American Journal of
Biomedical Science & Research

www.biomedgrid.com
ISSN: 2642-1747

Research Article

Dietary Patterns and their Association with Risk Factors for the Metabolic Syndrome among Postmenopausal Women

Hanan AL Farra[1], Abdel Hamid El Bilbeisi[2,3*], Kanan Wahedy[4] and Amany El Afifi[5]

[1]*Master Program of Clinical Nutrition, Faculty of Pharmacy, Al Azhar University of Gaza, Gaza Strip, Palestine*

[2]*Department of Clinical Nutrition, Faculty of Pharmacy, Al Azhar University of Gaza, Gaza Strip, Palestine*

[3]*Department of Nutrition, School of Medicine and Health Sciences, University of Palestine, Gaza Strip, Palestine*

[4]*Pharmaceutical Chemistry Department, Faculty of Pharmacy, Al Azhar University of Gaza, Gaza Strip, Palestine*

[5]*Faculty of Pharmacy, Al Azhar University of Gaza, Gaza Strip, Palestine*

***Corresponding author:** Abdel Hamid El Bilbeisi, Department of Clinical Nutrition, Faculty of Pharmacy, Al Azhar University of Gaza, Gaza Strip, Palestine.

To Cite This Article: *Hanan AL Farra, Abdel Hamid El Bilbeisi*, Kanan Wahedy and Amany El Afifi. Dietary Patterns and their Association with Risk Factors for the Metabolic Syndrome among Postmenopausal Women. Am J Biomed Sci & Res. 2024 23(6) AJBSR.MS.ID.003135,* DOI: 10.34297/AJBSR.2024.23.003135

Received: August 20, 2024; **Published:** August 26, 2024

Abstract

Background: This study was conducted to determine dietary patterns and their association with risk factors for metabolic syndrome (MetS) among postmenopausal women.

Methods: This cross-sectional study was conducted in 2023, among a representative sample 381 of postmenopausal women, receiving care in five primary healthcare centers in Gaza Strip, Palestine. Women were randomly selected using a systemic sampling method. MetS was defined based on the International Diabetes Federation criteria. Women were assessed using a validated semi-quantitative food frequency questionnaire, anthropometric measurements, physical examination, biochemical-measurements and interview-based questionnaire. Statistical analysis was performed using SPSS version-24.

Results: The mean of age of women was 61.7±7.9 years. The MetS is highly prevalent 80.6% among postmenopausal women. Two major dietary patterns were identified by factor analysis. After adjustment for confounding variables, women in the lowest tertile of the healthy dietary pattern had a lower odd for (MetS, central obesity, high triglycerides, low HDL-cholesterol, high blood pressure, and high fasting plasma glucose (FPG)), compared to those in the highest tertile (OR:0.863; CI:95% (.582-21 .845)), (OR:0.812; CI:95% (.755-.875)), (OR:0.791; CI:95% (.687-.911)), (OR:0.853; CI:95% (.743-.978)), (OR:0.713; CI:95% (.754-.872)) and (OR:0.630; CI:95% (0.396-.592)), respectively. Moreover, women in the lowest tertile of unhealthy dietary pattern had a higher odd for high FPG compared to those in the highest tertile (OR:1.025; CI:95% (.533-.852)).

Conclusions: The MetS is highly prevalent among postmenopausal women in Gaza Strip. Additionally, the healthy dietary pattern was associated with a lower prevalence of MetS and its components, whereas the unhealthy dietary pattern was associated with a higher level of FPG.

Keywords: Dietary patterns, Metabolic syndrome, Palestine, Postmenopausal women, Risk factors

Introduction

The most relevant risk factors for acute myocardial infarction, diabetes mellitus (DM), abdominal obesity, high cholesterol, and high blood pressure (BP), are all part of the metabolic syndrome (MetS) [1]. The MetS is thought to affect 20 to 25 percent of adult humans worldwide, and those who have it are three times more likely to experience a heart attack or stroke than those who do not

have it [2]. According to a meta-analysis by El *Bilbeisi, et al.*, (2017), the prevalence of MetS among adults in Palestine who are over the age of 15 was 37.0% [3]. MetS can have a variety of reasons, but the two most significant ones are central obesity and insulin resistance [4]. Obesity increases the risk of cardiovascular diseases (CVDs), high blood cholesterol, low high-density lipoprotein cholesterol (HDL-c), hyperglycemia, and hypertension (HTN) [5]. Numerous earlier studies have demonstrated that lifestyle variables, particularly food choices and physical inactivity, appear to be the primary causes of metabolic diseases [6,7].

On the other hand, menopause is defined more broadly as "the permanent end of menstrual periods following the decrease of ovarian follicular activity." Menopause is literally the cessation of menstruation [8]. The most significant endocrine shift that characterizes the gradual loss of ovarian function and eventually results in menopause is the reduction in circulating levels of ovarian steroids. Moreover, menopause is linked to an increase in the incidence of obesity, CVDs, and osteoporosis [9]. As estrogen levels drop in postmenopausal women, metabolic flexibility decreases, and more fat builds up in central depots [10]. To balance the negative effects of estrogen depletion on general well-being and reduce the risk of MetS, osteoporosis, bone fractures, and vascular events, the integrative health care of menopausal women should consequently focus lifestyle assessment and counseling, notably on nutritional habits [11].

It is clear that MetS is becoming more common, particularly in developing nations. Moreover, numerous earlier research demonstrated that postmenopausal women were very susceptible to obesity, CVDs, and osteoporosis as a result of the detrimental consequences of estrogen shortage [9,10]. In addition, lifestyle variables, particularly dietary choices and lack of exercise, appear to be the primary causes of MetS and its components [6,7]. Furthermore, the role of diet in the origin of MetS is not understood well [12]. Yet, a deeper comprehension of the connections between postmenopausal women's dietary patterns and metabolic traits may aid in halting the future MetS epidemic and lowering the risk of its consequences, particularly CVDs. Therefore, the current study was carried out to identify the major dietary patterns and their association with risk factors for the MetS among postmenopausal women in Gaza Strip, Palestine.

Materials and Methods

Study Design and Participants

This cross-sectional study was conducted in the year 2023, in the five primary health care centers (PHCs) (Rafah Martyrs Center, Khanyounis Martyrs Center, Deir Al-Balah Center, Al-Rimal Clinic, and Jabalia Martyrs Center) of Palestinian Ministry of Health (MOH), which are considered the main PHCs providing the health services to postmenopausal woman in Gaza Strip. In the current study, all postmenopausal women with absent of menstrual cycle for longer than 12 months, who were registered at the PHCs of Palestinian MOH, and live in Gaza Strip since at least three years were included. In contrary, women under hormonal replacement therapy, had a menstrual cycle, followed any kind of special diet that would impact their eating habits, used weight-loss or psychotropic drugs, or had other type of serious illnesses such as cancer, acute myocardial infarction or renal failure were excluded.

Sample Size and Sampling Technique

According to the recent report from the Palestinian MOH, the number of postmenopausal women who were attending the PHCs was 36,587 [13]. The representative sample size in the current study was 381 postmenopausal women, which calculated using Charan and Biswas formula [14]. After application of eligibility criteria, the study participants were randomly selected using a systemic sampling method.

Data Collection

Interview-Based Questionnaire: A structured interview-based questionnaire was used to collect the demographic socioeconomic data from each participant.

Anthropometric Measurements: Height (cm), weight (kg), and waist circumference (cm) for all women were assessed using standard methods [15]. In addition, central obesity was defined based on the International Diabetes Federation (IDF) guidelines for the Middle East (Arab population) as a waist circumference of less than 80 cm in women [16]. Furthermore, the body mass index (BMI) was calculated by dividing weight in kilograms by the square of height in meters [16].

Blood Pressure (mmHg): Blood pressure (BP) was measured from the left arm (mmHg) by mercury sphygmomanometer. Three readings on different days, while the women were seated after relaxing for at least fifteen minutes in a quiet environment, empty bladder. The average of the three measurements was recorded [17].

Biochemical Measurements: After 12hrs fasting, a venous blood samples were collected from all women, by well-trained and experienced nurses. Venous blood (4.0 ml) was drawn into vacutainer tubes and was used for blood chemistry analysis (fasting plasma glucose (FPG) mg/dl, HDL-c mg/dl, and TGs mg/dl). Mindray BS-300 chemistry analyzer instrument was used for blood chemistry analysis [18]. The laboratory tests were analyzed in a private licensed laboratory.

Clinical Examination: The study participants were examined by the physicians for signs and symptoms of any diseases.

Definition of MetS: MetS was defined according to the IDF definition. According to the IDF definition, for a person to be defined as having the MetS they must have central obesity (defined as waist circumference ≥ 80 cm in women plus any two of the following four factors: 1) raised TGs ≥ 150 mg/dl or specific treatment for this lipid abnormality; 2) reduced HDL-c < 40 mg/dl in males and < 50 mg/dl in females or specific treatment for this lipid abnormality; 3) raised BP systolic BP ≥ 130 or diastolic BP ≥ 85 mmHg or treatment of previously diagnosed HTN; or 4) raised FPG ≥ 100 mg/dl, or previously diagnosed T2DM. In addition, if BMI is > 30 kg/m^2, central obesity can be assumed, and waist circumference does not need to be measured [11].

Dietary Assessment: A Palestinian form of validated semi-quantitative food frequency questionnaire (FFQ) was used in this study to assess the dietary patterns [19]. The FFQ was used by Nutritionists to gather information about dietary patterns from all women in this study. Factor analysis test was employed for dietary patterns analysis.

Assessment of Physical Activity: Data on physical activity were obtained using the international physical activity questionnaire (IPAQ short form) [20].

Pilot Study: Pilot study was carried out before the actual data collection on twenty women, to examine women's responses to the questionnaire and how they understand it, this would enhance the validity of the questionnaire. The questionnaire and data collection process were modified according to the result of the pilot study. Also, the study questionnaire was evaluated by five experts to assess its relevance, and their comments were taken into consideration.

Statistical Analysis: With the use of SPSS version 24, statistical analysis was carried out. By using exploratory factor analysis, dietary patterns for 25 preset food groups were discovered. The dietary groups were based on similar nutritional profiles and resembled those employed in other studies [21,22]. The Kaiser-Mayer-Olkin coefficient test was 0.653. To find the significant differences between several categorical variables, the chi-square test was performed. The independent samples t-test and one-way ANOVA were used to analyze the differences in means. Lastly, binary logistic regression was used to examine the odds ratio (OR) and confidence interval (CI) for the MetS and its components across tertiles categories of dietary pattern scores. Statistics were considered significant with P values under 0.05.

Results

A total of 381 post-menopausal women were included in the final analysis. The study sample was distributed based on the population density in the five PHCs as follow: 78 (20.5%) women were from Rafah Martyrs Center, 95 (24.9%) from Khanyounis Martyrs Center, 54 (14.2%) from Deir Al-Balah Center, 84 (22.0%) from Al-Rimal Clinic and 70 (18.4%) were from Jabalia Martyrs Center. The results showed that 307 (80.6%) of the postmenopausal women had MetS. The mean age for the study participants was 61.7±7.9 years. Furthermore, for the following variables (number of family members, enough income, waist circumference, BMI, and physical activity levels) statistically significant associations were found between postmenopausal women with and without MetS, P-value = 0.036, 0.023, 0.001, 0.001 and 0.009, respectively (Table 1).

Table 1: Characteristics of the study participants in relation to the presence of MetS or its absence according to IDF definition.

Variables	Total(n=381)	Subjects with MetS (n=307)	Subjects without MetS (n=74)	P Value
	No. (%)	No. (%)	No. (%)	
Clinic name				
Rafah Martyrs Center	78 (20.5)	63 (20.5)	15 (20.3)	0.28
Khanyounis Martyrs Center	95 (24.9)	82 (26.7)	13 (17.6)	
Deir Al-Balah Center	54 (14.2)	42 (13.7)	12 (16.2)	
Al- Rimal Clinic	84 (22.0)	69 (22.5)	15 (20.3)	
Jabalia Martyrs Center	70 (18.4)	51 (16.6)	19 (25.7)	
Age (years) Mean±SD	61.7±7.9	62.0±7.8	60.3±8.0	0.094
Marital status				
Single	17 (4.5)	13 (4.2)	4 (5.4)	0.936
Married	263 (69.0)	212 (69.1)	51 (68.9)	
Separated	14 (3.7)	12 (3.9)	2 (2.7)	
Widow	87 (22.8)	70 (22.8)	17 (23.0)	
Education level				
Illiterate	61 (16.0)	53 (17.3)	8 (10.8)	0.256
Primary	103 (27.0)	86 (28.0)	17 (23.0)	
Preparatory	97 (25.5)	79 (25.7)	18 (24.3)	
Secondary	100 (26.2)	74 (24.1)	26 (35.1)	
University	20 (5.2)	15 (4.9)	5 (6.8)	
Work Status				
Has work	4 (1.0)	2 (0.7)	305 (99.3)	0.120
Do not have work	377 (99.0)	2 (2.7)	72 (97.3)	
Number of Family Members				
Less than five	230 (60.3)	182 (59.3)	48 (64.9)	0.036
Five to ten	114 (29.9)	92 (30.0)	22 (29.7)	
More than ten	37 (9.7)	33 (10.7)	4 (5.4)	

The House				
Owned	375 (98.4)	303 (98.7)	72 (97.3)	0.240
Rented	6 (1.6)	4 (1.3)	2 (2.7)	
Monthly Income (NIS)				
< 1000 (NIS)	345 (90.6)	281 (91.5)	64 (86.5)	0.187
1000-2000 (NIS)	36 (9.4)	26 (8.5)	10 (13.5)	
Enough Income				
Yes	27 (7.1)	17 (5.5)	10 (13.5)	0.023
No	354 (92.9)	290 (94.5)	64 (86.5)	
Waist Circumference (cm)				
Mean±SD	105.5±13.7	110.0±10.7	87.0±8.5	0.001
Body Mass Index (BMI): kg/m2				
Mean±SD	33.9±6.2	35.0±6.0	29.1±4.7	0.001
Physical Activity Levels (MET/wk)				
Insufficiently active (≤600)	226 (59.3)	191 (62.2)	35 (47.3)	0.009
Sufficiently active (601 to 1500)	98 (25.7)	78 (25.4)	20 (27.0)	
Very active (≥1500)	57 (15.0)	38 (12.4)	19 (25.7)	

Note*: Data are expressed as means ± SD for continuous variables and as percentage for categorical variables. The differences between means were tested by using independent sample t test and one-way ANOVA. The chi-square test was used to examine differences in the prevalence of different categorical variables. P value less than 0.05 was considered statistically significant. SD, stander deviation, NIS: New Israeli Shekel; MET/wk: Metabolic Equivalents per wk.

As shown in Table 2., 194 (63.2%) of postmenopausal women with MetS had family history of DM vs. 38 (51.4%) in the non-MetS group; and 181 (59.0%) of postmenopausal women with MetS had family history of HTN vs. 37 (50.0%) in the non-MetS group. 108 (28.3%) of postmenopausal women had family history of CVDs, 89 (23.4%) had family history of hyperlipidemia, and all of them were used medications. Furthermore, for the following risk factors (family history of diabetes, and family history of HTN), the difference was statistically significant between postmenopausal women with and without MetS, P-value = 0.019, and 0.039, respectively.

Table 2: Medical history variables of the study participants in relation to the presence of MetS or its absence.

Variables	Total(n=381)	Subjects with MetS (n=307)	Subjects without MetS (n=74)	P Value
	No. (%)	No. (%)	No. (%)	
Family history of diabetes				
Yes	232 (60.9)	194 (63.2)	38 (51.4)	0.019
No	149 (39.1)	113 (36.8)	36 (48.6)	
Family history of hypertension				
Yes	218 (57.2)	181 (59.0)	37 (50.0)	0.039
No	163 (42.8)	126 (41.0)	37 (50.0)	
Family history of CVDs				
Yes	108 (28.3)	88 (28.7)	20 (27.0)	0.451
No	273 (71.7)	219 (71.3)	54 (73.0)	
Family history of hyperlipidemia				
Yes	89 (23.4)	74 (24.1)	15 (20.3)	0.484
No	292 (76.6)	233 (75.9)	59 (79.7)	
Do you take any medications?				
Yes	381 (100)	307 (100)	74 (100)	-
Have you ever used hormone replacement therapy?				
No	381 (100)	307 (100)	74 (100)	-
History of smoking				
Yes	2 (0.5)	2 (0.7)	0 (0.0)	0.649
No	379 (99.5)	305 (99.3)	74 (100)	

Do you expose to second-hand smoke?				
Yes	132 (34.6)	105 (34.2)	27 (36.5)	0.786
No	249 (65.4)	202 (65.8)	47 (63.5)	
History of alcohol intake				
No	381 (100)	307 (100)	74 (100)	-

Note*: Data are expressed as percentage for categorical variables. The chi-square test was used to examine differences in the prevalence of different categorical variables. P value less than 0.05 was considered statistically significant.

The prevalence of the main components of MetS according to the IDF definition, among the postmenopausal women were distributed as follow: low HDL-c <50 mg/dl or specific treatment for this lipid abnormality (100%), central obesity (99.7%), high TGs ≥150mg/dl or specific treatment for this lipid abnormality (97.4%), high FPG ≥100 mg/dl or previously diagnosed type 2 DM (85.7%), and high BP (≥130/85mmHg) or treatment of previously diagnosed HTN (66.1%). Moreover, for the following factors (central obesity, high TGs, low HDL-c, high BP, and high FPG) the differences were statistically significant between postmenopausal women with and without MetS (P values < 0.05 for all) (Table 3).

Table 3: Prevalence of different factors that define the MetS, according to IDF definition.

Components of MetS	Total(n=381)	Subjects with MetS (n=307)	Subjects without MetS (n=74)	P Value
	No. (%)	No. (%)	No. (%)	
Central obesity: Waist circumference (cm): ≥ 80 in women				
Yes	363 (95.3)	306 (99.7)	57 (77.0)	0.001
No	**18 (4.7)**	1 (0.3)	17 (23.0)	
Triglycerides (mg/dl): ≥150 or specific treatment for this lipid abnormality				
Yes	304 (79.8)	299 (97.4)	5 (6.8)	0.001
No	77 (20.2)	8 (2.6)	69 (93.2)	
HDL cholesterol (mg/dl): <50 in females or specific treatment for this lipid abnormality				
Yes	323 (84.8)	307 (100)	16 (21.6)	0.001
No	58 (15.2)	0 (0.0)	58 (78.4)	
High blood pressure or treatment of previously diagnosed hypertension				
≥130/85 mmHg	208 (54.6)	203 (66.1)	5 (6.8)	0.001
<130/85 mmHg	173 (45.4)	104 (33.9)	69 (93.2)	
Fasting plasma glucose (mg/dl): ≥100 or previously diagnosed type 2 diabetes mellitus				
Yes	303 (79.5)	263 (85.7)	40 (54.1)	0.001
No	78 (20.5)	44 (14.3)	34 (45.9)	

Note*: The prevalence of MetS components was calculated for all of the study participants. Data are expressed as percentage for categorical variables. The chi-square test was used to examine differences in the prevalence of different categorical variables. P value less than 0.05 was considered statistically significant.

The factor loading matrixes for the two major patterns are shown in Table 4. The scree plot of eigenvalues indicated two major patterns: 1) Healthy dietary pattern characterized by a high intake of whole grains, poultry, fish and shellfish products, low fat dairy product, vegetables, tomatoes, fruits, olives, nuts and seed products as well as a low intake of refined grains, and potatoes; 2) Unhealthy dietary pattern characterized by a high intake of refined grains, potatoes, red meat, organ meat, fast foods, eggs, high fat dairy products, hydrogenated fats, sugar, sweets, and desserts, snacks, soft drinks, salt and pickles as well as a low intake of fruits, and nuts and seed products.

Table 4: Factor loading matrix for major dietary patterns.

Food groups:	Dietary patterns	
	Health pattern	Unhealthy pattern
1. Refined grains	0.333	0.561
2. Whole grains	0.342	-
3. Potatoes	0.379	0.441
4. Beans and legumes	-	-

5. Red meat	-	0.36
6. Organ meat	-	0.355
7. Poultry	0.38	-
8. Fish and shellfish products	0.666	-
9. Fast foods	-	0.437
10. Eggs	-	0.442
11. Low-fat dairy product	0.373	-
12. High-fat dairy products	-	0.418
13. Vegetables	0.432	-
14. Tomatoes	0.515	-
15. Fruits	0.408	0.393
16. Hydrogenated fats	-	0.461
17. Vegetable oils	-	-
18. Olives	0.303	-
19. Nuts and seed products	0.415	0.312
20. Sugar, sweets, and desserts	-	0.565
21. Snacks	-	0.618
22. Condiments	-	-
23. Soft drinks	-	0.479
24. Beverages	-	-
25. Salt and pickles	-	0.406
Percentage of variance explained (%)	23.987	14.138

Note*: Values < 0.30 were excluded for simplicity. Total variance explained by two factors: 38.125.

Finally, we computed the OR and CI for the MetS and its components across tertiles categories of dietary pattern scores Table 5. After adjustment for confounding variables, postmenopausal women in the lowest tertile (T1) of the healthy dietary pattern had a lower odd for (MetS, central obesity, high TGs, low HDL-c, high BP, and high FPG), (OR 0.863 CI 95% (.582-.845)), (OR 0.812 CI 95% (.755-.875)), (OR 0.791 CI 95% (.687-.911)), (OR 0.853 CI 95% (.743-.978)), (OR 0.713 CI 95% (.754 .872)) and (OR 0.630 CI 95% (0.396- .592)) respectively, compared to those in the highest tertile (T3), (P value < 0.05 for all). In addition, postmenopausal women in the lowest tertile (T1) of the unhealthy dietary pattern had a higher odd for high FPG (OR 1.025 CI 95% (.533-.852)) compared to those in the highest tertile (T3), (P value = 0.001).

Table 5: Odds ratio (OR) and confidence interval (CI) for the MetS and its components across tertiles categories of dietary pattern scores.

Health dietary pattern					Unhealthy dietary pattern				
T1	**T2**	**T3**	**P value**	**OR (95%CI)**	**T1**	**T2**	**T3**	**P value**	**OR (95%CI)**
Have metabolic syndrome:									
33.5	29.3	37.2	0.025	0.651(.550-.751)	29.7	34.2	36.1	0.057	0.51 (.735-.960)
Adjusted*			0.002	0.863(.582-.845)	Adjusted*			0.363	0.812 (.752-1.232)
Central obesity: Waist circumference (cm): ≥ 80 in women									
30.1	32.4	37.5	0.061	0.754(.327-.560)	34.8	30.2	35	0.255	0.554 (.645-.880)
Adjusted*			0.001	0.812(.755-.875)	Adjusted*			0.512	0.513 (.735-1.254)
Triglycerides (mg/dl): ≥150 or specific treatment for this lipid abnormality									
31.7	**30.1**	**38.2**	**0.029**	**0.756(.590-.772)**	**28.4**	**31.5**	**40.1**	**0.046**	**0.779 (.507-.862)**
Adjusted*			0.001	0.791(.687-.911)	Adjusted*			0.302	0.913 (.680-1.145)
HDL cholesterol (mg/dl): <50 in females or specific treatment for this lipid abnormality									
29.9	29.5	40.6	0.001	0.621(.632-.825)	30.1	32.4	37.5	0.013	0.792 (.616-.781)
Adjusted*			0.031	0.853(.743-.978)	Adjusted*			0.228	0.838 (.902-1.085)
High blood pressure ≥130/85 mmHg or treatment of previously diagnosed hypertension									

28.9	32	39.1	0.048	0.821(.584-.702)	30.4	31.6	38	0.212	0.648 (.565-.742)
Adjusted*			0.002	0.713(.754-.872)	Adjusted*			0.664	0.817 (.651-1.030)
Fasting plasma glucose (mg/dl): ≥100 or previously diagnosed type 2 diabetes mellitus									
34.7	**27.5**	**37.8**	**0.123**	**0.753(.611-.804)**	**31**	**28.3**	**40.7**	**0.098**	**0.794 (.625-1.234)**
Adjusted*			0.034	0.63(0.396- .592)	Adjusted*			0.001	1.025 (.533- .852)

Note*: The OR and CI for the MetS and its components across tertiles categories of dietary pattern scores were tested by binary logistic regression. *Adjusted for number of family members, enough income, family history of diabetes, family history of hypertension, weekly energy expenditure, and physical activity levels. P value less than 0.05 was considered statistically significant.

Discussion

To the best of our knowledge, this is the first study to examine dietary patterns among postmenopausal women in the Gaza Strip, Palestine, and how they relate to risk factors for the MetS. The IDF definition states that a significant portion of postmenopausal women (80.6%) have MetS. Similar research found that postmenopausal women in Nigeria had a high prevalence rate of 62.5%, while postmenopausal women of Saudi Arabian descent had a lower prevalence rate of 56% [23,24].

The high incidence of MetS in the current study may be related to the increased urbanization of our population and the adoption of unhealthy lifestyles including physical inactivity and poor dietary practices, which increase the risk of obesity. High percentage of the MetS may be caused by women transitioning from pre-menopause to post-menopause with fundamental metabolic alterations, particularly estrogen deprivation [25].

According to the results, women with MetS had a mean age (years) of 62.0±7.8, while women without MetS had a mean age (years) of 60.3±8.0. A higher percentage of MetS may be caused by the development of insulin resistance, hormonal changes, and an increase in visceral fat tissue as people age [26]. 69.0% of women reported being married, while 17.3% of postmenopausal women with MetS reported being illiterate. According to several research, married people are more likely to be overweight and obese than single people [27,28]. Research conducted in Iran and the United States revealed a negative correlation between the MetS and educational attainment [29,30]. These conclusions are supported by the study's findings. Moreover, (94.5%) of postmenopausal women with MetS were have low-income. In India, *Kaur, et al.,* [31], found that unemployed participants had a higher incidence of the MetS than did employed participants. It appears that a higher percentage of the MetS may be attributed to demographic and socioeconomic characteristics.

Also, the findings showed that postmenopausal women with and without MetS had statistically significant differences in waist circumference and BMI. According to the current study, postmenopausal women experience the MetS very frequently. This is likely due to the increasing incidence of obesity. According to a French study with a six-year follow-up on nearly 4,000 participants, the risk of the MetS increased by 22% for every kilogram that the BMI increased [32].

Furthermore, this study's findings suggest that low levels of physical activity are linked to a higher prevalence of MetS. In addition, 62.2% of postmenopausal women with MetS were not active enough, compared to 47.3% of those without MetS. An earlier study suggested that we should anticipate more people who are not properly active among MetS patients [33]. The results also showed that the difference between postmenopausal women with and without MetS was statistically significant for the following risk factors (family history of diabetes and family history of HTN). Moreover, central obesity (99.7%) and low HDL-c 50 mg/dl or special treatment for this lipid abnormality (100%) were the most prevalent abnormalities in our study sample. The most typical combination among patients with MetS was shown to be low HDL-c and central obesity [34]. These conclusions are supported by the study's findings.

In the current study, two main dietary patterns were found by using factor analysis. After controlling for potential confounding factors, women in the lowest tertile of the healthy eating pattern had a lower chance for (MetS, central obesity, high TGs, low HDL-c, high BP, and high FPG) than those in the highest tertile. Three dietary patterns were described by *Naja, et al*., [35]: the fast food/dessert pattern, the traditional Lebanese pattern, and the high protein pattern. The results of this study show that among Lebanese adults, the fast food/dessert trend is positively associated with MetS. The heavy consumption of fast-food sandwiches, pizzas, pies, desserts, carbonated beverages, and juices was the hallmark of the fast food/dessert trend. Three dietary patterns were identified by *Choi, et al.,* [36] and designated as Western, Traditional, and Prudent patterns. The cautious pattern, which was related negatively with the risk of MetS among Korean women, was defined by a high intake of fruits, fruit items, nuts, dairy, and a low intake of grains. Our study's findings confirm these conclusions. Previous dietary patterns diverged from those seen in our study, which can be attributed to variations in demography, culture, and ethnicity.

The beneficial components of that dietary pattern, such as vitamins, dietary fibre, potassium, magnesium, and antioxidants, may be responsible for the inverse connection between healthy dietary patterns and the MetS and its components in the current study. Several nutrients have independently been linked to lowered MetS-related hazards [37,38]. The healthy dietary pattern in our study was low in animal foods, saturated fat, trans fat, cholesterol, and simple sugar, which may be linked to a lower risk of MetS and its components [39]. Ultimately, the findings of our study demonstrated that post-menopausal women in the lowest tertile of unhealthy dietary pattern had a larger likelihood of having high FPG than those in the highest tertile. Numerous earlier research have demonstrated a favorable correlation between the risk of MetS and its components

and dietary patterns characterized by a high intake of refined carbohydrates, sugar, sweets, desserts, snacks, and soft drinks [40-43].

Strengths and Limitations

The primary advantage of our study was that it was the first to examine dietary patterns and their relationship to MetS risk factors among postmenopausal women in Gaza Strip, Palestine. In addition, the cross-sectional design of our study, which made it difficult to establish a causal connection and constrained the applicability of our findings, is one of its key weaknesses. Further restrictions include the potential for recollection bias and inaccurate reporting when evaluating dietary patterns using the FFQ.

Conclusion

In Gaza Strip, Palestine, postmenopausal women are disproportionately affected by the MetS. Furthermore, the healthy dietary pattern was linked to a reduced prevalence of MetS and its components, whereas the unhealthy dietary pattern was linked to a greater level of FPG.

Data Availability Statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics Statement

The study protocol was approved by the Palestinian Health Research Council (Helsinki Ethical Committee of Research PHRC/HC/1070/22), and from the Palestinian MOH. Written informed consent was also obtained from each participant.

Author Contributions

HF and AE collected, analyzed, and interpreted the data and wrote the first draft of the manuscript. HF, AE, KW, and AHB significantly contributed in the study design and the critical review of the manuscript. AHB remarkably contributed to the analysis and interpretation of data and the critical review of the manuscript. All authors contributed to the article and approved the submitted version.

Acknowledgments

The authors wish to thank and appreciate the Palestinian Ministry of Health, Al Azhar University of Gaza, and the study participants for their significant participation in the study.

References

1. Birarra MK, Gelayee DA (2018) Metabolic syndrome among type 2 diabetic patients in Ethiopia: a cross-sectional study. BMC cardiovascular disorders 18(1): 149.
2. El Bilbeisi AH, Hosseini S, Djafarian K (2018) Prevalence of metabolic syndrome and its components using two proposed criteria among patients with type 2 diabetes in Gaza Strip, Palestine. BAOJ Nutrition 4: 054.
3. El Bilbeisi AH, Shab Bidar S, Jackson D, Djafarian K (2017) The prevalence of metabolic syndrome and its related factors among adults in Palestine: a meta-analysis. Ethiopian journal of health sciences 27(1): 77-84.
4. El Bilbeisi AH, El Afifi A, Djafarian K (2019) Association of healthy eating index with metabolic syndrome and its components among type 2 diabetes patients in Gaza Strip, Palestine: A cross-sectional study. Integr Food Nutr Metab 6: 1e7.
5. El Bilbeisi AH, Srour M, el Afifi A, Farag HA, Djafarian K (2019) Dietary patterns and their association with depression among type 2 diabetes patients in Gaza Strip, Palestine. Food and Nutrition Sciences 10(5): 533-550.
6. Artinian NT, Fletcher GF, Mozaffarian D, Kris Etherton P, Van Horn L, et al. (2010) Interventions to promote physical activity and dietary lifestyle changes for cardiovascular risk factor reduction in adults: a scientific statement from the American Heart Association. Circulation 122(4): 406-441.
7. El Bilbeisi AH, Hosseini S, Djafarian K (2018) Dietary patterns and their association with blood pressure control among hypertensive patients in Gaza Strip, Palestine. Journal of Family Medicine and Health Care 4(2): 5-12.
8. Singh P, Dwivedi P, Mendiratta S (2016) Correlation of endometrial thickness with the histopathological pattern of endometrium in postmenopausal bleeding. The journal of Obstetrics and Gynecology of India 66(1): 42-46.
9. Laroche M, Pécourneau V, Blain H, Breuil V, Chapurlat R, et al. (2017) Osteoporosis and ischemic cardiovascular disease. Joint bone spine 84(4): 427-432.
10. Eaton SA, Sethi JK (2019) Immunometabolic links between estrogen, adipose tissue and female reproductive metabolism. Biology 8(1): 8.
11. El Bilbeisi AH, Hosseini S, Djafarian K (2017) Dietary patterns and metabolic syndrome among type 2 diabetes patients in Gaza Strip, Palestine. Ethiopian journal of health sciences 27(3): 227-238.
12. Silva TR, Oppermann K, Reis FM, Spritzer PM (2021) Nutrition in Menopausal Women: A Narrative Review. Nutrients 13(7): 2149.
13. (2020) Palestinian Ministry of Health, Annual Report.
14. Charan J, Biswas T (2013) How to calculate sample size for different study designs in medical research?. Indian journal of psychological medicine 35(2):121-126.
15. El Bilbeisi AH, Hosseini S, Djafarian K (2017) Association of dietary patterns with diabetes complications among type 2 diabetes patients in Gaza Strip, Palestine: a cross sectional study. Journal of Health, Population and Nutrition 36(1): 37.
16. Farag HA, Hosseinzadeh Attar MJ, Muhammad BA, Esmaillzadeh A, El Bilbeisi AH (2019) Effects of vitamin D supplementation along with endurance physical activity on lipid profile in metabolic syndrome patients: A randomized controlled trial. Diabetes & Metabolic Syndrome: Clinical Research & Reviews 13(2): 1093-1098.
17. Farag HA, Hosseinzadeh Attar MJ, Muhammad BA, Esmaillzadeh A, El Bilbeisi AH (2019) Effects of vitamin C supplementation with and without endurance physical activity on components of metabolic syndrome: A randomized, double-blind, placebo-controlled clinical trial. Clinical Nutrition Experimental 26: 23-33.
18. Farag HA, Baqi HR, Qadir SA, El Bilbeisi AH, Hamafarj KK, et al. (2020) Effects of Ramadan fasting on anthropometric measures, blood pressure, and lipid profile among hypertensive patients in the Kurdistan region of Iraq. SAGE Open Medicine 8: 2050312120965780.
19. Hamdan M, Monteagudo C, Lorenzo Tovar ML, Tur JA, Olea Serrano F, et al. (2014) Development and validation of a nutritional questionnaire for the Palestine population. Public health nutrition 17(11): 2512-2518.
20. El Bilbeisi AH, Hosseini S, Djafarian K (2017) The association between physical activity and the metabolic syndrome among type 2 diabetes patients in Gaza strip, Palestine. Ethiopian journal of health sciences 27(3): 273-282.

21. El Bilbeisi AH, Albelbeisi A, Hosseini S, Djafarian K (2019) Dietary pattern and their association with level of asthma control among patients with asthma at Al-Shifa medical complex in Gaza strip, Palestine. Nutrition and metabolic insights 12:1.

22. El Bilbeisi AH, El Afifi A, Baloushah S, Alblbeisi A, Albelbeisi AH, et al. (2020) Maternal dietary patterns during early pregnancy and their association with pregnancy outcome among obese women in Gaza Strip, Palestine: a prospective cohort study. Austin J Nutri Food Sci 8(1): 1138.

23. AlHarthi BK, Alkhodair A, Elias AY, Aleisa SN, ALMoumen FA, et al. (2017) Assessment of osteoporosis knowledge among Saudi females in Riyadh, KSA. The Egyptian Journal of Hospital Medicine 69(3): 2088-92.

24. Lee KT, Kim SH (2013) Association between metabolic syndrome and bone mineral density in pre and postmenopausal women. Korean Journal of Family Pracice 3(3): 315-22.

25. Bow C, Cheung C, Gao Y, Xiao S, Lau K, et al. (2011) Bone mineral density and serum osteoprotegerin levels in pre-and post-menopausal women. Hong Kong Med J 17(9).

26. Baffi CW, Wood L, Winnica D, Strollo Jr PJ, Gladwin MT, et al. (2016) Metabolic syndrome and the lung. Chest 149(6): 1525-34.

27. El Bilbeisi AH, Al Jawaldeh A, Albelbeisi A, Abuzerr S, Elmadfa I, et al. (2022) Households' food insecurity and its association with demographic and socioeconomic factors in Gaza Strip, Palestine: a cross-sectional study. Ethiopian Journal of Health Sciences 32(2): 369-380.

28. Abuzerr S, Zinszer K, Shaheen A, El Bilbeisi AH, Al Haj Daoud A, et al. (2021) Impact of the coronavirus disease 2019 pandemic on the Palestinian family: A cross-sectional study. SAGE open medicine 9: 20503121211001137.

29. Lobo RA (2008) Metabolic syndrome after menopause and the role of hormones. Maturitas 60(1): 10-8.

30. Eshtiaghi R, Esteghamati A, Nakhjavani M, (2010) Menopause is an independent predictor of metabolic syndrome in Iranian women. Maturitas 65(3): 262-6.

31. Kaur J (2014) Assessment and screening of the risk factors in metabolic syndrome. Medical sciences 2(3): 140-152.

32. Agarwal K, Sharma (2020) M Association of Hypovitaminosis D with Metabolic Syndrome in Postmenopausal Women. The Journal of Obstetrics and Gynecology of India 70(3): 184-8.

33. Myers J, Kokkinos P, Nyelin E (2019) Physical activity, cardiorespiratory fitness, and the metabolic syndrome. Nutrients 11(7): 1652.

34. Kolovou GD, Kolovou V, Mavrogeni S (2016) Cigarette smoking/cessation and metabolic syndrome. Clinical Lipidology 11(1): 6-14.

35. Naja F, Nasreddine L, Itani L, Adra N, Sibai AM, et al. (2013) Association between dietary patterns and the risk of metabolic syndrome among Lebanese adults. European journal of nutrition 52(1): 97-105.

36. Choi JH, Woo HD, Lee JH, Kim J (2015) Dietary patterns and risk for metabolic syndrome in Korean women: a cross-sectional study. Medicine 94(34): e1424.

37. Tosh SM, Bordenave N (2020) Emerging science on benefits of whole grain oat and barley and their soluble dietary fibers for heart health, glycemic response, and gut microbiota. Nutrition reviews 1;78(Supplement 1):13-20.

38. Jeria N, Cornejo S, Prado G, Bustamante A, Garcia Diaz DF, et al. (2022) Echeverria F. Beneficial Effects of Bioactive Compounds Obtained from Agro-Industrial By-Products on Obesity and Metabolic Syndrome Components. Food Reviews International 6: 1-30.

39. Sunmin Park, Jaeouk Ahn ,Nam Soo Kim , Byung Kook Lee (2017) High carbohydrate diets are positively associated with the risk of metabolic syndrome irrespective to fatty acid composition in women: the KNHANES 2007–2014. International journal of food sciences and nutrition 68(4): 479-487.

40. Shab Bidar S, Golzarand M, Hajimohammadi M, Mansouri S (2018) A posteriori dietary patterns and metabolic syndrome in adults: a systematic review and meta-analysis of observational studies. Public health nutrition 21(9): 1681-1692.

41. Deshmukh Taskar PR, O'Neil CE, Nicklas TA, Yang SJ, Liu Y, et al. (2009) Dietary patterns associated with metabolic syndrome, sociodemographic and lifestyle factors in young adults: the Bogalusa Heart Study. Public health nutrition 12(12): 2493-2503.

42. Farag HA, Baqi HR, Hussein YT, Shareef OH, Qadir SA, et al. (2020) The Role of Nutrients in Supporting the Immune System Against Viral Infection; Newly Emerged Coronavirus (COVID19): A Narrative Review. Kurdistan Journal of Applied Research 27: 84-96.

43. Albelbeisi AH, Albelbeisi A, El Bilbeisi AH, Taleb M, Takian A, et al. (2021) Barriers toward the practice of healthy behaviors among patients with non-communicable diseases in Gaza Strip, Palestine. SAGE Open Medicine.