Effect of the Mediterranean Diet on BMI in Middle-Aged Hispanic Women with Pre-Obesity and Obesity Central Washington State

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Abstract

Background: Conclusive evidence has yet to emerge regarding the effectiveness and applicability of the Mediterranean diet on middle-aged Hispanic women, the largest female minority group in the United States who is at-risk of metabolic disorders. **Objective:** The aim of this study is to evaluate the effect of the Mediterranean diet (MED) on the BMI in middle-aged Hispanic women with pre-obesity and obesity in Central Washington State. **Design:** A prospective study was performed to determine the effect of Mediterranean diet on the BMI of 67 Hispanic women with pre-obesity and obesity between 45 to 65 years of age in Central Washington State. The study was carried out for eight weeks. Dietary adherence was monitored to ensure consistent results. **Results:** The proportion of Hispanic women who reported a reduction in BMI was 94%, with a decrease in mean BMI after eight weeks of 2.8 (95% CI: 2.5 to 3.0) and P = 0.02, with an odds ratio of 2.6. Multiple linear regression analysis was used to adjust for age, education, physical activity, and smoking. **Conclusion:** The reduction in BMI demonstrates that the Mediterranean diet can be a promising, culturally appropriate therapy to address the obesity epidemic that is prevalent among Hispanic women.

1. Introduction

Obesity is a risk factor for the two leading causes of death in the United States

and the second leading cause of preventable death worldwide [1]. Classified as a chronic disease by Medicare in 2004, obesity is considered one of the most prevalent, costly, and preventable medical problems in the United States [2]. Over 50% of the population in rural areas of Central Washington State is characterized as Hispanic [3]. Despite being the largest, fastest-growing female minority group in the U.S., Hispanic women (Latinas) report higher rates of pre-obesity (BMI: 25 - 29.9 kg/m^2), obesity (BMI ≥ 30 kg/m^2), and metabolic disorders [3] [4] [5]. With low-income, limited access to basic medical services, and high uninsured rates, Latinas in Central Washington State are a vulnerable population that creates great economic and public health burden in the country [6]. Studies confirm that a proper diet is an important component in the prevention and management of obesity. Previous studies on Mediterranean diet (MED) have focused on the anti-inflammatory and neurocognitive effect on non-Hispanic populations but have not determined its effectiveness and applicability on middle-aged Latinas in Central Washington State, which is an underserved population [7] [8]. The aim of this study is to examine the effect of the Mediterranean diet on the body mass indices (BMIs) in middle-aged Hispanic women with pre-obesity and obesity in Central Washington State.

2. Methods

2.1. Description of Diet

A cohort of 67 middle-aged Hispanic women was recruited with pre-obesity (BMI of 25 - 29 kg/m^2) and obesity (BMI of ≥30 kg/m^2) and was placed on the Mediterranean diet for eight weeks. The low rates of coronary heart disease in the Mediterranean countries stimulated interest in the metabolic health benefits of this diet [9]. The important components of this lifestyle include a high polyphenol and fiber content, a rich variety of fruits and vegetables, healthy protein sources, and polyunsaturated fatty acids (**Figure 1** and **Table 1**). It is important to understand that the Mediterranean diet is a way of eating, not simply a compendium of recipes. Many observational studies show decreased rates in diabetes type 2, obesity, and cardiovascular disease in individuals adhering to a Mediterranean diet [10].

2.2. Sample Description

The population of interest consisted of all Hispanic women with pre-obesity or obesity, living in Central Washington State. **Table 2** includes the eligibility criteria for both inclusion and exclusion of participants in the study. Passive recruiting methods were employed to enroll the participants through television announcements in local channels seen in the Northwest United States. Interviews were conducted on 83 responders, 16 were disqualified, based on the selection criteria (**Table 2**), thus 67 participants were integrated into the study. A probability sampling technique, known as stratified sampling, was employed to ensure adequate representation of females within the middle-aged range. *Target Sample*

Figure 1. Mediterranean diet pyramid (center). Food groups (right) and servings (left).

Table 1. Mediterranean diet.

Food Component	Example	Servings	Clinical Features
Whole grain cereals, legumes	Brown rice, wheat, beans	2 - 3 per day	Fiber-rich; associated with early satiety and reduced obesity [11]
Vegetables, fruits	Apples, green leafy vegetables	3 - 4 per day	Antioxidant-rich; associated with reduced cellular damage [12]
Fish	Salmon, cod, tuna	3 - 4 per week	Omega 3-rich; associated with improved cardiovascular health and reduced mortality [13]
Poultry, eggs, dairy, meat	Chicken, yogurt, beef	1 - 2 per week	Rich sources of amino acids and saturated fats

Table 2. Selection criteria.

Inclusion Criteria	Example
Demographic Characteristics	Hispanic women 45 to 65 years of age
Geographic Characteristics	Living in Central Washington State
Clinical Characteristics	BMI ≥ 25
Temporal Characteristics	From Jan 25 to March 25, 2019

Exclusion Criteria	Example
Demographic Characteristics	Younger than 45 or older than 65 years of age
Geographic Characteristics	Living outside Central Washington State
Clinical Characteristics	History of bariatric surgery, on weight loss pharmacotherapy, or BMI < 25

Size. The statistical power calculation was computed to detect the minimum difference between the means in BMI. To have a 90% probability of detecting a 4-point difference in BMIs (in kg/m^2), at least 66 participants needed to be

enrolled, assuming an overall standard deviation in BMI scores of 10 points and a one-tailed alpha-level of 5%.

2.3. Procedures

Anthropometric measures were obtained (using Health O Meter Professional scale), which included weight and height. Body Mass Index (BMI) was calculated as kilograms divided by meters squared. BMI is a recommended standardized marker of obesity because it is independent of variables, such as ethnicity and sex [14]. A trained research assistant weighted and measured women by using standardized procedures shown in Table 3. At the beginning of the study, the subjects received a nutritional assessment questionnaire (**Appendix A**), which included nutritional and dietary history, physical activity evaluation, weight history, weight loss pharmacotherapy history, surgical procedure history, and screening for motivational level to complete the program. Evaluation tools, including 24-hour dietary recall and food frequency questionnaires (**Appendix B**), were implemented at the end of each week, to enhance awareness of eating patterns and to measure adherence level. Group support programs were conducted every week, to promote stronger adherence with the dietary regimen. Written consent forms were obtained from all women in either Spanish or English prior to the study. The consent forms and recruitment script were carefully designed to avoid excessive information and reduce response bias.

Missing Cases. Two of the 67 participants dropped out during the eight-week study (attrition rate = 2.9%). The data of these participants was included as part of the final analysis, to reduce the likelihood of migration bias.

2.4. Screening for Covariates

This study examined for socio-demographic confounders that may impact BMI, such as age, education, smoking, and physical activity level. Multiple linear regression model was used to analyze the outcome variable and odds ratio to measure the association between exposure (e.g., following the MED) and the outcome (e.g., reduction in BMI).

2.5. Analysis

This study compared the difference in means between the BMI before and after the MED administration. The statistical significance of the difference in means of BMI was assessed using the t-test. A one-sided (lower-tailed) t-test was selected with the alpha level set at 0.05. The lower-tailed result was of interest, because only a reduction in BMI in individuals with pre-obesity and obesity is clinically meaningful. Next, multivariable linear regression analysis was used to adjust for the effects of potential confounders, such as age (as a continuous variable), education, smoking, and physical activity (as dichotomous variables), respectively (Table 4). All statistical analyses were conducted in 2019 with IBM SPSS Statistics, version 24.0. The t-test statistics were one-sided and statistical significance was defined as $P < 0.05$.

Table 3. Standardization.

Methods	Source of Random Error	Example of Strategy
Measurement methods	Observer	Assigned a trained assistant to obtain BMIs
	Subject	Specified participants to remove heavy clothing
Refining the instrument	Instrument	Properly calibrate the scale prior to the study
Repeating the measurement	Observer, Subject, and Instrument	Used the mean of two or more BMI readings

Table 4. Multiple regression analysis.

Independent Variables	Coefficient (β)	Standard Error	t Stat	P-value
Intercept	18.66	2.56	7.28	<0.001
Age	0.13	0.04	2.80	0.006*
Smoking	−0.19	0.89	−0.21	0.83
Exercise	0.39	0.94	0.41	0.68
Education	−0.02	0.75	−0.02	0.97

*The greatest magnitude of association of all the independent variables.

3. Results

3.1. Socio-Demographic Characteristics

A cohort of 67 middle-aged Hispanic women were recruited with pre-obesity and obesity and were placed on the Mediterranean diet for eight weeks. The participants self-reported to adhere to the Standard American Diet (SAD) before the study. The summary statistics for this study are presented in Table 5. Most women were from Mexican origin (81%) and the remainder from Central and South America (19%). The classification of Hispanic ethnicity was according to the U.S. Department of Health and Human Services Office of Minority Health (2008) [15]. The mean age was 53.3 (SD = 6.3; range = 45 - 65). Occupation during the study was as follows: field workers, 65.2%; factory workers, 20.4%; housekeeping, 9.3%; daycare, 2.6%; other, 2.5%. Most women reported Spanish as their primary language (97.7%; English, 2.3%). Most women reported no education (17.3% reported High School education). Physical activity was evaluated using the minimum guidelines for adults, according to the Office of Disease Prevention and Health Promotion (150 minutes per week). Only 10% of subjects reported meeting the minimum guidelines for physical activity.

3.2. Main Finding

Of the 67 Hispanic women that were enrolled in this cohort study with pre-obesity and obesity, 94% demonstrated a reduction in BMI, with no participant reporting increases. During the eight-week follow up period on the MED, the mean BMI reduction was 2.8 (95% confidence interval: 2.5 to 3.0; P = 0.02) in middle-aged Latinas (n = 67), with an odds ratio of 2.6. At the beginning of

Table 5. Summary statistics.

Variable	Description	Minimum	Maximum	Mean	SD
Age	Years	45	65	53.3	6.3
BMI (before)	Kg/m	25.1	34.8	28.5	2.4
BMI (after)	Kg/m	22.1	32.9	25.7	2.4
Smoke*	Yes/No			11% Yes	
Education (High School)	Yes/No			17.3% Yes	
Exercise**	Yes/No			10% Yes	
Annual Household Income	US Dollars	25,000	40,345	30,158	3,367

**Defined as the minimum guidelines for adults, according to the Office of Disease Prevention and Health Promotion (150 minutes per week).

the study, most of the participants had pre-obesity (71%) and the remaining obesity (29%). At the end of the eight-week interval, a group (51%) of Hispanic women who had previous pre-obesity, reported a BMI within a normal range. Figure 2 shows the change of BMI in each individual participant before and after the eight weeks on the Mediterranean diet. Because the P-value achieved was 0.02, the null hypothesis, which stated that there was no change in means of BMIs, was rejected. After adjusting for age, physical activity, smoking, and education, the results remained consistent. The higher the adherence to the MED, the higher the likelihood of BMI reduction is. Adherence to the MED was measured via a questionnaire (see **Appendix B**), where subjects would give themselves a score based on the frequency of Mediterranean food servings, they had that week. Thus, adherence level was inversely related to BMI. Subjects reported having more difficulty adhering to the diet during the first week of the program. The subjects who experienced more dramatic reductions in BMIs reported higher motivation to continue this diet as a way of life. Whether weight reduction was defined using BMI or waist-to-hip ratio, the results were similar. Thus, MED was a positive moderator of BMI. Adjusting for age, physical activity levels, education, and smoking status using multiple linear regression analysis did not affect these results. Whether a manual professional-grade weight scale or a digital scale was used, the results were consistent throughout the study.

4. Discussion

A nonpharmacologic intervention to reduce the body mass index in Hispanic women with pre-obesity and obesity resulted in improved weight status and quality of life. When compared to their previous body mass indices (BMIs) before starting the MED, 94% of them experienced a significant reduction in BMI following the diet. The decrease in weight is associated with a 2.8 mean reduction in BMI. These findings may have important public health and clinical implications, since Hispanic women are at risk of obesity-related complications, such as ischemic heart disease, diabetes type 2, cancer, cerebrovascular disease,
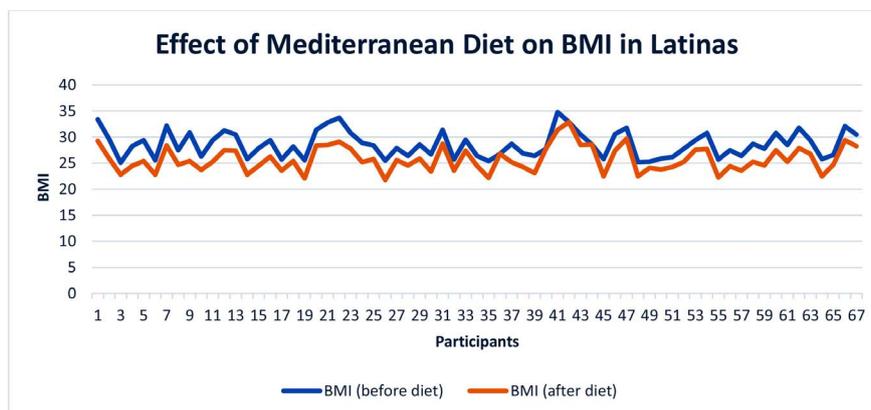
Figure 2. Body Mass Index change in each of the participants (n = 67) during the eight weeks on the Mediterranean diet.

and premature death, creating a great economic burden [16]. Hispanics tend to have less access to scheduled healthcare services, decreased medical compliance, and are twice as likely to visit the emergency room as the general population [17]. Because Hispanics have the highest uninsured rates in the U.S. and most of them belong to low-income families, an emphasis on prevention can yield greater health benefits for this rapidly growing population. Food plays a central role that accounts for the high prevalence of obesity, hypertension, and diabetes, among Hispanics [18]. Thus, early detection of poor lifestyle habits, such as an obesity-promoting diet, should be addressed diligently, which will allow more time to plan and monitor the progress of patients. These results indicate that clinicians should consider the use of the MED with their Hispanic patients, as an effective primary prevention strategy to improve their BMIs. Clinical studies demonstrate the linear relationship that exists between systolic blood pressure and BMI, and that having a BMI lower than 25 kg/m^2 is a promising primary prevention strategy in addressing hypertension [19]. Thus, implementing the Mediterranean diet, as a positive moderator of BMI, may be effective in the prevention and management of chronic diseases.

In addition, this study found that the improvement in quality of life was greatest in those who reported stronger adherence to the Mediterranean diet. One possible explanation for this result is that the MED is rich in anti-inflammatory and antioxidant phytonutrients, which help decrease the low-grade, systemic inflammation in individuals with obesity [20]. Thus, the decrease in inflammatory burden and oxidative stress results in systemic improvement in physiology and metabolic function. The Mediterranean diet provides a dietary basis that corrects many of the pathophysiologic mechanisms of obesity, diabetes type 2, and coronary heart disease [21].

Although other research studies have underscored the health-promoting benefits of the MED, this study adds the practicality and efficacy of this nutritional therapy in working with the Hispanic population. Prompt action from clinicians and health professionals is needed to address obesity in Hispanics, since pedia-

tric obesity is also higher among Hispanics [22]. Unless aggressive preventive measures and policies are set in motion, this generational obesity-gradient will continue to devastate many lives, strengthen racial/ethnic disparities, and increase healthcare cost. Most Hispanic women with pre-obesity and obesity have serious weight-related medical problems, thus addressing the obesity epidemic among Hispanic women and minorities in general should be America's number one public health priority.

While the sample size of this study was one of the main limitations, this study had five major strengths. First, the sample was representative of the general Hispanic population in the United States, which is characterized by low socioeconomic status. Second, the completion rate of the nutrition program by the subjects was high. Third, adjustment for potential confounders was performed to ensure the validity of the results. Fourth, the study is recent and reflects current health behavior trends in regions with high density of Hispanics. Finally, this study confirms that it is possible to achieve significant changes in BMI in a short period of time, by employing an interdisciplinary approach that includes social support and weekly nutritional assessments. The clinical and public health relevance of these findings are emphasized by the fact that lifestyle factors strongly influence the development of chronic diseases, thus promoting and educating underserved populations can produce remarkable changes in the health of these individuals. By further exploring and promoting the health-enhancing benefits of the Mediterranean diet, health professionals and clinicians will continue to make important contributions to stop the obesity epidemic that is disproportionately affecting minorities and accentuating health disparities.

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No sources of financial support were involved that could influence the results of this study.

Data Share

Data described in this manuscript will be made publicly and freely available without restrictions at the URL indicated by this journal.

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Conflict of Interest

Author Eloy Espinoza, MD, MPH declares that he has no conflict of interest.

Ethical Approval

All procedures performed in this study were done in accordance and acceptance with the institutional and national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent

Informed consent was obtained from all individual participants included in this study.

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Appendix A: Mediterranean Diet Study Questionnaire

Patient Information

Name: _____

Address: _____ Telephone: _____

Date of Birth: _____ Sex: _____ Weight (lbs.): _____

Height (ft): _____ BMI (Kg/m^2): _____

Motivation Assessment

Please, indicate what you expect to obtain from this Mediterranean diet program:

    weight management
    improved overall health
    look better
    advice on proper nutrition
    nothing
    other: _____

On the scale of 1 to 10, what level of motivation do you have to start this Mediterranean diet program during the next eight weeks? (0 = not motivated, 10 = maximum motivation)

0 1 2 3 4 5 6 7 8 9 10

Obesity History	Yes	No
1) Has your doctor ever diagnosed you with pre-obesity or obesity?		
2) Has your doctor ever prescribed medication for obesity or pre-obesity?		
3) Have you ever had bariatric surgery?		
4) Have you ever had any cosmetic procedures for obesity (liposuction)?		
5) Have you ever had obesity-related complications (insulin resistance, obstructive sleep apnea, etc.)?		
6) Do you have conditions that promote obesity (hypothyroidism)?		
7) Are you taking medications that promote obesity (antipsychotics)?		
8) Has obesity impaired your activities of daily living (work, moving)?		
9) Has your doctor referred you to a registered dietician or nutritionist?		

Intestinal Malabsorption

Do you have a history of gastro-intestinal tract problems? (e.g., gastritis, irritable bowel syndrome, stomach ulcers, food allergies or intolerances, colitis, Crohn's disease, etc.) If yes please describe, including type of treatment you are receiving:

_____

_____

_____

Allergy History

List any allergies you have (seasonal, food, or otherwise):

_____

_____

_____

Stress valuation

What level of stress do you routinely deal with? (0 = no stress, 10 = maximum stress)

0 1 2 3 4 5 6 7 8 9 10

Nutritional Assessment

The Mediterranean diet is rich in fruits, vegetables, and whole grain cereals; nuts and seeds are sources of fat, while legumes are fiber-rich sources of protein. The Mediterranean diet gives preference to fish and lean poultry, rather than red meat.

1) How often, on average, do you eat any of the following foods (*mark the food item that applies to you and circle the appropriate letter below*):

   Turkey
   Red meat
   Chicken
   Salmon

   a) daily
   b) most days of the week
   c) 1 - 2 days of the week

2) How often, on average, do you consume any of the following foods:

   Cheese and cow's milk
   Almond milk
   Coconut milk
   Rice milk

   a) daily
   b) most days of the week
   c) 1 - 2 days of the week

3) How often, on average, do you consume any of the following foods:

   Green leafy vegetables
   French fries
   Extra virgin olive oil
   Seeds and nuts (e.g., walnuts, pecans, sunflower seeds, etc.)

a) daily

b) most days of the week

c) 1 - 2 days of the week

4) How often, on average, do you consume any of the following foods:

Brown rice

White rice

Beans and lentils (e.g., garbanzo, etc.)

Oatmeal

a) daily

b) most days of the week

c) 1 - 2 days of the week

5) How often, on average, do you consume any of the following beverages:
Red wine

Beer

Soda

Fruit juice

a) daily

b) most days of the week

c) 1 - 2 days of the week

6) How often, on average, do you consume any of the following deserts:

Ice cream

Sweet cakes (e.g., brownies)

Dark chocolate

Dried fruit (e.g., dates, figs, etc.)

a) daily

b) most days of the week

c) 1 - 2 days of the week

7) How often, on average, do you consume any of the following snacks:
Gummi bears or hard candy

Nachos

Muffins

Celery sticks and baby carrots with sour cream

a) daily

b) most days of the week

c) 1 - 2 days of the week

Environmental Exposures

Exposure Type	Yes	No
Are you regularly exposed to second-hand smoke?		
Do you smoke 1 or more cigarettes per week or chew or snuff tobacco?		
Do you consume alcoholic beverages		
Do you use recreational or medicinal marijuana		
Do you use illegal drugs (e.g., amphetamines, cocaine, etc.)		
Are you exposed to environmental pollutants at work?		
Are you sitting down in front of a computer screen during the day?		
Do you perform regular exercise (150 minutes per week or more)?		

Vitamin and Supplements

List any nutritional and vitamin supplements you take (please include all vitamins, herbs, nutritional supplements for weight loss, energy enhancement, etc.):

_____

_____

_____

Drug-Nutrient Interaction

Do you take any of the following medications?	Yes	No
Laxatives		
Cholesterol-lowering drugs (cholestyramine, fibrates, etc.)		
Steroidal drugs (prednisone, methylprednisolone, cortisone)		
Hormonal Replacement Therapy (estrogen, progesterone)		
Antibiotics		
Antidepressants		
Nicotine		
Anti-gout agents (colchicine, allopurinol, febuxostat)		
Levothyroxine		
Levo-Dopa		
Anticonvulsants		
Aspirin		
Non-Steroidal Anti-Inflammatory Drugs (Naproxen, Ibuprofen, Diclofenac)		
Caffeine		
Antihypertensive drugs		
Statin drugs (atorvastatin, simvastatin)		

Additionally, please indicate if any of the following health conditions apply to you.

__ Hemochromatosis __ Ulcerative Colitis __ Glucose-6-Phosphate Dehydrogenase Deficiency

__ Chronic Kidney Disease __ Crohn's Disease __ Diabetes

__ Gouty Arthritis __ Rheumatoid Arthritis __ Insulinoma __ Celiac Disease

__ Other: _____

Future Expectations

Which of the following statements concerning the Mediterranean diet best describes you?

a) I am not planning on following the Mediterranean diet after I complete this program

b) I have not decided whether I will follow the Mediterranean diet or not

c) I would like to integrate *some* food components of the Mediterranean diet

d) I am seriously going to continue with the *whole* Mediterranean diet as a lifestyle

By signing this questionnaire, I confirm that the information provided is accurate and reflects my eating pattern during this program.

Signature: _____ Date: _____

Thank you for participating in this Mediterranean diet study!

Eloy Espinoza, MD, MPH

Appendix B: Mediterranean Diet Weekly Program Assessment Score

Give yourself a 1 for each "yes" and 0 for each "no"

Food Item	Yes	No
Fish: I ate 3 - 4 servings this week		
Fruit: I ate 3 - 4 servings every day this week		
Vegetables: I ate 3 - 4 servings every day this week		
Whole grains: I ate 1 - 3 servings every day this week		
Legumes: I ate 1 - 3 servings every day this week		
Red meat: I ate less than 1 or 2 servings every day this week		
Dairy: I ate less than 1 - 2 servings every day this week		
Poultry/eggs: I ate less than 1 - 2 servings every day this week		
Total:		

→ A total of 5 or more indicates *good* adherence to the diet and high likelihood of health benefit.

→ A total of less than 5 indicates *poor* adherence to the diet and lower likelihood of health benefit.

By signing this dietary assessment, I confirm that the information provided is accurate and reflects my eating pattern during this week in the program.

Signature: _____ Date: _____

Thank you for participating in this Mediterranean diet study!

Eloy Espinoza, MD, MPH