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DIETARY PATTERNS AND THEIR ASSOCIATION WITH GLYCEMIC CONTROL AND RISK OF GESTATIONAL DIABETES MELLITUS IN GAZA STRIP, PALESTINE: A CASE-CONTROL STUDY

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Background: *This study was conducted to determine the major dietary patterns and their association with risk of gestational diabetes mellitus (GDM); and to compare the level of glycemic control among women with and without GDM.* ***Method:*** *This is a case-control study was conducted in the primary healthcare centers, in the year 2021, among 210 pregnant women, with gestational age ≥ 24 weeks, aged 20-40 years (70 cases and 140 controls matched for age and geographical location), selected by a purposive sampling method. A validated semi-quantitative food frequency questionnaire and the international physical activity questionnaire short-form were used. Furthermore, the demographic-socioeconomic and medical history data were collected using an interview-based questionnaire. The WHO criteria were used for the diagnosis of GDM. Additionally, the HbA1c was used as a marker of glycemic control. Statistical analysis was performed using SPSS version 22.* ***Results:*** *The principle component analysis show two major dietary patterns (Healthy and unhealthy). After adjustment for confounding variables, women in the lowest tertile of the healthy dietary pattern had a lower odd for GDM [OR, CI 95%: 0.730 (0.596-.895); P-value 0.002]; whereas women in the lowest tertile of the unhealthy dietary pattern had a higher odd for GDM [OR, CI 95%: 3.41 (0.033-0.154); P-value 0.003].* ***Conclusion:*** *The healthy dietary pattern may be associated with a lower risk of GDM; whereas the unhealthy dietary pattern may be associated with a high risk of GDM in Gaza Strip, Palestine.*

INTRODUCTION

Gestational diabetes mellitus (GDM) is high blood sugar that develops during pregnancy and usually disappears after giving birth; it can happen at any stage of pregnancy, but is more common in the second or third trimester[1]. Poor glycemic control and GDM are one of the most common complications in gestation[1] that affect an estimated 1 to 14% of all pregnancies, or one in every eight births globally[2]. There has been a noticeable increase in the prevalence of GDM in the recent years due to overweight and obesity[3]. GDM is associated with short-term adverse perinatal outcomes[4] and long-term metabolic risks including diabetes, hypertension, and cardiovascular diseases (CVDs) for mothers and children[4]. In addition, GDM has been related to substantial short-term and long-term adverse health outcomes for both mothers and offspring such as pre-eclampsia, cesarean section, macrosomia, metabolic problems later in life, birth trauma, and type 2 diabetes mellitus[5]. Despite this, its prevalence rate has been growing substantially over the world; thus, the identification of modifiable risk factors related to the genesis of the disease is

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extremely relevant to prevent GDM among high-risk populations. Risk factors of GDM include several factors such as genetic, racial/ethnic disparities, physical inactivity, smoking, unhealthy dietary habits, and pregnancy age[6-8].

On the other hand, diet composition may be a modifiable predictor of risk for poor glycemic control and GDM during pregnancy[9&10]. In fact, foods and nutrients are mostly consumed together and this simultaneous intake can change the specific effects of foods and nutrients on chronic diseases, evaluating the whole dietary pattern may be more valuable[11]. However, few studies have explored the relationship between dietary patterns with glycemic control and GDM. Most of the previous studies focus on the association between single food or nutrients and GDM risk, while it is important to test the role of the overall diet on nutrition-related diseases[12-14].

Understanding the association between dietary patterns with glycemic control and GDM may be helpful in reducing disease-related premature mortality and improve outcomes among pregnant women. To the best of our knowledge, this is the first study, which will examine this association among pregnant women in Gaza Strip, Palestine. Thus, the aim of the present study is to determine the major dietary patterns and their association with risk of GDM; and to compare the level of glycemic control among women with and without GDM in Gaza Strip, Palestine.

METHODS

Study participants

This is a case-control study was conducted in five various maternal antenatal clinics at the governmental primary healthcare centers (PHCs) in the year 2021, among 210 pregnant women with gestational age≥ 24 weeks, aged 20 to 40 years (70 cases (pregnant women diagnosed as GDM) and 140 controls (pregnant women without GDM) matched for age and geographical location, the case/control ratio is 1:2) selected by a purposive sampling method. The study sample was distributed based on the population density in the five Gaza Strip governorates[15]. In addition, pregnant women who were previously diagnosed with diabetes mellitus or other types of serious illness such as cancer, thyroid diseases, acute myocardial infarction, or end-stage kidney disease were excluded from the study.

Method of sample size calculation

The sample size calculation was based on the primary outcome of GDM. According to the literature[16], the estimated incidence of GDM was 8% in the group exposed to the low-risk dietary pattern; and the estimated relative risk was 2.0 for GDM in the group exposed to the high-risk dietary pattern. A sample size of 200 was needed to show a difference between the two groups with 90% statistical power, at the 0.05 significance level. To consider a non-response rate, at the end a total of 210 pregnant women (70 cases and 140 controls matched for age and geographical location) was included in the present study.

Assessment of anthropometric measurements

In the present study, height (cm), weight (kg), and waist circumference (WC) in cm were measured and recorded using standard methods[17]. Furthermore, the body mass index (BMI) was calculated by dividing weight in kilograms by the square of height in meters[14].

Assessment of blood pressure (BP)

BP was measured from the left arm (mmHg) by a mercury sphygmomanometer. Three readings on different days and the mean of the three measurements was recorded[14].

Biochemical analysis

To compare the level of glycemic control among women with and without GDM, after 12 hrs. fasting venous blood samples was collected from all participants by well-trained and experienced nurses. Venous blood (4.0 ml) was drawn into vacutainer tubes and was used for blood chemistry analysis (FPG (mg/dL), and HbA1c test (%)). Mindray BS-300 chemistry analyzer instrument was used for blood chemistry analysis[17].

Assessment of dietary patterns

A validated semi-quantitative food frequency questionnaire (FFQ) was used to obtain data about dietary patterns. The FFQ is relatively easy and inexpensive to administer and can be used to measure dietary intake over a prolonged time period[18&19]. The Palestinian 98-items FFQ was developed and validated in 2014[20]. In the present study, all participants were asked to estimate the number of times per day, week, or month she consumed these particular food products and the amount usually eaten per food item by making comparisons with the specified reference portion. Furthermore, common household measures were used to facilitate the estimation process. Then the 98-food items were classified into 25 groups and used for factor analysis[21].

Assessment of physical activity (PA) level

Data on PA were obtained using the International Physical Activity Questionnaire (IPAQ short version)[22]. The internationally accepted protocol was used to estimate the weekly calorie expenditure expressed as metabolic equivalents per week (MET/wk) or converted to kcal/wk using the formula kcal= MET×weight÷60. Then, according to the IPAQ scoring protocol, the participants were classified based on their weekly energy expenditure as follows: Insufficiently Active (IA)≤ 600 MET/wk; Sufficiently Active (SA) 601 to 1500 MET/wk; and Very Active (VA)≥ 1500 MET/wk [22].

Clinical examination

In the present study, all participants were examined by the PHCs physicians for signs and symptoms of GDM. In addition, the WHO criteria was used by the PHCs physicians for diagnosis of GDM as follow: A standard oral glucose tolerance test was performed after overnight fasting by giving 75 gm of glucose. Furthermore, plasma glucose was measured at fasting and after 2 hrs. Pregnant women who meet the WHO criteria for impaired glucose tolerance and diabetes were classified as having GDM and included in the case group[23]. Furthermore, according to the American Diabetes Association, an HbA1c target value ranging between 6.0 and 6.5% is recommended, and if HbA1c> 6.5% represents poor glycemic control[24].

Assessment of other variables

Additional information regarding the demographic socioeconomic, gestational history, and medical history variables was obtained with an interview-based questionnaire. Additionally, reports and all relevant documentation, including the participant's medical records was checked. A pilot study was carried out on twenty participants to enable the researcher to examine the tools of the study. The questionnaire and data collection process were modified according to the result of the pilot study. The data were collected by five qualified data collectors (two nurses and three nutritionists) who were given a full explanation and training by the researcher about the study.

Statistical analysis

All statistical analysis was performed using SPSS version 22. Factor analysis was employed to determine the major dietary patterns. Factor analysis is a useful multivariable statistical tool for investigating dietary patterns[25-30]. In the present study, the 98-food items in the FFQ were classified into 25 food groups[21]. The food grouping was based on the similarity of nutrient profiles and was somewhat similar to that used in previous studies[30,31].

A varimax rotation was used to determine the dietary patterns. For defining food groups in each pattern and simplifying dietary pattern tables, factor loads under 0.2 were excluded[32]. For determining the number of factors, we considered eigenvalues> 1, the scree plot, and the interpretability of the factors. When a food group was loaded in more than one dietary pattern, only the pattern with a higher factor load was considered in the analysis. A factor score for the two major dietary patterns was calculated. The adequacy of data was evaluated based on the value of Kaiser-Meyer-Olkin and Bartlett's test. The Kaiser-Mayer-Olkin coefficient, which represents the adequacy of the sample size for factor analysis and should be greater than 0.5, was calculated and the obtained value was 0.634 in our study. The obtained dietary patterns scores are expressed as tertiles.

Furthermore, the chi-square test was used to determine the significant differences between different categorical variables. The differences between mean were tested by independent samples t-test and one-way ANOVA. Finally, the odds ratio (OR) and confidence interval (CI) for GDM across tertiles categories of dietary pattern scores were tested by binary logistic regression. A P-value less than 0.05 was considered statistically significant.

RESULTS AND DISCUSSION

Results

This is a case-control study was conducted in five various maternal antenatal clinics at the governmental PHCs in the year 2021. A total of 210 pregnant women with gestational age≥ 24 weeks; aged 20 to 40 years (70 cases (pregnant women diagnosed as GDM) and 140 controls (pregnant women without GDM) matched for age and geographical location, the case/control ratio is 1:2) were included in this study.

The distribution of the study participants by demographic and socioeconomic variables is shown in Table 1. The results revealed that the mean age (years) for the case group was 28.5 ± 6.3 vs. 26.8 ± 5.1 for control group. In addition, for the following factor (Family size) the difference was statistically significant between the case and the control groups (*P*-value< 0.05). No statistically significant associations were found for the following factors (Age (years), educational level, employment history, monthly income (NIS), and enough income) between the case and control groups (*P*-value> 0.05 for all).

With respect to medical and gestational history variables, Table 2 shows that 30.5% of the study participants had a family history of diabetes mellitus; 34.3% had a family history of hypertension; only 6.25 had a family history of CVDs, and 7.6% had a family history of hyperlipidemia. In addition, the results revealed that the mean gestational age (week) for the case group was (25.8 ± 1.7) vs. (25.8 ± 1.5) for the control group. In addition, for the following factors (Family history of diabetes mellitus, use of medications, gestational age (week), number of pregnancies, history of abortion, history of GDM, complain of edema, and dietary supplement use (including multivitamins)) the differences were statistically significant between the case and control groups (*P*-value< 0.05 for all).

Table 1: Distribution of the study participants by demographic and socioeconomic variables

Variables		Total (n=210)	Case (n=70)	Control (n=140)	P Value
		No. (%)	No. (%)	No. (%)	
Age (years)	Mean±SD	27.0±5.8	28.5±6.3	26.8±5.1	0.064
Educational level	Illiterate	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.265
	Elementary	1.0 (0.5)	1.0 (1.4)	0.0 (0.0)	
	Preparatory	13 (6.2)	2.0 (2.9)	11 (7.9)	
	Secondary	98 (46.7)	34 (48.6)	64 (45.7)	
	University	98 (46.7)	33 (47.1)	65 (46.4)	
Employment history	Yes	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	-
	No	210 (100.0)	70 (100.0)	140 (100.0)	
Family size	Less than five	142 (67.6)	38 (54.3)	104 (74.3)	0.007
	Five to ten	67 (31.9)	31 (44.3)	36 (25.7)	
	More than ten	1.0 (0.5)	1.0 (1.4)	0.0 (0.0)	
Monthly income (NIS)	< 1000	206 (98.1)	70 (100.0)	136 (97.1)	0.195
	1000-2000	4.0 (1.9)	0.0 (0.0)	4.0 (2.9)	
	2001-3000	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	
	> 3000	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	
Enough income	Yes	16 (7.6)	5.0 (7.1)	11 (7.9)	0.547
	No	194 (92.4)	65 (92.9)	129 (92.1)	

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. SD, stander deviation; NIS: New Israeli Shekel

Table 2: Distribution of the study participants by medical and gestational history variables

Variables		Total (n=210) No. (%)	Case (n=70) No. (%)	Control (n=140) No. (%)	P Value
Family history of diabetes mellitus	**Yes**	64 (30.5)	31 (48.4)	33 (51.6)	0.002
	No	146 (69.5)	39 (26.7)	107 (73.3)	
Family history of hypertension	**Yes**	72 (34.3)	23 (31.9)	49 (68.1)	0.441
	No	138 (65.7)	47 (34.1)	91 (65.9)	
Family history of cardiovascular diseases	**Yes**	13 (6.2)	6.0 (46.2)	7.0 (53.8)	0.235
	No	197 (93.8)	64 (32.5)	133 (67.5)	
Family history of hyperlipidemia	**Yes**	16 (7.6)	5.0 (31.2)	11 (68.8)	0.547
	No	194 (92.4)	65 (33.5)	129 (66.5)	
Do you take any medications?	**Yes**	69 (32.9)	17 (24.6)	52 (75.4)	0.042
	No	141 (67.1)	53 (37.6)	88 (62.4)	
Do you have lipid abnormality or take medications for lipid abnormality?	**Yes**	5.0 (2.4)	3.0 (60.0)	2.0 (40.0)	0.207
	No	205 (97.6)	67 (32.7)	138 (67.3)	
Do you have hypertension or use a specific treatment of previously diagnosed hypertension?	**Yes**	8.0 (3.8)	1.0 (12.5)	7.0 (87.5)	0.190
	No	202 (96.2)	69 (34.2)	133 (65.8)	
History of smoking	**Yes**	1.0 (0.5)	0.0 (0.0)	1.0 (100)	0.667
	No	209 (99.5)	70 (33.5)	139 (66.5)	
Do you expose to second-hand smoke?	**Yes**	11 (5.2)	1.0 (9.1)	10 (90.9)	0.070
	No	199 (94.8)	69 (34.7)	130 (65.3)	
History of alcohol intake	**Yes**	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	-
	No	210 (100.0)	70 (33.3)	140 (66.7)	
Gestational age (week)	**Mean±SD**	25.8±1.6	25.8±1.7	25.8±1.5	0.020
Mode of conception	**Natural conceived**	208 (99.0)	70 (33.7)	138 (66.3)	0.443
	In vitro fertilization	2.0 (1.0)	0.0 (0.0)	2.0 (100)	
Number of pregnancies	**Nulliparous**	66 (31.4)	14 (21.2)	52 (78.8)	0.035
	Primiparous	6.0 (2.9)	3.0 (50.0)	3.0 (50.0)	
	Multiparous	138 (65.7)	53 (38.4)	85 (61.6)	
History of abortion	**Yes**	52 (24.8)	24 (46.2)	28 (53.8)	0.019
	No	158 (75.2)	46 (29.1)	112 (70.9)	
History of gestational diabetes mellitus	**Yes**	15 (7.1)	10 (66.7)	5.0 (33.3)	0.007
	No	195 (92.9)	60 (30.8)	135 (69.2)	
History of big baby	**Yes**	11 (5.2)	2.0 (18.2)	9.0 (81.8)	0.227
	No	199 (94.8)	68 (34.2)	131 (65.8)	
History of previous caesarian section	**Yes**	27 (12.9)	11 (40.7)	16 (59.3)	0.253
	No	183 (87.1)	59 (32.2)	124 (67.8)	
History of hypertensive disorders during pregnancy	**Yes**	22 (10.5)	7.0 (31.8)	15 (68.2)	0.540
	No	188 (89.5)	63 (33.5)	125 (66.5)	
History of anemia	**Yes**	25 (11.9)	7.0 (28.0)	18 (72.0)	0.360
	No	185 (88.1)	63 (34.1)	122 (65.9)	
Complain of edema	**Yes**	12 (5.7)	1.0 (8.3)	11 (91.7)	0.049
	No	198 (94.3)	69 (34.8)	129 (65.2)	
Do you have a meal plan	**Yes**	8.0 (3.8)	5.0 (62.5)	3.0 (37.5)	0.084
	No	202 (96.2)	65 (32.2)	137 (67.8)	
Numbers of meals per day	**< three**	48 (22.9)	13 (27.1)	35 (72.9)	0.185
	Three meals	158 (75.2)	57 (36.1)	101 (63.9)	
	> three	4.0 (1.9)	0.0 (0.0)	4.0 (100)	
Dietary supplement use (including multivitamins)	**Yes**	153 (72.9)	62 (40.5)	91 (59.5)	0.001
	No	57 (27.1)	8.0 (14.0)	49 (86.0)	

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. SD, stander deviation.

On the other hand, Table 3 shows the distribution of the study participants by physical activity levels, anthropometric measurements, blood pressure measurements, and biochemical tests variables. The results of the present study demonstrated that the mean weekly energy expenditure in metabolic equivalents per week (MET/wk) for the case group was (3067.5 ± 256) vs. (3464.2 ± 294) for the control group; the mean weekly energy expenditure in kilocalories (Kcal/wk) for the case group was (4074.8 ± 360) vs. (4199.8 ± 376) for the control group. In addition, Table 3 shows that 23.3%, 13.3%, and 63.3% of the study participants were insufficiently active (IA), sufficiently active (SA), and very active (VA) respectively. Furthermore, the mean pre-pregnancy weight (kg) for the case group was (73.4 ± 14.0) vs. (63.6 ± 11.9) for the control group; the mean current weight (kg) was (79.5 ± 14.5) vs. (71.6 ± 13.1); the mean waist circumference (cm) was (105.9 ± 9.7) vs. (102.7 ± 8.2); the mean BMI (kg/m²) was (30.8 ± 5.8) vs. (27.8 ± 5.5); the mean fasting plasma glucose (mg/dL) was (108.3 ± 20.2) vs. (78.1 ± 7.5), and the mean HbA1c % for case group was (6.19 ± 0.99) vs. (4.81 ± 0.61) for the control group. Additionally, for the following factors (Pre-pregnancy weight (kg), current weight (kg), gestational weight gain (kg), waist circumference (cm), BMI (kg/m²), fasting plasma glucose (mg/dL), and HbA1c %) the differences were statistically significant between the case and control groups (*P*-value< 0.05 for all).

Table 3 : The distribution of the study participants by physical activity levels, anthropometric measurements, blood pressure measurements, and biochemical tests variables

Variables		**Total (n=210)**	**Case (n=70)**	**Control (n=140)**	**P Value**
		No. (%)	**No. (%)**	**No. (%)**	
Weekly energy expenditure					
MET/wk	Mean±SD	3332.0±282	3067.5±256	3464.2±294	0.133
Kcal/wk	Mean±SD	4158.2±118	4074.8±360	4199.8±376	0.551
Physical activity levels					
Insufficiently Active (IA)	≤ 600 MET/wk	49 (23.3)	20 (40.8)	29 (59.2)	0.220
Sufficiently Active (SA)	601 to 1500 MET/wk	28 (13.3)	6.0 (21.4)	22 (78.6)	
Very Active (VA)	≥1500 MET/wk	133 (63.3)	44 (33.1)	89 (66.9)	
Pre-pregnancy weight (kg)	Mean±SD	66.9±13.4	73.4±14.0	63.6±11.9	0.001
Current weight (kg)	Mean±SD	74.2±14.1	79.5±14.5	71.6±13.1	0.001
Gestational weight gain (kg)	Mean±SD	7.44±4.0	6.3±4.2	8.0±3.7	0.004
Height (m)	Mean±SD	1.60±0.06	1.60±0.05	1.60±0.07	0.950
Waist circumference (cm)	Mean±SD	103.8±8.9	105.9±9.7	102.7±8.2	0.015
BMI (kg/m²)	Mean±SD	28.8±5.8	30.8±5.8	27.8±5.5	0.001
Systolic blood pressure (mmHg)	Mean±SD	110.6±10.3	112.1±9.1	109.9±10.8	0.323
Diastolic blood pressure (mmHg)	Mean±SD	67.6±8.3	68.6±.9	67.0±6.5	0.412
Fasting plasma glucose (mg/dL)	Mean±SD	88.1±19.4	108.3±20.2	78.1±7.5	0.001
HbA1c %	Mean±SD	5.27±0.9	6.19±0.99	4.81±0.61	0.001

*Data are expressed as means ± SD for continuous variables. The differences between mean were tested by using independent sample T test and one-way ANOVA. P value less than 0.05 was considered as statistically significant. MET/wk: Weekly energy expenditure in metabolic equivalents per week; Kcal/wk: Weekly energy expenditure in kilocalories = MET * weight (kg) / 60; SD: stander deviation; BMI: Body mass index; HbA1c: Hemoglobin A1c*

The consumption data of the 25 food groups[21] were used for factor analysis. The scree plot of eigenvalues indicated two major patterns: 1) Healthy dietary pattern characterized by a high intake of whole grains, beans and legumes, poultry, fish and shellfish products, eggs, low-fat dairy product, vegetables, tomatoes, fruits, vegetable oils, olive, nuts, and seed products, as well as a low intake of red meat, salt, and pickles; 2) Unhealthy dietary pattern characterized by a high intake of refined grains, potatoes, red meat, fast foods, high-fat dairy products, hydrogenated fats, sugar, sweets, and desserts, snacks, condiments, salt, and pickles as well as a low intake of fish and shellfish products, vegetables, and olive. The factor loading matrixes for the two major patterns are shown in Table 4. These two major dietary patterns explained 13.12% and 11.19% of the total variance, respectively.

In the present study, the dietary patterns scores were classified as tertiles, and finally, we computed the odds ratio (OR) and confidence interval (CI) for GDM risk across tertiles categories of dietary pattern score Table 5. Our findings demonstrate that after adjustment for confounding variables, women in the lowest tertile (T1) of the healthy dietary pattern characterized by a high intake of whole grains, beans and legumes, poultry, fish and shellfish products, eggs, low-fat dairy products, vegetables, tomatoes, fruits, vegetable oils, olive, nuts and seed products, as well as a low intake of red meat, salt and pickles had a lower odds for GDM [OR, CI 95%: 0.730 (0.596-.895); P-value 0.002]; whereas women in the lowest tertile (T1) of the unhealthy dietary pattern characterized by a high intake of refined grains, potatoes, red meat, fast foods, high-fat dairy products, hydrogenated fats, sugar, sweets, and desserts, snacks, condiments, salt, and pickles as well as a low intake of fish and shellfish products, vegetables, and olive had a higher odds for GDM [OR, CI 95%: 3.41 (0.033-0.154); P-value 0.003] among pregnant women in Gaza Strip, Palestine.

Table 4: Factor loading matrix for major dietary patterns

	Dietary patterns	
Food Groups	**Healthy dietary pattern**	**Unhealthy dietary pattern**
Refined grains	-	0.264
Whole grains	0.562	-
Potatoes	-	0.420
Beans and legumes	0.468	-
Red meat	0.477	0.596
Organ meat	-	-
Poultry	0.280	-
Fish and shellfish products	0.449	0.350
Fast foods	-	0.282
Eggs	0.383	-
Low-fat dairy product	0.290	-
High-fat dairy products	-	0.560
Vegetables	0.524	0.298
Tomatoes	0.660	-
Fruits	0.778	-
Hydrogenated fats	-	0.308
Vegetable oils	0.274	-
Olive	0.393	0.211
Nuts and seed products	0.432	-
Sugar, sweets, and desserts	-	0.518
Snacks	-	0.231
Condiments	0.264	0.355
Soft drinks	0.219	-
Beverages	-	-
Salt and pickles	0.239	0.347
Variance explained (%)	13.126	11.194

Values less than 0.2 were omitted for simplicity. Total variance is explained by two factors: 24.320

Table 5: Odd ratio and confidence interval for gestational diabetes mellitus risk across tertiles categories of dietary pattern scores

Healthy dietary pattern					Unhealthy dietary pattern				
T1	**T2**	**T3**	**P value**	**OR (95%CI)**	**T1**	**T2**	**T3**	**P value**	**OR (95%CI)**
Case (currently diagnosed as gestational diabetes mellitus)									
25.3	25.3	49.4	0.123	0.855 (0.701-1.043)	35.6	23.0	41.4	0.298	0.894 (0.723-1.104)
Adjusted*			0.002	0.730 (0.596-.895)	Adjusted*			0.003	3.41 (0.033-0.154)
Control									
28.0	32.0	40.0	0.355	0.939 (0.822-1.073)	29.9	35.2	34.9	0.756	0.790 (0.179-3.486)
Adjusted*			0.616	1.039 (0.893-1.209)	Adjusted*			0.578	0.839 (0.451-1.560)

*The OR and CI for gestational diabetes mellitus risk across tertiles categories of dietary pattern scores were tested by binary logistic regression. *Adjusted for family history of diabetes mellitus, family history of cardiovascular diseases, family history of hyperlipidemia, physical activity (Total MET), gestational weight gain (kg), and fasting plasma glucose (mg/dL). P value less than 0.05 was considered as statistically significant. OR, odds ratio; CI, confidence interval*

Discussion

To the best of our knowledge, this is the first study, which describes the major dietary patterns and their association with risk of GDM; and compare the level of glycemic control among women with and without GDM in Gaza Strip, Palestine. The principle component analysis show two major dietary patterns: 1) Healthy dietary pattern characterized by a high intake of whole grains, beans and legumes, poultry, fish and shellfish products, eggs, low-fat dairy products, vegetables, tomatoes, fruits, vegetable oils, olive, nuts, and seed products, as well as a low intake of red meat, salt, and pickles; 2) Unhealthy dietary pattern characterized by a high intake of refined grains, potatoes, red meat, fast foods, high-fat dairy products, hydrogenated fats, sugar, sweets, and desserts, snacks, condiments, salt, and pickles as well as a low intake of fish and shellfish products, vegetables, and olive. The main findings of this study indicate that, after adjustment for confounding variables, the healthy dietary pattern may be associated with a lower risk of GDM; whereas the unhealthy dietary pattern may be associated with a high risk of GDM among pregnant women in Gaza Strip, Palestine.

In fact, very few studies have explored the relationship between dietary patterns with glycemic control and GDM, 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 GDM[9-12], instead of focusing on dietary patterns, which is the most sensible approach to test the role of the overall diet on nutrition-related diseases[13]. Diet composition may be a modifiable predictor of risk for poor glycemic control and GDM during pregnancy[9&10]. Long-standing findings established the association of the increased risk of GDM and poor glycemic control with low intakes of polyunsaturated fatty acids[33], fiber[34], foods with low glycemic load[34], and high consumption of saturated fatty acids[12], total fat[12], cholesterol[13], iron[13], carbohydrates[34], and red and processed meat [11]. Furthermore, foods with reduced content of saturated fat and sodium, rich in dietary fibers, phytochemical compounds, and antioxidants, mainly flavonoids, are present in dietary patterns that have been associated with better glycemic control[35]. The results of our study support these findings.

The previous studies shows incompatible findings regarding dietary patterns and GDM[3&4&36&,37], for example, the recent studies have shown that higher adherence to the western dietary pattern[38&39], characterized by high intake of red meat, refined sugars, and fried foods increased the risk of GDM; whereas, these results were not reported in other studies[40&41]. Moreover, studies reached contradictory results about the effect of healthy dietary patterns on GDM or poor glycemic risk.

For instance, some studies revealed that GDM had a protective association with prudent[36], vegetable[40], and Mediterranean[4] dietary patterns. However, other studies did not reach the same results[3&39&41&42]. The previous dietary patterns differ from those in our study. This can be explained by demographic, cultural, and ethnic differences.

The inverse association between healthy dietary patterns with GDM risk could be attributed to the pattern’s healthy ingredients including vitamins, dietary fibers, potassium, magnesium, and antioxidants. These nutrients have been independently associated with reduced risks of GDM or poor glycemic control[43&44]. Additionally, vegetables, legumes, and fruits contain minerals, polyphenols, and other phytochemicals that fight oxidative stress, inflammation, and insulin resistance[45]. In our study, the healthy dietary pattern is quite close to that diet, which is generally recommended as a healthy dietary pattern with low in animal foods, saturated fat, trans fat, cholesterol, and simple sugar, which may be associated with a higher risk of GDM and poor glycemic control[45]. Actually, the relationship between dietary patterns with GDM and the risk of poor glycemic control needs more studies in the future.

The main limitations of this study are its purposive sampling method, which limits the generalizability of the study results. In addition, the possibility of recall bias and misreporting by using the FFQ assessment of dietary patterns are other limitations. The main strength of our study was it's being the first study, which shows the dietary patterns among pregnant women and its association with GDM and glycemic control in Gaza Strip, Palestine.

Conclusion

The healthy dietary pattern may be associated with a lower risk of GDM; whereas the unhealthy dietary pattern may be associated with a high risk of GDM in Gaza Strip, Palestine.

Ethics approval and consent to participate

The study protocol was approved by the Palestinian Health Research Council (Helsinki Ethical Committee of Research PHRC/HC/798/20). In addition, written informed consent was also obtained from each participant.

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الأنماط الغذائية وارتباطها بضبط نسبة السكر في الدم وخطر الإصابة بسكري الحمل في قطاع غزة – فلسطين

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المقدمة: أجريت هذه الدراسة لتحديد الأنماط الغذائية الرئيسية وعلاقتها بالتحكم في نسبة السكر في الدم وخطر الإصابة بسكري الحمل في قطاع غزة، فلسطين.

منهجية الدراسة: أجريت هذه الدراسة في مراكز الرعاية الصحية الأولية في عام ٢٠٢١، على ٢١٠ امرأة حامل، تتراوح أعمارهن بين ٢٠-٤٠ سنة (٧٠ امرأة حامل تعاني من سكري الحمل و ١٤٠ حالة تحكم مطابقة للعمر والموقع الجغرافي) تم اختيارها عن طريق أخذ عينة هادفة. تم تقييم الأنماط الغذائية باستخدام استبيان تردد الغذاء شبه الكمي. تم استخدام استبيان النشاط البدني الدولي لقياس مستوى النشاط البدني. تم الحصول على معلومات إضافية بشأن متغيرات التاريخ الديموغرافي والاجتماعي والاقتصادي والطبي من خلال استبيان قائم على المقابلة. تم استخدام معايير منظمة الصحة العالمية لتشخيص وتحديد سكري الحمل، بالإضافة إلى ذلك تم استخدام فحص مخزون السكر في الدم كعلامة للتحكم في نسبة السكر في الدم. تم إجراء التحليل الإحصائي باستخدام برنامج التحليل الاحصائي.SPSS

النتائج: تم تحديد نمطين غذائيين رئيسيين من خلال تحليل العوامل: نمط غذائي صحي ونمط غذائي غير صحي. بعد تعديل المتغيرات المربكة، كان لدى النساء في أدنى مستوى من النمط الغذائي الصحي احتمالات أقل للإصابة بسكري الحمل أو ضعف التحكم في نسبة السكر في الدم [نسبة الأرجحية ٠.٧٣٠ : مجال الثقة ٩٥٪ (٠.٥٩٦-٨٩٥)، القيمة الاحتمالية ٠.٠٠٢]، في حين أن النساء في أدنى مستوى من النمط الغذائي غير الصحي كان لديهن احتمالات أعلى للإصابة بسكري الحمل أو ضعف التحكم في نسبة السكر في الدم [نسبة الأرجحية: ٣.٤١ مجال الثقة ٩٥٪ (٠.١٥٤-٠.٠٣٣)، القيمة الاحتمالية ٠.٠٠٣].

الخلاصة: قد يترافق النمط الغذائي الصحي مع انخفاض خطر الإصابة بسكر الدم أو ضعف التحكم في نسبة السكر في الدم، في حين أن النمط الغذائي غير الصحي قد يترافق مع ارتفاع مخاطر الإصابة بسكر الدم أو ضعف التحكم في نسبة السكر في الدم.