Acta Medical and Health Sciences, 1 (1): 28-37 (2022)

Advance Access Publication Date: June 2022

Original Article

Differences in mediterranean diet adherence on bmi, waist circumference, fat percentage, muscle mass in obesity

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ABSTRACT

Obesity is a multifactorial disease that occurs when there is an abnormal accumulation of body fat due to an imbalance between energy intake and energy expenditure. The prevalence of Riset Kesehatan Dasar in 2018 showed that 21.8% of the Indonesian population over 18 years is obese. One of the diets recommended by European Association for the Study of Obesity Community for obesity is the Mediterranean diet. This study aims to determine the difference of adherence level in the Mediterranean diet to nutritional status, and muscle mass in obese patients. The method used in this study is analytic observational with prospective cohort observations. Subjects in this study were 37 obese patients who were monitored for diet four times in one month with food frequency questionnaire and checked for BMI, waist circumference, body fat percentage, and muscle mass at the end of the month. BMI and body fat percentage were analyzed using the Anova test while waist circumference and muscle mass data were analyzed using the Kruskal Wallis test. The level of adherence to the Mediterranean diet has been shown to significantly affect BMI (p=0.008), waist circumference (p=0.042), body fat percentage (p=0.014), and muscle mass (p=0.009) in obese patients. This associated with the composition of Mediterranean diet which affects increase in thermogenesis, fat oxidation, anti-inflammatory, and increases satiety for a longer period. The results of this study support the hypothesis that there is the difference of adherence to the Mediterranean diet to nutritional status and muscle mass in obese patients.

Keyword: Body fat percentage, Body mass index, Mediterranean diet, Muscle mass, Waist circumference.

INTRODUCTION

Obesity is a multifactorial disease that occurs when there is an abnormal accumulation of body fat.[1] Obesity occurs when there is an imbalance between energy intake and expenditure. Obesity conditions can increase the risk of other diseases because of its association with metabolic syndrome or insulin resistance syndrome which makes obesity a serious problem that needs to be addressed.[1,2] Nutritional status is a condition that is influenced by the balance between intake and nutritional needs needed for body metabolism, this illustrates the condition of obesity is a condition when nutritional status is in an abnormal condition. Several assessments of nutritional status that can be carried out and recommended by the Indonesian Ministry of Health are the assessment of Body Mass Index (BMI) and waist circumference measurement.[3,4] Another assessment of obesity conditions can also be seen from fat content to see more specifically the composition of excess in obese patients, besides that muscle mass assessment can also be assessed to see the effect of increasing proinflammatory cytokines in obesity conditions.[5,6]

The main therapeutic option for obesity is non-pharmacotherapy, one of which is diet. One of the diets recommended by the Indonesian Endocrinology Association (PERKENI) and *The European Association for the Study of Obesity Community* (EASO) for obesity is the Mediterranean diet which is based on the consumption of unsaturated fats, plant foods, fruits, vegetables, nuts, legumes and seeds. whole grains, moderate consumption of fish, seafood and dairy products, and low alcohol intake, and relatively limited use of red meat and other meat products.[7,8,9] The current application of the Mediterranean diet is not only seen from the intake of each nutrient or the duration of its application but needs to be seen from the side of compliance.[10] Adherence to the Mediterranean diet can be assessed using *the Alternate Mediterranean Diet Score* (aMED) which looks at the diet as well as the composition of the food, the method for assessing adherence to the Mediterranean diet of the aMED was based on 9 food components which were assessed based on the median value of each of these food compositions.[11]

Which is balanced with a high level of adherence is evidenced from several previous studies, where the effect of the level of adherence of the Mediterranean diet to a decrease in body mass index, waist circumference and fat content as well as prevention of a decrease in muscle mass is associated with the content of the diet. Mediterranean is high in fiber, anti-inflammatory and antioxidant effects and contains MUFA and PUFA which are good for obese patients because they can increase fat oxidation and greater thermogenesis. body mass, waist circumference and fat content and muscle mass in obese patients.

METHODS AND SUBJECT

The study used an analytical observation method which was carried out for 30 days. The study was conducted on obese patients on a Mediterranean diet with a prospective cohort observation. The subject's physical activity was identified by using the *International Physical Activity Questionnaire* (IPAQ) which was used to determine the inclusion criteria. The level of adherence was assessed using the *Alternate Mediterranean Diet Score* (aMED) scoring system based on the median value of the patient's diet based on the *Food Frequency Questionnaire* (FFQ).

Research Subjects

Population in this study were obese patients at the *Healthy Life Clinic* in Bandung. Which has a Prolanis community consisting of men and women aged 40 years. Inclusion criteria in this study included subjects with a body mass index (BMI) 25 kg/m^2 and subjects with low levels of physical activity, while the exclusion criteria included subjects who

were not willing to follow all research procedures. Criteria *drop out* in this study were subjects who died, subjects who moved residence, and subjects who stopped dieting in the middle of the research. Sampling was carried out using a systematic *random sampling technique*, where sampling of research data was carried out 4 times in 1 month which was determined randomly. The calculation of the minimum sample size uses the sample size formula to test the independent mean difference hypothesis so that a minimum sample of 27 people is obtained (each level of compliance is at least 9 people).

Place and Time of Research

This research was conducted at the Healthy Life clinic in Bandung City from November to December 2021.

Research procedure

The study began with the application of permission to the ethics committee, then continued with initial screening so that samples were obtained according to the inclusion criteria. Patients who fit the inclusion criteria were given a food frequency questionnaire (FFQ) and follow-up 4 times over a period of 30 days. The results of the FFQ assessment of research subjects describe food consumption for 1 month so that it can determine the median value of each component of the Mediterranean diet for the Alternate Mediterranean Diet **(**AMED) and determined adherence of each subject. After one month, BMI, waist circumference, fat content, and muscle mass will be checked. BMI examination was carried out using beam balance and Microtoise, for waist circumference using a measuring tape, and for fat content and muscle mass using bioelectrical impedance analysis from Omron HBF – 222T.

Score Alternate Mediterranean Diet (AMED)

In this study using the AMED scoring system as shown in table 1 to determine the subject's adherence based on the median value of the subject's food consumption. The level of adherence is divided into 3 categories. scores 0-3, 4-6, and 7-9 which are interpreted as low, medium, and high adherence.

Table 1. Alternate Mediterranean Diet (aMED)

Components	Food included	Scoring criterion
Fruits	All fruits and 100% fruit juices	Servings/d > median intake
Vegetables	All vegetables except potatoes	Servings/d > median intake
Legumes	Dried beans and peas, lentils, tofu, soya	Servings/d > median intake
Nuts	Nuts and peanut butter	Servings/d > median intake
Whole grain	Whole grain ready-to-eat cereals, cooked cereals, crackers, dark breads, brown rice, other whole grains	Servings/d > median intake
Fish	Fish, shellfish, canned fish, dried fish	Servings/d > median intake
Red and processed meats	Red meats, processed meats	Servings/d < median intake
MUFA : SAFA ratio	MUFA (g):SFA (g)	Ratio > median
Alcohol	Beer, hard liquor, wine	Men : 10-25 g/day Women : 5-15 g/day

Reference: Shvetsov YB, et al [13].

Research Ethical Aspects

This research was approved by the Health Research Ethics Commission of the Faculty of Medicine, Jenderal Achmad Yani University with ethical approval number 056/UM2.11/2021

RESULTS AND DISCUSSION

The results obtained were 37 patients who had met the inclusion and exclusion criteria which were divided into three categories based on the level of adherence to the Mediterranean diet, such as low adherence, moderate adherence, and high adherence through the AMED score.

The results of the study were analyzed using the *Saphiro Wilks* test for normality test and the homogeneity test with the *Levene* because the number of subjects was less than 50 and there were data that were normally distributed (*p-value*> 0.05) so as to determine differences in the level of adherence of the Mediterranean diet to BMI and fat content in obese patients used the *Anova* and then the *Post Hoc Tukey test*. Waist circumference and muscle mass variables had abnormal data distributions (*p-value* < 0.05) so to see differences in the level of adherence of the Mediterranean diet to waist circumference and muscle mass were tested using *Kruskal Wallis* and then the Mann Whitney test was performed.

Age and Gender Characteristics

Based on the results of the study in, it is known that the average age of obese patients undergoing a Mediterranean diet at the Healthy Life Bandung is 56.05 years old. The youngest patient in the study was 40 years old and the oldest was 67 years old.

Age is related to the incidence of obesity, because when someone get older, the body's metabolic function decreases. The process of fat oxidation into energy which decreases with age causes the energy source consumed to be stored in energy reserves, one of which is fat deposits, thereby increasing the risk of obesity.[12,13]

Based on the results of the study, most of the obese patients undergoing the Mediterranean diet at the *Healthy Life* Bandung are female, namely 25 people (67.57%), while male patients are 12 people (32.43%). Gender affects the occurrence of obesity, where in women who experience menopause have a higher risk of obesity. This is influenced by a decrease in estrogen hormone levels which affect lipoprotein synthesis from the effect of lipoprotein lipase which causes triglyceride accumulation.[14]

Table 2. Level of Adherence to The Mediterranean Diet

Mediterranean Diet Adherence	Total (n)	Percentage (%)
Low (0-3)	14	37.84
Medium (4-5)	11	29.73
High (≥ 6)	12	32.43
Total	37	100.00

Level of Adherence to The Mediterranean Diet

Results for the level of adherence to the Mediterranean diet show that most obese patients who follow a Mediterranean diet at the Healthy Life Clinic in Bandung City have a low level of adherence (aMED score 0-3) as many as 14 patients (37.84%), 11 patients (29.73). %) with moderate dietary adherence (aMED score 4-5) and 12 patients (32.43%) with high dietary adherence of Mediterranean diet (aMED≥ score 6).

The Differences between The Level of Adherence to The Mediterranean Diet to BMI and Body Fat Percentage in Obese Patients

The result shows that there was a significant difference in the level of adherence of the Mediterranean diet to BMI ($p = 0.008 < 0.05$) and body fat percentage in obese patient ($p=0,0014 < 0,05$). The analysis was continued with the Post Hoc Tukey to see the difference in BMI and body fat percentage between three adherence categories

Table 3. Anova Test of BMI and Body Fat Percentage

	Low Adherence (n=14)	Moderate Adherence (n=11)	High Adherence (n=12)	*p-value*
BMI	30,04	27,03	26,21	0,008
Body Fat Percentage	37,86	34,50	31,00	0,014

Table 4. Post Hoc Tukey test of BMI

Variable	Adherence Level	P value	Conclusion
Body Mass Index	High vs Moderate	0.841	Not significantly different
	High vs Low	0.010	Significantly different
	Moderate vs Low	0.050	Not significantly different
Body Fat Percentage	High vs Moderate	0.302	Not significantly different
	High vs Low	0.010	Significantly different
	Moderate vs Low	0.305	Not significantly different

Table 5. Kruskal Wallis Test of Waist Circumference and Muscle Mass

	Low Adherence (n=14)	Moderate Adherence (n=11)	High Adherence (n=12)	*p-value*
Waist Circumference	99,71	94,55	93,75	0,042
Muscle Mass	23,07	26,38	27,61	0,009

There is a significant difference between BMI values to categories of obese patients with high and low Mediterranean diet adherence (p=0.010<0.05) and between body fat percentage values to categories of obese patients with high and low Mediterranean diet adherence (p=0.010<0.05). This shows that the higher patient's adherence to the diet, the lower body mass index and body fat percentage value.

The Differences between The Level of Adherence to The Mediterranean Diet to Waist Circumference and Muscle Mass in Obese Patients

The results of the analysis of the differences in the level of adherence of the Mediterranean diet to waist circumference in obese patients can be seen in table 5. Table 6 shows that there was a significant difference in the level of adherence of the Mediterranean diet to waist circumference (p=0.042<0.05) and muscle mass in obese patients (p=0.009<0.05). The analysis was continued with the Mann Whitney test to see the difference in waist circumference between three adherence categories.

Table 6. Mann Whitney test of Waist Circumference

Variable	Adherence Level	P value	Conclusion
Waist Circumference	High vs Moderate	0.928	Not significantly different
	High vs Low	0.041	Significantly different
	Moderate vs Low	0.025	Significantly different
Muscle Mass	High vs Moderate	0.449	Not significantly different
	High vs Low	0.004	Significantly different
	Moderate vs Low	0.018	Significantly different

There is a significant difference between waist circumference values between categories of obese patients with high and low Mediterranean diet adherence (p=0.041<0.05), and between obese patients with moderate and low Mediterranean diet adherence (p=0.025<0.05). There is also significant difference between muscle mass values in obese patients with high and low Mediterranean diet adherence (p=0.041<0.05), and between obese patients with moderate and low Mediterranean diet adherence (p=0.025<0.05). This shows that waist circumference and muscle mass conditions at a high level of adherence to the Mediterranean diet are better than those with a low level of adherence to the Mediterranean diet.

The mechanism of weight gain is based on an imbalance between energy intake and energy expenditure which results in fat accumulation, especially TGA in adipose tissue. When the body needs energy, TGA will be broken down into fatty acids and glycerol to be transported to cells to be oxidized into energy. When the body does not need more energy, the TGA is not broken down, which causes the TGA to accumulate which has an impact on weight gain. [15,16,17]

The results of the study of the differences in the level of adherence of the Mediterranean diet to BMI illustrate that high adherence to the Mediterranean diet provides better body mass index levels when compared to other levels of compliance. This is in accordance with other studies by Poulimeneas et al. In 2020,

the results of the high level of adherence to the Mediterranean diet were found to be effective in weight loss. The effect on weight loss is attributed to the high intake of fiber in the Mediterranean diet which increases and prolongs satiety. The effect of consuming a Mediterranean diet can also increase the release of the hormone cholecystokinin which can control appetite, these things contribute to an increase in satiety so that energy intake is lower which has an impact on avoiding excess lipogenesis.[18]

The increase in waist circumference is related to the accumulation of fat tissue in the body. This begins with high energy intake which can cause lipogenesis which results in the accumulation of fatty acids which will later be stored in the form of TGA thereby increasing waist circumference. The accumulation of this fat tissue can cause insulin resistance through the mechanism of releasing proinflammatory cytokines which can cause an increase in lipolysis and the production of free fatty acids which will induce an increase in TGA synthesis in the liver which will then go to the circulation resulting in hypertriglyceridemia which can result in the accumulation of fat tissue.[19,20,21]

The results of the data analysis in Table 4 can be related to the effect of Mediterranean dietary adherence in another study by Agnoli et al. The year 2018 illustrates that adherence to the Mediterranean diet has an effect on reducing the risk of increasing body weight and waist circumference due to several things, namely unsaturated fatty acids which affect energy expenditure, induction of thermogenesis and fat oxidation, so that energy intake can be converted into energy more quickly and not into fat deposits in the form of TGA which has an impact on reducing or preventing an increase in waist circumference.[22] The polyphenol content found in the Mediterranean diet also has an anti-inflammatory effect that can prevent insulin resistance, in addition to fat components that are not Saturated in the Mediterranean diet also plays a role in stimulating the secretion of glucagon-like peptide-1 (GLP-1) which functions to stimulate insulin secretion and protect against pancreatic β-cells. [23,24]

The product of fat metabolism is fatty acids. Fatty acids can be transported across the intestinal membrane, but when they cross the membrane, they are recombined to form TGA molecules. These triglycerides are packaged together with cholesterol molecules in phospholipid vesicles called chylomicrons inside the intestinal cells. Chylomicrons leave enterocytes through exocytosis and enter the lymphatic system where they are transported to the circulatory system to the liver or stored in fat cells consisting of adipose tissue found throughout the body, causing an increase in body fat levels. [25,26]

Buchanan A's research in 2021 describes several mechanisms that influence adherence to the Mediterranean diet and body fat levels. The polyphenol content in the Mediterranean diet plays a role by activating the enzymes Adenosine Monophosphate Protein Kinase (AMPK) and Peroxisome Proliferator Activated Receptor Alpha (PPARα) which can cause inhibition of Acetyl-CoA Carboxylase (ACC) and fatty acid synthesis. This activity can cause a decrease in fatty acid synthesis and an increase in fatty acid oxidation so that it can reduce the accumulation of fat levels in the body.[27,28]

Obesity conditions will cause an increase in proinflammatory cytokines such as Tumor Necrosis Factor Alpha (TNF-a), Interleukin-6 (IL-6) and interleukin-1 (IL-1) due to apoptosis of adipocyte cells. Which will cause a decrease in muscle mass. Proinflammatory cytokines will increase muscle catabolism through acceleration of muscle protein degradation and myocyte apoptosis, in addition oxidative stress can also damage mitochondrial function in muscle cells so that ATP formation is disrupted and has an impact on muscle cell atrophy.[29,30,31,32]

Research conducted by Kelaiditi E in 2016 illustrates that higher adherence to the Mediterranean diet has a direct role in muscle metabolism and muscle physiology through anti-inflammatory effects.[33] The polyphenol content has an effect by inhibiting the release of proinflammatory cytokines that can cause a decrease in muscle mass.[34] The polyphenol content found in olive oil, grain, vegetables, and fruits also has the function of maintaining mitochondrial function and muscle mass through the mechanism of mitochondrial biogenesis. and myogenesis to prevent a decrease in muscle mass.[32]

Based on the research that has been done, the researchers assess further research is needed on the relationship between adherence to the Mediterranean diet and nutritional status considering the differences of each component more effective foods in the Mediterranean diet based on the patient's diet and other factors that influence obesity conditions with the Mediterranean diet such as the difference between each level of physical activity that was not carried out in this study.

CONCLUSION

There was a significant difference in the level of adherence to the Mediterranean diet to BMI ($p=0.001<0.05$), waist circumference ($p=0.029<0.05$), body fat percentage ($p=0.003<0.05$), and muscle mass in obese patients. This shows that BMI, waist circumference, body fat percentage, and muscle mass conditions at a higher level of adherence to the Mediterranean diet are better than those with a lower level of adherence to the Mediterranean diet.

ACKNOWLEDGEMENTS

Thanks are given to the Institute for Research and Community Service (LPPM) Jenderal Achmad Yani University for providing grant funding for this research.

DECLARATION OF INTERESTS

The authors declared that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

FUNDING

This research was funded by a grant from the Lembaga Penelitian dan Pengabdian pada Masyarakat (LPPM) of Jendral Achmad Yani University

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