	0,000*
Changes WC	-7,21 ± 3,57[a]	1,00 ± 2,80[b]	
p-value	0,000*	0,205	
WHR			
Before	0,79 ± 0,25	0,79 ± 0,03	
After	0,76 ± 0,33	0,80 ± 0,03	0,027*
Changes WHR	-0,02 ± 0,03	0,01 ± 0,03	
p-value	0,020*	0,473	
Muscle strength			
Before	24,50 ± 4,20	28,85 ± 4,18	
After	26,00 ± 4,72	29,21 ± 4,96	0,259
Changes VJ	1,50 ± 3,10	0,35 ± 2,02	
p-value	0,094	0,520	

BMI-for-age= Body Mass Index by Age, WHR= Waist to Hip Ratio, VJ=Vertical Jump

A smaller waist circumference was observed in the skipping-treatment group. Waist circumference in the skipping treatment group decreased from 84,21 ± 8,35 cm to 77,00 ± 9,19 cm (ΔWC= -7,21 cm). After the intervention, the average waist circumference of the subjects in the skipping group was categorized as normal (<80 cm), while in the control group, it was still in the abdominal obesity category (≥80 cm). The results of the differential test showed a significant

difference in waist circumference (p<0,05) after the intervention. The results of this study are consistent with other research on skipping intervention programs for obese adolescents that reported a significant effect in the form of changes in waist circumference after receiving the intervention (p<0,05) (Kim et al., 2020).

The waist-hip circumference ratio (WHR) describes the proportion of fat within the waist-to-hip area. For women, WHR is categorized as normal when the number is < 0,85 cm and has a risk when the number is ≥0,85 (≥0,85) (WHO, 2008). In the skipping treatment group, there was a decrease in form of decreasing size. The size of WHR in skipping treatment group decreased from 0,79 ± 0,25 to 0,76 ± 0,33 (ΔWHR= -0,02). The average RLPP values in the skipped and control groups were categorized as normal (<0,85 cm). The differential test results showed a significant difference between the intervention and WHR groups (p<0,05). Result of this research is supported by previous research that reported there was a significant influence (p<0,05) on WHR of obese adolescents after given skipping training (Mozhgan Eskandari et al., 2020).

The combination of BMI and WHR is beneficial for assessing health risk. A high BMI with a low WHR indicates that BMI measurements are overestimated (Stefani, 2015). In this study, the BMI measurement of the research subjects was in the overweight category; however, the WHR was still classified as normal. It is assumed that excess fat in the body tends to be distributed in the lower part of the body (pear shape); therefore, excess fat in women will be stored as subcutaneous fat, while excess fat in men will be stored as visceral fat (Nurohmi et al., 2021). Therefore, it is important to assess overweight/obesity in women by considering the fat stores in the lower body.

Muscle strength is a component of body fitness that is important for health. The strength of the back and limb muscles can provide the highest validity for assessing whole-body muscle strength (Domitilla & Yani, 2020). One method for measuring the muscle strength of the body is to perform a vertical jump. In this study, limb muscle strength was measured using the vertical jump value.

Changes in the vertical jump increased in the skipping and control groups. Vertical jump in the skipping treatment group increased from 24,50 ± 4,20 cm to 26,00 ± 4,72 (ΔVJ = 1,50). The results of the differential test showed no significant differences between the interventions on muscle strength (p>0,05).

These results are in line with a previous study that reported no significant effect (p>0,05) of skipping training on limb muscle strength (Da'i, 2022). The mean vertical jump in the skipping treatment group increased, although the difference was not significant. This increase occurs because skipping is a form of physical exercise that uses jumping movement. From a physiological perspective, there are various kinds of muscles in the limbs that are used when jumping. The similarity of muscles used during exercise increases muscle strength (Marpaung & Sari, 2022). An increase in muscle strength is caused by the adaptation of the body to the skipping exercise (Domitilla & Yani, 2020).

Other studies also supported this finding by stating that jump rope training or skipping training for five weeks, three times a week according to the frequency and intensity given, will be able to increase muscle strength capacity to the maximum level (Domitilla & Yani, 2020). Physical exercise using special techniques that utilize fat as an energy source is an ideal method for weight loss (Arief et al., 2021). Physical activity that makes the body use reserved energy, such as fat, can reduce weight and prevent obesity (Arief et al., 2021). Regular physical activity had a positive effect on body weight, waist circumference, and muscle strength. Physical activity is important for individuals to avoid many diseases such as hypokinetics, lack of movement, and obesity. It can promote a healthier and fitter body, so that the individual becomes more productive.

Table 3. The effect of skipping on variables

Outcome	Equation	p-value	R^2
Weight	Decrease weight = -4,129+1,921(skipping)	0,000	0,692
BMI-for-age	Decrease BMI = -1,286+0,643(skipping)	0,003	0,286
WC	Decrease WC = -15,429+8,214(skipping)	0,000	0,638
WHR	Decrease WHR = -0,056+0,031(skipping)	0,027	0,174
Muscle strength (VJ)	Increase VJ = 2,643-1,143(skipping)	0,259	0,049

BMI-for-age= Body Mass Index by Age, WHR= Waist to Hip Ratio, VJ=Vertical Jump

Table 3 describes the effect of the skipping intervention on changes in body weight, BMI for age, waist circumference, WHR, and muscle strength. The results were obtained using a simple linear regression test that produced several equations.

Result of the simple linear regression for weight loss revealed that skipping intervention explains only 69,2 % of the effect from the treatment of weight loss in overweight female adolescents, while the rest of percentage (30,8%) came from other factors that were not observed in this study. Nutritional education is another factor influencing weight loss (Assidhiq et al., 2018). Other studies have reported that peer group activity is another influential factor in weight loss. The existence of a peer group helps motivate someone to put effort into weight loss based on shared feelings that affect the eating habits of female adolescents (Jaelani et al., 2018). There was a significant relationship ($p<0,05$) between the change in body weight of overweight adolescents after skipping the intervention. This explains why skipping intervention had a significant influence on reducing body weight in overweight adolescents.

The results of simple linear regression of BMI-for-age decrease number showed that skipping intervention only explains 28,6 % effect of the treatment on reducing the BMI-for-age for overweight female adolescents, while the rest of percentage (71,4%) of BMI-for-age decrease came from other factors that were not observed in this study. Other factors that influence female adolescents' BMI-for-age are fast food consumption habits; watching TV; total consumption of energy, carbohydrates, protein, and fat; and nutritional knowledge (Oktaviani et al., 2012). Other research has also stated that physical activity is another influential factor in adolescents' BMI-for-age (Krismawati et al., 2018). There was a significant relationship ($p<0,05$) with changes in the BMI-for-age of overweight adolescents after receiving the skipping intervention. This explains why skipping intervention treatment had a significant influence on reducing the BMI-for-age of overweight adolescents.

The results of simple linear regression to the smaller waist circumference showed that skipping intervention only explains 63,8% of the effect of the treatment on reducing the size of waist circumference in overweight female adolescents, while the rest (36,2%) came from other factors that were not observed in this study. Another factor that influences changes in waist circumference of overweight female adolescents is the eating pattern of sweet snacks, salty snacks, and sweet drinks (Fayasari et al., 2018). Another study also stated that other factors that influence changes in waist circumference are the level of nutritional knowledge and eating patterns (Sineke et al., 2019; Yani et al., 2023). There was a significant relationship ($p<0,05$) with changes in waist circumference of overweight female adolescents after receiving skipping intervention, which was interpreted as the skipping intervention treatment having a significant influence on reducing the waist circumference of overweight female adolescents.

The result of simple linear regression of the decrease number in WHR showed the skipping intervention only explains 17,4 % of the effect of the treatment on reducing the size of WHR in overweight female adolescents, while the rest of percentage (82,6%) of the decrease number in WHR came from other factors which not observed in this study. Another factor that can influence changes in WHR is the consumption of sweet snacks, food portion in a plate, and sweet drinks (Fayasari et al., 2018). Other studies have also reported that other factors influencing changes in WHR include high energy intake, fat, carbohydrates, and physical activity (Wulandari, 2017). There was a significant relationship ($p<0,05$) with changes in WHR of overweight female adolescents after receiving skipping intervention, which was interpreted as the skipping intervention treatment having a significant influence on reducing the WHR of overweight adolescents.

The results of simple linear regression of the increase in muscle strength showed that skipping intervention only to explain 4,9 % of the effect of the treatment on increasing muscle strength in overweight female adolescents, while the remaining percentage (95,1 %) of the muscle strength increase came from other factors that were not observed in this study. Other factors that can influence the increase in muscle strength are nutritious food, adequate sleep and rest, physical exercise, and regular exercise, including type of circuit training such as sit-ups, push-ups, backups, and squad trasses (Aisyah, 2015). There was no significant relationship ($p>0,05$) found in changes in muscle strength in overweight female

adolescents after receiving skipping intervention, which was interpreted as the skipping intervention treatment, did not have a significant effect on the increase in muscle strength in overweight female adolescents.

The limitation of this study is that it merely focused on providing physical activity without giving control to other factors such as the subject's eating pattern during the intervention period; thus, several variables did not have a significant influence on the intervention provided. In addition, no nutritional education was provided in this study, so the participants' understanding of weight control and obesity prevention was unknown.

Conclusion

The indigenous mothers of the Kaluppini and This research demonstrated that skipping treatment has a significant influence on changes in body weight, BMI, waist circumference, and WHR. Skipping exercise three times per week can be used as an alternative method to lose weight and help prevent obesity.

Skipping is recommended for individuals who plan to lose weight and improve their waist circumference. Future research should extend the duration of the intervention to 12 weeks to observe long-term effects, and include a larger sample size to increase the statistical power and generalizability of the results.

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