Original Article

Prevalence and risk factors of gestational diabetes mellitus among pregnant patients visiting National Guard primary health care centers in Saudi Arabia

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ABSTRACT

الهدف: نحن نهدف إلى تقييم مدى انتشار وعوامل الخطر لمرض سكري الحمل في المملكة العربية السعودية، ومقارنة ذلك بالدول المتقدمة والنامية في جميع أنحاء العالم.

الطريقة: لقد أدرجنا الحوامل اللاتي تتراوح أعمارهن ما بين 15 و45 عامًا واللاتي زرن ثلاثة مراكز للرعاية الصحية الأولية للحرس الوطني في جدة من 1 يناير 2017 إلى 31 ديسمبر 2017. قمنا بجمع البيانات باستخدام عينات طبقية وأرقام عشوائية منتجة بالكمبيوتر. هذه البيانات تشمل التركيبة السكانية، تاريخ التوليد، ضغط الدم، اختبار تحدي الجلوكوز لمدة ساعة واحدة، اختبار تحمل الجلوكوز عن طريق الفم لمدة 3 ساعات، مستوى الهيموغلوبين، حالة التحصين ضد الحصبة الألمانية، حالة مستضد التهاب الكبد ب السطحي، نتائج تحليل البول، وملاحظات الولادة. تم تصنيف المرضى إلى مجموعة سكري الحمل ومجموعة بدون سكري الحمل اعتمادا على اختباري تحدي الجلوكوز وتحمل الجلوكوز.

النتائج: في المجموع، تم تسجيل 347 امرأة في الدراسة (متوسط العمر، 28.79 ± 5.99 سنة؛ المدى، 45–18 سنة). في اختبار تحدي الجلوكوز، أظهر 36.6٪ من النساء قيماً مرتفعة و6.9٪ عرضن قيم تشخيصية لسكري الحمل. أشار اختبار تحمل الجلوكوز الى اختلال في تحمل الجلوكوز في 18.7٪ من المرضى وأظهر 15٪ من المرضى قيم تشخيصية للمرض. تميل النساء المصابات بسكري الحمل لأن يكونن أكبر سناً ولديهن قيم أكبر في مؤشر كتلة الجسم.

الخلاصة: إن انتشار سكري الحمل في المملكة العربية السعودية مرتفع مقارنة بالدول الأخرى. كما وجدنا علاقة بين تقدم عمر الأم، القصر وارتفاع مؤشر كتلة الجسم مع انتشار سكري الحمل. وبالتالي فإن الوقاية المبكرة من سكري الحمل ومعالجته أمر ضروري لتقليل المخاطر على كل من الأم والجنين.

Objectives: To measure the prevalence of gestational diabetes mellitus (GDM) and its risk factors in Saudi Arabia, in comparison with developed and developing countries worldwide.

Methods: We enrolled pregnant women aged 15-45 years who visited 3 National Guard-Health Affairs' primary health care centers in Jeddah, Saudi Arabia between January 2017 and December 2017. We used stratified samples and computer-generated random numbers to collect data. This data includes demographics, obstetric history, blood pressure, non-fasting 1-hour glucose challenge test (GCT), 3-hour oral glucose tolerance test (OGTT), hemoglobin level, rubella immunization status, hepatitis B surface antigen status, urinalysis results, and labor, and delivery notes. We categorized the patients into 2 groups, GDM and non-GDM, based on GCT and OGTT.

Results: We enrolled 347 women in the study (mean age, 28.8±6 years; range, 18-45 years). On GCT, 36.6% of women showed abnormal values and 6.9% exhibited diagnostic values. Oral glucose tolerance test indicated impairment in 18.7% of patients and a diagnostic finding in 15% of patients. Women diagnosed with GDM tended to be older and have greater body mass index (BMI) values.

Conclusion: The prevalence of GDM in Saudi Arabia is high compared to other countries. Advanced maternal age and higher BMI values were associated with increased prevalence of GDM. Thus, early prevention and management of GDM is vital to minimize the risks to both the mother and fetus.

Keywords: gestational diabetes mellitus, primary care, BMI, pregnancy, glucose tolerance

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The American Diabetes Association (ADA) defines gestational diabetes mellitus (GDM) as diabetes diagnosed in the second or third trimester of pregnancy that was not clearly overt diabetes prior to gestation.[1] There are many risk factors for GDM including history of unexplained stillbirth, history of delivering a macrosomic fetus (defined as birth weight >90th percentile), obesity, age >25 years, congenital malformations, and a strong family history of type 2 diabetes.[2,3] Ethnicity play a role in the contribution of each risk factor, as they vary in their prevalence among different populations.[4] Gestational diabetes mellitus affects both the mother and the fetus, and thus it is vital to detect such condition promptly. The effects on the mother include mild or severe preeclampsia, eclampsia, higher likelihood of preterm delivery, induction of labor, cesarean section, intrauterine fetal demise, and infant death.[5] Furthermore, up to 50% of patients with GDM are at a risk of developing type 2 diabetes mellitus.[6] The effects of GDM on the child can be classified into: fetal and neonatal defects (including macrosomia, delayed organ maturity, hypocalcemia, and hypoglycemia); and fetal compromise (including intrauterine growth restriction and fetal death).[2] Early identification of GDM and appropriate management are vital to prevent these complications. Patients usually undergo screening for GDM between the 24th to 28th gestational week, unless the patient is at high risk of developing GDM; in those cases, screening is conducted at the first antenatal visit.[7] Early GDM treatment is associated with better pregnancy outcomes and has been found to be cost-effective.[8] Gestational diabetes mellitus screening can be conducted using tests such as the non-fasting 50 g 1-hour glucose challenge test (1-h GCT), 100 g 3-h oral glucose tolerance test (3-h OGTT), and 75 g 2-h oral glucose tolerance test (2-h OGTT). The ADA recommends using either a one-step approach with the 2-h OGTT or a 2-step approach involving screening with the 1-h GCT, tailed by the 3-h OGTT for those testing positive for 1-h GCT.[1,9] The aim of this study is to measure the prevalence of GDM and its risk factors among pregnant patients in Saudi Arabia, in comparison with those in developed and developing countries worldwide

Methods. In this record-based observational analytical retrospective cohort study, we enrolled patients visiting National Guard (NGHA) Primary Health Care Centers in Jeddah, Saudi Arabia, between January 2017 and December 2017. There are 3 primary health care centers with antenatal clinics that continuously follow-up pregnant women in Jeddah, including the Al-Waha specialized polyclinics, King Faisal Residential City Centers (Jeddah Housing), and Bahrah centers.

In 2017, 2040 pregnant females visited the 3 clinics. Using Raosoft® software, with a confidence interval (CI) of 95% and a margin of error of ± 5%, we estimated that the ideal sample size would be 347. We used the stratified random sampling technique with computer-generated random numbers. Patients were stratified by the primary health care centers. Al-Waha specialized polyclinics accounted for 66% of the population, and 66% of the sample was taken from there. The same rule applies to King Faisal Residential City (Jeddah Housing) which accounted for 12% and Bahrah centers for 22%.

We enrolled pregnant women aged 15-45 years who visited the centers during the study period, and excluded those who were already diagnosed with diabetes mellitus type 1 or 2, and patients without complete 1-h GCT data. After obtaining patient medical record numbers (MRN), we used BESTCare software to access patients' electronic files and antenatal follow-up sheets, investigation panel information, and labor and delivery notes. After obtaining approval from the Institutional Review Board, data were collected from the patients' electronic files. The data included demographics, obstetric history, systolic and diastolic blood pressure, 1-h GCT, 3-h OGTT, hemoglobin level, rubella immunization status, hepatitis B surface antigen status, urinalysis results, and labor and delivery notes. The demographic data included age, height, and weight. Obstetric history included gravidity, parity, occurrence of previous abortions, or prior macrosomic fetus delivery. The gestational age at delivery, mode of delivery, gender of the baby, and birth weight were obtained from the labor and delivery notes.

According to the ADA, the 2-step method of GDM diagnosis requires screening at 24-28 weeks of gestation. The first step involves the 1-h GCT, which can indicate diagnostic or positive findings, and is tailed by a confirmation test with the 3-h OGTT, which can indicate either impaired glucose tolerance or the presence of GDM. If the pregnant woman exhibits risk factors for GDM, screening is usually performed during the first antenatal visit.

Statistical analysis. The statistical analysis was performed by the Statistical Package for Social Sciences

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for Windows, version 24.0 (IBM Corp, Armonk, NY, USA). For descriptive statistics, we used percentage and frequency for qualitative variables. For quantitative variables, firstly, we determined the distribution through visual review of histograms, normal Q-Q plots, and box plots, in addition to Shapiro-Wilk test. Secondly, we used mean and standard deviation for normally distributed quantitative variables, and median and interquartile range for skewed quantitative variables. For inferential statistics, Pearson's Chi-squared method was used to test the relationship between GDM and the qualitative independent variables. Fisher-exact test was used to test the relationship between GDM and qualitative independent variables with small expected numbers. Depending on the distribution, either t-tests or Man-Whitney tests were used to test the relationship between GDM and the quantitative independent variables. A $p<0.05$ is considered statistically significant.

Results. A total of 347 women were included in this study, and their baseline characteristics are shown in **Table 1**. The prevalence of GDM was 19.6% (68/347) in the population. Regarding 1-h GCT findings, 36.6% (127/347) of the enrolled women showed abnormal values and 6.9% (24/347) exhibited values diagnostic of GDM. Three-hour OGTT indicated glucose impairment in 12.5% (13/104) of the patients, and a diagnostic finding in 50% (52/104) of patients.

Included patients had a mean age of 28.8±6 years (range, 18-45 years). Gestational diabetes mellitus group patients were significantly older, relative to the non-GDM group (mean age, 28.1±5.6 versus [vs.] 31.7±6.6 years; t(345): −4.6, $p<0.001$). Furthermore, 29.45% (38/129) of women aged >30 years were diagnosed with GDM, which accounted for 55.9% of the entire GDM group. In comparison, only 11.1% (2/18) of women aged 18 to 20 years were diagnosed with GDM; these values were significantly different ($\chi^2(3)$: 14.1, $p=0.003$) (**Table 2**).

Gestational diabetes mellitus group patients had a mean BMI of 29.3 ± 6.2 kg/m^2 (range, 12.6-47.8 kg/m^2), Which is significantly higher compared to the non-GDM group (mean BMI, 30.6±6.1 kg/m^2 vs. 28.9±6.2 kg/m^2; t(340): −2.0; $p=0.045$). In addition, 27.1% (38/140) of obese women were diagnosed with GDM, which accounted for 55.9% of the entire GDM group. In comparison, 15.6% (14/90) of women with normal BMI were diagnosed with GDM; these values were found to be significantly different ($p=0.028$) (**Table 2**).

Even though 58.8% (40/68) of women diagnosed with GDM had blood group O, blood groups were not significantly associated with GDM ($\chi^2(3)$: 1.35,

Table 1 - Baseline characteristics of patients (N=347).

Characteristics	n (%)
Age (mean±SD)	28.8±6.0
Body mass index (kg/m^2)	29.3±6.2
Blood group	
O	211 (60.8)
A	88 (25.4)
B	42 (12.1)
AB	6 (1.7)
Hemoglobin (g/dL) (mean±SD)	11.3±1.1
Gravidity†	3 (4.0)
Parity†	1 (2.0)
Smoking	8 (2.3)
Gestational age	
Preterm (<37 weeks)	19 (5.5)
Term	309 (89.0)
Post-term (>42 weeks)	2 (0.6)
Birth weight (kg) (mean±SD)	3.0±0.5
Type of delivery	
Vaginal delivery	231 (66.6)
Cesarian section	95 (27.4)
Glucose challenge test	
Normal	220 (63.4)
Elevated	103 (29.7)
Diagnostic	24 (6.9)
Glucose tolerance test	
Negative	39 (11.2)
Impaired	13 (3.7)
Diagnostic	52 (15.0)
Not performed	243 (70.0)
Gestational diabetes mellitus	
Yes	68 (19.6) (16.2-23.9) ‡
No	279 (80.4)

Values are presented as numbers and percentages (%). ‡95% CI

Table 2 - Association between demographic variables and gestational diabetes mellitus (N=347).

Demographic data	Non-GDM (n=279)	GDM (n=68)	*P* -value*
Age (mean±SD)	28.1 (5.6)	31.7 (6.6)	<0.0001
Age categories†			
18-20	16 (5.7)	2 (2.9)	0.03
21-25	91 (32.6)	11 (16.2)	
26-30	81 (29.0)	17 (25.0)	
>30	91 (32.6)	38 (55.9)	
Body mass index‡ (mean±SD)	28.9 (6.1)	30.6 (6.2)	0.045
Body mass index categories			
Underweight, <18.5	5 (1.8)	1 (1.5)	0.028
Normal, 18.5-24.9	76 (27.2)	14 (20.6)	
Overweight, 25-29.9	93 (33.3)	14 (20.6)	
Obese, ≥30	102 (36.55)	38 (55.9)	

*T-test was used for age and body mass index. †Pearson's Chi-squared test was used. ‡Fisher Exact test was use. Values are presented as numbers and percentages (%). GDM: gestational diabetes mellitus

p=0.715). Furthermore, parity, gravidity, history of smoking, previous macrosomic fetus delivery, and previous cesarian section were not associated with GDM in the present study. The gestational age of the born child, mode of delivery, and gender were also not associated with GDM (Tables 3 & 4).

Discussion. In 1828, the first description of GDM was made when a lady was diagnosed with diabetes during pregnancy, which resolved after delivery.[10] The patient had signs and symptoms of severe hyperglycemia, and the delivered child was macrosomic and stillborn. Later in 1957, such cases were labeled as gestational diabetes.[11]

The International Diabetes Federation (IDF)

Table 3 - Association between obstetric and delivery variables and gestational diabetes mellitus (N=347).

Variables	Frequency		*P*-value*
	Non-GDM (n=279)	GDM (n=68)	
Obstetric history			
Gravidity†	3 (3)	3 (5)	0.189
Parity†	1 (2)	2 (4)	0.231
Miscarriages			
Yes	85 (30.5)	23 (33.8)	0.592
No	194 (69.5)	45 (66.2)	
Multiple gestations			
Yes	5 (1.8)	2 (2.9)	0.447
No	273 (97.8)	66 (97.1)	
Previous macrosomia			
Yes	1 (0.4)	1 (1.5)	0.975
No	278 (99.6)	67 (98.5)	
Previous caesarean section			
Yes	61 (21.9)	14 (20.6)	0.819
No	218 (78.1)	54 (79.4)	
Blood pressure at initial visit			
Elevated	59 (21.1)	21 (30.9)	0.087
Normal	220 (78.9)	47 (69.1)	
Delivery history			
Gestational age			
Preterm	13 (4.65)	6 (8.8)	0.180
Term	252 (90.3)	59 (86.8)	
Type of delivery			
Vaginal	188 (67.4)	43 (63.2)	0.471
Cesarian	74 (26.5)	21 (30.9)	
Gender of the baby			
Male	145 (52.0)	38 (55.9)	0.792
Female	119 (42.7)	29 (42.6)	
Birth weight (mean±SD)	2.9±0.5	3.0±0.3	0.981

*T-test was used. Mann-Whitney test was used for gravidity and parity. †Median and interquartile range are presented instead of frequency and percentage, respectively. Values are presented as numbers and percentages (%). GDM: gestational diabetes mellitus

Table 4 - Association between medical and laboratory variables and gestational diabetes mellitus (N=347).

Variables	Frequency		*P*-value*
	Non-GDM (n=279)	GDM (n=68)	
Medical history			
Hypertension			
Yes	1 (0.35)	0 (0)	0.843
No	277 (99.3)	68 (100.0)	
Thyroid diseases			
Yes	21 (7.5)	7 (10.3)	0.452
No	258 (92.5)	61 (89.7)	
Cardiac diseases			
Yes	0 (0)	1 (1.45)	0.390
No	277 (99.3)	67 (98.5)	
Neurological diseases			
Yes	1 (0.35)	1 (1.5)	0.289
No	278 (99.6)	67 (98.5)	
Renal diseases			
Yes	2 (0.7)	1 (1.5)	0.404
No	275 (98.6)	67 (98.5)	
Blood transfusion			
Yes	15 (5.4)	6 (8.8)	0.292
No	262 (93.9)	62 (91.2)	
Allergy			
Yes	10 (3.6)	3 (4.4)	0.756
No	267 (95.7)	65 (95.6)	
Infection			
Yes	3 (1.1)	0 (0)	0.603
No	276 (98.9)	67 (98.5)	
Smoking			
Yes	6 (2.15)	2 (2.9)	0.401
No	268 (96.1)	65 (95.6)	
Consanguinity			
Yes	70 (25.1)	24 (35.3)	0.080
No	203 (72.8)	42 (61.8)	
Laboratory tests			
Hemoglobin (g/dL) (mean±SD)			
Non-GDM	11.3±1.1		0.840
GDM	11.3±1.3		
Antibodies			
Positive	4 (1.4)	1 (1.5)	0.995
Negative	266 (95.3)	66 (97.05)	
Hepatitis B surface antigen (HbsAg)			
Positive	0 (0)	1 (1.5)	0.151
Negative	274 (98.2)	65 (95.6)	
Proteinuria			
Positive	27 (9.7)	7 (10.3)	0.855
Negative	247 (88.5)	59 (86.8)	
Ketonuria			
Positive	15 (5.4)	6 (8.8)	0.284
Negative	260 (93.2)	61 (89.7)	
Glycosuria			
Positive	2 (0.7)	2 (2.9)	0.123
Negative	273 (97.8)	65 (95.6)	
Blood groups			
O	171 (61.3)	40 (58.8)	0.715
A	72 (25.8)	16 (23.5)	
B	31 (11.1)	11 (16.2)	
AB	5 (1.8)	1 (1.5)	
Rhesus factor (Rh)			
Positive	259 (92.8)	61 (89.7)	0.388
Negative	20 (7.2)	7 (10.3)	

* t-test was used for hemoglobin, Pearson's Chi-squared test was used for thyroid diseases, blood transfusion, allergy, consanguinity, rhesus factor, proteinuria, ketonuria, glycosuria, blood groups. Fisher Exact test was used for hypertension, cardiac diseases, neurological diseases, renal diseases, infection, smoking, antibodies and hepatitis B surface antigen. GDM: gestational diabetes mellitus

estimates that 17.8 million live births to women in 2015 involved gestational diabetes, that 85.1% of all hyperglycemia cases occur during pregnancy, and that one in 7 births is affected by GDM. The IDF also indicated that one in 25 pregnancies worldwide involves GDM, including 4 million women annually presenting with GDM in India alone.[7] There are published papers on the prevalence of GDM in various countries, although these studies differ in their method of screening and diagnosing GDM. The most commonly used criteria include those suggested by the World Health Organization (WHO), International Association of the Diabetes and Pregnancy Study Groups (IADPSG), and ADA, which were also used in the present study.[8,12] The main differences between these criteria include the cut-off values for positive results and in the tests they use. The tests include the 1-h GCT, 2-h OGTT, 3-h OGTT, fasting blood glucose, and random blood glucose tests.[1] In our research, we want to compare the prevalence of GDM in developed, developing, and some Gulf countries, while focusing on the criteria used in the studies. In addition, we want to compare the risk factors recognized in our paper with those in other studies.

The prevalence in developed countries was 5.7% in Australia, 10-11% in Finland, 3.7% in Germany, 4.3% Greenland, and 12.4% in Ireland using the IADPSG criteria. The prevalence in Scotland was 1.9%, Sweden was 2.2%, and USA was found to be <1.5% or up to 8.0%.[13-20] In Hungary, the prevalence was measured using WHO criteria was 8.7% and the IADPSG criteria was 16.6%.[21]

In contrast, the prevalence of GDM in developing countries such Bangladesh were 9.7% (WHO criteria) and 12.9% (ADA criteria); China were 8.1% (WHO criteria) and 9.3% (IADPSG criteria); India were 10.5% (WHO criteria) and 15.7% (IADPSG criteria); Iran was 41.9% (IADPSG criteria); lastly, Rafsanjan (a city in Iran) were 9.3% (WHO criteria), 15.2% (ADA criteria), and 31% (IADPSG criteria). It appears that the use of the IADPSG criteria leads to a higher prevalence of GDM, and the study conducted in Rafsanjan is a pertinent example.[22-26]

Finally, among Gulf countries, a population-based study covering the period from January 2001 to December 2002 was conducted in Bahrain using a 2-step protocol (50 g GCT and 75 g OGTT), and reported the prevalence of GDM as 13.5% (n=10495); thus, that study considered people from Bahrain as a high-risk ethnic group for GDM. Another retrospective study was conducted in Oman using a 2-step protocol and covered the period from January 2009 and December 2010, and reported that 10% of 5811 screened women had GDM.[27,28]

The prevalence of 19.6% based on the ADA criteria in the present study may be considered high, and can be explained by dietary habits, and by the reasoning that the metabolism is in overdrive during pregnancy, which can exacerbate glucose intolerance and lead to GDM.[1] Developed countries have a lower prevalence of GDM compared with developing countries, even judged using IADPSG criteria, which have been found to inflate the prevalence. This may be attributed to the higher level of education, better healthcare systems, and available access to health care facilities in developed countries.

Regarding the risk factors, we found that advanced maternal age and higher BMI are significantly associated with GDM. A study conducted among Asian subgroups (Indian, Chinese, Filipino, Japanese, Korean, and Vietnamese), Hispanics and Africans in 2015 showed a strong relationship between overweight/obesity, advanced maternal age, family history of type 2 diabetes, foreign-born status and an increased risk of GDM. Ethnicity play a role in the contribution of each risk factor, as they vary in their prevalence among different populations.[4] Moreover, early pregnancy vitamin D status, particularly the concentration of 25[OH]D3, is inversely associated with GDM risk, and women with blood groups other than AB were reportedly more likely to develop GDM compared with those with blood group AB in Tianjin, China.[29-31] Furthermore, maternal age and BMI exhibited interactions with race in terms of their relationship with GDM prevalence. Both factors are important in the development of GDM, particularly among African and South Asian women.[31]

Gestational diabetes mellitus mothers are at high risk of pregnancy complications. Studies have found that GDM increases the risk of developing diabetes to more than 7 times, and that approximately 50% of GDM pregnant women will develop diabetes.[6] Another study conducted in the United States found that adolescent pregnancies with GDM had a higher degree of preterm delivery, mild preeclampsia, severe preeclampsia, eclampsia, induction of labor, intrauterine fetal demise, and infant death, compared with adult pregnancies with GDM. In contrast, the rates of cesarean section were higher among the adult pregnancies with GDM.[5]

Study limitations. We recommend routine screening for GDM and awareness leaflets and campaigns regarding the importance of adherence to antenatal follow-up appointments. However, the present study had some limitations. One of them is the availability of multiple diagnostic criteria for GDM. Another limitation we had is that we did not include patients

who are older than 45 years due to lower numbers of pregnancy in this age group. Moreover, our study was conducted in three NGHA health care primary centers in Jeddah and included only NGHA eligible patients (National Guard soldiers, employees and their dependents) while outside patients were not involved. Additionally, some patients started their antenatal visits in NGHA clinics but continued somewhere else, which led to incomplete antenatal sheet in their electronic files. All in all, our results seem to agree with the global trend of the increasing prevalence of GDM.

In conclusion, the prevalence of GDM in Saudi Arabia is high compared to other countries. Advanced maternal age and higher BMI were associated with increased prevalence of GDM. Early prevention and management of GDM are vital to minimize the risks to both the mother and fetus.

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Case Reports

Case reports will only be considered for unusual topics that add something new to the literature. All Case Reports should include at least one figure. Written informed consent for publication must accompany any photograph in which the subject can be identified. Figures should be submitted with a 300 dpi resolution when submitting electronically. The abstract should be unstructured, and the introductory section should always include the objective and reason why the author is presenting this particular case. References should be up to date, preferably not exceeding 15.