



MAT PILATES EXERCISE IMPROVES STATIC BALANCE OF YOUNG ADULTS WITH OBESITY

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ABSTRACT

Background: The prevalence of obesity in women in Semarang at the age over 18 is 29.93%. This high prevalence rate of obesity can have a negative impact on individual health. The condition of obesity is closely related to its complications that can occur in various aspects of the body's physiology, in the example it can reduce functional abilities such as static balance which can interfere with activities and decrease quality of life. One of the methods that can be used to improve static balance is mat pilates. Mat pilates prioritizes stretching and strengthening core muscles with controlled and precise movements so that mat pilates exercises can improve static balance. However, no studies have yet discussed the effect of mat pilates exercise on static balance in obese young adults. **Aims:** To prove that mat pilates exercise can increase static balance of female aged 18-23 years old with obesity. **Methods:** This study used quasi experimental pre and post-test design and was done in August-October 2020. The subjects were 33 female students of Medical Faculty of Diponegoro University aged 18-23 years with BMI over 27 kg/m², divided in 2 groups. Treatment group (n=15) was instructed to do 8 weeks of mat pilates exercise (3 times a week) and control group (n=18) was instructed to not do any exercise. Static balance was measured with Flamingo Balance Test (FBT). Data's significance was analyzed with paired t test and independent t test. **Results :** There's a significant decrease (p<0,001; paired t test) in FBT score before and after of the mat pilates treatment group from 12,31 ± 5,15 to 10,09 ± 5,59. An insignificant increase (p=0,798; paired t test) found in FBT score before and after of the control group from 12,74 ± 4,65 to 12,93 ± 6,29. The score difference of FBT test of the mat pilates treatment group and control group shows significant result (p=0,013). **Conclusion:** There is an improvement of static balance after mat pilates exercise intervention on female aged 18-23 years old with obesity.

Keywords: *Flamingo balance test, mat pilates exercise, obesity, static balance, young adults*

INTRODUCTION

Obesity is an abnormal condition where there is an excessive accumulation of body fat which can interfere with health.¹ According to the Ministry of Health of the Republic of Indonesia, the Body Mass Index (BMI) for obesity is ≥ 27 .² Obesity is caused by an imbalance between calories consumed and calories expended or used. The growth in the calories consumed number is due to increased intake of high-fat foods.³

In 2016, 1.9 billion adults aged 18 or above were overweight, of which 650 million were obese. The prevalence of obesity and overweight aged 5-19 has increased sharply from 4% in 1975 to more than 18% in 2016. According to the results of Basic Health Research (Riskesdas) conducted by the Ministry of Health of the Republic of Indonesia in 2018, the prevalence of obesity at age over 18 was as much as 21.8%.⁴ In Semarang, the prevalence of obesity is 14.36% for men and 29.93% for women.⁵

The high prevalence rates of obesity can impact negatively on individual health. Obesity is closely

associated with complications that occur in numerous aspects of body physiology, such as malignancy, cardiovascular disease, stroke, osteoarthritis, metabolic syndrome, and obstructive sleep apnea. Obesity also reduces functional abilities such as balance which can interfere with activities and lower life quality.⁶

Obesity significantly changes body movements as a result of body's anthropometry's alteration. This results in body's modification in performing movements and receiving reflexes. Reduced Range of Motion (ROM) also occurs due to postural deviation because of increased body mass. Overweight and obesity also reduce muscles' strength and fatigue resistance. All of these factors lead to impaired postural control.⁷

Balance disorders in overweight and obesity need special attention. For young adults, increased physical activity can be done to improve posture and body ROM with the right methods. One of the methods is mat pilates exercise. Mat pilates prioritizes stretching and strengthening muscle



movements with controlled and precise movements where the mat is used as a medium. The basic principles of mat pilates are centralization, concentration, control, precision, breathing, and flow.⁸

Mat Pilates exercise has advantages compared to other sports that can reduce balance disorders. This exercise can improve core strength, flexibility, circulation, and balance. These advantages are obtained from the various principles of numerous mat pilates movements. In previous studies, mat pilates exercise improved static or postural balance and dynamic balance.^{9,10} This is because mat pilates can improve postural alignment related to body fats and muscles.¹¹ A lower BMI is also part of mat pilates program's advantage. Mat pilates exercise use up a large amount of calories which could lowering BMI.^{12,13} Mat pilates are carried out using pilates mat as the media, therefore this program is relatively easy to do because it can be done in various places since it only needs pilates mats.¹⁴ Thus this research was conducted to assess the static balance in obese young adults after doing mat pilates exercise.

MATERIALS AND METHODS

This research is an experimental type with quasi experimental design paired with pre-test and post-test design. The research was conducted in Semarang from August-October 2020 for 8 weeks.

Samples were taken by purposive sampling method based on predetermined criteria and divided into two groups, the treatment group and the control group. The samples for this research were students from Semarang who met the inclusion and exclusion criteria. The inclusion criteria were women aged 18-23 years, body mass index (BMI) obesity ($> 27 \text{ kg} / \text{m}^2$), willing to be included in the research by signing the informed consent sheet as evidence, and obliging not to do other sports that could affect the balance control for 8 weeks. While the exclusion criteria were having a history or experiencing vestibuloserberal and visual, having a history of or experiencing movement disorders that disturb the exercise, and having a history of fractures 10-12 weeks prior to the research.

The sample size for each group is 18 members of treatment group and 18 members of control group. There are 36 people in total.

The independent variable for this research is mat pilates exercise. Meanwhile, the dependent variable

is a static balance. The data used in this research is primary data. The data collection process was carried out starting from all research subjects following the pre-test of static balance measurement using the flamingo balance test method. The control group was instructed not to do any type of exercise for 8 weeks. The treatment group was instructed to do mat pilates exercises. The appliance of mat pilates exercises was starting from a 5-minute warm-up movement, followed by a core movement consisting of 16 movements and doing 3-5 repetitions, then cooling down for 5 minutes.

During the COVID-19 pandemic, mat pilates exercises were executed online and monitored via video. After 8 weeks of the intervention, all research subjects were measured again for their static balance using the flamingo balance test method. Measurement of static balance before and after the intervention was done by meeting directly with research subjects using the door-to-door method to avoid crowds while still adhering to health protocols.

The data is then processed, coded, and entered into a computer for descriptive analysis and hypothesis testing. The data normality test on the dependent variable was analyzed using the Saphiro-Wilk test. Hypothesis test regarding the difference in static balance before and after the mat pilates exercise was analyzed using paired t test. Hypothesis tests regarding the difference in static balance between the control group and the treatment group were analyzed using independent t test.

This research have received ethical clearance from the Ethics Committees of Medical Research of the Faculty of Medicine, Diponegoro University Semarang on June 22nd 2020. The Ethical Clearance Number is 149 / EC / KEPK / FK-UNDIP / VI / 2020.

RESULTS

This research was conducted in August-October 2020 with 36 research subjects who met the research criteria. There were 36 research subjects selected based on inclusion and exclusion criteria. Subjects were divided into 2 groups, each group consisting of 18 people. After being observed until the end of the research, the entire control group was able to carry out until it was finished, while the treatment group had 3 research subjects who could not be followed up because the subjects did not reply



to the researchers' message that made the total research subjects became 33 people.

There were 33 research subjects with average age \pm SD 21.11 ± 0.96 from the control group while the treatment group had 20.53 ± 0.83 . The age ranges in control groups were 20-23 (min-max) and 18-21 (min-max) in the treatment group. While the average BMI \pm SD (min-max) of the control group was 30.99 ± 2.57 (27.93 - 36.20) and the treatment group was 29.37 ± 2.57 (27.24 - 35.76). In addition, on physical activities' characteristics, there were 15 subjects (100%) in the treatment group and 15 subjects

(83.3%) in the control group included in the sedentary category while 3 subjects (16.7%) in the control group were included in the non sedentary. The difference in physical activity was not significant with $p = 0.150$ (Chi square test).

Static balance's measurement was done by using the flamingo balance test method 2 times, before the intervention (pre-test) and after 8 weeks of giving mat pilates (post-test). The following is the data obtained on the static balance's measurement using the flamingo balance test method (Table 1).

Table 1. Flamingo Balance Test

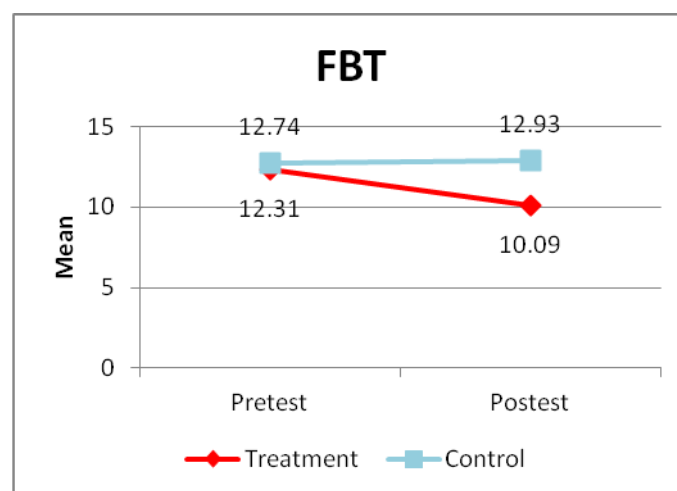
FBT	Group		p
	Treatment (Mean \pm SD)	Control (Mean \pm SD)	
Pre-test	12,31 \pm 5,15	12,74 \pm 4,65	0,803 [§]
Post-test	10,09 \pm 5,59	12,93 \pm 6,29	0,185 [§]
p	0,001 ^{¶*}	0,798 [¶]	
Deviation	-2,22 \pm 1,99	0,19 \pm 3,01	0,013 ^{§*}

* Significant ($p < 0,05$); [§] Independent t; [¶] Mann whitney; [¶] Paired t

Based on table 1, the results show that the pre-test FBT score in the treatment group is lower than the control group. However, the statistical test results using independent t test show that the difference is not significant ($p = 0.803$). Meanwhile, the results of the FBT score at post-test in the treatment group are lower than the control group. The results of the

independent t test show no significant difference ($p = 0.185$).

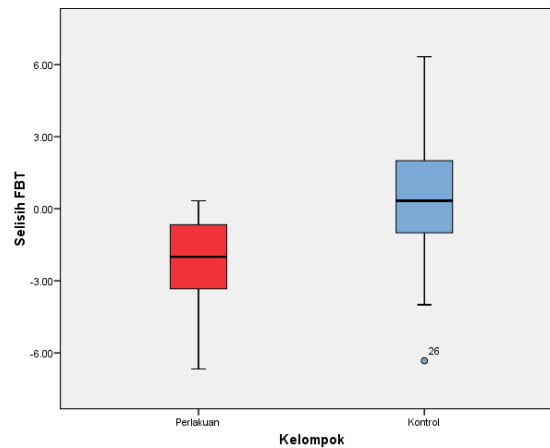
Table 1 also shows that in the treatment group there is a significant decrease in the FBT score ($p < 0.001$; paired t test). While the increase of the FBT score from control group is not significant ($p = 0.798$; paired t test).



Picture 1. Diagram of FBT scores during pre-test and post-test in the treatment group (n = 15) and the control group (n = 18).

Based on picture 1, it can be seen that the treatment group's FBT score decreased while in the control group there is an increase. The treatment group take a significant decrease in FBT score ($p < 0.001$; paired t test), while in the control group there

is an insignificant increase in FBT score ($p = 0.798$; paired t test). The comparison between the pre-test and post-test FBT score for both groups is shown in picture 2.



Picture 2. A Boxplot graph of the FBT scores deviation between the pre-test and post-test for both control and the treatment groups.

In picture 2, it can be seen that the FBT scores deviation between the pre-test and post-test in the treatment group is normally distributed, on the contrary the control group's data is not normally distributed.

DISCUSSION

Mat Pilates exercises' intervention in this research was conducted for 8 weeks from August-October 2020. It was executed on 36 subjects that divided into treatment and control groups equally. In its implementation, during the exercise, 3 subjects met the dropout criteria therefore at the end of the study there were 33 subjects.

In its application, mat pilates exercises were carried out online by zoom meeting in each subjects' house due to the ongoing COVID-19 pandemic. By online course, the subjects have to turn their camera on and follow the mat pilates instructor. The instructor also supervised the subject movement to make sure they follow direction correctly. This was needed to prevent the spread of the COVID-19. All research subjects were asked to fill out a daily activity record via Google Form as a conformation of controlling physical activity. Static balance's measurement was done using the Flamingo Balance Test method before the mat pilates exercise intervention (pre-test) and after the mat pilates exercise intervention (post-test).

The results of this research indicate that there is an increase in the static balance ability that proves by a greater decrease in FBT score in the treatment group compared to control group, after having the mat pilates exercises intervention for 8 weeks. This result is in accordance with the research hypothesis, which says the balance ability increased after giving the mat pilates exercises to obese young adults.

The results are in line with research conducted by Ju Hyun¹¹ which examined the effects of mat pilates exercise on balance ability towards elderly women. In this research, a comparison of the loss of balance pace after intervention in the treatment and control groups showed a more significant reduction in the treatment group given the mat pilates exercise intervention ($p < 0.05$). This is similar to a study conducted by Risangdiptya¹⁷ which measured the difference between body balance before and after mat pilates exercise in young women. This research found out a significant difference between body balance before and after pilates exercise for young women ($p < 0.001$).

Increasing muscle mass due to obesity has a negative impact on the lower extremities and legs. This occurs due to biomechanical changes of feet's structures such as the pes planus or flat feet and also changing fat pads on the feet sole including alteration in pressure on the soles, inappropriate muscle strength. These biomechanical changes will hamper



activities, especially one that require anti-gravity movement.¹⁵

Contrasting with other resistance exercises that are based on training the muscles separately, mat pilates requires a holistic approach and demands the coordination of several muscle groups at the same time. Mat pilates exercises are designed to strengthen the core muscles, like the transverse abdominus muscles. The body's proprioceptive ability will increase as long as core muscles' ability develops successfully through mat pilates. This exercise also improves balance by increasing muscle tone, balancing muscle work, and improving posture. The gravity line normally forms a vertical line across the ears, neckbone, shoulder joints, lumbar vertebrae and knees. Balance can be fulfilled when the line of gravity lies on the fulcrum. A shift in the gravity's line towards the fulcrum will result in a change of the postural state. In mat pilates exercise, the body will be trained to make adjustments with loss of balance during activities so therefore one's life quality will not be disturbed.^{16,17}

The Flamingo Balance Test requires leg, pelvic and abdominal muscles' coordinations. The muscles that are mostly used in this include the gluteus maximus, gluteus medius, gluteus minimus, quadriceps, hamstrings, tensor fascia latae, and pelvic flexor muscles. In the implementation of mat pilates exercises, the muscles will be stimulated to be more active. For the spine stretch I, it stretches the vastus lateralis muscle, which is one of the quadriceps femoris muscles. This movement is also able to extend the tensor fascia latae muscle. Spine stretch II can strengthen the quadriceps femoris muscles. Spine twist is a movement that can strengthen the transverse abdominis and obliquus externus muscles which are part of the abdominal muscles. While for wind mill, this movement can strengthen the hamstring and gluteus maximus muscles.

Half curl and single leg stretch movements can help with strengthening core muscles and increasing abdominal muscle endurance. For tiny step movement, it can develop the abdominal muscles' stability and protect the hip joint. The hundred I and double leg stretches aim to strengthen the abdominal muscles. Rolling like a ball and rolling down can improve abdominal muscle control. Single leg circle, is a movement to strengthen the abdominal muscles and increase pelvic stability. Other muscles that are

stimulated by the mat pilates movements are the spine and chest muscles. Based on the explanation above, mat pilates exercise affects the muscles that are used in doing the Flamingo Balance Test. This is in agreement with the results of this research, which is the Flamingo Balance Test score decreased significantly ($p < 0.001$; paired t test) in the group treated with mat pilates exercise for 8 weeks.

The limitation of this study is that it does not examine the subjects' fats' distribution therefore the mechanical resistance of fat accumulation in the extremities is unknown. This research was also conducted online, hence the accuracy of the mat pilates movement is hard to assess.

CONCLUSION AND SUGGESTION

Conclusion

After the mat pilates exercise for 8 weeks, the static balance ability increased in the treatment group, on the other hand, in the control group did not has any increase.

Suggestion

Further research on the effect of mat pilates exercise on dynamic balance in obese young adults ranging from 18-23 years old is needed. And it is necessary to do further research on mat pilates exercise on the static balance ability by calculating and analyzing the research subjects' fat distribution.

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REFERENCES

1. Overweight and obesity. World Health Organization. 2018.
2. Badan Penelitian dan Pengembangan Kesehatan. Riset Kesehatan Dasar 2013.
3. Kementerian Kesehatan RI. Pedoman Pencegahan dan Penanggulangan Kegemukan dan Obesitas pada Anak Sekolah. 2012.
4. Badan Penelitian dan Pengembangan Kesehatan. Laporan Hasil Riset Kesehatan Dasar (Riskesdas) Indonesia tahun 2018. p. 182-3.
5. Kementerian Kesehatan RI. Laporan Provinsi Jawa Tengah Riskesdas 2018.



6. Abdelaal M, le Roux CW, Docherty NG. Morbidity and mortality associated with obesity. *Ann Transl Med.* 2017;5(7):1–12.
7. Del Porto HC, Pechak CM, Smith DR, Reed-Jones RJ. Biomechanical Effects of Obesity on Balance. *Int J Exerc Sci.* 2012;5(4):301–20.
8. Natour J, Cazotti LDA, Ribeiro LH, Baptista AS, Jones A. Pilates improves pain, function and quality of life in patients with chronic low back pain: A randomized controlled trial. *Clin Rehabi.* 2015;29(1):59–68.
9. Johnson EG, Larsen A, Ozawa H, Wilson CA, Kennedy KL. The effects of Pilates-based exercise on dynamic balance in healthy adults. In: *Journal of Bodywork and Movement Therapies.* 2007.
10. Hall DW, Nichols J, Aguilar L, Larkam E. Effects of Pilates-Based-Training on Static and Dynamic Balance in An Elderly Population. *Medicine & Science in Sports & Exercise.* 1999.
11. Hyun J, Hwangbo K, Lee CW. The effects of pilates mat exercise on the balance ability of elderly females. *J Phys Ther Sci.* 2014 ; 26(2):291–3.
12. Agustina D, Novannisa N. Pilates Exercise Dapat Menurunkan Indeks Massa Tubuh (Imt) Perempuan Obesitas Tingkat 1 Di Perumahan Bumi Dirgantara Permai Bekasi. 2017;4(2):111–22.
13. Pestana MDS, Netto EM, Pestana MCS, Pestana VS, Schinoni MI. Pilates versus resistance exercise on the serum levels of hs-CRP, in the abdominal circumference and body mass index (BMI) in elderly individuals. *Motricidade.* 2016.
14. Sorosky S, Stilp S, Akuthota V. Yoga and pilates in the management of low back pain. *Curr Rev Musculoskelet Med.* 2008.
15. Daneshmandi H, Rahnema N, Mehdizadeh R. Relationship between Obesity and Flatfoot in High-school Boys and Girls. *Int J Sport Sci Eng.* 2009.
16. Irez GB, Ozdemir RA, Evin R, Irez SG, Korkusuz F. Integrating pilates exercise into an exercise program for 65+ year-old women to reduce falls. *J Sport Sci Med.* 2011.
17. Geremia JM, Iskiewicz MM, Marschner RA, Lehnen TE, Lehnen AM. Effect of a physical training program using the Pilates method on flexibility in elderly subjects. *Age (Omaha).* 2015.