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Factors associated with gestational diabetes among women registered at secondary hospitals in Karachi, Pakistan

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FACTORS ASSOCIATED WITH GESTATIONAL DIABETES AMONG WOMEN REGISTERED AT SECONDARY HOSPITALS IN KARACHI PAKISTAN

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Abstract:

Introduction: Few things are proven, there are modifiable and non-modifiable factors that could impact on the health of pregnant women who have Gestational Diabetes Millitus (GDM). However, case control studies are lacking that explore the modifiable factors and identify which modifiable factors are associated with GDM.

Purpose : The aim of this study was to identify the modifiable associated risk factors of GDM among women at 32 to 40 weeks of gestation.

Methodology: A case-control study design was conducted at secondary hospitals for women and children in Karachi, Pakistan. The data were collected from 100 cases and same number of controls, through a structured questionnaire. The data was analyzed by means of descriptive and inferential statistics, using Stata$^{(TM)}$ Version 12.0.

Results: The majority of the study participants had a past history of GDM and had a Body Mass Index (BMI) greater than 25kg/m^2. Most of the participants were graduates or post-graduates. The results of the study identified that the modifiable factors which were significantly associated with GDM included household physical activities, transportation related physical activities, recreational activities (i.e., walking, number of stairs climbed daily), use of fruits and eggs, and night time sleep duration. Only 12% of the participants reported that they spent greater than or equal to six hours in recreational physical activities. About one-third (35%) of the participants reported sleeping more than six hours a night.

Conclusion: The present study identified the association of some modifiable factors with GDM. There is a dire need to develop preventive strategies that can promote a healthy lifestyle among pregnant women. Attention should be given to increasing physical activity, promoting a healthy diet, and having proper sleep. In light of the current study findings, a study with a large sample size, including multi-center settings, is needed.

Keywords: *Modifiable and non-modifiable risk factors, Gestational Diabetes, Pakistan*

Introduction

Gestational Diabetes Mellitus (GDM) refers to glucose intolerance that is identified during a pregnancy (1). The peak level of glucose is observed in the latter half of the second and third trimester of pregnancy (2).Gestational diabetes affects about 15% of all pregnancies globally (3). In the developed countries like, the United States of America (USA), GDM occurs in 7% of all pregnancies, which accounts for an economic burden of $636 million annually (4). Prevalence of GDM in developing countries can be high ranges from 1.5% to 24.30% in Vietnam, India, Cuba, Bangladesh, and Iran (5).

GDM is diagnosed through an Oral Glucose Tolerance Test (OGTT) which includes the pregnant woman ingesting between; 75 and 100 grams of glucose with test plasma glucose values measured at set intervals to ascertain its clearance from the blood. According to WHO (World Health Organization) criteria, the blood glucose level is monitored for two hour duration that is, fasting blood glucose, one hour and two hours after loading the required glucose. If at least one of the three values of blood glucose is at an elevated level from normal, the person would be considered as having GDM (1).

Lifestyle and GDM

A healthy lifestyle behavior includes a healthy diet, exercise, and normal weight, which are related to the prevention of diabetes mellitus. An unhealthy diet with a high content of fats and free sugars, and physical inactivity are the leading causes of type II diabetes (6). In developing countries, the prevalence of diabetes is increasing due to urbanization, easily available fast food and a sedentary lifestyle (7). Buildup of an extra fat is referred to as being overweight or obese, which damages the health (6). The problem of being overweight and obese is becoming more significant in low and middle income countries, mainly in the urban settings. Approximately, 2.7 million deaths occur due to unhealthy diet and 1.9 million deaths due to physical inactivity, worldwide (6,8). The preventive strategies including lifestyle modification can minimize the risk of chronic diseases.

A prospective study in the USA showed several modifiable factors, that is, regular physical activity, healthy diet, and abstinence from smoking, which play an important role in decreasing the risk of GDM (9). Moreover, BMI (Body Mass Index) ≥ 25 kg/m^2 before

pregnancy increase the risk of GDM (10). Other observational studies revealed that participants were at high risk of GDM if they were physically inactive (11,12).

Inadequate and poor sleep quality is another modifiable factor related to an increased risk of GDM. A prospective study conducted in Japan showed that the risk of GDM increased among those who slept < five hours, as compared to those who sleep seven hours per night (13). Hence, the risk of GDM can be delayed or prevented by addressing the modifiable factors.

Study Purpose

The aim of this study was to identify the modifiable risk factors associated with GDM among women between 32 and 40 weeks of pregnancy, at two secondary hospitals (Garden & Karimabad) in Karachi, Pakistan. Building on the previous studies we hypothesized that there is an association between unhealthy food intake, physical activity, obesity, sleep quality and duration, socioeconomic status and GDM (14).

Methods

Study Design, Setting and Sample recruitment

A case control study design was used to identify the modifiable risk factors of GDM. The case control study design is a form of observational study design that assists the researcher to assess the association of multiple independent factors with the outcome (15).The current study was carried out in the Garden and Karimabad secondary hospitals for women, Karachi, Pakistan. Epi Info7^{TM} software was used to calculate the sample size. The sample size was calculated using a 95% confidence interval, followed by 80% power, with an odds ratio of 4.11 % (16). The highest calculated sample size was 72 cases and 72 controls. However, to account for potential participant departure from the study and other risks to sample integrity, final sample size was set at 200, which included 100 participants for the cases and the same number for controls. The case and control ratio was kept 1:1 (i.e., one case per one control) as it can increase the result precision (17). This study was conducted after approval from the Ethical Review Committee (ERC) of the Aga Khan University Hospital (AKUH) Karachi, Pakistan.

Inclusion Criteria for Cases and Controls

1. For cases participants were 32 to 40 weeks gestation and diagnosed with GDM;
   For Controls participants were 32 to 40 weeks gestation without the diagnosis of GDM.
2. 30 to 49 years old
3. Able to communicate in English or Urdu
4. Voluntarily agree to participate

Exclusion Criteria for Cases and Controls

1. Unable to provide a voluntary informed consent
2. Diagnosed with type I and type II diabetes

Study Variables

Definition of dependent variable

Gestational Diabetes Mellitus

Impaired glucose tolerance diagnosed initially during pregnancy (18).
For this study, it refers to those participants who were diagnosed with GDM as confirmed by an oral glucose tolerance test.

Definitions of independent variables

Food intake

The food consumption choices of the participants during the pregnancy.

Physical activity

The duration of recreational physical activity, such as walking, and the time spent on exertion activities during household, transportation, and occupational work.

Obesity

Being overweight is defined as gaining a total weight of 6.8-11.3 kg (15-25 lbs) and a BMI of 30 kg/m^2 or greater is considered as obese during pregnancy (6).
For this study, the BMI was calculated at the time of recruitment by the researcher, taking weight in kilograms and dividing it by height in centimeter square.

Sleep

It is a condition in which responsiveness to environmental stimuli decreases but, is reversible, and is associated with different postural positioning, behavioral serenity, and closed eyes (19). For this study, it refers to self-reported sleep pattern of the study participants.

Socio-economic status

The participants stated the family monthly income according to a given range.

Data Collection Tools

The data for this study were collected through a self-reported questionnaire. A self-reported questionnaire is a powerfull data collection method as it can collects information about behaviours directly and can gather the information which occur in past. (20). A demographic form was developed to gather the information. To collect the data regarding modifiable risk factors, two questionnaire were adapted and one was developed. To measure sleep and physical activity questionnaire were adapted, wherease a food intake questionaire was newly developed by reviewing the WHO guidelines and published literature on GDM (21,22). The developed questionnaire's validity was assessed through content validity and pilot testing. The pilot testing of the questionnaire allows for the face validity of the tool and ensures its relevancy to the context. This helps the tool's clarity, completeness, and effectiveness and to measure the time needed for the completing the tool (23).The documented reliability for the Pittsburgh sleep quality questionnaire was 0.87 (24).The reliability of the physical activity and food intake questionnaire were calculated by Cronbach's alpha. The Content Index Validity (CVI) was computed with the help of an expert committee. The CVI ratio was 0.83 after the modification. The calculated value of Cronbach's alpha was 0.60 for physical activity and 0.57 for food intake questionnaire, as these tools were modified and newly developed respectively, and were tested for the first time, to measure physical activity and food intake in Pakistan.

Variables Transformation

A few variables were changed to present the data in a more meaningful way. Initially the age variable was continuous, but later was grouped into three categories. The income variable was

initially grouped into ≤ 15,000 pakistani rupees, 15,000-30,000, 30,001-45,000 and >45,000, which was merged in to three categories; these included ≤ 15,000-30,000, 30,001-45,000, and >45,000. At the time of study 100 Pakistani rupees were worth 0.58 US$ and 0.54 Euros. The day time dysfunction was earlier grouped into No problem, A slight problem, Some what a problem, A very big problem, which was later changed into No problem and slight to very big problem. The data on time spent on recreational activity, that is, walk, was changed into None to 1.9, 2.0-5.9, ≥6.0, from None, 0.1-1.9, 2.0-3.9, 4.0-5.9, ≥6.0 . The duration of household exertional activities categories were taken earlier as None, 0.1-1.9, 2.0-3.9, 4.0-5.9 and ≥6.0, afterwards modified into None-3.9, 4.0-5.9, ≥6.0 . The number of stairs climbed was grouped before None, 1-4, 5-9 and > 10, afterwards it was merged into None, 1-9 and >10. The data on vegetables,fruits, eggs and meat intake was categorized as Never, Sometimes, Often, and Mostly. However, it was changed into Never, Sometimes, Often-Mostly. Moreover, the data on the comparison of milk, bread, vegetables, fruits, eggs, and meat consumption was categorized into As Before, More, Less, Stopped Completely, which was turned to As Before, More and Less-Stopped Complete.

Results

Demographic Profile of the Study Participants

Most of the women, among cases 61% (n=61), and 75% (n=75) of contorls were between 30 and 33 years old, and all were married. The past history of GDM was more common (48%, n=48) in the case group, whereas, 08% controls had a positive history of GDM. Similarly, family history of diabetes was more common (74%) in the cases than the controls (65%). The diagnosis of GDM among the cases was 33%, 07%, 27%, 26%, and 07% in the 4^{th},5^{th},6^{th},7^{th}, and 8^{th} months of pregnancy, respectively.

The majority of the participants were found to be obese, as almost half of the cases (48%, n=48) and of controls (50%, n=50) had a BMI higher than 30 kg/m^2. Moreover, 44 (44%) cases and 43 (43%) controls had a BMI of over 25 kg/m^2. Most of the participants in the (50%, n=50) cases and (52%, n=52) controls were graduates or post-graduates and only 26% (n=26) cases and 24%, (n=24) controls had middle to higher secondary education. A number of the cases (41%, n=41) and controls (40%, n=40) had an average monthly income greater than or equal to 45,000

Pakistani rupees. Additionally, 38% (n=38) cases and 28% (n=28) controls had an income of ≤15,000-30,000 Pakistani rupees.

Univariate Analysis

This part describes the association of the modifiable and non-modifiable risk factors with GDM. The univariate analysis was carried out for all predictor variables and the cut-off of P-value for the significance of the Wald test was kept to ≤ 0.25, so that all the important variables could be added in the multivariate model. Only those variables have been explained which were found to be significant in the univariate analysis.

The identified non-modifiable significant factors were: 1) increased maternal age; 2) past history of GDM; and 3) family history of diabetes. The modifiable significant factors were: low to middle average monthly income, sleep duration 6-7 hours, and daytime dysfunction. In terms of physical activity: 1) less time spent in walking; 2) less time spent in extraneous household physical activities; 3) transportation related physical activities; 4) not performing up to the desired moderate intensity physical activity; and 5) less than the desired number of stairs to be climbed were significantly related with GDM. With regards to food intake: 1) consumption of fruits; 2) utilization of butter; 3) consumption of white bread; 4) red and white meat; 5) full fat milk and yogurt; 6) fried egg, fresh fruits; 7) fast food; 8) eating less than before during pregnancy; 9) less consumption of milk, bread and fruits; 10) increased intake of eggs than before pregnancy; and 11) utilization of certain foods, which included milk, yogurt, and soft drinks, were statistically linked with GDM.

Table 1: Logistic Regression forDemographic and Non-Modifiable Associated Factors of GDM among Pregnant Women (30-49 years)

Demographic Variables and Associated factors	Cases (n=100) N %	Controls (n=100) N %	OR	CI 95% Lower Upper	Wald test (p-value)	p-value χ^2
Age in years						
30-33	61 (61.00)	75(75.00)	01			0.00
34-37	34 (34.00)	16 (16.00)	2.61	(1.10--13.27)	**0.00**	
38-41	05(05.00)	09 (09.00)	0.68	(0.21—2.14)	0.51	

Past History of GDM						
Yes	48(48.00)	08(08.00)	10.61	(4.66--24.15)	**0.00**	0.000
No	52(52.00)	92(92.00)	01			
Family History of DM						
Yes	74(74.00)	65(65.00)	1.53	(0.83---2.81)	**0.16**	0.166
No	26(26.00)	35(35.00)	01			

Table 2: Logistic Regression for Demographics and Modifiable Associated Factors of GDM among Pregnant Women (30-49 years)

Demographic Variables and Associated Factors	Cases (n=100) N %	Controls (n=100) N %	OR	CI 95% Lower Upper	Wald test (p-value)	p-value χ^2
Body Mass Index (BMI kg/m^2)						
18.50-24.99	08(08.00)	07(07.00)	01			
≥25.00	44(44.00)	43(43.00)	0.89	(0.29—2.68)	0.84	0.94
≥30.00	48(48.00)	50(50.00)	0.84	(0.28—2.49)	0.75	
Level of education						
Graduation-post Graduation	50(50.00)	52(52.00)	01			
Under graduation	22(22.00)	20(20.00)	1.14	(0.55—2.34)	0.71	0.91
Higher/Secondary /Middle	26(26.00)	24(24.00)	1.12	(0.57—2.21)	0.73	
At least Primary Education	02(00.00)	04(03.00)	0.52	(0.91—2.96)		
Income						
<15,000-30,000	38(38.00)	28(28.00)	1.32	(0.68—2.54)	0.40	0.14
30,001-45,000	21(21.00)	32(32.00)	0.64	(0.31—1.29)	**0.21**	
>45,000	41(41.00)	40(40.00)	01			

Table 3: Logistic Regression for Modifiable Associated Factors of GDM among Pregnant Women (30-49 years)

Variables	Cases (n=100) N %	Control (n=100) N %	OR	CI 95% Lower Upper	Wald test (p-value)	p-vale χ^2
Associated Factors: Poor Sleep						
Sleep quality						
Very Good	26(26.00)	27(27.00)	01			
Fairly Good	56(56.00)	59(59.00)	0.98	(0.51---1.88)	0.96	0.89
Fairly Bad	14(14.00)	11(11.00)	1.32	(0.50---3.43)	0.56	
Very Bad	04(04.00)	03(03.00)	1.38	(0.28---6.79)	0.68	

Sleep latency						
≤15 min	32(32.00)	29(29.00)	01			
16-30 min	25(25.00)	21(21.00)	1.07	(0.50---2.32)	0.84	
31-60 min	06(06.00)	08(08.00)	0.67	(0.21---2.19)	0.51	0.77
>60min	37(37.00)	42(42.00)	0.79	(0.40---1.55)	0.51	
Sleep duration						
>7 hours	14(14.00)	21(21.00)	01			
6-7 hours	22(22.00)	12(12.00)	2.75	(1.03---7.29)	**0.04**	0.21
5-6 hours	39(39.00)	42(42.00)	1.39	(0.62---3.11)	0.42	
<5 hours	25(25.00)	25(25.00)	1.5	(0.62---3.59)	0.36	
Sleep efficiency						
>85%	44(44.00)	45(45.00)	01			
75-84%	12(12.00)	09(09.00)	1.36	(0.52---3.55)	0.52	0.66
65-74%	10(10.00)	15(15.00)	0.68	(0.27---1.67)	0.40	
<65%	34(34.00)	31(31.00)	1.12	(0.59---2.12)	0.72	
Sleep disturbance						
Not during the past month	09(09.00)	11(11.00)	01			
Less than once - twice in a week	31(31.00)	31(31.00)	1.22	(0.44---3.36)	0.69	0.88
Three or more times in a week	60(60.00)	58(58.00)	1.26	(0.48---3.27)	0.62	
Day time dysfunction						
No problem at all	69(69.00)	61(61.00)	01			
Only a very slight problem- A very big problem	31(31.00)	39(39.00)	0.70	(0.39---1.26)	**0.23**	0.235

Associated Factors: Physical inactivity						
Time spent during walking (hr/wk)						
None-1.9	65(65.00)	66(66.00)	2.95	(1.10---7.91)	**0.03**	0.00
2.0-5.9	29(29.00)	16(16.00)	5.43	(1.79--16.45)	**0.00**	
≥6.0	06(06.00)	18(18.00)	01			
Time spent in occupational Activities (hr/wk)						
None	89 (89.00)	89(89.00)	01	(0.24—4.12)	1.00	0.69
0.1-1.9	03(03.00)	01(01.00)	03	(0.21---42.62)	0.41	
2.0-3.9	04(04.00)	06(06.00)	0.6	(0.10—4.35)	0.67	
4.0-≥6.0	04(04.00)	04(04.00)	01			
Time spent in household activities(hr/wk)						
None-3.9	23(23.00)	06(06.00)	3.83	(1.42—10.32)	**0.00**	0.00
4.0-5.9	33(33.00)	50(50.00)	0.66	(0.35—1.21)	**0.17**	

≥6.0	44(44.00)	44(44.00)	01			
Time spent in transportation related activities(hr/wk)						
None	83(83.00)	64(64.00)	4.86	(1.53—15.36)	**0.00**	0.00
0.1-1.9	06(06.00)	07(07.00)	3.21	(0.68—15.15)	0.14	
2.0-5.9	07(07.00)	14(14.00)	1.87	(0.44—7.82)	0.38	
≥6.0	04(04.00)	15(15.00)	01			
Intensity of physical activity						
None	28(28.00)	22(22.00)	1.72	(0.74---3.98)	0.20	0.27
Light	53(53.00)	49(49.00)	1.46	(0.69---3.05)	0.31	
Moderate	17(17.00)	23(23.00)	01			
Light to Moderate	02(02.00)	06(06.00)	0.45	(0.08—2.51)	0.36	
Type of physical activity						
Light intensity activity						
Sleeping, watching TV, Writing Doing desk work.	27(27.00)	34(34.00)	0.59	(0.27---1.27)	**0.18**	0.40
Sleeping, Watching TV, Writing, Doing desk work & walk. <150	28(28.00)	21(21.00)	01			
None	45(45.00)	45(45.00)	0.75	(0.37---1.51)	0.42	
Moderate intensity activity						
Home exercise	01(01.00)	02(02.00)	0.75	(0.06---8.89)	0.82	0.24
Walk ≥150	18(18.00)	27(27.00)	01			
None	81(81.00)	71(71.00)	1.71	(0.87---3.36)	**0.01**	
Number of stairs						
None	27(27.00)	31(31.00)	0.88	(0.47---1.64)	0.69	0.32
1-9	09(09.00)	04(03.00)	2.28	(0.66---7.79)	**0.18**	
≥10	64(64.00)	65(65.00)	01			

Associated Factors: Unhealthy Food Intake

Variables	**Cases (n=100) N %**	**Control (n=100) N %**	**OR**	**CI 95% Lower Upper**	**Wald test (p-value)**	**p-value (Chi2)**
Use of the following products during pregnancy.						
Milk						
Never	06(06.00)	06(06.00)	01	(0.30--- 3.28)	1.00	
Sometimes	26(26.00)	23(23.00)	1.13	(0.57----2.21)	0.72	0.91

Often	13(13.00)	15(15.00)	0.8	(0.34----1.86)	0.60		
Mostly	55(55.00)	56(56.00)	01				
Bread							
Never	07(07.00)	07(07.00)	1.13	(0.30----2.82)	0.88		
Sometimes	34(34.00)	26(26.00)	1.48	(0.63--- 2.30)	0.57		0.08
Often-Mostly	59(59.00)	67(67.00)	01				
Vegetable							
Never-some times	33(33.00)	30(30.00)	01				
Often-mostly	67(67.00)	70(70.00)	1.14	(0.49---1.63)	0.64		0.64
Fruits							
Never-sometimes	23(23.00)	10(10.00)	01				0.01
Often-Mostly	77(77.00)	90(90.00)	2.68	(1.20---5.99)	**0.01**		
Eggs							
Never	12(12.00)	14(14.00)	0.73	(0.30---1.78)	0.49		
Sometimes	42(42.00)	36(36.00)	01				0.67
Often-Mostly	46(46.00)	50(50.00)	0.78	(0.43—1.13)	0.43		
Meat							
Never	07(07.00)	04(04.00)	1.53	(0.41---5.68)	0.52		
Sometimes	41(41.00)	36(36.00)	01				0.42
Often-mostly	52(52.00)	60(60.00)	0.76	(0.42—1.36)	0.35		
Use of butter							
Yes	53(53.00)	68(68.00)	0.53	(0.29---0.94)	**0.03**		0.02
NO	47(47.00)	32(32.00)	01				
Type of butter							
None	47(47.00)	31(31.00)	01				
Butter	19(19.00)	22(22.00)	0.56	(0.26---1.22)	**0.14**		0.09
Margarine	32(32.00)	46(46.00)	0.45	(0.24---0.86)	**0.01**		
Both	02(02.00)	01(01.00)	1.31	(0.11—15.1)	**0.82**		
Type of bread							
White Bread	58(58.00)	82(82.00)	0.20	(0.08—0.51)	**0.00**		
Brown Bread	24(24.00)	07(07.00)	01				
Unspecified	11(11.00)	03(03.00)	1.06	(0.23---4.93)	0.93		
None of them	07(07.00)	08(08.00)	0.25	(0.06---0.95)		0.00	
Type of meat							
Red Meat	24(24.00)	26(26.00)	1.16	(0.57---2.36)	0.68		
White Meat	35(35.00)	44(44.00)	01				
Red & white	38(38.00)	29(29.00)	1.64	(0.85---3.17)	**0.13**		
None of them	03(03.00)	01(01.00)	3.77	(0.37---37.8)	**0.25**	0.33	
Type of vegetal							
Raw & cooked	98(98.00)	95(95.00)	2.57	(0.48---13.61)	0.26	0.24	
Raw, cooked &	02(02.00)	05(05.00)					
Type of milk							
Skimmed milk	17(17.00)	09(09.00)	01				
Full fat milk & y	70(70.00)	81(81.00)	0.45	(0.191---1.09)	**0.07**		
Low fat milk & yogurt	09(09.00)	07(07.00)	0.68	(0.18---2.43)	0.55	0.29	
None of them	04(04.00)	03(03.00)	0.70	(0.12---3.86)	0.68		
Type of egg							
Boil egg	19(19.00)	12(12.00)	01				
Fried Egg	46(46.00)	57(57.00)	0.50	(0.22--- 1.15)	**0.10**		
Both	25(25.00)	18(18.00)	0.87	(0 .34--- 2.25)	0.78	0.23	
None of them	10(10.00)	13(13.00)	0.48	(0 .16--- 1.45)	0.19		
Type of fruits							

Fresh Fruits	86(86.00)	80(80.00)	1.61	(0.75---3.46)	**0.21**	0.21
Fresh and Dry F	13(13.00)	20(20.00)				
None of them	01(01.00)	00(00.00)	01			
Fast food						
Never	27(27.00)	21(21.00)	0.78	(0.40—1.53)	0.48	
Sometime	67(67.00)	66(66.00)	0.35	(0.11---1.10)	**0.07**	0.18
Often-mostly	06(06.00)	13(13.00)	01			
Item fast food						
None	27(27.00)	22(22.00)	01			
Burger & fries	27(27.00)	32(32.00)	0.68	(0.32---1.47)	0.33	
Burger, fries, &	26(26.00)	24(24.00)	0.88	(0.40---1.94)	0.75	
Burger, fries piz fried chicken.	17(17.00)	16(16.00)	0.86	(0 .35-- 2.09)	0.74	
Burger, fries, piz & sandwich.	02(02.00)	04(04.00)	0.40	(0 .06--- 2.43)	0.32	0.84
Pizza, samosa, roll, & chat.	01(01.00)	02(02.00)	0.40	(0 .03--- 4.79)	0.47	
Nausea/ vomiting during this pregnancy						
Yes	71(71.00)	75(75.00)	1.26	(0.52---2.89)	0.46	0.44
No	29(29.00)	25(25.00)	01			
Months when nausea/ vomiting experience						
One to three month	51(51.00)	53(53.00)	1.04	(0.52--- 2.07)	0.89	
Three to six month	07(07.00)	06(06.00)	1.26	(0.37--- 4.33)	0.70	0.96
Six to nine month	04(04.00)	02(02.00)	2.17	(0.36--- 13.01)	0.39	
One to six month	09(09.00)	09(09.00)	1.08	(0.36--- 3.21)	0.88	
One to nine month	06(06.00)	05(05.00)	1.30	(0.35--- 4.85)	0.69	
None of them	23(23.00)	25(25.00)	01			
Started to eat or drink certain food items during this pregnancy						
Yes	27(27.00)	35(35.00)	0.68	(0.37---1.25)	0.22	0.22
No	73(73.00)	65(65.00)	01			
Difference in tl utilization of food products during Pregnar						
More	38(38.00)	53(53.00)	01			
Less	49(49.00)	40(40.00)	1.70	(0.94—3.08)	**0.07**	
As before	13(13.00)	07(07.00)	2.59	(0.94—7.1)	**0.06**	0.07
Milk						
As before	48(48.00)	33(33.00)	01			

More	40(40.00)	49(49.00)	0.56	(0.30---1.03)	0.06	0.08
Less-stopped completely	12(12.00)	18(18.00)	0.45	(0.19---1.07)	0.07	
Bread						
As before	57(57.00)	67(67.00)	01			
More	17(17.00)	18(18.00)	1.11	(0.52---2.35)	0.78	0.28
Less- stopped completely	26(26.00)	15(15.00)	2.03	(0.984--- 4.21)	**0.05**	
Vegetable						
As before	61(61.00)	60(60.00)	01			
More	24(24.00)	29(29.00)	0.36	(0.42—1.55)	0.53	0.57
Less	15(15.00)	11(11.00)	1.34	(0.56---3.15)	0.50	
Fruits						
As before	38(38.00)	41(41.00)	01			
More	40(40.00)	57(57.00)	0.75	(0.41---1.37)	0.36	0.00
Less-stopped completely	22(22.00)	00(00.00)	11.8	(2.61---53.90)	**0.00**	
Eggs						
As before	49(49.00)	48(48.00)	01			
More	17(17.00)	26(26.00)	0.64	(0.30---1.32)	**0.23**	0.22
Less-stopped completely	34(34.00)	26(26.00)	1.28	(0.67—2.44)	0.45	
Meat*						
As before	63(63.00)	64(64.00)	01			
More	12(12.00)	16(16.00)	0.76	(0.33---1.73)	0.51	0.56
Less-stopped completely	25(25.00)	20(20.00)	1.22	(0.64---2.51)	0.49	

Multicollinearity

Multicollinearity was checked between all independent predictor variables; Cramer's V was applied between two independent variables as all the predictor variables were categorical. Multicollinearity was found between variables, such as type of butter and use of butter (0.9). One variable (use of butter) was dropped from the multivariate analysis to deal with it in the multicollinearity.

Multivariate analysis

The multivariate analysis was carried out using the backward elimination approach for model building. Initially, the significance level for keeping the variable in the model was kept to 0.25; the model building process was started with all possible variables. The variables, whose p values were greater than the selected level of significance, were removed from the model one by one. This process was repeated until the p values of the all variables were less than selected level of significance. Afterwards the cut-off for p-value in the multivariate model was kept to not more than 0.05, which was checked for each variable's corresponding p-value on the Wald test. The

criteria for the model were: as a whole it needs to be significant, along with the significance of the individual variable, based on their p-value of the Wald test. Moreover, every time, upon adding or removing variables, the likelihood ratio test was performed to observe whether the model improved by adding the variable, as compared to the previous model.

Table 04 shows that those who spent less than four hours on exerting household physical activities were 3.87 times more likely to have the risk of GDM as compared to those who spent ≥ 6.0 hours per week, adjusted for other variables (Adjusted OR=3.87; CI: 1.34- 11.10).

Similarly, time spent on recreational activities was also associated with GDM. The women who engaged less than six hours per week in recreational activities were 4.77 times more likely to have GDM, as compared to those who engaged in ≥6.0 hours per week, adjusted for other variables (Adjusted OR= 4.77; CI:1.37-16.55). The findings related to reducing or completely stopping the use of fruits during pregnancy, and night the time sleep duration, were statistically related to GDM but, due to unusual results, these will be explained in the discussion with literature support.

Table 04: Multivariate Logistic Regression Model for Modifiable Associated Factors of GDM (p-value χ^2= 0.000).

Variable	OR	95% CI Upper & lower limit	Wald test (Pvalue)
Time spent in exertion household activities (hr/wk)			
None-3.9	3.87	(1.34---11.10)	0.01
4.0-5.9	0.52	(0.25---1.07)	0.07
≥6.0	01		
Time spent in recreational physical activity(hr/wk)			
None-1.9	1.90	(0.61---5.84)	0.26
2.0-5.9	4.77	(1.37---16.55)	0.01
≥6.0	01		
Difference in the utilization of fruits during pregnancy			
As before	01		
More	0.80	(0.41---1.54)	0.51
Less-stopped completely	16.11	(3.29---78.85)	0.001
Night time sleep duration			

>7 hours	01		
>6-7 hour	4.30	(1.40---13.23)	0.01
5-6 hour	1.78	(0.68---4.64)	0.23
<5 hour	2.17	(0.77---6.12)	0.14

Discussion

Non-modifiable Associated Factors of GDM

In this study, maternal age, past history of GDM, and family history of diabetes were identified as non-modifiable associated factors of GDM.

Maternal age

The present study revealed that, increased maternal age (i.e., 34-37) years was significantly associated with GDM, which is similar to the studies carried out in the United Kingdom, China, Saudi Arabia, and Asia (25,26, 27). This relationship can be explained as age is associated with GDM; advanced maternal age is related to the decreasing function of pancreatic beta cells, insulin sensitivity, and increasing insulin resistance (28). The reasons for the increase in maternal age, in South Asia, could be related to delays in pregnancy because of social, educational, and economic reasons (29).

Past history of GDM

In this study, past history of GDM was found to be associated with GDM in a current pregnancy, as supported by a study conducted in Iran (12). Moreover a study conducted in Peshawar, Pakistan, reported that most of the women with GDM had a past history of GDM, as compared to the non-GDM women (30), which aligns with the current study findings, where most of the cases (48%) had a past history of GDM.

Family History of Diabetes

Consistent with other studies, the present study illustrated that family history of diabetes was significantly associated with GDM (31). In this study, family history of diabetes was more prevalent among cases, which is in concordance with a study conducted in Iran (12). The impact of family history on GDM could be due to inherited and lifestyle risk elements, such as socio-

economic condition, and educational status (32), while the potential effect on GDM may depend on the presence of a set of other risk factors.

Modifiable Risk Factors of GDM

The results revealed that less household physical activity, difference in the uptake of fruits during pregnancy, less recreational physical activity (walking) and varied sleep duration were modifiable associated factors of GDM.

Less household physical activity

The current study revealed that participants, who spent less time on extraneous household physical activities, were more prone to have GDM. This study further demonstrated that less than four hours per week engagement in household activities was associated with GDM. This is consistent with the findings of other study. Household chores account for a major portion of the physical activity for women. However, intensity level of household chores determine the health benefits (33). In the Pakistani context, most women perform routine household chores, whereas, they spend less time in major household physical activities, such as major cleaning or shampooing of carpets, washing windows or walls etc. Also, a change in behavior may be due to the myths of taking more rest at the commencement of pregnancy and avoiding physical activity (34).

Less recreational physical activity (walking)

In the current study, participants who performed less recreational physical activity, like walking were more likely to have GDM. The study illustrated that less than six hours per week of recreational physical activity (walking) was significantly associated with GDM (35). This point is further supported by the present study, as only 06% of the cases spent more than six hours, and 65% of the cases spent less than two hours on recreational activities (walking). This may be due to an increase in house hold responsibilities, such as taking care of children and home cleaning, leaving limited time for recreational activity. In Pakistan, due to the cultural influences, women take the overall household responsibilities. Another study carried out in Pakistan showed that GDM developed in those participants who did not indulge in proper walking for 30-45 minutes per day, although they are doing their routine household chores (34).

Difference in the uptake of fruits during pregnancy

The results of the current study revealed that those participants who reduced or stopped the use of fruits during pregnancy were likely to have GDM, which is in line with the study conducted in the USA (36). The biological plausibility of this relationship is not fully explained, since the association of less amount of fruit intake during pregnancy with GDM is not well explored in the literature. The study revealed that pre-pregnancy fruit intake was inversely related to GDM, as its fiber contents helped in decreasing GDM (37,22). However, in the current study, the type of fruits and its fiber contents were not explored. Hence, no inference could be made. It is essential to carry out future prospective studies to elucidate and affirm the association of fruit intake with GDM.

Conversely, a study that was carried out in the West China Second Hospital of Sichuan University showed that higher intake of fruits was associated with the risk of GDM, as in this study a daily intake of 500 grams of fruits showed higher risks of GDM in the participants (38). The difference in this pattern and previous mentioned studies could be due to the access, preference, amount, type, and contents of fruit intake.

Varied level of sleep duration

Self-reported sleep duration of ≤ seven hours was associated with the risk of GDM (39). Another study showed that < five hours of sleep duration was related to GDM, whereas in the current study six to seven hours of night time sleep duration was significantly related to GDM (13). This variation in the findings could be because of self-reported sleep duration and different definitions of short sleep duration. The self-reported measurement of sleep duration is practical, but, it does not assess the precise relationship. It may be possible that the self-reported ways of measurement overestimate the sleep duration, as compared to the objective measurement of sleep (40). The definition of short sleep duration was mentioned to be < 7 hours (41).

Future studies are needed to objectively measure the impact of sleep duration and disturbance on GDM. Moreover, according to the researcher's knowledge, there is no recommended guideline related to the sleep duration of GDM patients because of the inconclusive nature of the studies.

Strengths and Limitations of the Study

This is possibly the first case-control study at the secondary hospitals, Karachi, Pakistan to assess the modifiable factors of GDM among pregnant women (30-49 years). This design was preferred, as it assesses the association of multiple exposures with outcomes at one time.

In the case-control study design, the possibility of selection bias and recall bias was overcome by taking all the possible cases and controls during the study duration and by gathering the data related to the current pregnancy lifestyle habits. Moreover, cases were confirmed by their documented value of OGTT, which is a valid test to diagnose GDM. The controls were selected at 32 weeks of gestation in order to reduce in chance of getting the disease in the future.

On the other hand, in a case-control study design, temporality is an inherent bias, which could affect the findings of the study; as in the multivariate model of the current study, some findings were unusual. The tool was newly developed and Cronbach's alpha value was in the less than the acceptable range, and not tested before in Pakistani context. As a result, further studies are needed to be tested in the Pakistani context. In the future a quantitative study is recommended, which needs to add more modifiable factors of GDM. Also, further validation of the current tool is also needed. Furthermore, there is a possibility of over- or under-reporting, as a self-reported questionnaire was used in the study.

Conclusion and Implication for Practice

Unlike the non-modifiable factors of GDM, diet, physical activity, and sleep are the potential modifiable factors of GDM. If future researches elicit the impact of these modifiable factors on GDM, maternity care provider can be trained to screen for the non-modifiable factors by adding a few questions in their routine history taking. Also, there is a need to involve active family members in the antenatal routine visits so that pregnant women can adopt a healthy lifestyle and follow-up visits to maintain a healthy pregnancy.There should be general awareness programs on healthy lifestyle through the media and community based sessions can be arranged by the lady health visitors which can play an important role in its prevention.

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Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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