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The Effect of Flexitarian Diet on Waist Circumference and Sagittal Abdominal Diameter in Obese Female Students

Pengaruh Diet Flexitarian terhadap Lingkar Pinggang dan Diameter Sagital Abdominal pada Mahasiswi Obesitas

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ABSTRAK

Background: Central obesity causes various diseases. Abdominal fat is associated with metabolic disturbances. Dietary interventions targeting abdominal fat are reported to have health benefits. A plant-based diet is known to be beneficial in reducing abdominal fat.
Objectives: This study aims to see the effect of a flexitarian diet on abdominal fat through waist circumference and SAD.
Methods: This research used a quasi-experimental design with a pre-post-test control group design. The research sample size was 21 obese female students aged 19-25 in Semarang. Subjects were selected using the consecutive sampling method and divided into treatment groups (11 subjects) and control groups (10 subjects). The four-week flexitarian diet treatment group included three main meals and two snacks, while the control group was not given any dietary intervention. However, both groups (all subjects) were given nutrition and obesity education through lectures and leaflets. Anthropometric data on body weight, waist circumference, and SAD were taken before and after the intervention. Statistical analysis was performed using paired t-test, independent T-test, Mann Whitney, and ANCOVA.
Results: Intakes between groups during the intervention showed statistical energy, fat, and fibre differences. SAD between the treatment group (-1.2±0.6cm) and the control group (0.2±1.5cm) showed a significant difference (p=0.010). There was no significant difference in waist circumference between the groups, but the decrease in the treatment group was more significant (-6.6±5.5cm). Physical activity did not affect changes in SAD (p=0.210), while diet treatment affected changes in SAD (p=0.010).
Conclusions: Changes in SAD showed a significant difference between groups after intervention. Changes in waist circumference were insignificant between groups, but the decrease was more significant in the treatment group.

INTRODUCTION

Obesity is an abnormal condition resulting in excess weight due to excessive fat accumulation[1]. Obesity contributes to metabolic changes that present a disease risk and contributes to 2.8 million deaths in adults each year[2]. Central obesity tends to increase and trigger a global epidemic over the next few decades. Based on the Indonesian Basic Health Research (Riskesdas), from 2007 to 2018, the prevalence of central obesity increased every year, from 18.8% to 31%. In addition, females have a higher prevalence of obesity (46.7%) than males (15.7%)[3]. A study assessing central obesity based on abdominal diameter in obese Universitas Diponegoro student subjects showed that 42.5% of female students had SAD at risk[4].

The diagnosis of central obesity is commonly based on widely available measurements. Measurements using computed tomography (CT), magnetic resonance imaging (MRI), and dual-energy x-ray absorptiometry are considered the gold standard for assessing abdominal adiposity. However, these measurements are expensive, impractical, and involve radiation exposure[5]. Anthropometric measurements are more accessible, cheaper, faster, and more straightforward. Waist circumference and SAD are better indicators of abdominal fat than other anthropometric measurements[6]. Waist circumference measurement includes abdominal height and width to describe visceral and subcutaneous fat[7], whereas SAD focuses on abdominal height, which describes the size of visceral fat[4].

Central obesity occurs due to a positive energy balance. The transition from adolescence to adulthood is identified as a period at risk for overweight, poor diet quality, and low physical activity[8]. Students are one of the population groups that often experience lifestyle

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changes. The tight lectures and campus activities schedule make students buy food sold on campus. Most of the food vendors around campus offer fast food. Moreover, students tend to consume food from street vendors, predominantly female students[9]. Research shows that Universitas Diponegoro students need better diet quality and adequate fibre, vegetables, and fruit intake, while total fat, saturated fat, and cholesterol are high[10].

Female students are included in the women of childbearing age group, one of the vulnerable groups, due to their role as future mothers for their children. The nutritional status of the preconception mother impacts the fertility process. Women of childbearing age who are overweight or obese are at risk of having ovulation disorders, disrupting the process of pregnancy and delivery. Therefore, women of childbearing age should achieve and maintain good nutritional status prior to the preconception period, prepare for pregnancy, and give birth to healthy children [11].

Dietary regulation generates some health benefits. Recent recommendations suggest that a diet high in vegetables, fruits, whole grains, and legumes and low in red and processed meats has the desired health outcomes[12]. Research on North Sumatra University students shows that they know and choose a vegetarian diet but still need to implement it. Some people want to be vegetarian, but sometimes they still want to eat meat. Therefore, a flexitarian diet offers a more flexible option. A flexitarian diet is a plant-based diet that reduces meat consumption at multiple meals, so animal product consumption is not entirely omitted. The flexitarian diet is considered sustainable because it does not require extra effort[13].

A plant-based diet is high in fibre, antioxidants, and plant protein and low in saturated fatty acids. Restricting animal products on a flexitarian diet can reduce incredibly saturated fat intake. Therefore, a flexitarian diet might help reduce body lipid levels[12]. Moreover, an observational study involving 773 subjects from the Adventist Health Study showed that adopting a flexitarian diet resulted in lower waist circumferences than non-vegetarians[14]. Similarly, Najjar et al. and Macknin et al. also found that a four-week plant-based diet resulted in a lower waist circumference[15,16]. However, few studies refer specifically to the flexitarian diet. In addition, research on plant-based diets, especially the flexitarian diet associated with waist circumference and SAD, has never been conducted in Indonesia. Based on this background, researchers are interested in analyzing the effect of a four-week flexitarian diet intervention on abdominal fat by measuring waist circumference and SAD in obese female students.

METHODS

Study Design and Participants

This study incorporated a quasi-experimental design with a pre-post-test control group and was conducted in Semarang from July to September 2021. The study has received ethical approval from the Health Research Ethics Committee, Faculty of Medicine, Diponegoro University/Central General Hospital Dr. Kariadi with No. 308/EC/KEPK/FK-UNDIP/VIII/2021. The target population of this study was obese female students aged 19-25 years, with the accessible population being obese female students aged 19-25 years in Semarang.

The sample size was calculated using the hypothesis test formula on the mean of the two independent test populations, using data on the standard deviation and the desired clinical differences obtained from previous studies. A consecutive sampling method was employed in this study. Inclusion criteria included: female students aged 19-25 years in Semarang, obese nutritional status (BMI >25 kg/m²) and waist circumference ≥80 cm, not pregnant or breastfeeding, did not smoke, have no infectious or chronic disease, not currently on a diet or weight loss program, willing to participate in this study and complete the informed consent. Exclusion criteria included sample dropout, illness or death during the study, and nonadherence to the study intervention (adherence rate <80% of intervention days). Based on the inclusion criteria, 24 participants were obtained. However, three participants (1 treatment group and two control groups) dropped out during the intervention period due to nonadherence to the intervention. In total, 21 people participated in this study (11 subjects from the treatment group and ten from the control group). The subjects in the case and control groups were randomly selected using a random number table.

Study participants were divided into the treatment group (P) and the control group (K). The four-week flexitarian diet treatment group included three main meals and two snacks, while the control group was not given any dietary intervention. However, both groups were given nutrition and obesity education through lecture methods and leaflet media. Educational material containing obesity, risk factors and impacts of obesity, treating obesity through diet management, increasing physical activity and behaviour modification. Education was given once to both groups for 2 hours and was carried out before intervention activities were given. The primary outcomes include the results of the waist circumference and SAD. The obesity education was conducted prior to the intervention period in all groups. At baseline, all study participants received directions on study techniques and procedures.

Data Collection and Measurement

The researcher gave the flexitarian diet gradually over a week's intervention period. The diet includes three main meals and two snacks. The frequency of eating animal sources is regulated for meat and poultry according to the diet stages, while fish and eggs (without yolk) are still allowed in the diet. The first week was labelled as the beginner stage (consumption of meat/poultry five days per week with a maximum amount of 147.4 grams per day or 1.5 to 2 portions per day), the second and third weeks were labelled as the advanced stage (4 days meat/poultry consumption with a maximum amount of 127.5 grams per day or 1 to 1.5 portions per day), and the fourth week labelled as expert stage (consumption of meat/poultry two days per week with a maximum amount of 127.5 grams per day or 1 to 1.5 portions per day)[17]. The diet was administered on five

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consecutive days, from Monday to Friday. Participants were allowed to consume the diet independently on Saturday and Sunday according to the researcher's direction. Trained researchers performed the monitoring process. The daily food intake was calculated based on weight, height, age, and activity level, which was then reduced by 500 kcal so that 1500 kcal was obtained. Carbohydrates, protein, and fat were given 50-60%, 13-16%, and 25-30% of energy requirements per day, respectively, with 25-35 grams of dietary fibre. In a day, study participants had three main meals and two snacks—300 kcal breakfast, 400 kcal lunch, 500 kcal dinner, and 150 kcal snacks each. The enumerator will deliver food three times before mealtime and evaluate food intake during the intervention. The study participant's adherence was monitored daily on an evaluation sheet via a Google form equipped with a consumed food picture attachment. In addition, WhatsApp groups were created for each treatment group to deliver information and motivation to study participants. Before the intervention, food intake data was obtained through the Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ). Food intake during the intervention period was assessed via a food recall 3x24 hours per week.

Anthropometric data were obtained before and after the intervention period. Bodyweight and per cent, body fat measurements were performed using the Tanita BC-730 Body Compact Composition Monitor with an accuracy of 0.1 kg. Body height was measured using a microtome with an accuracy of 0.1 cm. Waist circumference was measured using a MEDLINE with an accuracy of 1 mm, which was performed by looping the tape at the midpoint between the lower margin of the last palpable rib and the top of the iliac crest. Waist circumference indicating central obesity if >80 cm[18]. The SAD measurement uses a calibrated knee height calliper with an accuracy of 0.1 cm. SAD was measured lying, and the leg's knee was bent at a 90˚ angle. The measurement reading was conducted during expiration in the middle of the previously marked iliac crest[19]. The SAD measurement result was at risk if the value ≥19.3 cm[6]. All anthropometric measurements were performed twice and averaged. Physical activity as a confounding variable was obtained weekly through the International Physical Activity Questionnaire (IPAQ).

Data collection, which enables direct meetings with study participants, was conducted by implementing health protocols. For example, study participants were given a separate room, arranged arrival schedules, and a hand sanitiser or a place to wash their hands with soap. In addition, the researchers have been vaccinated and use personal protective equipment (masks, face shields, gloves, and lab coats).

Data Analysis

Univariate analysis was performed to obtain study participants' characteristics for each variable. Bivariate analysis was performed to assess differences in waist circumference. In addition, SAD in each treatment group was analyzedanalyzed using the paired t-test. The effect of flexitarian diet intervention on intake, waist circumference, and SAD between the two treatment groups was assessed using an independent t-test and the Mann-Whitney-u test. Finally, the ANCOVA test was performed to determine the precision of the treatment due to other uncontrolled variables.

RESULTS AND DISCUSSION

Study Participants Characteristics

There was no significant difference (p>0.05) in the study participant's characteristic data (age, BMI, per cent fat, waist circumference, SAD, physical activity, and nutrient intake) between the treatment group and the control group. This result shows that the baseline characteristics of study participants were the same in both groups. The study participants' characteristics and data are shown in Table 1.

Table 1. Characteristics of Subjects Before Intervention of Flexitarian Diet in Obese Female Student

Variable	Treatment	Control	p
	Mean±SD	Mean±SD	
Age (years)	22.2±1.4	21.9±1.4	0.656[a]
Weight (kg)	80.6±16.8	78.0±14.4	0.944[b]
Height (cm)	155.7±3.4	154.2±6.9	0.525[a]
BMI (kg/m²)	33.3±7.5	32.6±3.9	0.776[a]
Body fat (%)	44.3±6.9	43.3±4.6	0.719[a]
Waist circumference (cm)	95.6±10.9	93.9±11.7	0.744[a]
SAD (cm)	21.6±3.8	20.8±1.9	0.562[a]
Energy (kcal)	2559±460.6	2727±606	0.479[a]
Carbohydrate (g)	313.1±69.6	329.6±125.6	0.888[b]
Protein (g)	89.3±24.9	77.4±27.8	0.316[a]
Fat (g)	111.9±34.5	122±40.9	0.550[a]
Fibre (g)	12.5±5.9	14.7±7.8	0.622[b]
Physical activity (MET-min per week)	1670±1599.8	2197±1496.9	0.291[b]

*Signifikansi statistik p<0,05; [a]Uji Independent T-Test; [b]Uji Mann Whitney Test

Central obesity is at risk for disease because it is more metabolic than obesity in general[20]. Dietary interventions targeting abdominal fat are reported to have health benefits. Low visceral fat is associated with a lower risk of metabolic syndrome[21]. A plant-based diet has benefits in reducing abdominal fat. Previous studies have shown that adherence to a plant-based diet is associated with lower waist circumference[14,16,22,23].

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Nutrition Intake and Physical Activity during the Intervention Period

A Flexitarian diet for four weeks altered participants' food intake. Table 2 shows a significant difference (p<0.05) in energy, fat, and fibre intake. As for carbohydrate and protein intake, no significant difference (p>0.05) was observed. However, overall carbohydrate and protein intakes were lower in the treatment group than in the control group. In addition, physical activity variables showed a significant difference (p<0.05).

Table 2. Nutrition Intake and Physical Activity during Intervention Period of Flexitarian Diet in Obese Female Student

Variable	Treatment	Control	p
	Mean±SD	Mean±SD	
Energy (kcal)	1271±88.7	1780±706.8	**0.049[a]***
Carbohydrate (g)	190,7±12,2	221.9±82.7	0.266[a]
Protein (g)	53.3±4.3	60.9±22.5	0.398[b]
Fat (g)	40.6±5.6	73.7±42.2	**0.035[a]***
Fibre (g)	13.5±1.6	9.5±5.9	**0.024[b]***
Physical Activity (MET-min per week)	789±406.1	1362±443.8	**0.006[a]***

*Statistically significant p<0.05; [a]Independent T-Test; [b]Mann Whitney Test

A Flexitarian diet for four weeks influenced the difference in energy, fat, and fibre intake in the two groups. Differences in energy intake were due to a 500 kcal reduction from the daily requirement in the treatment group and food not consumed (usually from 15% carbohydrates, 46% vegetables, 5% side dishes, and fruit that can reach 100%). A flexitarian diet is a plant-based diet that reduces the consumption of animal products. Limiting the consumption of animal products on a flexitarian diet can reduce fat intake[13], further affecting the fat intake in the two groups. In addition, food processing in the control group is often fried. This study showed that fibre intake in the treatment group was higher. Although there is a significant difference in fibre intake, it does not follow the daily recommendation of 25-35 grams. During the implementatio of the intervention, motivation was continuously provided for the study participants. However, vegetable and fruit consumption awareness was still relatively low. This result can be seen from monitoring and evaluating dietary leftovers, which show that study participants do not finish the given vegetables or fruit. The vegetable consumption was around 54% of the portion served. In addition, varied results were observed for fruit consumption; sometimes, participants finished the given portion, while other participants did not eat it. Consumption of vegetables and fruit was challenging for the participants because they were not used to eating vegetables in large portions, while others did not like certain types of fruit. When independent meals were provided, fruit and vegetable consumption was less than the given portion (25% of the portion).

Anthropometric Profiles Differences in Treatment and Control Groups Before and After Intervention

Based on Table 3, the flexitarian diet influenced the anthropometric profile. For instance, waist circumference and SAD showed significant differences (p<0.05) in the treatment group after intervention. On the other hand, the SAD did not show a significant difference after the intervention (p=0.643) in the control group, but a significant difference (p=0.042) was observed for waist circumference.

Table 3. Anthropometric Profile of Subjects Before and After Intervention of Flexitarian Diet in Obese Female Student

Variable	Treatment Mean±SD		p	Control Mean±SD		p
	Pre	Post		Pre	Post	
Waist circumference (cm)	95.6±10.9	88.9±11.4	**0.003[b]***	93.9±11.7	91.4±10.8	**0.042[a]***
SAD (cm)	21.6±3.8	20.4±3.9	**<0.001[b]***	20.8±1.9	21.0±2.7	**0.643[a]**

*Signifikansi statistik p<0,05; [a]Paired T-Test

The anthropometric profile in the treatment group had a steeper decline than the control group. Changes in SAD showed a significant difference (p=0.010) between the two groups. However, changes in waist circumference did not show any significant difference (p=0.078) (Table 4).

Table 4. Differences in Anthropometric Profile Changes of Flexitarian Diet in Obese Female Student

Value Change (Δ)	Treatment	Control	p
	Mean±SD	Mean±SD	
Δ Waist circumference (cm)	-6.6±5.5	-2.5±3.4	0.078[a]
Δ SAD (cm)	-1.2±0.6	0.2±1.5	**0.010[b]***

*Statistically significant p<0.05; [a]Mann Whitney Test; [b]Independent T-Test

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There was a significant difference (p=0.006) between the treatment and the control group in the physical activity variable. Therefore, the differences in SAD changes might be due to the treatment or the differences in physical activity levels. Based on the results of the ANCOVA test shown in Table 5, physical activity has a significance value of 0.210 (p>0.05), so physical activity has no effect on SAD changes. Meanwhile, the significance value of dietary intervention was 0.006 (p <0.05), which means that dietary intervention had an effect on changes in SAD. An adjusted R Square value of 0.288 shows that diet and physical activity contributed 28.8% to changes in SAD, while the other 71.2% came from other unknown variables.

The anthropometric profile of waist circumference and SAD has changed. A calorie-restricted plant-based diet provides benefits for reducing waist circumference and SAD. After four weeks of administration, SAD values decreased by 1.2 cm and waist circumference 6.6 cm. A 2019 cohort study by Chen et al. in a middle-aged and elderly population showed that adherence to a plant-based diet was associated with a lower waist circumference (-2.0 cm)[22]. A similar study on a plant-based diet for four weeks in cardiovascular centre patients showed a decrease in waist circumference compared to baseline (-6.6 cm)[15].

Table 5. Variables Affecting Changes in SAD of Flexitarian Diet in Obese Female Student

Variable	p	Adjusted R^2
Corrected model	0.018	0.288
Intercept	0.605	
Physical Activity (MET-min per week)	0.210	
Treatment (diet and not)	**0.006***	

*Statistically significant p<0.05; Dependent Variable: Δ SAD; ANCOVA test

Calorie restriction in the diet can play a role in reducing abdominal fat. A systematic review of reduced visceral and subcutaneous adipose tissue revealed that calorie restriction resulted in higher visceral and subcutaneous fat reductions than the treatment group with calorie restriction and exercise and the treatment group that only had exercise modification [24]. Another abdominal fat loss trial with a calorie-restricted diet intervention also found decreased abdominal visceral and subcutaneous fat[25,26]. Caloric restriction induces lipolysis of subcutaneous fat stimulated by increased adrenaline. During a negative energy balance, the response to β-adrenergic stimulation of lipolysis is maintained, and the antilipolytic effect of α2-ARs is reduced so that the lipolytic response to adrenergic stimulation is enhanced. Lipolysis via adrenaline catecholamines is enhanced due to decreased α2-adrenergic response[27]. In addition, visceral fat is also sensitive to catecholamine stress signals. Catecholamines act through β-adrenergic receptors in adipocytes, inducing increased levels of cAMP, which activate protein kinase A and ultimately increase lipolysis[28]. Loss of visceral fat is mainly due to the urgent need for energy when an acute negative energy balance utilizes metabolically active fat stores[29].

The current study shows a correlation between nutrient intake and abdominal fat accumulation[30]. A plant-based diet offers fibre-rich food, antioxidants, vegetable protein and unsaturated fatty acids. A study on adopting a plant-based diet found that it produces the best adiposity and does not require completely eliminating meat or animal product consumption. However, this result can be achieved with a moderate reduction of animal products[22]. Reducing animal food consumption in a flexitarian diet can reduce saturated fat intake[31,32]. Excess saturated fat intake induces visceral fat accumulation, while unsaturated fat intake is known to have protective effects against visceral fat accumulation [33,34]. Consumption of monounsaturated fatty acids, omega-3 and omega-6, was inversely related to the accumulation of subcutaneous fat. Unsaturated fatty acids have a higher oxidation rate than saturated fat, which prevents fat accumulation35. Fat intake was lower in the treatment group. The control group was free to consume animal products and processed foods, which were often fried, resulting in higher fat intake. Fat will be absorbed as chylomicrons, which are transported to the liver and converted into fat fractions in the blood. According to their function, excessive fat intake triggers fat accumulation in adipose tissue, especially in the abdominal area[23].

Adopting a flexitarian diet increases the consumption of vegetable protein and reduces animal protein. A study on postmenopausal women in Korea who followed a flexitarian diet found that vegetable protein intake was higher than animal protein[36]. Increased vegetable protein and reduced animal protein contribute to adiposity[37]. Animal protein such as red meat and its processed products are energy-dense foods, usually high in cholesterol and saturated fat, thereby contributing to the accumulation of body fat. In addition, consumption of animal protein is associated with increased stimulation of insulin and insulin-like growth factor (IGF-1). IGF-1 is associated with adiposity proliferation and differentiation. Dietary intake from plant food sources showed lower circulating levels of IGF-1. In addition, consumption of vegetable protein was associated with lower energy, total fat, cholesterol, saturated fat and a higher PUFA: SFA ratio[38,39]. Subjects with normal WHTr had a higher vegetable protein intake and lower animal protein intake than subjects with central obesity. Consumption of animal protein was positively related to WHTr, while consumption of vegetable protein had a negative relationship with WHTr[38]. Research on a Belgian population aged 15 years or more showed that animal protein consumption increased waist circumference in male subjects. In contrast, vegetable protein decreased waist circumference in men and women [39].

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Carbohydrate intake between the two groups did not show a significant difference during the intervention, although the treatment group showed lower results. A study found that carbohydrate intake is not associated with visceral fat changes[40]. However, Tayyem et al. 2019 found that subjects with the highest visceral fat had a higher carbohydrate intake than subjects with the lowest visceral fat[30]. Similar results were also shown in another study where a low-carbohydrate diet intervention in obese female subjects resulted in a more significant reduction in waist circumference than the control group [41].

A flexitarian diet can significantly increase daily fibre intake in the treatment group than in the control group before the intervention. However, the amount of fibre consumed by study participants was still less than the recommended daily fibre intake. Increased fibre intake is associated with lower adiposity. Intake of total fibre and insoluble fibre is associated with the degree of visceral fat accumulation. A decrease in fibre intake of 3 g/1000 kcal/day significantly increased visceral adiposity, whereas increased fibre intake decreased visceral adiposity[42]. Research by Hairston et al. stated that soluble fibre intake was also inversely related to visceral fat accumulation. For every 10 g increase in soluble fibre, there was a 3.37% decrease in visceral fat over five years, whereas a decrease in fibre was associated with an increase in visceral fat43. Fibre has a lower energy content, slows the gastric emptying rate, and induces a more prolonged feeling of fullness. Insoluble fibre will shorten the transit time, so digestion and absorption of nutrients are more efficient. This fibre is fermented in the large intestine, producing short-chain fatty acids (SCFA). SCFAs act as free fatty acid receptor (FFAR) ligands. FFAR activation triggers an increase in the expression and secretion of enteroendocrine hormones, such as glucagon-like peptide-1 or peptide YY, that affect satiety. In addition, high-fiber foods usually contain phytoestrogens—for example, isoflavones, which are inversely related to visceral adiposity[35,42,43]. During the flexitarian diet, the subject did not feel any negative impact on the body; the subject felt it was easy to defecate and did not get tired or hungry.

Physical activity during the intervention between the treatment group and the control group showed a significant difference. The control group had higher physical activity. Based on data from the IPAQ questionnaire, it was found that the treatment group had low and moderate levels of physical activity with a duration of about 25 minutes. The control group had low, moderate, and high physical activity levels for about 45 minutes. This higher physical activity may play a role in decreasing waist circumference in the control group. Exercise is reported to induce activation of the sympathetic nervous system, which activates brown adipose tissue to release stored energy. Exercise induces the secretion of lipolytic hormones, facilitating more significant energy expenditure and fat oxidation[25]. A study involving obese women as study participants show that moderate and heavy intensity exercise significantly reduces waist circumference[44]. Friederichs et al.'s study on increasing the volume of aerobic exercise found a significant difference in the decrease in subcutaneous fat but not in visceral fat[45]. SAD in the control group did not show a significant change. In line with the findings in Gemert et al.'s study on abdominal fat, it was shown that increased exercise did not affect specific visceral fat loss compared to the diet group[25,26]. Accumulated visceral fat is more resistant to insulin than subcutaneous fat. Insulin can induce de novo inactivation of lipogenesis, so visceral fat will be more challenging to inactivate insulin-induced de novo lipogenesis[30]. In addition, adiponectin expression levels were more significant in subcutaneous fat than visceral fat. Peroxisome proliferator-activated receptor (PPAR-α)-mediated adiponectin signalling increases metabolism and fatty acid oxidation[46]. Research with aerobic or resistance exercise interventions takes eight weeks to reduce visceral fat in overweight or obese adult subjects [47]. A meta-analysis of obese adult subjects also showed that an exercise intervention carried out for at least eight weeks reduced visceral fat[48]. So far, no evidence of interventions targeting specific fat deposit reduction exists.

CONCLUSIONS

The adoption of a flexitarian diet in obese female students resulted in a significant change in SAD between the two groups. However, the two groups had no significant difference in waist circumference. The treatment group had a more significant reduction.

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Conflict of Interest and Funding Disclosure

All authors have no conflict of interest in this article.

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