Dietary Pattern and Their Association With Level of Asthma Control Among Patients With Asthma at Al-Shifa Medical Complex in Gaza Strip, Palestine

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ABSTRACT

BACKGROUND: This study was conducted to identify major dietary patterns and their association with level of asthma control among patients with asthma in Gaza Strip, Palestine.

METHODS: This cross-sectional study was conducted among a representative sample of Palestinian patients with asthma (both sex, aged 19-64 years) receiving care in chest department at Al-Shifa Medical Complex. Asthma control level was obtained using asthma control test. Data regarding other variables were obtained using an interview-based questionnaire and a semi-quantitative food frequency questionnaire. Statistical analysis was performed using SPSS version 20.

RESULTS: Two major dietary patterns were identified including (1) Prudent pattern characterized by a high intake of whole grains, beans and legumes, fish and shellfish products, vegetables, tomatoes, fruits, and vegetable oils, and (2) Western pattern characterized by a high intake of refined grains, red meat, poultry, fast foods, eggs, low-fat dairy product, high-fat dairy products, hydrogenated fats, olive, sugar, sweets, desserts, and snacks. After adjustment for confounding variables, patients in the lowest tertile (T1) of Prudent pattern had a lower odds for poorly controlled asthma (odds ratio [OR] = 0.044, 95% confidence interval [CI] = [0.002-1.316], P value < 0.05), whereas patients in the lowest tertile (T1) of Western pattern had a higher odds for poorly controlled asthma (OR = 2.499, 95% CI = [1.288-4.850], P value < 0.05), compared with those in the highest tertile (T3).

CONCLUSION: A Prudent pattern may be associated with a lower prevalence of poorly controlled asthma, whereas a Western pattern may be associated with a higher prevalence of poorly controlled asthma.

KEYWORDS: asthma, asthma control test, dietary patterns, factor analysis, Palestine

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Background

Asthma is a common and potentially serious chronic disease that imposes a substantial burden on patients, their families, and the community.[1] It causes respiratory symptoms, limitation of activity, and exacerbations that sometimes require urgent health care and may be fatal.[2] Globally, asthma affects approximately 300 million people, and this number is expected to reach 400 million by 2050.[3] In Palestine, the prevalence rate of asthma in children living in villages, cities, and refugee camps were 17.1%, 8.8%, and 9.4%, respectively, with urban area having higher prevalence rate than rural areas.[4] Asthma is a serious global health problem affecting all age groups, with increasing prevalence in many developing countries, rising treatment costs, and a rising burden for patients and the community.[5] Asthma still imposes an unacceptable burden on health care systems and on society through loss of productivity in the workplace, and it still contributes to many deaths worldwide.[2] A number of factors including genetic predisposition, environmental factors, and lifestyle factors including dietary habits influence the development and expression of asthma.[6] The goal of asthma treatment is to achieve and maintain clinical control, which can be achieved in most patients with pharmacologic intervention strategy.[7] However, asthma control is still difficult to attain in all patients.[8] When asthma is uncontrolled, it has dire consequences for health and well-being.[9] Asthma Control Test (ACT) is a short, simple, patient-based tool for identifying patients with poorly controlled asthma; it is reliable, valid, and responsive to changes in asthma control over time, and in a clinical setting.[10] The ACT is a useful tool to help physicians identify patients with uncontrolled asthma and facilitate their ability to follow patients' progress with treatment.[10] Asthma and its complications impact harshly on the finances of individuals and their families and on health systems and national economies through direct medical costs and loss of work and wages.[1] Dietary patterns is an approach that has been used to investigate diet-disease relations.[11] Studying dietary patterns instead of specific foods or nutrients is a new approach in nutritional epidemiology to assess the effects of overall diet.[12] Dietary patterns is usually determined by factor analysis and has been used to

investigate the role of diet in several chronic diseases,[13,14] but rarely in respiratory diseases.[15] Dietary pattern is potentially useful in making dietary recommendations because overall dietary patterns might be easy for the public to interpret or translate into diets.[16] Diet is one of the lifestyle factors that may play an important role in development and expression of asthma.[17] However, few studies have explored the relationship between dietary patterns and the level of asthma control. Most studies have examined the associations between individual foods or food groups and nutrients and the level of asthma control,[18-20] instead of focusing on dietary patterns which is the most sensible approach to test the role of the overall diet on nutrition-related diseases. Therefore, understanding the association between dietary patterns with the level of asthma control may be helpful in reducing asthma-related premature mortality and improving outcomes among patients with asthma. To the best of our knowledge, this is the first study that examined this association among patients with asthma in Gaza Strip, Palestine. This study was conducted to identify major dietary patterns and their association with the level of asthma control among patients with asthma at Al-Shifa Medical Complex in Gaza Strip, Palestine.

Methodology

Study population

This cross-sectional study was conducted in the year 2018, among a representative sample of Palestinian patients with asthma. Patients were randomly selected using the systemic random sampling method. We recruited 105 patients with asthma, both sex, aged 19 to 64 years, receiving care in the chest department at Al-Shifa Medical Complex in Gaza Strip, Palestine. This hospital had the biggest chest department in Gaza Strip with 26 beds.[21] Pregnant women; lactating mothers; patients with other type of serious diseases such as cancer, acute myocardial infarction, end-stage kidney disease, and septicemia; and patients with other type of respiratory diseases were excluded from the study.

Asthma control test

The ACT was used to determine the level of asthma control.[22] The ACT is a patient completed questionnaire with 5 items assessing asthma symptoms (daytime and nocturnal), use of rescue medications, and the effect of asthma on daily functioning. Each item includes 5 response options corresponding to a 5-point Likert-type rating scale. In scoring the ACT, responses for each of the 5 items are summed to yield a score ranging from 5 (poor control of asthma) to 25 (complete control of asthma).[10,23] Then, patients with asthma were classified into 2 groups: (1) well-controlled asthma (ACT scores: >19) and (2) poorly controlled asthma (ACT scores: 19 or less).[22]

Assessment of anthropometric measurements

Weight was measured using a standard scale (Seca); the scale was placed on a hard floor surface; patients were asked to remove their heavy outer garments, and weight was measured and recorded to the nearest 0.1 kg. Height was measured in all patients (patients bare footed and head upright) with a measuring rod attached to the balanced beam scale; the height was reported to the nearest 0.5 cm. In addition, a stretch-resistant tape was used for measuring waist circumference (WC); WC was measured at the approximate midpoint between the lower margin of the last palpable rib and the top of the iliac crest. The body mass index (BMI) was calculated by dividing weight in kilograms by the square of height in meters.

Dietary assessment

A comprehensive data regarding dietary patterns were collected by an expert nutritionist, using a validated semi-quantitative food frequency questionnaire (FFQ). The FFQ is relatively easy and inexpensive to administer and can be used to measure dietary intake over a prolonged time period.[24] In this study, the FFQ contains a list of 98 food items; it was developed and validated among Palestinian population in 2014.[25] In our study, the method of dietary patterns assessment was published as in the previous study.[12] Furthermore, the major dietary patterns were obtained using factor analysis after the classification of food items into 25 groups (Table 1). The food grouping was based on the similarity of nutrient profiles and was somewhat similar to that used in previous studies.[26,27]

Assessment of other variables

The socioeconomic, demographic, behavioral, and medical history data were collected through an interview-based questionnaire. Reports and all relevant documentation, including medical records, were also checked. Data about physical activity were obtained using the International Physical Activity Questionnaire (IPAQ short version).[28] The internationally accepted protocol was used to estimate the weekly calorie expenditure expressed as metabolic equivalents per week (MET/wk).[28] Pilot study was conducted on 15 patients to evaluate the tools of the study. Then, the tools of the study were modified according to the result of the pilot study.

Statistical analysis

All statistical analysis was performed using SPSS version 20. The major dietary patterns were obtained using factor analysis. Then, the obtained dietary patterns scores are expressed as tertiles. The chi-square test was used to determine the significant differences between different categorical variables. The differences between means were tested by independent-samples *t* test and one-way analysis of variance (ANOVA). Moreover, the odds ratio (OR) and confidence interval (CI) for the ACT across tertiles categories of dietary pattern scores were tested by binary logistic regression. *P* value less than 0.05 was considered as statistically significant.

Table 1. Food groupings used in the dietary pattern analysis.

FOOD GROUPS	FOOD ITEMS
Refined grains	White breads, toasted bread, cooked white rice, pasta (macaroni, spaghetti, and the like)
Whole grains	Wheat bread, corn or canned, cooked cereals (as bulgur and the like)
Potatoes	Boiled potatoes
Beans and legumes	Cooked (lentils, chickpeas, black beans or white)
Red meat	(Beef, lamb), other meat (rabbit, duck), cold meats, hamburger
Organ meat	Beef liver or chicken liver, viscera (tripe, brains, and the like)
Poultry	Chicken with skin, skinless chicken
Fish and shellfish products	Mixed fried fish, boiled or grilled fish (sardines, tuna), salted fish, canned water fish, canned fish in oil, (oysters, clams, mussels, and the like), shellfish (shrimp and the like)
Fast foods	Meats as mortadella, sausage, pizza, pie
Eggs	Eggs
Low-fat dairy product	Skim milk, skimmed milk powder, yogurt
High-fat dairy products	Whole milk, (condensed milk, milk powder), cottage cheese curd or fresh white cheese, cream cheese or portions, ice cream, chocolate powder and the like, chocolate
Vegetables	Cooked spinach, (cabbage, cauliflower, broccoli), lettuce, onions, (carrots, pumpkin), cooked green beans, (eggplant, zucchini, cucumbers), mushrooms, canned vegetables, cooked green peas, garlic, pepper, (parsley, thyme, bay leaves, oregano, cilantro, mint, and the like), avocado
Tomatoes	Tomatoes, tomato sauce (ketchup)
Fruit	Lemons, (oranges, grapefruit, and the like), bananas, apple or pear, strawberries, (peach, apricot), fresh figs, (watermelon, cantaloupe, pineapple), papaya, grapes, mango, guava, kiwi, dried fruits (as raisins, prunes), fruits in syrup (juices of fruits, peach, pear, pineapple, fig)
Hydrogenated fats	Margarine, butter, mayonnaise
Vegetable oils	Corn oil, sunflower oil
Olive	Olives, olive oil
Nuts and seed products	Nuts (almonds, peanuts, hazelnuts, walnuts, and the like), tahini (sesame seeds)
Sugar, sweets, and desserts	Biscuit, (croissant, pastries), shortbread, brownie, (custard, custard pudding), (jams, honey), sugar, tasty type artificial sweeteners
Snacks	Potato chips, bag of chips
Condiments	Spicy (pepper, chili)
Soft drinks	Soft drinks with sugar (as cola, orange, lemon, fanta, and the like), low calorie soft drinks, fruit juice packaging
Beverages	Coffee, decaffeinated coffee, tea
Salt and pickles	Salt, pickles

Results

A total of 105 patients with asthma aged 19 to 64 years old (52.4% women, 47.6% men) were recruited in this study. The characteristics of the study population by sex are shown in Table 2. The results revealed that the mean age (years) for male patients was 41.90 ± 14 vs 46.21 ± 10 for females. In addition, for the following factors—age, educational level, employment history, history of smoking, multivitamin supplement use, height, BMI, and physical activity level—the difference was statistically significant in both sexes (P value < 0.05 for all). On the contrary, the results of ACT for the study population by sex are shown in Table 3. The collected data demonstrate that the mean total scores for ACT in male patients was 15.44 ± 4.1 vs 13.65 ± 3.6 for females. In addition, only 9.5% of the patients were classified as having well-controlled asthma (ACT scores: >19), while 90.5% of the patients were classified as having poorly controlled asthma (ACT scores: 19 or less), and the difference was statistically significant in both sexes (P value = 0.033). Furthermore, the food consumption data for the 25 food groups (Table 1) were entered into the SPSS for factor

Table 2. Characteristics of the study population by sex.

VARIABLES		BRONCHIAL ASTHMA (N = 105)	MALE (N = 50)	FEMALE (N = 55)	*P* VALUE
		n (%)	n (%)	n (%)	
Age (years)	Mean ± SD	44.16 ± 12	41.90 ± 14	46.21 ± 10	0.006
Marital status	Married	101 (96.2)	50.0 (49.5)	51.0 (50.5)	0.071
	Unmarried	4.0 (3.8)	0.0 (0.0)	4.0 (100.0)	
Educational level	Low education	36.0 (34.3)	9.0 (25.0)	27.0 (75.0)	0.001
	High education	69.0 (65.7)	41.0 (59.4)	28.0 (40.6)	
Employment history	Yes	26.0 (24.8)	19.0 (73.1)	7.0 (26.9)	0.003
	No	79.0 (75.2)	31.0 (39.2)	48.0 (60.8)	
Family size	Less than 5	38.0 (36.2)	21.0 (55.3)	17.0 (44.7)	0.164
	5 or more	67.0 (63.8)	29.0 (43.3)	38.0 (56.7)	
Monthly income	⩽2000 (NIS)	91.0 (86.7)	43.0 (47.3)	48.0 (52.7)	0.537
	>2000 (NIS)	14.0 (13.3)	7.0 (50.0)	7.0 (50.0)	
Enough income	Yes	17.0 (16.2)	8.0 (47.1)	9.0 (52.9)	0.586
	No	88.0 (83.8)	42.0 (47.7)	46.0 (52.3)	
History of smoking	Yes	15.0 (14.3)	15.0 (100.0)	0.0 (0.0)	0.001
	No	90.0 (85.7)	35.0 (38.9)	55.0 (61.1)	
History of alcohol intake	No	105 (100.0)	50 (47.6)	55 (52.4)	—
Female menopausal status	Premenopausal	20.0 (19.0)	0.0 (0.0)	20.0 (100.0)	—
	Postmenopausal	35.0 (33.3)	0.0 (0.0)	35.0 (100.0)	
	Male	50.0 (47.6)	50.0 (100.0)	0.0 (0.0)	
Have a meal plan for bronchial asthma	Yes	49.0 (46.7)	22.0 (44.9)	27.0 (55.1)	0.372
	No	56.0 (53.3)	28.0 (50.0)	28.0 (50.0)	
Who describe diet regimen	Physician	34.0 (32.4)	17.0 (50.0)	17.0 (50.0)	0.489
	Self-reading	15.0 (14.3)	5.0 (33.3)	10.0 (66.7)	
	Do not fellow diet regimen	56.0 (53.3)	28.0 (50.0)	28.0 (50.0)	
Number of meals per day	Less than 3 meals	29.0 (27.6)	14.0 (48.3)	15.0 (51.7)	0.407
	Three meals	49.0 (46.7)	26.0 (53.1)	23.0 (46.9)	
	Less than 5 meals	27.0 (25.7)	10.0 (37.0)	17.0 (63.0)	
Multivitamin supplement use	Yes	43.0 (41.0)	6.0 (14.0)	37.0 (86.0)	0.001
	No	62.0 (59.0)	44.0 (71.0)	18.0 (29.0)	
Weight (kg)	Mean ± SD	82.63 ± 16	80.94 ± 15	84.18 ± 17	0.204
Height (m)	Mean ± SD	1.67 ± 0.06	1.71 ± 0.05	1.63 ± 0.04	0.049
Waist circumference (cm)	Mean ± SD	100.5 ± 16	97.38 ± 14	103.34 ± 16	0.399
Body mass index (kg/m²)	Mean ± SD	29.56 ± 6.1	27.34 ± 4.8	31.58 ± 6.6	0.007
Underweight	(<18.5)	1.0 (1.0)	1.0 (100)	0.0 (0.0)	0.001
Normal weight (BMI: kg/m²)	(18.5-24.9)	25.0 (23.8)	13.0 (52.0)	12.0 (48.0)	
Overweight (BMI: kg/m²)	(25-29.9)	39.0 (37.1)	28.0 (71.8)	11.0 (28.2)	
Obesity (BMI: kg/m²)	(⩾30)	40.0 (38.1)	8.0 (20.0)	32.0 (80.0)	
Physical activity (total MET)	Mean ± SD	1748.5 ± 1746	2351.7 ± 1982	1200.2 ± 1290	0.016

Abbreviations: BMI, body mass index; MET, metabolic equivalents.
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. The chi-square test was used to examine differences in the prevalence of different categorical variables. *P* value less than 0.05 was considered as statistically significant.

Table 3. The asthma control test for the study population by sex.

VARIABLES		BRONCHIAL ASTHMA (N = 105) n (%)	MALE (N = 50) n (%)	FEMALE (N = 55) n (%)	*P* VALUE
In the past 4 weeks, how much of the time did your asthma keep you from getting as much done at work, school, or at home?	All of the time (1)	11.0 (10.5)	4.0 (36.4)	7.0 (63.6)	0.245
	Most of the time (2)	14.0 (13.3)	6.0 (42.9)	8.0 (57.1)	
	Some of the time (3)	55.0 (52.4)	24.0 (43.6)	31.0 (56.4)	
	A little of the time (4)	15.0 (14.3)	8.0 (53.3)	7.0 (46.7)	
	None of the time (5)	10.0 (9.5)	8.0 (80.0)	2.0 (20.0)	
During the past 4 weeks, how often have you had shortness of breath?	More than once a day (1)	11.0 (10.5)	4.0 (36.4)	7.0 (63.6)	0.052
	Once a day (2)	15.0 (14.3)	7.0 (46.7)	8.0 (53.3)	
	3 to 6 times a week (3)	59.0 (56.2)	24.0 (40.7)	35.0 (59.3)	
	Once or twice a week (4)	20.0 (19.0)	15.0 (75.0)	5.0 (25.0)	
	Not at all (5)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	
During the past 4 weeks, how often did your asthma symptoms (wheezing, coughing, shortness of breath, chest tightness, or pain) wake you up at night or earlier than usual in the morning?	4 or more nights a week (1)	6.0 (5.7)	2.0 (33.3)	4.0 (66.7)	0.016
	2 to 3 nights a week (2)	14.0 (13.3)	7.0 (50.0)	7.0 (50.0)	
	Once a week (3)	44.0 (41.9)	14.0 (31.8)	30.0 (68.2)	
	Once or twice (4)	41.0 (39.0)	27.0 (65.9)	14.0 (34.1)	
	Not at all (5)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	
During the past 4 weeks, how often have you used your rescue inhaler or nebulizer medication (such as albuterol)?	3 or more times per day (1)	20.0 (19.0)	8.0 (40.0)	12.0 (60.0)	0.034
	1 to 2 times per day (2)	40.0 (38.1)	14.0 (35.0)	26.0 (65.0)	
	2 or 3 times per week (3)	38.0 (36.2)	22.0 (57.9)	16.0 (42.1)	
	Once a week or less (4)	7.0 (6.7)	6.0 (85.7)	1.0 (14.3)	
	Not at all (5)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	
How would you rate your asthma control during the past 4 weeks?	Not controlled at all (1)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.064
	Poorly controlled (2)	11.0 (10.5)	4.0 (36.4)	7.0 (63.6)	
	Somewhat controlled (3)	63.0 (60.0)	25.0 (39.7)	38.0 (60.3)	
	Well controlled (4)	27.0 (25.7)	18.0 (66.7)	9.0 (33.3)	
	Completely controlled (5)	4.0 (3.8)	3.0 (75.0)	1.0 (25.0)	
Total scores for ACT	Mean ± SD	14.50 ± 3.9	15.44 ± 4.1	13.65 ± 3.6	0.160
Well-controlled asthma	ACT scores: >19	10.0 (9.5)	8.0 (80.0)	2.0 (20.0)	0.033
Poorly controlled asthma	ACT scores: 19 or less	95.0 (90.5)	42.0 (44.2)	53.0 (55.8)	

Abbreviations: ACT, Asthma Control Test.
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. The chi-square test was used to examine differences in the prevalence of different categorical variable. *P* value less than 0.05 was considered as statistically significant.

analysis. The scree plot of eigenvalues indicated 2 major patterns: (1) Prudent dietary pattern characterized by a high intake of whole grains, beans and legumes, fish and shellfish products, vegetables, tomatoes, fruits, and vegetable oils as well as a low intake of snacks and (2) Western dietary pattern characterized by a high intake of refined grains, red meat, poultry, fast foods, eggs, low-fat dairy product, high-fat dairy products, hydrogenated fats, olive, sugar, sweets, desserts, and snacks as well as a low intake of fish and shellfish products. The factor loading matrixes for major patterns are shown in Table 4. These 2 major dietary patterns explained 14.01% and 12.56% of the total variance, respectively. Then, the dietary pattern scores

Table 4. Factor loading matrix for major dietary patterns.

FOOD GROUPS	DIETARY PATTERNS	
	PRUDENT PATTERN	WESTERN PATTERN
Refined grains	—	0.596
Whole grains	0.373	—
Potatoes	—	—
Beans and legumes	0.428	—
Red meat	—	0.549
Organ meat	—	—
Poultry	—	0.465
Fish and shellfish products	0.454	0.328
Fast foods	—	0.455
Eggs	—	0.557
Low-fat dairy product	—	0.338
High-fat dairy products	—	0.541
Vegetables	0.638	—
Tomatoes	0.651	—
Fruits	0.707	—
Hydrogenated fats	—	0.380
Vegetable oils	0.741	—
Olive	—	0.311
Nuts and seed products	—	—
Sugar, sweets, and desserts	—	0.326
Snacks	0.329	0.418
Condiments	—	—
Soft drinks	—	—
Beverages	—	—
Salt and pickles	—	—
Variance explained (%)	14.014	12.569

Values less than 0.3 were omitted for simplicity. Total variance explained by 2 factors: 26.583.

were classified as tertiles, and the characteristics of the study population were evaluated within the tertiles. Table 5 shows that patients in the lowest tertile (T1) of Prudent pattern were older (48.9 ± 12.7 vs 37.5 ± 10.8, P value < 0.001), 38.1% vs 18.1% were female (P value < 0.005), had a lower education level (52.8% vs 11.1%, P value < 0.05), had a high weight (kg) (83.5 ± 15.5 vs 78.5 ± 15.9, P value < 0.05), had a high WC (cm) (106.1 ± 13 vs 93.3 ± 15, P value < 0.005), and had a lower physical activity level (MET/wk) (1373 ± 1446 vs 2304 ± 1944, P value < 0.05), compared with those in the highest tertile (T3). On the contrary, only the distribution of patients regarding having a meal plan for asthma, who describe diet regimen, number of meal per day, and height (m) was significantly different across the tertiles of Western dietary pattern (P value < 0.05). Finally, the OR and CI for well-controlled asthma (ACT scores: >19) and poorly controlled asthma (ACT scores: 19 or less) across tertile categories of dietary pattern scores were computed (Table 6). Our findings revealed that, after adjustment for confounding variables, patients in the lowest tertile (T1) of Prudent dietary pattern had a lower odds for poorly controlled asthma (OR = 0.044, 95% CI = [0.002-1.316], P value < 0.05), while patients in the lowest tertile (T1) of Western dietary pattern had a higher odds for poorly controlled asthma (OR = 2.499, 95% CI = [1.288-4.850], P value < 0.05), compared with those in the highest tertile (T3). No significant associations were found between these 2 major dietary patterns with well-controlled asthma.

Discussion

Asthma is a common and potentially serious chronic disease that imposes a substantial burden on patients, their families, and the community.[1] Uncontrolled asthma is associated with decreased quality of life and increased health care system use.[9] Our study was conducted to determine the associations between major dietary patterns and the level of asthma control among patients with asthma at Al-Shifa Medical Complex in Gaza Strip, Palestine. To the best of our knowledge, this is the first study that examined this association among patients with asthma in Gaza Strip, Palestine. In our study, 105 patients with asthma (52.4% women, 47.6% men) were divided into 2 groups according to the results of ACT (poorly controlled asthma and well-controlled asthma). Our results revealed that only 9.5% of the patients had well-controlled asthma (ACT scores: >19), while 90.5% of the patients were classified as having poorly controlled asthma (ACT scores: 19 or less). Previous studies reported that poorly controlled asthma was found among a sizable percentage (40%) of US adults with asthma.[29] Lee et al[9] in a cross-sectional study show that, among patients with asthma, more than half of patients (54.4%) had very poor or not well-controlled asthma. In addition, Chapman et al[30] show that most (59%) of patients with asthma treated in general practice were uncontrolled. In our study, lack of asthma control can be due to a complex web of factors including genetics factors, types of asthma drugs, adherence, intrinsic factors, psychological factors, and environmental exposures, which could contribute to these results.

On the contrary, with the use of dietary data from the FFQ, 2 major dietary patterns were identified by factor analysis: (1) a Prudent dietary pattern characterized by a high intake of whole grains, beans and legumes, fish and shellfish products, vegetables, tomatoes, fruits, and vegetable oils as well as a low intake of snacks, and (2) a Western dietary pattern characterized by a

Table 5. Characteristics and dietary intakes of study population by tertile (T) categories of dietary pattern scores.

VARIABLES	PRUDENT PATTERN			*P* VALUE	WESTERN PATTERN			*P* VALUE
	T1	T2	T3		T1	T2	T3	
Age (years)								
Mean ± SD	48.9 ± 12.7	45.9 ± 11.4	37.5 ± 10.8	0.001	42.5 ± 12.7	47.7 ± 11.2	42.2 ± 13.2	0.578
Sex (%)								
Males	28.0	22.0	50.0	0.027	32.0	32.0	36.0	0.878
Females	38.1	43.6	18.1		34.5	34.5	31.0	
Marital status (%)								
Married	33.7	30.6	33.7	0.615	30.6	33.7	33.7	0.501
Unmarried	25.0	50.0	25.0		50.0	25.0	25.0	
Educational level (%)								
Low education	52.8	36.1	11.1	0.004	41.7	36.1	22.2	0.244
High education	23.2	31.9	44.9		29.0	31.9	39.1	
Employment history (%)								
Yes	15.4	34.6	50.0	0.126	42.3	26.9	30.8	0.178
Family size (%)								
Less than 5	42.1	18.4	39.5	0.206	34.2	23.7	42.1	0.923
5 or more	28.4	41.8	29.8		32.8	38.8	28.4	
Monthly income (NIS) (%)								
⩽2000 (NIS)	35.1	31.9	33.0	0.516	33.0	35.1	31.9	0.794
>2000 (NIS)	21.4	42.9	35.7		35.7	21.4	42.9	
Enough income (%)								
Yes	23.5	47.1	29.4	0.666	35.3	23.5	41.2	0.767
History of smoking (%)								
Yes	20.0	26.7	53.3	0.248	40.0	20.0	40.0	0.285
Female menopausal status (%)								
Premenopausal	35.0	35.0	30.0	0.219	35.0	20.0	45.0	0.632
Postmenopausal	40.0	48.6	11.4		34.3	42.9	22.8	
Male	28.0	22.0	50.0		32.0	32.0	36.0	
Have a meal plan for bronchial asthma (%)								
Yes	30.6	34.7	34.7	0.883	26.5	30.6	42.9	0.083
Who describe diet regimen (%)								
Physician	32.4	38.2	29.4	0.968	20.6	32.4	47.0	0.020
Self-reading	26.7	26.7	46.6		40.0	26.7	33.3	
No diet regimen	35.6	32.2	32.2		39.3	35.7	25.0	
Number of meal per day (%)								
<3 meals	17.2	34.5	48.3	0.330	48.3	24.1	27.6	0.005
3 meals	42.9	22.4	34.7		34.7	34.7	30.6	
<5 meals	33.3	51.9	14.8		14.8	40.7	44.5	
Multivitamin supplement use (%)								
Yes	41.9	37.2	20.9	0.059	30.2	39.6	30.2	0.944

(continued)

Table 5. continued

VARIABLES	PRUDENT PATTERN			*P* VALUE	WESTERN PATTERN			*P* VALUE
	T1	T2	T3		T1	T2	T3	
Weight (kg)								
Mean ± SD	83.5 ± 15.5	85.8 ± 18.2	78.5 ± 15.9	0.029	85.0 ± 20.0	81.1 ± 13.7	81.8 ± 16.0	0.729
Height (m)								
Mean ± SD	1.66 ± 0.05	1.66 ± 0.06	1.69 ± 0.07	0.028	1.68 ± 0.06	1.66 ± 0.06	1.68 ± 0.06	0.025
Waist circumference (cm)								
Mean ± SD	106.1 ± 13	102.0 ± 16	93.3 ± 15	0.001	101.2 ± 18	100.1 ± 15	100.2 ± 15	0.550
Body mass index (kg/m^2)								
Mean ± SD	30.1 ± 5.1	31.0 ± 7.2	27.4 ± 5.5	0.452	30.2 ± 7.8	29.5 ± 5.3	28.8 ± 5.0	0.530
Physical activity (Total MET)								
Mean ± SD	1373 ± 1446	1567 ± 1720	2304 ± 1944	0.001	1786 ± 2009	1603 ± 1720	1855 ± 1515	0.729

Abbreviations: ANOVA, analysis of variance; MET, metabolic equivalents.
ANOVA test was used for quantitative variables and chi-square for qualitative variables. *P* value less than 0.05 was considered as statistically significant.

Table 6. Odds ratio and confidence interval for the asthma control test across tertile categories of dietary pattern scores.

PRUDENT PATTERN					WESTERN PATTERN				
T1	T2	T3	*P* VALUE	OR (95% CI)	T1	T2	T3	*P* VALUE	OR (95% CI)
Well-controlled asthma (ACT scores: >19)									
20.0	30.0	50.0	0.756	0.790 (0.179-3.486)	32.6	33.7	33.7	0.228	0.362 (0.069-1.890)
Adjusted[a]			0.578	0.839 (0.451-1.560)	Adjusted[a]			0.271	1.093 (0.933-1.280)
Poorly controlled asthma (ACT scores: 19 or less)									
34.7	33.7	31.6	0.135	0.886 (0.757-1.038)	40.0	30.0	30.0	0.150	0.549 (0.242-1.242)
Adjusted[a]			0.072	0.044 (0.002-1.316)	Adjusted[a]			0.007	2.499 (1.288-4.850)

Abbreviations: ACT, Asthma Control Test; CI, confidence interval; OR, odds ratio.
The OR and CI for well-controlled (ACT scores: >19) and poorly controlled (ACT scores: 19 or less) across tertiles categories of dietary pattern scores were tested by binary logistic regression. *P* value less than 0.05 was considered as statistically significant.
[a]Adjusted for age, sex, educational level, who describe diet regimen, number of meals per day, weight (kg), height (m), WC (cm), and physical activity (Total MET).

high intake of refined grains, red meat, poultry, fast foods, eggs, low-fat dairy product, high-fat dairy products, hydrogenated fats, olive, sugar, sweets, desserts, and snacks as well as a low intake of fish and shellfish products. The main findings of this study indicate that, after adjustment for confounding variables, a Prudent dietary pattern may be associated with a lower prevalence of poorly controlled asthma, whereas a Western dietary pattern may be associated with a higher prevalence of poorly controlled asthma among patients with asthma in Gaza Strip, Palestine. In fact, studying the overall effect of dietary patterns on asthma control is an emerging literature; an overall approach based on dietary patterns could provide some insight into the combination of foods that might be beneficial or detrimental to asthma control.[31] In addition, very few population-based studies have been conducted to investigate the association between dietary patterns and the level of asthma control, which made the comparison of our results with previous studies difficult. Most studies have examined the associations between individual foods or food groups and nutrients and asthma outcomes.[18-20] Poongadan et al in a cross-sectional study show an increased consumption of vegetables and cereals in patients with total controlled asthma in comparison with partially and poorly controlled asthma. In addition, the author revealed increased consumption of sugar, non-vegetarian, fast food, salted, and fried snacks in patients with poorly controlled asthma.[17] Garcia-Marcos et al[32] in a meta-analysis of 8 cross-sectional studies in children concluded that the Mediterranean diet might protect against asthma ever and current wheeze. Furthermore, a positive correlation exists between consumption of diet rich in vegetables and fresh fruits along with lifestyle habits as periodical exercise and good asthma control.[33] Iikura et al[33] in their study in Japanese population concluded

raw vegetable intake (more than 5 units/wk) was significantly associated with good asthma control. The results of our study support these findings. Moreover, an association between dietary patterns and newly diagnosed chronic obstructive pulmonary disease was reported in a large cohort of men and women in the United States.[15] A Prudent dietary pattern characterized by a high intake of fruits, vegetables, fish, and whole grain products was associated with a decreased risk, whereas a Western pattern characterized by a high intake of refined grains, cured and red meats, desserts, and French fries was associated with an increased risk.[15] The results of our study support these findings. The previous dietary patterns are different from those obtained in our study. This can be explained by demographic, cultural, and ethnic differences, varying between countries, influencing behavior and attitudes regarding food choices.

In our study, the inverse association between Prudent dietary pattern with poorly controlled asthma could be attributed to pattern's healthy ingredients including vitamins, dietary fibers, potassium, magnesium, and antioxidants. These nutrients have been independently associated with reduced risks of asthma exacerbation.[34] In addition, anti-inflammatory and antioxidant effects in these foods may have beneficial effects in alleviating inflammation and oxidative stress, which are pathogenic factors in asthma exacerbation.[35] Furthermore, vegetables, legumes, and fruits contain minerals, polyphenols, and other phytochemicals that combat oxidative stress and inflammation.[36,37] In our study, the Prudent dietary pattern has been shown to be the healthiest dietary pattern and is quite close to that diet, which is generally recommended as a healthy dietary pattern with low animal foods, saturated fat, trans fat, cholesterol, and simple sugar, which may be associated with a higher risks of asthma exacerbation.[38] Our study is not adjusted for other confounding variables such as genetics factors, types of asthma drugs, adherence, intrinsic factors, psychological factors, and environmental exposures, which could contribute to these results. Actually, the relationship between dietary patterns with the level of asthma control needs more studies in the future.

The main limitation of this study is its cross-sectional design; the causal relationship could not be determined. Moreover, the possibility of recall bias and misreporting by using FFQ assessment of dietary patterns are other limitations. The main strength of our study was its being the first study, which identified the major dietary patterns and their association with the level of asthma control among patients with asthma in Gaza Strip, Palestine.

Conclusion

In conclusion, a Prudent dietary pattern may be associated with a lower prevalence of poorly controlled asthma, whereas a Western dietary pattern may be associated with a higher prevalence of poorly controlled asthma among patients with asthma in Gaza Strip, Palestine. Further future studies with large sample size are required to confirm these findings.

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Author Contributions

AHB (Principal Investigator) collected, analyzed, and interpreted the data and wrote the first draft of the manuscript. AHB, AB, SH, and KD significantly contributed in the study design and the critical review of the manuscript. AHB and AB remarkably contributed in the analysis and interpretation of data and the critical review of the manuscript. All authors approved the final manuscript.

Ethical Approval

The study protocol was approved by the Ethics Committee of Al-Azhar University of Gaza and by the Palestinian Health Research Council (Helsinki Ethical Committee). Moreover, written informed consent was also obtained from each participant.

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