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Effect of Resistance Training with Gym Machines On Muscle Strength and Body Mass Index in Obese Women Student College

Efecto del entrenamiento de resistencia con máquinas de gimnasio sobre la fuerza muscular y el índice de masa corporal en estudiantes universitarias obesas

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Abstract. Several countries have high obesity rates. Obesity poses serious health risks that require effective treatment. Too much fat reduces muscle strength, affecting obesity. Resistance training can overcome weight gain and muscle loss. Resistance training with gym machines for obese women is understudied. The effects of gym machine resistance training on muscle strength and BMI can help physical trainers design appropriate exercise programs. This study examines how gym-machine resistance training affects muscle strength and BMI in obese women. One pre- and post-test group included 30 obese 17-25-year-old women. Resistance training uses gym machines to target major muscle groups and lose fat. Prisoners are trained three times a week for ten weeks under supervision. Resistance exercises include lati pulldown, abdominal crunch, cable curl, chest press, and leg press. The one-repetition maximum (1RM) test measures muscle strength, while height and weight calculate BMI. Paired difference test (paired sample t-test) effect was then tested. Ten weeks of resistance training led to significant muscle strength gains across all measures ($p < 0.05$). Moreover, the resistance training group demonstrated a significant BMI reduction ($p < 0.05$). These findings suggest that gym-machine resistance training can help obese women lose weight and gain muscle. Resistance training on gym machines can help obese women lose weight and build muscle. This study suggests systematic resistance training can improve muscle fitness and weight control in this population. Long-term health and well-being effects of these therapies can be examined.
Keywords: Resistance Training, Obesity, Women, Muscle Strength, BMI

Resumen. Varios países tienen altas tasas de obesidad. La obesidad plantea graves riesgos para la salud que requieren un tratamiento eficaz. Demasiada grasa reduce la fuerza muscular, lo que afecta la obesidad. El entrenamiento de resistencia puede superar el aumento de peso y la pérdida de masa muscular. El entrenamiento de resistencia con máquinas de gimnasio para mujeres obesas está poco estudiado. Los efectos del entrenamiento de resistencia con máquinas de gimnasio sobre la fuerza muscular y el IMC pueden ayudar a los preparadores físicos a diseñar programas de ejercicio adecuados. Este estudio examina cómo el entrenamiento de resistencia con máquinas de gimnasio afecta la fuerza muscular y el IMC en mujeres obesas. Un grupo de prueba previa y posterior incluyó a 30 mujeres obesas de entre 17 y 25 años. El entrenamiento de resistencia utiliza máquinas de gimnasio para apuntar a los principales grupos de músculos y perder grasa. Los reclusos reciben formación tres veces por semana durante diez semanas bajo supervisión. Los ejercicios de resistencia incluyen jalones de dorsales, abdominales, curl con cable, press de pecho y press de piernas. La prueba de una repetición máxima (1RM) mide la fuerza muscular, mientras que la altura y el peso calculan el IMC. Luego se probó el efecto de la prueba de diferencias pareadas (prueba t de muestras pareadas). Diez semanas de entrenamiento de resistencia condujeron a ganancias significativas de fuerza muscular en todas las medidas ($p <0,05$). Además, el grupo de entrenamiento de resistencia demostró una reducción significativa del IMC ($p <0,05$). Estos hallazgos sugieren que el entrenamiento de resistencia con máquinas de gimnasio puede ayudar a las mujeres obesas a perder peso y ganar músculo. El entrenamiento de resistencia en máquinas de gimnasio puede ayudar a las mujeres obesas a perder peso y desarrollar músculo. Este estudio sugiere que el entrenamiento de resistencia sistemático puede mejorar la aptitud muscular y el control del peso en esta población. Se pueden examinar los efectos a largo plazo de estas terapias sobre la salud y el bienestar.
Palabras clave: Entrenamiento de resistencia, Obesidad, Mujeres, Fuerza muscular, IMC

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Introduction

Body Mass Index is a measurement used to determine a person's weight status by comparing their body weight and height (Nuttall, 2015). Body mass index (BMI) is one of the factors related to physical activity. Body mass index (BMI) is a simple way to monitor an adult's nutritional status, especially about being underweight or overweight (obesity) (Gite et al., 2021).

According to WHO, body mass index (BMI) can be classified into five categories, including underweight with a BMI score below 18.5. Normal body mass index is between 18.5 and 22.9. Overweight with a BMI score of 23-24.9. Obesity I with a BMI of 25–29.9 and obesity II with a BMI greater than 30 (Wahyuti et al., 2022). However, for Indonesia, there are differences in BMI categories (Zulaekah & Oktaria, 2020). The thin category has a BMI score below 18.5, a normal BMI between 18.5 and 25, and fat (obesity) with a score above 25 (Syamsuryadin et al., 2022).

Obesity is a disorder that affects a person's health and has become a global problem in recent decades (Bray et al., 2017). Obesity among students is a problem in several countries, including Indonesia (Miko & Pratiwi, 2017). The increasing prevalence of student obesity is associated with several causes, including unhealthy lifestyles, eating patterns and lack of physical activity (Pibriyanti, 2018). Apart from that, there is a problem that many students face, namely academic stress. Students often face academic pressure, which causes high levels of stress (Kountul et al., 2018). Eating behaviour can change due to stress, such as switching to foods that contain lots of sugar or fat for entertainment (Richardson et al., 2015). A high percentage of fat

can reduce muscle strength due to differences in the level of physical activity of people with different body fat percentage categories (Savitri et al., 2020). Muscle weakness will certainly hinder the ability to carry out functional activities, especially for adolescents with various activities, not only functional abilities. Muscle strength also predicts various conditions(Rahman et al., 2022; Rahman & Anugerah, 2022). Weak grip muscle strength is considered to represent muscle strength throughout the body and is strongly related to the risk of metabolic syndrome (Febrianta et al., 2023). This means that one of the causes of metabolic syndrome disorders is obesity (Kurniawati et al., 2022).

Resistance training is very important in a weight loss program. Resistance training usually uses fitness equipment (gym machines) or free weights. Resistance training improves overall health, increases metabolism, burns calories, and builds and maintains muscle mass (Ribeiro et al., 2022). It is very important to do Resistance training at least two or three times a week (Fariz & Dewangga, 2020). Training must be intensified gradually to increase muscle strength by increasing the load or number of repetitions (Dewangga & Irianto, 2023).

Previous studies found that obese people can do resistance training twice or thrice a week to lose weight (Fernandez-del-Valle et al., 2018). Based on the explanation above, researchers are interested in determining the effect of resistance training on obese students by measuring body mass index and muscle strength in obese students.

Method

The type of research used is quantitative research. The type of experimental research is Pre-Experimental with a one-group pretest-posttest design.

The author took the research object to the Faculty of Health Sciences, Muhammadiyah University of Surakarta, located in Kartasura District, Sukoharjo Regency, Central Java. Then, the resistance training was carried out at the Fitness Center, Faculty of Sports, Sebelas Maret University. This research was conducted from May to August 2023.

An incidental sampling technique was used for this research. Incidental sampling is a method of determining samples based on chance, meaning anyone who coincidentally or accidentally meets the researcher can be used as a sample (Imron, 2019). The sample obtained consisted of 30 people with a BMI above 25.

The research ethics committee of the Faculty of Medicine Universitas Islam Sultan Agung, Semarang, Jawa Tengah has given approval to this study No. 219/VII/2023/Bioethic Committee. Prior to conducting the research, the respondents had agreed and signed their consent to become research respondents after reading of the experimental methods.

This study's resistance training movements included biceps curls, chest presses, leg presses, lat pull downs and abdominal crunches. Respondents were given resistance training with a frequency of 3 times a week. The resistance training dose is obtained after getting a muscle strength measurement score of 1 RM. This study uses 40-60% of 1 RM. The use of load intensity increases gradually. In the first to third weeks, 40% of 1 RM is given. Weeks four to six increased to 50% of 1 RM. The seventh to tenth week is increased to 60% of 1 RM. Resistance training is given 15-20 repetitions and 3-5 sets with rest time after completing 1 set for 2 minutes (Lee et al., 2022).

BMI examination was carried out by measuring the height and weight of research respondents. Then, after the height and weight data is obtained, it is calculated using a formula. BMI = Body Weight (kg): [Height (m) x Body Height (m)] (Lim et al., 2017).

Table 1.
Body Mass Index Category (Nuttall, 2015)

Category	Body Mass Index Score
Underweight	< 18.5
Normal	18.5-25
Overweight	25-30
Obesity	>30

The measurement of hand grip strength (HGS) was conducted utilizing the Hand Grip Dynamometer Camry EH101 (Díaz Muñoz & Calvera Millán, 2019). The examination is conducted while the individual is seated. The elbows are flexed at a 90-degree angle, while the shoulders are abducted (Huang et al., 2022). The hand grip dynamometer for each individual was adjusted to the second grip position. The participants were provided with instructions to exert pressure on the grip for a duration not exceeding three seconds. The experiment was conducted on three separate occasions, with a time interval of one minute between each iteration. The results of the HGS (Hand Grip Strength) test are typically measured and documented in kilos, rounded to the next decimal point (Elsais & Mohammad, 2016). The calculation of the handgrip strength (HGS) involves determining the average value of the three measurements obtained for each hand. Next, calculate the mean value by finding the average between the measurements obtained from the right and left hands (Ashraf et al., 2022). The findings derived from the aggregated data will be utilized for scholarly investigation.

Table 2.
Grip strength rate (Wood, 2012)

Category	Grip Strength Rate (in kg)
	Female
Very Weak	<13.50
Weak	14.00-18.50
Moderate	33.50-44.00
Strong	44.50-54.00
Very Strong	>37.00

The leg and back dynamometer measures the strength of the leg muscles and the muscles in the back. The range for measuring muscle strength with a leg and back dynamometer is as follows:

Table 3.
Leg dynamometer rate (Wiriawan, 2017)

Category	Leg dynamometer rate (in kg)
	Female
Very Weak	<13.50
Weak	14.00-18.50
Moderate	33.50-44.00
Strong	44.50-54.00
Very Strong	>37.00

Table 4.
Back dynamometer rate (Wiriawan, 2017)

Category	Back dynamometer rate (in kg)
	Female
Very Weak	<18.00
Weak	18.50-24.00
Moderate	24.50-32.00
Strong	32.50-41.00
Very Strong	>42.50

The 1-RM test is utilized to assess an individual's maximal strength by determining the utmost weight they can successfully lift for a single repetition. The requisite equipment for conducting measurements with barbells, dumbbells, or other similar apparatus. The methodology employed to assess muscle strength entails providing the individual with explicit instructions to execute customary activities. Illustrative instances of customary exercises include the chest press, biceps curl cable, pull-down, and leg press (Kanada et al., 2018).

The data analysis technique uses SPSS 23. The Shapiro-Wilk test is used to carry out normality analysis on the data. If the significant value is greater than 0.05, it is said to be normally distributed, but it is said to be not normally distributed if the significant value is smaller than 0.05. Test the effect using a paired sample t-test. This analysis was produced using independent variables as factor variables. If the value is less than 0.05, then variable x has an effect on variable y; if the value is greater than 0.05, then variable x has no effect on variable y.

Result

The research results were obtained by pre-test xaminations carried out in May 2023 and post-test examinations carried out in August 2023. The research results can be seen in the table below.

Table 5.
Research Result

Variable	Average Pre-test	Average Post-test	Sig
BMI	27,93	24,64	0.000
Handgrip Dynamometer Right Hand*	27,98	34,33	0.003
Handgrip Dynamometer Left Hand*	26,74	30,19	0.000
Leg Dynamometer*	44,69	63,75	0.000
Back Dynamometer*	48,06	59,66	0.000
Lat Pull Down*	27,5	35,38	0.000
Chest Press*	20	26,25	0.000
Biceps Cable Curl*	9,38	12,56	0.000
Leg Press*	56,25	72,5	0.000
Abdominal Crunch*	14,06	19,38	0.000

Note: *In Kilogram

Based on the table above, giving resistance training with a gym machine at a dose of 40%-60 % of 1 RM can reduce BMI and increase muscle strength. This can be concluded based on the research results. The results of the study showed that the average BMI of the 30 respondents who took part in the study before providing resistance training was 27.93. After participating in the resistance training program, it was 24.64. The results of the SPSS analysis test using the paired sample t-test also showed that the significance value was <0.05.

Resistance training can also increase grip strength in the hands, and this has been proven before getting a resistance training program. Grip strength was measured using a handgrip dynamometer on the right and left hand. On the right hand, grip strength before participating in the training program was 27.98kg, and after following the resistance training program, strength increased to 34.33kg. Meanwhile, on the left hand, grip strength before participating in the training program was 26.74kg, and after following the training program was 30.19kg. The results of the SPSS analysis test on the strength of both arms using a paired sample t-test also showed that the significance value was <0.05.

Resistance training can also increase strength in the leg muscles, and measurements prove this before and after receiving a resistance training program. The strength of the leg muscles was measured using a leg dynamometer. Leg muscle strength before participating in the training program was 44.69kg, and after following the resistance training program, strength increased to 63.75. The results of the SPSS analysis test on leg strength using the paired sample t-test also showed that the significance value was <0.05.

Resistance training can also increase the strength of the back muscles, and measurements prove this before and after receiving a resistance training program. The strength of the muscles in the back is measured using a back dynamometer. Leg muscle strength before participating in the training program was 48.06kg, and after following the resistance training program, strength increased to 59.66kg. The results of the SPSS analysis test on back muscle strength using a paired sample t-test also showed that the significance value was <0.05.

Resistance training also increases certain muscles' strength, especially those used when performing exercise movements. Such as biceps cable curls, lat pull downs, chest presses, leg presses and abdominal crunches. In the lat pull-down movement, the average initial 1 RM check before carrying out the training program for ten weeks was 27.5kg; after carrying out the training program, the average 1 RM increased to 35.38kg. In the chest press movement at the initial examination, 1 RM was found to be 20kg. After following the exercise program, 1 RM increased to 26.25kg. In the biceps cable curl movement, 1 RM at the initial examination was found to be an average of 9.38kg. After following the training program for ten weeks, the average 1 RM increased to 12.56kg. Another movement used is the Leg Press. 1 RM on initial examination was found to be an average of 56.25kg. After following the training program for ten weeks, 1 RM increased to 72.5kg. The last

movement used in this exercise is the abdominal crunch. On initial examination, it was found that 1 RM was 14.063kg. After following the training program for ten weeks, 1 RM increased to 19.38kg. Based on the SPSS test with the influence of the paired sample t-test on several movements, the results showed a significance value of <0.05.

Discussion

The relationship between body composition and physiological and pathological conditions has been widely recognized. Overcoming obesity and its complications requires lifestyle changes like cutting calories and exercising more. Dietary choices significantly impact manageability of health issues as obesity, inflammation, and metabolic illnesses (Botchlett et al., 2017). Carbohydrate and lipid oxidation significantly increases energy needs during exercise (Spriet, 2014). Exercise decreases body fat by increasing glucose intake and blood flow through muscle contractions (Pranoto et al., 2024). Physical activity activates AMPK, AMPK regulates growth, metabolism, autophagy, and cell polarity (Mihaylova & Shaw, 2011). Signaling via FGF-21, irisin, and PGC-1α increases energy consumption during exercise by boosting mitochondrial energy production in muscles (Chen et al., 2023).

The assessment of body composition typically involves multiple indicators (Müller et al., 2012). It is important to note that the evaluation of obesity should not solely rely on BMI values but should also consider factors such as body fat, fat-free mass, and skeletal muscle content (Bosy-Westphal & Müller, 2021). This comprehensive approach ensures a more accurate and comprehensive assessment of body composition. The present study demonstrated a statistically significant effect between resistance training and BMI levels ($p < 0.05$) (Schranz et al., 2014). The present study observed a noteworthy decrease in BMI values as a result of engaging in resistance training involving a diverse range of motions. The observed outcomes in this investigation could perhaps be attributed to the unique configuration of certain exercises performed on gym machines. It is hypothesized that tensile strength will progressively augment as the muscles are elongated during training sessions utilizing a load equivalent to 40%-60% of an individual's one-repetition maximum (1 RM). These training sessions consist of doing 20 repetitions for each exercise, with 4-5 sets completed. This exercise is characterized by a relatively high degree of resistance training, leading to the body primarily relying on aerobic oxidation of carbohydrates and lipids for energy production. This heightened energy demand can greatly contribute to the attainment of fat loss objectives (Stisen et al., 2006).

Muscle hypertrophy and resistance training have been linked. Two main ideas in consistent resistance training are progressive overload and variation to promote continued muscle adaptation (Dewangga & Irianto, 2023). Variability in resistance training refers to the methodical modification of one or more program elements, like volume and intensity, while progressive overload refers to a steady increase in the body's stress (Dewangga et al., 2021). Engaging in appropriate exercise at a suitable intensity has the potential to produce significant health benefits. While variations in volume and intensity have been thoroughly studied as variables for systematic adjustments, it is important to keep in mind that other aspects of resistance training, like exercise, can also be modified to achieve variety (Mangine et al., 2015).

Resistance training, also known as strength or weight training, exerts a powerful influence on fat loss (Andarianto et al., 2024). By engaging in regular resistance exercises, individuals can expect a series of transformative effects. Firstly, it stimulates the development of lean muscle mass, which elevates the resting metabolic rate. This means more calories are burned even at rest, a crucial factor in fat reduction (Westcott, 2012). Additionally, resistance training triggers an afterburn effect, scientifically termed Excess Post-Exercise Oxygen Consumption (EPOC), where the body continues to burn calories post-workout during the recovery and repair process. This results in a sustained calorie expenditure, further aiding in fat loss efforts. Moreover, it improves insulin sensitivity, facilitating better glucose utilization and reducing the likelihood of excess glucose being stored as fat. The exercise regimen also promotes the utilization of fat for energy, both during the workout itself and in the recovery period afterward, contributing to a reduction in overall body fat percentage. In combination with a balanced diet, resistance training offers a comprehensive approach to achieving sustainable and impactful fat loss (Greer et al., 2021).

When compared with other forms of resistance training, using a gym machine with cable can change the direction of resistance at will. Users can train most of the body's muscles in any position and posture, which is very good for achieving fat-burning goals. Another advantage is that because the equipment used has a load that can be adjusted, the resistance training intensity is relatively high and can cause further muscle stimulation, so the cable's effect on muscle strengthening is ideal (Motameni et al., 2020). For overweight and obese people, they are heavier, so the intensity of this exercise is sufficient to stimulate the muscles and promote the thickening of muscle fibres. Additionally, resistance training alone simultaneously allows our muscles to participate in the movement. Rather than isolated muscle stimulation, this training is more comprehensive to improve all muscle groups, thereby achieving the goal of muscle building (Liu et al., 2022).

This is a very interesting finding, as it has been previously reported that the effects of resistance training can improve body composition. For example, a 6-month period of resistance training showed that resistance training was good for increasing strength but was not statistically significant for improving body composition (Schranz et al., 2014). Previous research found that resistance training for one year did not reduce body mass in obese people (Hintze et al.,

2018). Moreover, resistance training can increase lean body mass and muscle mass and reduce fat content compared with aerobic exercise, thereby improving body composition (García-Hermoso et al., 2018). Therefore, this study undoubtedly provides information and education for resistance training as an effective way to combat obesity, lose fat, and build muscle. In this study, we performed physical exercise without providing dietary intervention to assess better the effects of various forms of resistance training on body composition in overweight and obese individuals.

Muscular strength serves as a reliable measure of an individual's functional capacity (Barbat-Artigas et al., 2014). Decreased muscle strength is associated with diminished physical mobility and heightened susceptibility to falls and fractures, particularly in older individuals. All the muscular strength assessments in this study only focused on absolute strength, a crucial factor in comprehending exercise intensity and mitigating the likelihood of sports-related injuries. Undoubtedly, resistance training has been shown to enhance both muscular mass and muscle strength. This assertion is further substantiated by the existing body of evidence about those classified as fat or overweight (Saif & Alsenany, 2015).

Conclusion

The study involves implementing a resistance training regimen using a gym machine set at a load ranging from 40% to 60% of an individual's one-repetition maximum (1 RM). This training protocol is to be conducted over a period of 10 weeks, with participants engaging in three training sessions per week. This physical activity has the potential to decrease body mass index and enhance muscular strength in individuals classified as obese. Resistance training encompasses a series of exercises, including lat pull-down movements, chest press, biceps cable curl, leg press, and abdominal crunch.

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Conflict of Interest

The authors declare that there are no conflicts of interest.

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