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ORIGINAL ARTICLE

Adherence to the Mediterranean Diet and anthropometric profile of obese Algerian subjects

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Abstract

Background: Obesity is currently considered an increasingly more severe social and health-related problem. The World Health Organization qualified obesity as a chronic disease associated with several chronic complications such as circulatory diseases, diabetes, cancer, and respiratory diseases. **Aims**: We aim to establish the correlation between Adherence to the Mediterranean Diet MD and the anthropometric profile of obese Algerian subjects. **Subjects and Methods:** Our study included a cohort of 104 subjects. 47 subjects were at a normal weight and 57 subjects with an overweight (a body mass index BMI of 26 to 35 Kg/m^2). Assessment of anthropometric profile took into account the BMI and body composition. The adherence to the MD was assessed using Mediterranean Diet Score MDS. **Results:** there is a positive correlation between adherence to MD and anthropometric parameters in obese subjects. **Conclusions**: The Mediterranean diet could positively impact comorbidities accompanying this disease that poses a major public health problem.

Keywords: Obesity, Mediterranean Diet, anthropometric profile, body mass index, Mediterranean Diet Score.

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1 Introduction

Obesity is excess fat with adverse health consequences, because of the many complications that it generates during its evolution. The prevalence of obesity has increased significantly since the eighty years. The phenomenon, first noted in the United States, has spread to other developed countries. This increase was also observed in developing countries [1]. According to the World Health Organization (WHO), more than 1.6 billion adults are overweight and more than 400 million are obese worldwide [2]. The achievement of a very large geographical area and an exceptionally high proportion of the population are thus compatible with the concept of obesity pandemic. Developing countries are experiencing phenomena of demographic transitions (lower fertility and increased life expectancy) and social (improving economy, urban migration, and mechanization of the environment) [3]. In Algeria, according to the latest statistics from the Ministry of Health, Population and Hospital Reform, 21% of Algerian women are obese. This prevalence is lower in men with an obesity rate of 9%. In another study, the prevalence of obesity was 24, 9% (12, 7% for males and 66, 4% for females)[4]. A high statistics, which makes Algeria the Maghreb country with the highest number of obese people.

Among the different nutritional strategies, the Mediterranean diet (MD) is commonly recognized as a health-promoting dietary pattern due to its peculiar features [5], including the regular consumption of unsaturated fats, low glycemic index carbohydrates, fiber, vitamins and antioxidants, and a moderate amount of animal-derived proteins [6-9].

Several studies showed that the follow-up of a Mediterranean-type diet provides, in primary prevention, a significant benefit in terms of overall and cardiovascular mortality, diabetes, obesity, cancer, Alzheimer's, and Parkinson's diseases [10-14].

The Algerian diet, like the rest of the Maghreb, is a diet particularly high in cereals because they provide more than 50% of the energy and protein intake. This diet is also rich in fruits and vegetables and therefore rich in vitamins, antioxidants, and fiber. In addition, the Algerian diet is low in total fat, low in saturated fat and the oils are essentially vegetable with frequent use of olive oil. The consumption of animal products is also very low and the consumption of fish and seafood is frequent in the coastal regions in the north of the country. Nevertheless, global changes concerning the eating habits of Algerians are observed in recent times, and the diet is becoming more and more Western-type rich in fat and sugars and an increasingly rare consumption of vegetables and fruits leading to the emergence of chronic diseases.

The objective of our study is to establish the correlation between Adherence to the Mediterranean Diet MD and anthropometric profile of obese Algerian subjects and know the link between the body composition of obese subjects and the influence of the quality of the diet consumed on it.

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2 Subjects and Methods

2.1 Study design and subjects

Our study is a cross-sectional descriptive study with prospective data collection, involving 104 subjects aged between 40 and 58 years old including 47 subjects at a normal weight and 57 subjects with obesity an overweight followed for their metabolic disorder during specialized clinical nutrition consultation, where the various measurements and clinical data were taken on the day of consultation.

The observational work is carried out over two years (2017-2019). Obese and overweight subjects are defined as a body mass index BMI (weight in kg/height in m^2) greater than 24.9 Kg/m^2 and 29.9 Kg/m^2 successively.

2.2 Instruments

All of the anthropometric measurements were taken with subjects only wearing light clothes and without shoes. In each subject, weight and height were measured to calculate the BMI. Height was measured to the nearest 0.5 cm while using a wall-mounted stadiometer (Seca 711; Seca, Hamburg, Germany). Body weight was determined to the nearest 0.1 kg while using a calibrated balance beam scale. BMI was classified according to World Health Organization's criteria with normal weight: 18.5–24.9 kg/m^2; overweight, 25.0–29.9 kg/m^2; obesity ≥ 30.0 kg/m^2.

The adherence to the MD was assessed using Mediterranean Diet Score (MDS) developed by Trichopoulou and colleagues [15, 16], this score indicating compliance to the Mediterranean diet. A high intake of Mediterranean foods: cereals, legumes, fruits, vegetables, olive oil, and fish were scored positive (1) and a high intake of the non-Mediterranean foods: dairy and meat negative (0).

Adherence to the Mediterranean diet is estimated by an adhesion score ranging from 0 to 9, from which three levels of adhesion are released: low for a score of 0 to 3, moderate for a score of 4-5, and adhesion strong from 6 to 9. This score represents a good tool for evaluating adherence to the MD.

A scale indicating the degree of adherence to the traditional Mediterranean diet was constructed by Trichopoulou *et al.* A value of 0 or 1 was assigned to each of nine indicated components with the use of the sex-specific median as the cutoff. For beneficial components (vegetables, legumes, fruits and nuts, cereal, and fish), persons whose consumption was below the median were assigned a value of 0, and persons whose consumption was at or above the median were assigned a value of 1 (Table 1).

Mediterranean diet and is estimated using a frequency questionnaire evaluating the weekly consumption of the main components of this food model [15]. The data were recorded by the patient at home and given to the dietitian to calculate adherence level and caloric intake. The data were recorded in Arabic and French and then translated.

2.3 Materials availability

The body composition was assessed by bioelectrical impedance meter type BODYSTAT 1500 MDD. It works by passing a safe battery generated signal through the body and measuring the impedance at two frequencies of 5 kHz and 50 kHz allowing also a fairly reliable estimate of the energy needs of the body. Once the test has been performed, the Display Options are shown within five seconds. A complete body composition analysis is displayed comprising Body Fat (Kg and %), Lean Body Mass (Kg and %), Dry Lean Mass (Kg and %), Total Body Water (L and %), and Optimal Ranges (Kg, L and %) [17].

All the rest of the material was available for the realization of the different measurements.

Table 1: Components of the Mediterranean diet score and scoring system [9]

How often do you consume?	Score = 1	Score = 0
All cereals (bread, pasta, rice, etc.)	Above the median	Below the median
Fruits and nuts	Above the median	Below the median
Vegetables	Above the median	Below the median
Legumes	Above the median	Below the median
Fish and sea food	Above the median	Below the median
Meat and meat products	Below the median	Above the median
Full fat dairy product	Below the median	Above the median
Monounsaturated / saturated fat ration	Above the median	Below the median
Alcohol	5 – 25 g/ day for women 10 to 50 g/ day for men	Abstainers

2.4 Statistical analysis

Statistical analyses were performed using the Statistical Package for Social Sciences software, version 24 (IBM SPSS, Chicago, IL, USA). Parametric variables were analyzed using Student's t-tests and analysis of variance (ANOVA) to examine the differences in the measurements of the biological and anthropometric parameters. A two-sided value of less than 0.05 was considered statistically significant.

2.5 Ethics consideration

Patients have been informed of the purpose of the study and are assured of the confidentiality of the data collected. Their consent has been given for the use of the information collected and the results obtained. The study has been carried out in accordance with the Code of Ethics of the World Medical Association for experiments that involved humans. The aim of the study was

Table 2: Adherence to the Mediterranean Diet and anthropometric parameters of study population, total and by gender (n = 104)

Anthropometric profile	Obese subjects (n=47)		Normal weight subjects (control) (n=57)		P value
	Men (n=19)	Women (n=28)	Men (n=31)	Women (n=26)	
Weight (Kg)	91.2 ± 9.5	97.7 ± 7.7	73.2 ± 3.7	64.8 ± 2.8	< 0.001
Height (cm)	177.1 ± 2.8	155.7 ± 4.6	172.8 ± 4.2	161.5 ± 3.2	NS
BMI (kg/m²)(mean ± SD)	31.7 ± 1.6	33.2 ± 2.4	22.8 ± 2.1	20.9 ± 3.8	< 0.001
Waist circumference (cm)	117.4 ± 9.1	111.2 ±4.6	91.5 ± 3.8	77.4 ± 2.2	< 0.001
Bioelectrical impedance analysis					
Fat mass (kg)	39.4 ± 5.8	48.5 ± 3.6	14.1 ± 4.1	16.7 ± 2.4	< 0.001
Fat mass (%)	43.2 ± 3.9	49.6 ± 2.7	19.2 ± 3.1	25.7 ± 1.4	< 0.001
Fat free mass (lean mass) (kg)	51.8 ± 7.4	49.2 ± 4.7	59.1 ± 3.6	48.1 ± 1.6	< 0.001
Fat free mass (%)	56.7 ± 5.7	50.3 ± 3.3	80.7 ± 1.6	74.2 ± 2.9	< 0.001
Total body water (L)	44.6 ± 5.6	42.9 ± 4.4	46.6 ± 2.6	43.8 ± 2.9	NS
Total body water (%)	48.9 ± 1.6	43.9 ± 2.3	63.6 ± 1.1	67.5 ± 1.4	< 0.05
MDS score %					
low adhesion (0 to 3)	65.4	59.7	37.9	31.6	< 0.05
moderate adhesion (4 to 5)	23.4	27.2	33.4	29.8	< 0.05
strong adhesion (6 to 9)	11.2	13.1	28.7	38.6	< 0.05

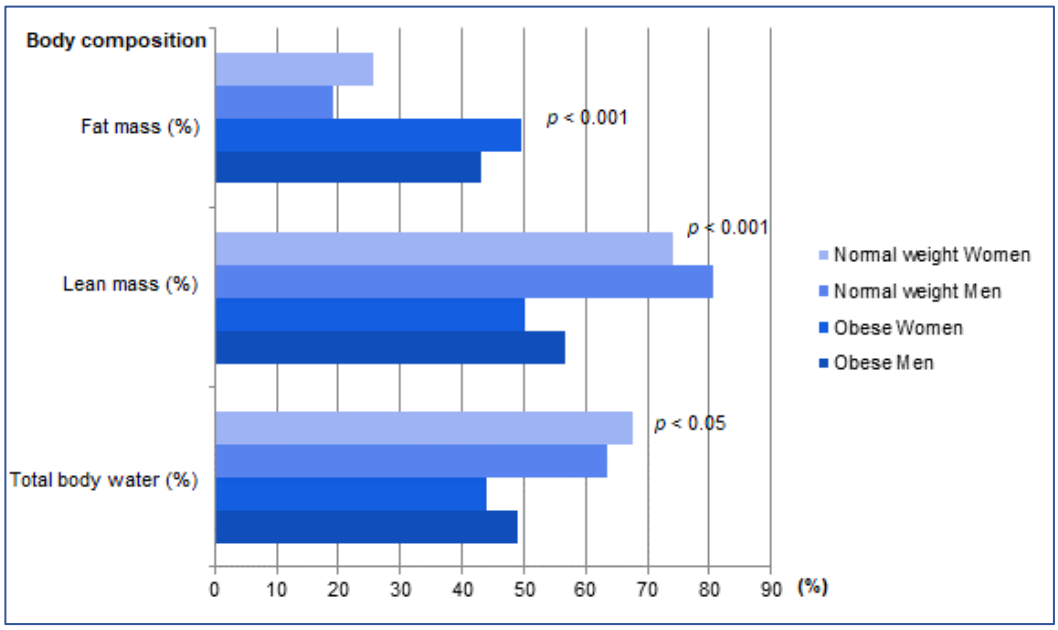

Figure 1: Body composition of obese subjects

clearly explained to all of the study participants and a written informed consent was obtained.

2.6 Inclusion criteria

Subjects are included in the study

- With obesity (BMI > 29.9 kg/m²) or overweight (BMI= 25 – 29.9 kg/m²)
- Normal weight subject without metabolic disorder (BMI = 18.9- 24,9 kg/m²)
- Of both sexes
- Over 40 years of age
- Followed in the course of our clinical nutrition consultation

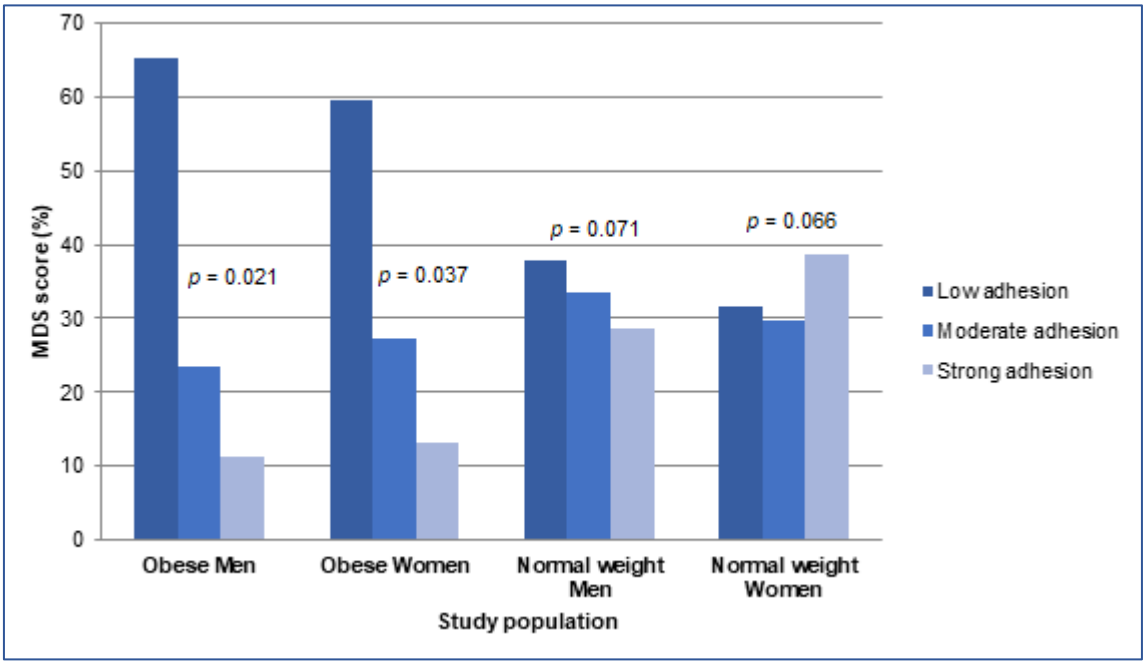

Figure 2: MDS score of obese subjects

2.7 Exclusion criteria

Subjects carrying the following drugs are excluded from the study

- Peripheral edema or ascites;
- Difficulty in verbal communication ;
- Endocrine pathologies ;
- Skin pathologies that prevent anthropometric measurements from being taken;
- BMI ≤ 15 kg/m^2 or ≥ 40 kg/m^2 (whose bioelectrical measurements are not validated)

3 Results

It is found in our study, a high value in basal energy expenditure in obese subjects compared to control subjects is 1927 Kcal versus 1470 kcal (P < 0.001). It is also observed a lower lean mass only of man obese subjects compared to normal-weight subjects (56.7 ± 5.7 % vs 80.7 ± 1.6 %); the difference is significant (p < 0.001). There is also a significant correlation between the low MDS score and high BMI (p < 0.001) and the high body fat (p < 0.005) of both sexes (Table 2).

Obese subjects with the lowest adherence (score less than 3 points) had higher weight gain than participants with a score greater than 6 points (strong adherence) (Figure 2). This eating model can thus be recommended to slow down the weight gain linked to age.

4 Discussion

The objective of our study is to assess the association between the adhesion to the Mediterranean Diet and the anthropometric profile of obese subjects.

Obesity is not only the cause of a significant increase in morbidity and mortality but also of various disabilities or handicaps and a decline in quality of life. The direct economic health costs of obesity in Europe represent 2-8% of health expenditure and are therefore comparable to those of other diseases such as cancer [18]. Obesity is undoubtedly one of the major health challenges, a veritable epidemic explosion, and a genuine chronic pathology. Above all, obesity is a privileged provider of numerous co-morbidities dominated by metabolic and cardiovascular diseases, thus increasing the risk of mortality and hindering the obese person's quality of life [19, 20].

In Algeria, the prevalence of obesity has worryingly increased in recent years mainly among women, which requires the implementation of a health strategy to change the eating habits of the population and promote physical activity as a means to fight against this pathology. The Mediterranean diet has been identified as an effective means for the prevention of obesity-related diseases[21]. This type of diet is characterized by high consumption of vegetables, fruit, nuts, cereals, whole grains, and olive oil, as well as moderate consumption of fish and poultry, and low consumption of red meat, dairy products, and high carbohydrate foods [22]. From a nutritional point of view, the Mediterranean diet provides an adequate supply of dietary fiber, antioxidants, and essential fatty acids with a balanced intake of ω-6 and ω-3 fatty acids [23,24].

In spite of these nutritional facts, people adhere less and less to the Mediterranean diet in our region due to the spread of western-style diets and fast food rich in saturated fats and high glycemic index carbohydrates [25]; on the other hand, many people think they are eating a Mediterranean diet by confusing the foods that make

up this type of diet or due to a lack of information on the definition of the Mediterranean diet [26].

This has been confirmed by our study, where a low adherence to the Mediterranean diet (score between 0 and 3) was found in more than 65% of obese men and more than 59% of obese women compared to subjects with a normal weight (37.9% in men and 31.6% in women) ($p<0.05$). In parallel, a high adherence (score 6 to 9) was found in normal-weight subjects compared to obese subjects in both sexes, as it was found that this high adherence was more noticeable in women compared to men in both obese and normal-weight subjects (Table 2).

Concerning the body composition of the subjects studied, the bioelectrical impedance allowed us to know in detail the distribution of fat and non-fat mass as well as total body water. The results of our study support the following assumptions: The average fat mass is highest in obese subjects; it is about 43% in men and higher in women with an average of 49 % of the total body weight, compared to normal-weight subjects, where the fat mass was on average 19% in men and about 25% in women ($p<0.001$) as opposed to the non-fat mass, or the latter is lower in obese subjects compared to normal-weight subjects. We have also found in our work that the lean mass rate is proportional to the weight (inflation adipose tissue is accompanied by and decrease in lean mass). This result confirms the decrease in lean mass in obese subjects reflecting sarcopenic obesity. Multiple interactions between fat and muscle exist; a model indicating interrelationships between adipose tissue and muscle, which may underpin mechanisms leading to a decrease in lean mass is reproduced [27]; obesity is associated with reduced physical activity, which in turn leads to reductions in muscle mass, muscle strength, and even lower physical activity and decreased endurance [28]. On another hand, as fat mass increases, secretion of Leptin and other adipokines and cytokines could also contribute to the development of sarcopenic obesity [28].

The adherence to the Mediterranean Diet has a direct influence on the distribution of body fat. Furthermore, our work revealed a positive correlation between adherence to the Mediterranean diet and the degree of fat mass in both sexes ($p< 0.05$). Thus obese subjects with a high-fat mass had low adherence to the Mediterranean diet (more than 88% of obese men and more than 86% of obese women had either low or medium adherence) in contrast to subjects of normal weight, where adherence to the same diet was inversely proportional to the degree of fat mass.

One of the best-studied diets for weight loss and cardiovascular health is the Mediterranean diet. This latter is characterized by a low-calorie diet rich in mono-saturated and polyunsaturated fatty acids such as ω-3 provided by fish, olive oil, and whole grains and nuts, in addition, this diet is rich in fiber and antioxidants and micronutrients provided by fruits and vegetables [29]. In obese adults, the Mediterranean diet led to more weight loss than did a low-fat (30% of calories from fat) diet [30]. In another study, which randomized individuals with the metabolic syndrome to either a prudent diet (fat <30% daily energy intake) or a Mediterranean diet, found that after 2 years, mean body weight loss was higher in patients following the Mediterranean diet than in those following the low-fat diet (4.0 kg ± 1.1 versus 1.2 kg ± 0.6; P <0.001) [31]. In a more recent study, Michaëlsson et al, found in their study that there is a correlation between adherence to the Mediterranean diet and BMI in a group of obese subjects, this correlation was also present for cardiovascular complications in these subjects [32].

In our study, we were able to establish a link between adherence to the Mediterranean diet and the anthropometric profile of obese subjects, where we found a positive correlation between an increase in fat mass, a decrease in lean mass, and low adherence to the Mediterranean diet. In parallel, obese subjects who had high adherence to the Mediterranean diet had, on the contrary, a higher lean mass with a low-fat mass. This can be explained by the role of the Mediterranean diet in reducing inflammatory markers responsible for muscle damage in obese subjects (cytokines, TNF-α, etc.), this role was detailed in the literature through various studies that have proven the importance of this type of diet in the reduction of inflammatory processes [33-35].

However, the Mediterranean diet can also influence food intake through the role of oleic acid strongly present in olive oil. This monounsaturated fatty acid is used during the production of oleoylethanolamide OEA in the intestine, a hormone that increases satiety [36-38], which may also explain the decrease in BMI and fat mass in both obese and normal-weight subjects who had a strong adherence to the Mediterranean diet in our study.

5 Conclusions

The Mediterranean diet resulted significantly associated with weight status and body composition in obese subjects in Algeria. These results underline the importance of providing lifestyle and dietary habits education to prevent overweight and obesity. Obese subjects present a deficit of lean mass and are therefore sarcopenic. This imposes the introduction of endurance physical activity in these subjects in order to increase their lean mass and accelerate their basic metabolism, which is still beneficial for weight loss. Due to the complexity in inducing lifestyle changes, a multilevel approach, involving the family and the environment is highly desirable. Bioelectrical impedance meter is a tool for exploring body composition and can be used in the monitoring and management of obese subjects in clinical practice.

Ethical approval: The study has been carried out in accordance with the Code of Ethics of the World Medical Association for experiments that involved humans. The aim of the study was clearly explained to all of the study participants and a written informed consent was obtained.

Author contribution: L.R. conceived and designed the study, and undertook the literature research. All authors participated in the experiment and data acquisition, Anthropometric analyses during nutrition consultations; calculates score and statistics. A.G. performed the data analysis, carried out the statistical analysis, prepared, reviewed, and drafted the manuscript. All authors approved the final version before submission. All authors have read and agreed to the published version of the manuscript.

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