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# Factors associated with adherence to Mediterranean diet among Saudi non-diabetic patients attending primary health care centers: A cross-sectional study

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**الملخص**

**أهداف البحث:** للتحقيق في العوامل المسؤولة ودرجة الالتزام بحمية البحر الأبيض المتوسط بين المرضى غير المصابين بالسكري من مراجعي مراكز الرعاية الصحية الأولية.

**طرق البحث:** أُجريت دراسة مستعرضة في مراكز الرعاية الصحية الأولية بجدة، بواسطة استبانة مصدقة ذاتية الاستخدام، تقوم بتقييم مستويات الالتزام لـ ١٤ جانبا غذائيا متعلقا بحمية البحر الأبيض المتوسط. تمكن الاستبانة من حساب درجة التزام (٠- ١٤)، في حين تم افتراض التزام غير كافي للنتائج ≥٧. وقد شملت عوامل الالتزام الخصائص الديموغرافية الاجتماعية العامة والتاريخ المَرَضي ونمط الحياة وعوامل الخطورة القلبية الوعائية مثل مؤشر كتلة الجسم ونسبة الخصر إلى الورك وضغط الدم والصيام ومستوى الجلوكوز في الدم بعد الأكل بساعة واحدة.

**النتائج:** من بين المشاركين الـ ٢٦٥ (٥٠.٦٪ ذكورا)، سُجل عدم الالتزام الكافي في ٧٤.٣٪. وكانت درجات الالتزام أعلى في المشاركين المتزوجين (٦.٨٦ ± ١.٧٤مقابل ٦.٢٤ ± ١.٧٩) والممارسين للنشاط البدني المنتظم (٦.٧٩ ± ١.٩٠مقابل ٦.٣٠ ± ١.٦٣) بالمقارنة مع نظرائهم، على التوالي. علاوة على ذلك، فقد ازداد الالتزام بالحمية المتوسطية مع التقدم في العمر (معامل انحدار غير معياري=٠.٠٢ ومعامل ارتباط= ٠.١٣٣). ومن المثير للاهتمام، أنه لم ترتبط درجات الالتزام بعوامل الخطورة الرئيسة المتعلقة بالقلب والأوعية الدموية، فيما عدا الارتفاع البيّن في ضغط الدم الانبساطي بين المشاركين الملتزمين مقارنة بقرنائهم قليلي الالتزام (٧٧.٩٦± ١٢.٢٠مقابل ٧٤.٠١± ١٢.٢٤، على التوالي).

**الاستنتاجات:** كان لواحد من أصل ٤ مرضى غير مصابين بداء السكري من الذين راجعوا مراكز الرعاية الصحية الأولية، التزام جيد بحمية البحر الأبيض المتوسط دون ارتباط يُذكر بعوامل الخطورة القلبية الوعائية. يُوصى بإجراء المزيد من الدراسات للتحقيق في الوعي والمعرفة حول النظام الغذائي المتوسطي بين السكان السعوديين، ومن بعدها يمكن تفصيل برامج التوعية وفقًا لذلك.

**الكلمات المفتاحية:** حمية البحر الأبيض المتوسط؛ غير السكري؛ الالتزام؛ المملكة العربية السعودية؛ القلب والأوعية الدموية

**Abstract**

**Objectives:** To investigate the degree and factors responsible for adherence to a Mediterranean diet among non-diabetic patients attending primary health care centres (PHCCs).

**Methods:** A cross-sectional study was conducted in Jeddah PHCCs using a validated self-administered questionnaire which assessed adherence levels to 14 dietary aspects related to the Mediterranean diet. The questionnaire enabled calculation of an adherence score (0–14), where inadequate adherence was assumed for scores ≤7. Factors of adherence included general socio-demographic characteristics, medical history, lifestyle, and cardiovascular risk factors such as body mass index, waist-to-hip ratio, blood pressure, and fasting and 1-h postprandial blood glucose levels.

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**Results:** Of the 265 participants (50.6% males), inadequate adherence was reported in 74.3%. Adherence scores were higher in married participants than in unmarried ones (6.68 ± 1.74 vs. 6.24 ± 1.79, p = 0.04), as well as in those who engaged in regular physical activity vs. those who did not (6.79 ± 1.90 vs. 6.30 ± 1.63, p = 0.02). Furthermore, Mediterranean diet adherence increased with age (B = 0.02, r = 0.133; $p < 0.001$). Interestingly, adherence scores were not associated with major cardiovascular risk factors except for a significantly higher diastolic blood pressure in participants with adequate as opposed to low adherence (77.96 ± 12.20 vs. 74.01 ± 12.24, respectively, $p = 0.022$).

**Conclusion:** One out of 4 non-diabetic patients attending PHCCs exhibited good adherence to a Mediterranean diet without considerable association with cardiovascular risk factors. Further studies are recommended to investigate awareness and knowledge regarding the Mediterranean diet among Saudi populations. Subsequently, awareness programs could be tailored accordingly.

**Keywords:** Adherence; Cardiovascular; KSA; Mediterranean diet; Non-diabetes



## Introduction

The prospected burden of cardiovascular diseases (CVD) on both the individual and healthcare providers could be prevented through amelioration of risk factors leading to inhibition of 75% of premature CVD cases.[1] Risk factors such as sedentary lifestyle, obesity, smoking, diabetes, and hypercholesterolaemia have an important role in CVD pathogenesis[2] and are intrinsically affected by multiple social, behavioural, economic, and cultural aspects.[3,4] Therefore, various interventions (for example, proper diet) might be considered as simple and cost-effective approaches for reducing the possibility of CVD development.[5]

Dietary guidelines usually focus on dietary patterns and recommendations for the most over-consumed nutrients, such as sodium, added sugar, saturated fat, and dietary cholesterol, since they augment the risk of chronic diseases. For example, recommended healthy foods for the general population include vegetables, fruits, low-fat or fat-free dairy products, seeds, nuts, and vegetable oils, and experts advocate limiting saturated fat, salt, and added sugar.[6] Additionally, Briggs et al.[7] stated that saturated fat should be replaced with unsaturated fat or whole grains to prevent CVD development. A recent meta-analysis indicated that increased intake of whole grains, fruits, vegetables, fish, and nuts reduces the risk of all-cause mortality, while its risk rises in a linear pattern with increased intake of processed and red meat.[8]

Interestingly, traditional dietary patterns in countries surrounding the Mediterranean Sea have been associated with multiple health benefits. Although the Mediterranean diet varies among different countries, its common features include high consumption of cereals and grains (mainly whole grains), fruits, legumes, vegetables, nuts, and fish, as well as a reliance on olive oil as its main source of fat. Consequently, the Mediterranean diet involves high monounsaturated fat-saturated fat ratios, low consumption of meat and meat products, and moderate intake of milk and dairy.

Since the Mediterranean diet is rich in vitamin C, vitamin E, and β-carotene (antioxidant vitamins), it might reduce oxidative stress, which has been involved in the pathogenesis of cancer, CVD, and other chronic disorders such as dementia. One large case–control study, in fact, did reveal that the Mediterranean diet can reduce oxidative stress.[9] Additionally, evidence also indicates that the Mediterranean diet plays a role in protection against inflammation, platelet aggregation, and coronary thrombosis.[10–12] Dinu et al.[13] found that adherence to this diet was associated with a reduced risk of overall mortality, diabetes, neurodegenerative diseases, and CVD. Furthermore, cancer incidence was decreased remarkably by following this dietary pattern despite weak evidence against site-specific cancers and metabolic parameters.[13]

To maximize the beneficial outcome of this diet, Widmer et al.[14] recommended consuming Mediterranean dietary components in moderation to obtain balanced nutrition and avoid high caloric intake. Further, Martínez-González[15] advocated spreading the Mediterranean diet beyond the boundaries of the Mediterranean Sea since it is expected that approximately 19,000 deaths due to CVD could be prevented by promoting this diet in the United Kingdom.

However, in some Gulf countries, the presence of individuals with adequate knowledge about the health benefits of the Mediterranean diet is still insufficient to ensure the best patterns of this type of consumption. Only one systematic review has been done, and it revealed few adherents to this dietary regimen.[16] To our knowledge, there are no studies investigating the relationship between Mediterranean diet adherence and inhibition of CVD risk factors. This is in parallel with the increasing burden of CVD that has occurred at the local level with the rapid urbanization and major economic transition of recent years.[2] These issues are leading to a high prevalence of cardiovascular risk factors, particularly obesity, which has been reported in approximately 65%–72% of Saudi nationals.[17,18] Moreover, dyslipidaemia, hypertension, smoking, and diabetes were prevalent in both genders and in various age groups that did not employ suitable management approaches.[17] As such, the present study attempted to investigate adherence to a Mediterranean diet and elucidate its association with risk factors of CVDs among patients attending primary health care centres (PHCCs) in KSA.

## Materials and Methods

A cross-sectional study was conducted among non-diabetic patients visiting Ministry of Health (MOH) PHCCs in Jeddah, KSA. Jeddah Province, a western coastal city in KSA, contains 88 PHCCs that cover all districts. Among these, 44 are in its central region. Jeddah's centre is divided into 5 regulatory sectors. Target sample size (N = 236) was computed with 80% statistical power, 5% margin of error, and a 95% confidence interval. A stratified two-stage cluster sampling method was employed to select one PHCC from each sector. Systematic

random sampling was used to include the first and second of each three consecutive eligible and consenting patients in the participating centres, beginning on 01 October 2017 and extending until the target sample size was reached. Diabetic patients were excluded using glycated haemoglobin (HbA1c), fasting blood glucose, and/or 1-h glucose tests.

A validated self-administered questionnaire developed by Martınez-Gonzalez et al.[22] was used to assess adherence levels to a Mediterranean diet. This questionnaire consisted of 14 items, each relating to a specific dietary aspect such as the use of olive oil as a principal source of fat; the number of daily servings of vegetables, fruits, and red meat; the number of fish and seafood-based dishes eaten per week; and the amount of carbonated and/or sweetened beverages consumed, etc. Each of these items involved a 2-option question enabling a unitary score of 0 (no adherence) or 1 (adherence) depending upon whether the answer adhered to Mediterranean diet characteristics.

The questionnaire was completed through face-to-face interview and contained three additional parts: 1) general information including socio-demographic characteristics (age, gender, education level, income, etc.), lifestyle data (tobacco consumption, physical activity at one's job, etc.), and medical history (hypertension, dyslipidaemia); 2) anthropometric measurements which were taken by the investigators and included weight and height with calculation of body mass index (BMI), waist and hip circumferences with calculation of waist-to-hip ratio (WHR), and blood pressure (BP); and 3) a blood sample that was drawn using a butterfly needle, one tube containing ethylene-diaminetetraacetic acid (EDTA) (2.0 mL), and one plain tube (4.0 mL). The following tests were conducted in the fasting serum sample: glucose, total cholesterol, triglycerides, and HbA1c.

All anthropometric measurements were performed twice by two different examiners, and the mean values were considered.

Participants were informed about the study objectives and signed a written consent. Collected data were kept confidential and were not accessed by anyone besides investigators and trusted partners, for the unique purpose of scientific research. The study protocol was approved by the Directorate of Health Affairs, Ministry of Health, Jeddah.

### *Statistical methods*

Statistical analysis was performed with the Statistical Package for Social Sciences version 21.0 for Windows (SPSS Inc., Chicago, IL, USA). Adherence score (range: 0–14) was computed as the number of dietary rules to which the participant declared being adherent. Analysis of the distribution of the adherence score in the study population showed a bell-shaped distribution, whereas normality tests including Kolmogorov–Smirnov (statistics = 0.135, $p < 0.001$) and Shapiro–Wilk (statistics = 0.968, $p = 0.001$) demonstrated non-normal distribution of the variable. Consequently, the adherence score was analyzed using both parametric and nonparametric tests by comparing the scores between the different categories of the factor variables. Analysis used independent t- and Mann–Whitney U tests for binomial variables, and one-way ANOVA and Kruskal–Wallis tests for multinomial variables. Further, to analyze the association of adherence level with cardiovascular risk factors, the population was divided into two groups: inadequate [score 0–7] versus adequate [score 8–14] adherence levels to a Mediterranean diet, according to adherence scores. Independent t-test was used to compare the two groups regarding cardiac risk factors including anthropomorphic measurements (BMI, WHR, etc.), BP, and glucose metabolism (H0 and H1 serum glucose level). A $p = \text{value} < 0.05$ was considered for statistical significance.

## Results

### *Participants' characteristics*

Two hundred and sixty-five individuals participated in the study. Of these, 50.6% were males, and the mean (SD) age of

**Table 1: Participants' socio-demographic and lifestyle factors (N = 265).**

| Parameter | Category | Frequency | Percentage |
|---|---|---|---|
| Gender | Male | 134 | 50.6 |
| | Female | 131 | 49.4 |
| Age (years) | Mean, SD | 32.98 | 10.70 |
| Marital status | Single or divorced | 101 | 38.1 |
| | Married | 164 | 61.9 |
| Education level | Illiterate or uneducated | 12 | 4.5 |
| | Primary & middle school | 31 | 11.7 |
| | Secondary | 63 | 23.8 |
| | University+ | 159 | 60.0 |
| Residence | Modest | 36 | 13.6 |
| | Flat | 178 | 67.2 |
| | Villa | 51 | 19.2 |
| Home ownership | Rented | 149 | 52.8 |
| | Owned | 114 | 43.0 |
| | Other | 11 | 4.2 |
| Job category | None | 118 | 44.5 |
| | Office | 51 | 19.2 |
| | Some PA | 64 | 24.2 |
| | Considerable PA | 32 | 12.1 |
| Income (SAR) | <3 K | 53 | 20.0 |
| | 3 K–5 K | 63 | 23.8 |
| | 5 K–10 K | 74 | 27.9 |
| | 10 K–20 K | 55 | 20.8 |
| | >20 K | 20 | 7.5 |
| Smoking status | Non-smoker | 177 | 66.8 |
| | Ex-smoker | 9 | 3.4 |
| | Passive smoker | 14 | 5.3 |
| | Current smoker | 65 | 24.5 |
| Physical activity ≥30 min/day | No | 81 | 30.6 |
| | Yes | 17 | 6.4 |
| Hours spent sitting per day | <4 | 45 | 17.0 |
| | 4–5 | 70 | 26.4 |
| | 6–8 | 91 | 34.3 |
| | >8 | 59 | 22.3 |
| Bedtime | Before 12:00 a.m. (midnight) | 84 | 31.7 |
| | Midnight-2:00 a.m. | 136 | 51.3 |
| | After 2:00 a.m. | 45 | 17.0 |
| Amount of sleep (in hours) | <5 | 16 | 6.0 |
| | 5–6 | 92 | 34.7 |
| | 6–7 | 92 | 34.7 |
| | 7–8 | 49 | 18.5 |
| | >8 | 16 | 6.0 |

Due to missing data, all frequencies do not equal the total.
PA: physical activity; SAR: Saudi Riyal; SD: standard deviation.

the participants was 32.98 (10.70) years. Other demographic characteristics of the study population showed that 60.0% were highly educated (university + level), 67.2% were living in a flat, 44.5% were unemployed, and 66.8% were non-smokers. Assessment of other lifestyle factors showed low rates of regular physical activity (6.4%), high rates of poor sleep patterns (including late bedtimes) (68.3%), and insufficient amounts of sleep (40.7% declared sleeping less than 6 h per night) (Table 1).

*Clinical assessments and cardiovascular risk factors*

Results showed prevalence of hypertension (10.6%), hypercholesterolaemia (5.7%), hypertriglyceridaemia (3.8%), and pre-diabetes (24.2%). Assessment of cardiovascular risk factors showed mean (SD) BMI (28.03 [6.83] kg/m$^2$), fat percentage (33.95 [12.00]), WHR (0.88 [0.11]), systolic BP (118.97 [16.06] mmHg), and diastolic BP (75.02 [12.33] mmHg). Glucose blood tests showed mean (SD) fasting (4.79 [1.35] mmol/L) and 1-h postprandial (6.96 [2.46] mmol/L) glucose levels and diagnosed isolated impaired fasting glucose (IFG) (6.5%), isolated impaired glucose tolerance (IGT) (15.7%), and combined IFG and IGT (2.3%), resulting in 24.4% of patients being diagnosed with pre-diabetes and 6.5% with incidental diabetes (Table 2).

*Adherence to a Mediterranean diet*

All but one participant declared having no alcohol consumption (99.5%). Investigation of other dietary habits showed that 80.8% of participants preferred consuming chicken, turkey, or rabbit meat instead of veal, hamburger, or sausages; 78.9% declared consuming ≥3 servings of fish or shellfish per week; and 74.3% consumed <1 serving per week of red meat, hamburger, or meat products. When omitting the question on alcohol consumption, the lowest adherence rates were observed for daily vegetable intake (≥2 servings, 14.3%), olive oil consumption (≥4 tablespoons per day, 20.4%), and amount of commercial sweets and pastries ingested each week (<3 times per week, 23.8%) (Figure 1).

Adherence scores were computed as the number of rules (0−13) that the participant declared adhering to, and the histogram of the different adherence scores is depicted in Figure 2, showing a bell-shaped distribution ranging between 2 and 13. By dividing adherence level into two categories, we

**Table 2: Clinical assessments and cardiovascular risk factors.**

| Parameter | Range/category | Mean | SD | Frequency | Percentage |
|---|---|---|---|---|---|
| Medical history | Hypertension | | | 28 | 10.6 |
| | On medication | | | 13 | 4.9 |
| | High fat | | | 18 | 6.8 |
| | On medication | | | 8 | 3.0 |
| | Hypercholesterolaemia | | | 15 | 5.7 |
| | On medication | | | 5 | 1.9 |
| | Hypertriglyceridaemia | | | 10 | 3.8 |
| | On medication | | | 5 | 1.9 |
| Height (kg) | (144, 186) | 165.13 | 8.807 | | |
| Weight (cm) | (35, 173) | 76.63 | 20.091 | | |
| BMI (kg/m$^2$) | (14.82, 60.52) | 28.03 | 6.83 | | |
| Fat percentage | (5, 71) | 33.95 | 12.00 | | |
| Neck circ. (cm) | (26, 56) | 37.10 | 5.11 | | |
| Waist circ. (cm) | (40, 150) | 93.73 | 17.09 | | |
| Hip circ. (cm) | (50, 162) | 106.75 | 15.35 | | |
| WHR | (0.33, 1.69) | 0.88 | 0.11 | | |
| | High (male>0.91, female>0.84) | | | 121 | 45.7 |
| Pulse (pulse/min) | (39, 140) | 75.34 | 11.84 | | |
| Systolic BP (mmHg) | (80.0, 240.0) | 118.97 | 16.06 | | |
| Diastolic BP (mmHg) | (10.0, 110.0) | 75.02 | 12.33 | | |
| Glucose 0 h (mmol/L) | (2.50, 14.60) | 4.79 | 1.35 | | |
| Glucose 1 h (mmol/L) | (3.30, 21.40) | 6.96 | 2.46 | | |
| Glucose metabolism | Normal | | | 150 | 69.1 |
| | IFG | | | 14 | 6.5 |
| | IGT | | | 34 | 15.7 |
| | IFG & IGT | | | 5 | 2.3 |
| | Diabetes | | | 14 | 6.5 |
| Pre-diabetes | No | | | 150 | 69.1 |
| | Yes | | | 48 | 30.9 |

Due to missing data, all frequencies do not equal the total.
BMI: body mass index; BP: blood pressure; circ.: circumference; IFG: impaired fasting glucose; IGT: impaired glucose tolerance; SD: standard deviation; WHR: waist-to-hip ratio.

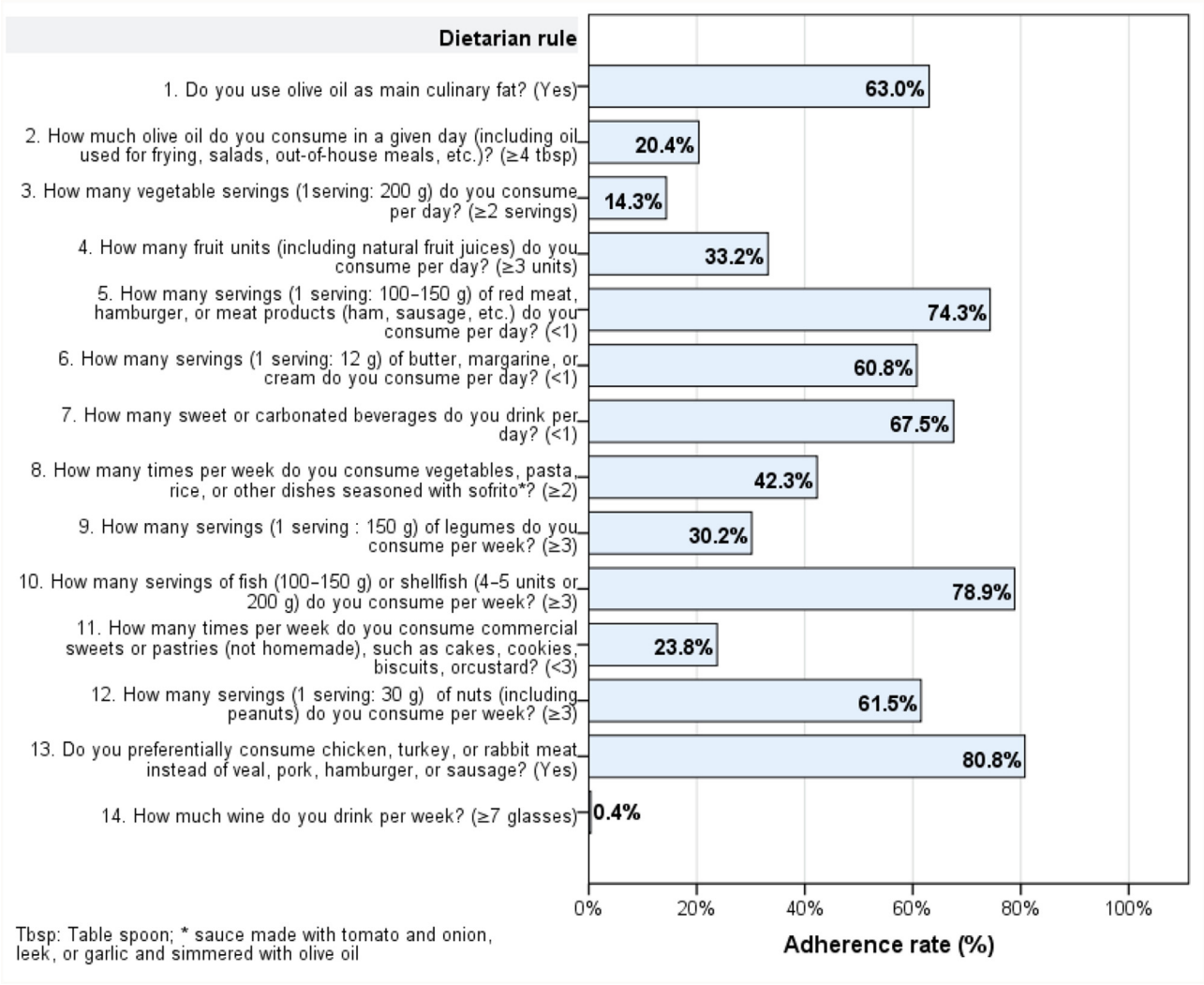


**Figure 1:** Adherence to a Mediterranean diet among patients of primary health care centres. Bars represent the percentage of participants who declared being adherent to the given dietary rule.

observed the following distributions: inadequate (score 0−7, 74.3% of participants) and adequate (score>7, 25.7%).

*Factors of adherence to a Mediterranean diet*

Analysis of adherence factors showed weak positive linear correlation between adherence score and age (B = 0.02, r = 0.133; p < 0.001), as well as relatively higher scores among married participants than unmarried ones (mean [SD] = 6.68 [1.74] versus 6.24 [1.79]) and in those who reported practicing regular exercise as opposed to those who did not (mean [SD] = 6.79 [1.90] versus 6.30 [1.63]); however, these differences were statistically significant in parametric tests (p = 0.046 and 0.025, respectively) but not in nonparametric tests (p = 0.070 and 0.094, respectively). No association was found between adherence score and the other demographic and lifestyle factors (p > 0.05), or between adherence score and a history of hypertension, hypercholesterolaemia, hypertriglyceridaemia, or pre-diabetes. Further, adherence level was not associated with glucose metabolism abnormalities (Table 3). Stepwise linear regression, including age, marital status, and physical activity as the independent variables, showed that adherence score was significantly predicted by age (B = 0.024, p = 0.017) and physical activity (B = 0.537, p = 0.014); these results are not presented in tables.

*Adherence to a Mediterranean diet and other cardiovascular risk factors*

To assess the association between adherence to a Mediterranean diet and measurable cardiovascular risk factors, the study population was divided into two groups: those who had inadequate (adherence score 0−7) versus adequate (score 8−14) levels of adherence to a Mediterranean diet. Comparative analysis between the two groups showed no statistically significant difference in major cardiovascular risk factors, including BMI (p = 0.784), body fat percentage (p = 0.113), and waist-to-hip ratio (0.462), while a marginal statistically significant difference was found in

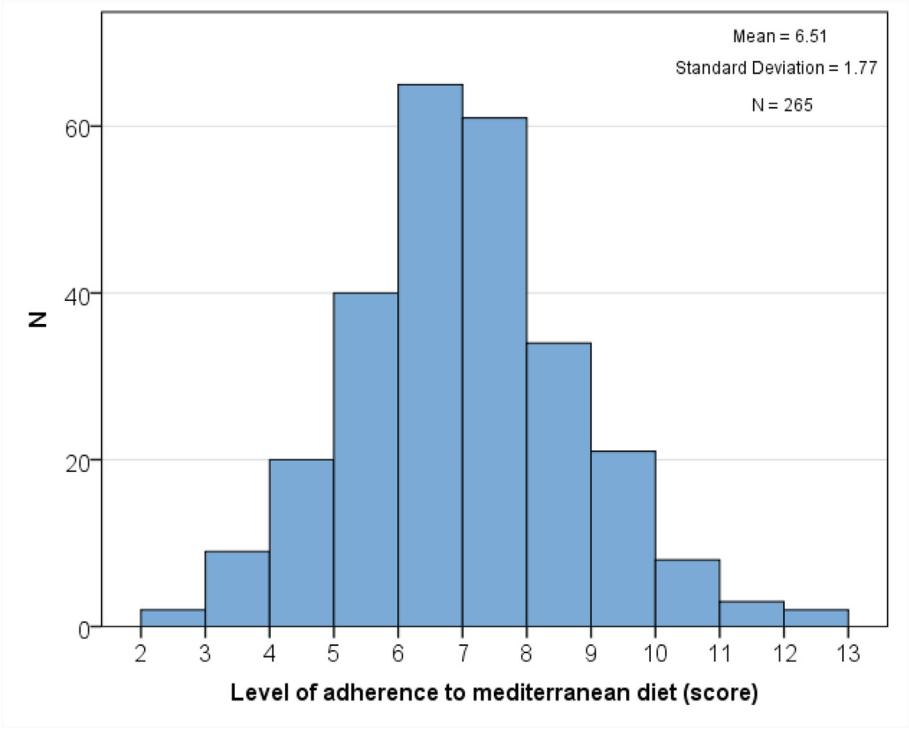


**Figure 2:** Levels of adherence to a Mediterranean diet. Bars represent the number of participants who exhibited the given level of adherence (measured by the number of dietary rules followed).

**Table 3: Factors associated with adherence to a Mediterranean diet.**

| Parameter | Category | Adherence level (score) | | p-value | |
|---|---|---|---|---|---|
| | | Mean | SD | Param. | NP |
| Gender | Male | 6.43 | 1.98 | 0.455 | 0.668 |
| | Female | 6.60 | 1.53 | | |
| Age (years) | B, r | 0.02 | 0.133 | <0.001* | – |
| Marital status | Single or divorced | 6.24 | 1.79 | 0.046* | 0.070 |
| | Married | 6.68 | 1.74 | | |
| Education level | Illiterate or uneducated | 7.08 | 1.51 | 0.319 | 0.305 |
| | Primary & middle school | 6.07 | 1.73 | | |
| | Secondary | 6.46 | 1.96 | | |
| | University+ | 6.58 | 1.71 | | |
| Residence | Modest | 6.42 | 1.59 | 0.852 | 0.879 |
| | Flat | 6.56 | 1.78 | | |
| | Villa | 6.43 | 1.85 | | |
| Home ownership | Rented | 6.74 | 1.86 | 0.083 | 0.138 |
| | Owned | 6.29 | 1.65 | | |
| | Other | 6.00 | 1.34 | | |
| Job type | None | 6.53 | 1.57 | 0.728 | 0.674 |
| | Office | 6.55 | 2.27 | | |
| | Some PA | 6.33 | 1.65 | | |
| | Considerable PA | 6.75 | 1.81 | | |
| Income (SAR) | <3 K | 6.25 | 1.56 | 0.555 | 0.434 |
| | 3 K−5 K | 6.68 | 2.11 | | |
| | 5 K−10 K | 6.38 | 1.73 | | |
| | 10 K−20 K | 6.67 | 1.74 | | |
| | >20 K | 6.75 | 1.29 | | |
| Smoking status | Non-smoker | 6.63 | 1.75 | 0.515 | 0.739 |
| | Passive smoker | 6.29 | 1.44 | | |
| | Ex-smoker | 6.44 | 2.07 | | |
| | Current smoker | 6.26 | 1.85 | | |
| PA ≥ 30 min/day | No | 6.30 | 1.63 | 0.025* | 0.094 |

**Table 3** (*continued*)

| Parameter | Category | Adherence level (score) | | p-value | |
|---|---|---|---|---|---|
| | | Mean | SD | Param. | NP |
| | Yes | 6.79 | 1.90 | | |
| Hours spent sitting per day | <4 | 6.78 | 1.62 | 0.430 | 0.510 |
| | 4–5 | 6.43 | 1.85 | | |
| | 6–8 | 6.33 | 1.69 | | |
| | >8 | 6.69 | 1.90 | | |
| Bedtime | Before 12:00 a.m. (midnight) | 6.68 | 1.76 | 0.475 | 0.430 |
| | Midnight-2:00 a.m. | 6.49 | 1.78 | | |
| | After 2:00 a.m. | 6.29 | 1.74 | | |
| Amount of sleep (in hours) | <5 | 6.75 | 2.62 | 0.313 | 0.310 |
| | 5–6 | 6.64 | 1.61 | | |
| | 6–7 | 6.29 | 1.90 | | |
| | 7–8 | 6.39 | 1.55 | | |
| | >8 | 7.19 | 1.33 | | |
| Hypertension | No | 6.45 | 1.75 | 0.098 | 0.121 |
| | Yes | 7.04 | 1.82 | | |
| High fat | No | 6.47 | 1.75 | 0.178 | 0.359 |
| | Yes | 7.06 | 2.01 | | |
| Hypercholeste-rolaemia | No | 6.51 | 1.77 | 0.964 | 0.924 |
| | Yes | 6.53 | 1.85 | | |
| Hypertriglyceri-daemia | No | 6.49 | 1.78 | 0.211 | 0.157 |
| | Yes | 7.20 | 1.40 | | |
| Pre-diabetes | No | 6.51 | 1.77 | 0.289 | 0.203 |
| | Yes | 6.79 | 1.80 | | |

B: unstandardized regression coefficient; PA: physical activity; r: correlation coefficient; SD: standard deviation.
*Statistically significant difference ($p < 0.05$).
Parametric tests used: independent t-test, one-way ANOVA, linear regression.
Non-parametric tests used: Mann–Whitney U, Kruskal–Wallis test.

**Table 4: Association of adequate adherence to a Mediterranean diet with cardiovascular risk factors.**

| Parameter (unit) | Adherence level to Mediterranean diet | | | | p-value |
|---|---|---|---|---|---|
| | Inadequate (score 0–7) | | Adequate (score 8–14) | | |
| | Mean | SD | Mean | SD | |
| Weight (cm) | 76.18 | 20.11 | 77.93 | 20.13 | 0.537 |
| BMI (kg/m$^2$) | 28.10 | 7.03 | 27.83 | 6.28 | 0.784 |
| Fat percentage (%) | 34.64 | 12.53 | 31.95 | 10.15 | 0.113 |
| Neck circ. (cm) | 36.85 | 5.06 | 37.81 | 5.23 | 0.187 |
| Waist circ. (cm) | 93.27 | 16.96 | 95.06 | 17.50 | 0.460 |
| Hip circ. (cm) | 106.78 | 15.83 | 106.66 | 13.98 | 0.119 |
| WHR | 0.88 | 0.12 | 0.89 | 0.08 | 0.462 |
| Below cut-off[a] (freq., %) | 102 | 52.8 | 37 | 55.2 | 0.737[b] |
| Above cut-off[a] (freq., %) | 91 | 47.2 | 30 | 44.8 | |
| Pulse (pulse/min) | 76.05 | 12.46 | 73.26 | 9.62 | 0.095 |
| Systolic BP (mmHg) | 118.52 | 14.02 | 120.26 | 20.94 | 0.442 |
| Diastolic BP (mmHg) | 74.01 | 12.24 | 77.96 | 12.20 | 0.022* |
| Glucose, 0 h | 4.77 | 1.33 | 4.87 | 1.40 | 0.621 |
| Glucose, 1 h | 6.94 | 2.42 | 7.01 | 2.59 | 0.854 |

Values are means and standard deviation (SD), except as otherwise specified.
BMI: body mass index; BP: blood pressure; circ.: circumference; freq.: frequency; WHR: waist-to-hip ratio.
[a] WHR cut-off was adjusted for gender.
[b] Chi square test; additional test used: independent t-test.

diastolic BP ($p = 0.022$). No significant association was found between adherence to a Mediterranean diet and fasting ($p = 0.621$) or post-prandial ($p = 0.854$) glucose levels (Table 4).

## Discussion

The role of dietary interventions in the protection against CVD has been of major importance due to the consistently

increased burden of such diseases in several countries, including KSA. Different aspects concerning the health benefits of a Mediterranean diet have been reviewed in the literature, yielding an overall significant improvement in cardiovascular health in people with high adherence to this diet as compared to those following a Western one.[23] The present study utilized the Mediterranean Diet Adherence Screener questionnaire to investigate the patterns of adherence in a sample of the Saudi population.[24]

Our data showed that only 1 in every 4 participants had eating habits that adhered to at least 50% of the characteristics of the Mediterranean diet. Unexpectedly, no notable variation across socio-demographic and economic factors was demonstrated (especially at the educational level), except for marital status or age, where adherence score increased proportionally. This is in contrast with data from other studies showing better adherence to dietary rules among individuals with higher education.[25,26] Further, in the present study, the highest adherence levels were reported in illiterate participants, although this was not statistically significant. This may be related to the impact of economic status on dietary habits or to the influence of a highly educated social environment that encourages bad eating habits. The correlation between participants' age and adherence score in the current study was similarly observed in a recent prospective evaluation of adherence to a Mediterranean diet in an Italian cohort of the European Prospective Investigation into Cancer and Nutrition (EPIC).[25] Such association might reflect better awareness and knowledge about the health benefits of a Mediterranean diet in adults.

Being married was another important parameter that was associated with high scores of adherence to a Mediterranean diet, and this agreed with a large cross-sectional survey among employees in the United Kingdom[27] and adults in Morocco.[28] Indeed, married participants usually share patterns of food preparation with other family members, and thus family influences can have a more noticeable effect on their dietary behaviours than those of single individuals. Generally, eating in a family setting usually includes consuming meals cooked according to the family's tradition rather than other types of fast food meals.

Generally, although there is no distinct description of a single type of Mediterranean diet, its ideal content includes daily consumption of extra-virgin olive oil as the principal fat for cooking as well as high contents of whole grain foods, fruits, legumes, nuts, and vegetables, along with small portions of yogurt and cheese. Additionally, varying amounts of fish are consumed, and few to moderate amounts of red meat, eggs, poultry, wine, and sweets are ingested.[29] Inconsistent with Mediterranean dietary recommendations, almost all participants in this study refrained from alcohol consumption, which is attributable to their strong religious beliefs against using alcohol or other addictive substances along with the strict legal and religious rules in KSA that forbid its consumption.[30] Consequently, a cultural adaptation of the questionnaire would be suitable for future studies. Further, more than three-quarters of the population under investigation consumed more than the weekly recommended amount of commercial pastries and sweets and less than the daily recommended amount of olive oil and vegetables, which may reflect the discrepancy between local dietary habits and the Mediterranean diet. Additionally, the present study showed high adherence levels (80.8%) to low meat consumption per day, which may reflect the rarity of red meat and sausage consumption among the studied population.

The present study demonstrated no notable impact of socio-demographic factors, lifestyle, or medical history on the level of adherence to a Mediterranean diet. Moreover, adherence was not associated with the major risk factors of CVD. The only notable effect was on BMI, as it was slightly lower in participants who had high scores of adherence to a Mediterranean diet vs. those with low scores; however, it was not statistically significant. In contrast, other studies based on large populations demonstrated a significant association of adherence to a Mediterranean diet with weight, such as the entire EPIC cohort,[31] which showed higher Mediterranean diet adherence scores in individuals with reduced weight gain and that the risk of becoming obese was low in adherent participants with normal weight at the baseline. Furthermore, another prospective study conducted over a 3-year follow-up to the Spanish EPIC cohort[32] revealed low incidence rates of obesity, but not of being overweight, in participants with high Mediterranean diet adherence levels as assessed by its score. It is worth noting that low consumption of meat products had the greatest impact on this factor, such that the association between higher adherence levels and low weight gain has vanished with the removal of low meat consumption.[31]

Surprisingly, high diastolic BP, which is considered a CVD risk factor,[33] was associated with higher scores of adherence to a Mediterranean diet than lower ones. This might be related to hypertensive patients being more prone to follow the Dietary Approaches to Stop Hypertension (DASH) diet. In contrast, although Nunez-Cordoba et al.[34] found that adherence to a Mediterranean diet was not associated with hypertension, high Mediterranean diet scores based on a 9-item questionnaire were associated with a slight reduction of mean diastolic BP (−1.9 mm Hg, 95% CI: −3.6, −0.1).[34] Further, a study conducted in Italy by La Verde et al. reported an inverse correlation between higher adherence to a Mediterranean diet and hypertension, possibly due to the salt restriction in such a dietary regimen.[35] In France, Lelong et al. emphasized this correlation in women, but not in men, and subsequently recommended a Mediterranean diet to reduce the risk of diseases related to high BP. The difference in our data could be interpreted as an effect of the cut-off used to define adequate versus inadequate adherence, as there was no reference value or golden standard test to determine this cut-off.[36]

This study has some limitations. First, its cross-sectional design might bias the interpretation of the statistical association between adherence and cardiovascular risk factors. Second, the duration of adherence to a Mediterranean diet was not assessed and may have a significant impact on cardiovascular risk factors. Thus, an interventional design would be more appropriate to demonstrate the causal relationship between adherence and cardiovascular risk factors. Third, estimation of adherence to a Mediterranean diet relied on self-reported declarations; the questionnaire that was used depended on self-reported adherence, which could lead to obtaining invalid answers since accuracy depends on participants' levels of awareness regarding types of foods and the preparation and components of meals. Finally, the

questionnaire failed to assess degrees of awareness and knowledge concerning the health benefits of Mediterranean dietary patterns and their correlation with adherence to this type of diet. Nonetheless, utilizing a validated questionnaire remains a remarkable strength of this study.

## Conclusion

There was low adherence to a Mediterranean diet among patients attending PHCCs in Jeddah, with no notable effect of socio-demographic factors, lifestyle, or medical history on levels of adherence. This suggests a low level of awareness and inadequate education regarding the healthy properties of the Mediterranean diet and a significant gap in local culinary traditions and eating habits. However, the present study did not demonstrate any significant association between the level of adherence to a Mediterranean diet and cardiovascular risk factors, which is probably due to design limitations. A prospective controlled study is warranted to demonstrate the association and the causal relationship between adherence to the Mediterranean diet and reduction of cardiovascular risk factors.

## Recommendations

Its recommended to establish specifically-tailored programs to increase awareness levels concerning the Mediterranean diet, its characteristics, and health benefits related to CVD and other chronic conditions. This could be attained among the Saudi population by means of distinct governmental measures. It is also possible to develop and distribute newsletters among individuals at workplace events to enhance food-related family interactions and improve adherence to a Mediterranean diet.

Future prospective studies based on large populations are recommended along with using intervention measures to confirm the impact of the Mediterranean diet on weight gain. Investigations concerning awareness and knowledge regarding the Mediterranean diet as well as other dietary patterns are warranted.

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## Conflict of interest

The authors have no conflict of interest to declare.

## Ethical approval

The authors declare that the manuscript is original, has not been published before, and is not being considered for publication elsewhere.

Additionally, there are no ethical or financial issues, conflicts of interest, or animal experiments related to this research.

We agree to submit documentary evidence of any of the above-mentioned issues if asked by the journal.

## Authors' contributions

MA and her co-author, RAR, conceived and designed the study; provided research materials; collected, organized, analyzed, and interpreted data; wrote the initial and final drafts of the article; and critically reviewed the final draft. They are responsible for the content and originality of the manuscript. All other authors contributed equally in interpreting the data and drafting and reviewing the final draft.

All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

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