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Original Article

Postpartum glucose testing, related factors and progression to abnormal glucose tolerance in a rural population with a known history of gestational diabetes

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ABSTRACT

Aims: Gestational diabetes is a strong risk factor for postpartum progression to glucose intolerance. The aims of the study were to determine rate of postpartum glucose testing , its related factors and rate of progression to glucose intolerance in women who underwent postpartum glucose testing after pregnancy that complicated by gestational diabetes.

Materials: this is a retrospective study and women with gestational diabetes who received prenatal care during 2005-2015 in 3 rural health centers of Khuramshahr (southwestern of Iran) were enrolled. Gestational diabetes mellitus diagnosed by FPG test only, 75g OGTT or GCT. The American Diabetes Association(ADA) criteria applied for definition of postpartum glucose intolerance (pre-diabetes or diabetes) .

Results: Mean duration of follow-up was 29.7 months. BMI≥ 25 was detected in 73.3% and 78.7% of women during pre-pregnancy and postpartum respectively. Overall 45.8% (60/131) of women received postpartum glucose testing. Rate of progression to abnormal glucose tolerance was 23.3% (8.5% pre-diabetes and 15.2% diabetes). Advanced maternal age was associated with postpartum glucose testing (OR 1.066, CI 1.008-1.128, p=0.02).

Discussion: high rate of overweight and obesity, sub optimal rate of postpartum glucose testing and high prevalence of glucose intolerance, highlights the importance of postpartum screening with a more sensitive test and implementation of an intervention program to prevent type 2 diabetes in rural population particularly older women with prior gestational diabetes.

Diabetes Mellitus (DM) as a leading cause of mortality and disability imposes a large economic burden on global health care system [1,2]. In women, incidence of DM has been reported up to 12 million in 2010 and more undiagnosed cases were reported in this population versus men [3]. About one third of women with type 2 diabetes had history of gestational diabetes mellitus [4].

Gestational diabetes mellitus (GDM) includes any degree of glucose intolerance that begins or is first recognized during pregnancy [5]. Diabetes epidemic, high rate of obesity, as well as advanced maternal age at pregnancy, and use of new diagnostic criteria may be causes of rising trend of GDM prevalence [6–8], 1–28% [9] even more [10], in recent decades.

Hyperglycemia disappears immediately after termination of pregnancy in 90–95% of women with GDM [11,12] but this population is at increased risk for future progression to type 2 diabetes or pre-diabetes. The risk of developing type 2 diabetes can remain for more than 25 years in former gestational diabetes patients [13]. A study suggested that this risk varied from 2 to 70%, 6–8 weeks to 28 years after GDM pregnancy [14].

Early postpartum screening at 6 weeks postpartum by the 75 g, 2 h oral glucose tolerance test (OGTT), and repeat the test at one-year postpartum and then every 3 years for women after GDM

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pregnancy is suggested by the International Workshop Conference of GDM, American college of Obstetricians and Gynecologists (ACOG) and the American Diabetes Association (ADA) [15–17]. Well-documented increased risk of diabetes after GDM pregnancy and clear recommendation of international associations for postpartum screening cannot overcome on barrier of return and adherence of a postpartum glucose screening in this high-risk population. In most population, rates of women who screened are low [18].

Few studies focused on postpartum screening in rural area. For this reasons, we sought to determined rate of postpartum glucose testing and to identify related factors and rate of progression to glucose intolerance in women who underwent postpartum glucose testing.

1. METHODS

In a retrospective study women with gestational diabetes who received prenatal care during 2005–2015 in three rural health centers of Khuramshahr were recruited in 2016. Khuramshahr is located in Khuzestan province (southwestern of Iran) with high fertility rate [19].

High rate of gestational diabetes and low rate postpartum after GDM pregnancy were reported in Ahvaz city, neighbor city with many similar characteristics [10,20].

A list of women with gestational hyperglycemia and details of glucose screening during pregnancy and contact information were extracted from health records. Known cases of diabetes type 1 or type 2 excluded. In addition women who were unavailable due to move out of Khuramshahr or changed their address or phone number excluded. Of 303 women identified with GDM in this period, 131 women accepted to attend to rural center and participated in the study. Using direct contact by phone we invited the women for participation in the study.

Questionnaires related to socio-demographic characteristic, obstetrics and medical history, family history of diabetes mellitus, previous GDM, details of gestational diabetes screening in pregnancy, numbers and date of screening for postpartum glucose intolerance and infant nutrition after delivery up to 2 years postpartum (breast feeding, formula or combined) were completed by trained questionnaires.

Postpartum blood pressure, weight, height and waist and hip circumferences were measured and recorded. Pregnancy blood pressure, weight in first and last months of pregnancy extracted from health records.

GDM were diagnosed using three methods inclusive of fasting plasma glucose (FPG), glucose challenge test (GCT) or 75 g oral glucose tolerance test (OGTT). Postpartum pre-diabetes and diabetes defined in accordance with ADA criteria (fasting plasma glucose between 100 and125 mg/dl, and, fasting plasma glucose $\geq$126 mg/dl, respectively) [21].

BMI calculated and body mass index (BMI) $\geq$25 kg/m^2 and BMI$\geq$30 kg/m^2 considered as overweight and obesity, respectively.

Data were expressed as frequency and percentages for categorical variables. Categorical variables were compared using the chi-square test and *t*-test. A model of multivariate logistic regression was used to evaluate the factors related to postpartum glucose testing. Data were analyzed using SPSS software version 22 at a significance level of $p < 0.05$.

2. RESULTS

One hundred and thirty-one women with history of GDM were studied mean age was 32.64 ($\pm$6.42, SD) years and almost all of them were of Arab ethnicity (94.7%) and housewife (98.5%). Distribution of demographic, obstetrics and clinical characteristics in women with gestational diabetes mellitus is presented in Table 1.

Table 1
Distribution of demographic, obstetrics and clinical characteristics in women with gestational diabetes mellitus.

Gravidity	
1	18 (13.7)
2	36 (27.5)
3	30 (22.9)
4	23 (17.6)
5–6	24 (18.3)
History of IUFD	8 (6.1)
History of abortion	44 (33.6)
Family history diabetes mellitus	54 (41.2)
Number of pregnancy with GDM	
1	107 (81.7)
2	24 (18.3)
Hypertension	10 (7.6)
Prepregnancy BMI*	
Normal	35 (26.7)
Overweight	46 (35.1)
Obesity	50 (38.2)
Postpartum BMI	
Normal	28 (21.4)
Overweight	50 (38.2)
Obesity	53 (40.5)
Waist circumference $\geq$88	53 (40.5)
Waist/hip ratio $\geq$0.85	51 (41.8)
Results of postpartum test**	
Normal	46 (76.7)
Prediabetes	5 (8.3)
diabetes	9 (15)
Child nutrition	
Breast feeding	81 (65.3)
Formula	8 (6.5)
Combined	35*** (28.2)

IUFD: intra uterine fetal death; GDM: gestational diabetes mellitus; BMI: body mass index.
* BMI < 25, BMI 25–29.9, BMI $\geq$30 defined as normal, overweight and obesity, respectively.
** In 60 women who tested postpartum.
*** 7 missing cases.

Gestational diabetes mellitus diagnosed by FPG test (9.9%), 75 g OGTT (47.3%) or GCT (42.7%) (Chart 1). Excess BMI ($\geq$25 kg/m^2) was detected in 73.3% of women before pregnancy and 78.7% postpartum and 40.3% had central obesity. Mean duration of follow-up was 29.7 months.

Overall 45.8% (60/131) received postpartum glucose testing. Of women who underwent postpartum glucose testing, one half of women were screened at 6–12 weeks postpartum (Chart 2). Mean age of mother who received postpartum glucose testing was higher than who not compliance for postpartum screening (OR 1.066, CI: 1.008–1.128, $p = 0.02$).

Rate of progression to abnormal glucose tolerance was 23.3% (8.5% prediabetes and 15.2% diabetes. All of postpartum screening performed by only FPG test. Mean $\pm$ SD of clinical and biochemical characteristic of women based on receiving at least one postpartum glucose test are presented in Table 2.

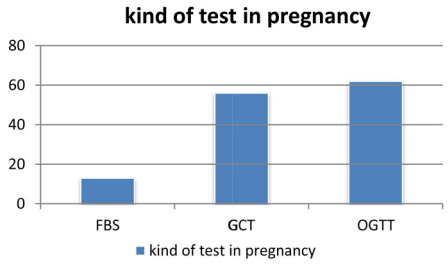

Chart 1. Distribution of screening methods for diagnosed of gestational diabetes mellitus in pregnancy.

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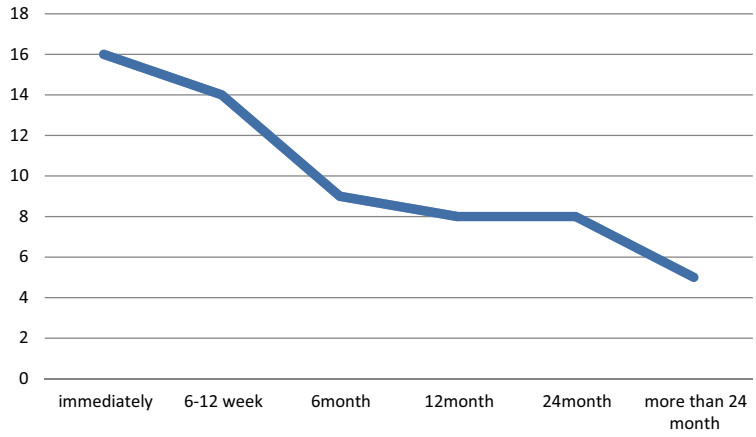

Chart 2. Postpartum test timing in women with prior gestational diabetes.

Table 2
Mean ± SD of clinical and biochemical characteristic of women based on receiving at least one postpartum glucose test.

Variable	Total ($N = 131$)	Tested ($N = 60$)	Non-tested($N = 71$)	p value*
Mother age	32.64 (6.42)	34.01 (5.97)	31.47 (6.60)	0.02
Weight first months pregnancy (kg)	70.23 (13.3)	70.45 (11.93)	70.05 (14.49)	0.86
Weight last month pregnancy (kg)	78.35 (12.32)	78.25 (11.44)	78.44 (13.11)	0.92
Height (cm)	157.16 (6.19)	157.88 (6.72)	156.56 (5.68)	0.22
BMI prepregnancy (kg/m$^{2)}$	28.38 (4.97)	28.18 (4.06)	28.54 (5.65)	0.68
BMI postpartum (kg/m$^{2)}$	28.92 (4.77)	28.85 (4.45)	28.98 (5.06)	0.87
Duration follow-up (months) now (months)	29.74 (24.22)	30.18 (23.56)	29.40 (24.93)	0.85
FPG first visit pregnancy (mg/dl)	105.01 (25.4)	108.55 (26.64)	102.02 (24.24)	0.14
FPG postpartum*** (mg/dl)	96.36 (34.94)	96.36 (34.94)	–	–
Systolic BP	109.84 (11.96)	110.66 (12.19)	109.15 (11.80)	0.47
Diastolic BP	68.44 (9.15)	67.50 (9.13)	69.23 (9.16)	0.28
Waist circumference	84.96 (12.32)	86.99 (11.76)	83.26 (12.60)	0.08
Hip circumference	102.56 (17.82)	105.00 (17.74)	100.50 (17.75)	0.15
Waist/hip ratio	0.83 (0.08)	0.83 (0.09	0.83 (0.08)	0.94
Mean duration of breastfeeding (months)	15.43 (9.20)	16.28 (8.48)	14.52 (9.92)	0.35

*** Calculated only in women who underwent postpartum glucose testing.

3. DISCUSSION

3.1. Rate of Postpartum Glucose Screening

Rate of postpartum glucose screening in this study was 45.8% (60/131). Several studies reported prevalence of postpartum screening rate in women with history of GDM, but few studies focused on rural population. Consistent with our results, suboptimal attendance rate for postpartum glucose test (less than 50%) indicated in many previous reports [18,22,23]. This rate varies from 14 to 60% (in usual care versus randomized control trials) [24]. This range has been from 19 to 73% based. A review of postpartum diabetes screening in women with gestational diabetes, conducted by Tovar et al., showed 34 to 73% of women screened with variations by race [23]. Recalled with different kind of reminders has been associated with increased rate from 33 to 60% [25].

Kaufmann et al. [26] studied postpartum follow-up testing in a rural population. Of women with prior GDM, 30.3% reported having received a yearly 2 h OGTT and 59% (39/66) had been tested at least once during 5 year period. Also Swan et al. [27] evaluated readiness to engage diabetes risk reduction behaviors among rural women with GDM during their last pregnancy. Of them 61% had a postpartum screening test.

3.2. Postpartum Glucose Intolerance

In this study 23.3% of women that received at least one postpartum screening test progressed to glucose intolerance (8.5% pre-diabetes and 15.2% diabetes).

Hyperglycemia disappears immediately after termination of pregnancy in 90–95% of women with GDM [11,12] but this population is at increased risk for future progression to type 2 diabetes or pre-diabetes. The risk of developing type 2 diabetes can remain for more than 25 years in former gestational diabetes patients [13]. A study suggested that this risk varied from 2 to 70%, 6–8 weeks to 28 years after GDM pregnancy [14].

3.3. Determinant of Postpartum Testing

We expected women who received postpartum glucose screening be different in demographic characteristics and other potential diabetes risk factors, but only advanced age was associated with higher tend to return for postpartum glucose testing. Consistent with our results Morrison et al. [28] reported Australian older women, compared with younger ones, more attended in prevention studies. In another report, Infanti et al. identified women older than 34 years at delivery being more likely

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to participate in a diabetes prevention trial among Irish women with gestational diabetes [29].

3.4. Kind of Postpartum Test

In this study all of women who had at least one postpartum glucose screening test, were checked by fasting plasma glucose test (FPG) without completion of the 75 g OGTT. Lack of sensitivity of this test compared with OGTT is reported in previous studies [30,18]. Improved diagnostic sensitivity of FBS suggested by cutoff lower than 5.6 mmol/l [31], but even with applied of this cutoff, 56% of cases of hyperglycemia would be missed [32].

3.5. Limitations

This study has two main limitations. Diagnosis of GDM defined by three criteria and all of postpartum screening were done by only FPG test.

4. CONCLUSION

Rate of postpartum glucose testing was less than 50%. Excess BMI was detected in 78.7% of women. Rate of persistent glucose intolerance estimated high using FPG test. These findings highlight the importance of early screening by valid tests and timely implementation of intervention program to prevent type 2 diabetes in rural population. This report is a part of PhD thesis written by Nouhjah which approved by Ahvaz Jundishapur University of Medical Sciences (Registration number:D-9405).

References

[1] Wild S, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes: estimates for the year 2000 and projections for 2030. Diabetes Care 2004;27(5):1047–53.
[2] Kakkar R. Rising burden of diabetes-public health challenges and way out. Nepal J Epidemiol 2016;6(2):557–9.
[3] Centers for Disease Control and Prevention. National diabetes fact sheet: national estimates and general information on diabetes and prediabetes in the United States, 2011. Atlanta, GA: US Department of Health and Human Services, Centers for Disease Control and Prevention. 2011; 2011.
[4] Cheung NW, Byth K. Population health significance of gestational diabetes. Diabetes Care 2003;26(7):2005–9.
[5] O'Sullivan JB. Diabetes mellitus after GDM. Diabetes 1991;40(Supplement 2):131–5.
[6] Ferrara A. Increasing prevalence of gestational diabetes mellitus a public health perspective. Diabetes Care 2007;30(Supplement 2):S141–6.
[7] Noctor E, Dunne FP. Type 2 diabetes after gestational diabetes: the influence of changing diagnostic criteria. World J Diabetes 2015;6(2):234.
[8] Xu Y, Shen S, Sun L, Yang H, Jin B, Cao X. Metabolic syndrome risk after gestational diabetes: a systematic review and meta-analysis. PLoS One. 2014;9(1):e87863.
[9] Jiwani A, Marseille E, Lohse N, Damm P, Hod M, Kahn JG. Gestational diabetes mellitus: results from a survey of country prevalence and practices. J Matern Fetal Neonatal Med 2012;25(6):600–10.
[10] Shahbazian H, Nouhjah S, Shahbazian N, Jahanfar S, Latifi SM, Aleali A, et al. Gestational diabetes mellitus in an Iranian pregnant population using IADPSG criteria: incidence, contributing factors and outcomes. Diabetes Metab Syndr 2016;10(4):242–6.
[11] Ural SH, Repke JT. Gestational diabetes mellitus. Rev Obstet Gynecol 2008;1(3):129.
[12] Inturrisi M, Lintner NC, Sorem KA. Diagnosis and treatment of hyperglycemia in pregnancy. Endocrinol Metab Clin North Am 2011;40(4):703–26.
[13] Wasalathanthri S. Attenuating type 2 diabetes with postpartum interventions following gestational diabetes mellitus. World J Diabetes 2015;6(4):648.
[14] Kim C, Newton KM, Knopp RH. Gestational diabetes and the incidence of type 2 diabetes: a systematic review. Diabetes Care 2002;25(10):1862–8.
[15] American Diabetes Association. Standards of medical care in diabetes–2013. Diabetes Care 2013;36(Supplement 1):S11–66.
[16] Metzger BE, Buchanan TA, Coustan DR, de Leiva A, Dunger DB, Hadden DR, et al. Summary and recommendations of the Fifth International Workshop-Conference on gestational diabetes mellitus. Diabetes Care 2007;30(Supplement 2):S251–60.
[17] American Diabetes Association. Gestational diabetes mellitus. Diabetes Care 2004;27(Supplement 1):S88–90.
[18] Ferrara A, Peng T, Kim C. Trends in postpartum diabetes screening and subsequent diabetes and impaired fasting glucose among women with histories of gestational diabetes mellitus: a report from the translating research into action for diabetes (TRIAD) study. Diabetes Care 2009;32(2):269–74.
[19] Nouhjah S, Amiri E, Khodai A, Yazdanpanah A, Nadi Baghu M. Popular contraceptive methods in women aged 35 years and older attending health centers of 4 cities in Khuzestan Province, Iran. Iran Red Crescent Med J 2013;15(10):e4414.
[20] Shahbazian H, Nouhjah S, Jahanfar S, Nasiri M. Recall for postpartum follow-up of women with gestational diabetes mellitus: climbing a mountain. J Diabetes Metab Disord 2016;15(1):20.
[21] Report of the expert committee on the diagnosis and classification of diabetes mellitus. Diabetes Care 1997;20(7):1183–97.
[22] Kim C, Tabaei BP, Burke R, McEwen LN, Lash RW, Johnson SL, et al. Missed opportunities for type 2 diabetes mellitus screening among women with a history of gestational diabetes mellitus. Am J Public Health 2006;96(9):1643–8.
[23] Tovar A, Chasan-Taber L, Eggleston E, Oken E. Postpartum screening for diabetes among women with a history of gestational diabetes mellitus. Prev Chronic Dis 2011;8(6):A124.
[24] Shea AK, Shah BR, Clark HD, Malcolm J, Walker M, Karovitch A, et al. The effectiveness of implementing a reminder system into routine clinical practice: does it increase postpartum screening in women with gestational diabetes? Chronic Dis Can. 2011;31(2):58–64.
[25] Carson MP, Frank MI, Keely E. Original research: postpartum testing rates among women with a history of gestational diabetes–systematic review. Prim Care Diabetes 2013;7(3):177–86.
[26] Kaufmann RC, Smith T, Bochantin T, Khardori R, Evans MS, Steahly L. Failure to obtain follow-up testing for gestational diabetic patients in a rural population. Obstet Gynecol 1999;93(5 Pt 1):734–7.
[27] Swan WE, Liaw ST, Dunning T, Pallant JF, Kilmartin G. Diabetes risk reduction behaviours of rural postpartum women with a recent history of gestational diabetes. Rural Remote Health 2010;10(4):1461.
[28] Morrison MK, Lowe JM, Collins CE. Perceived risk of Type 2 diabetes in Australian women with a recent history of gestational diabetes mellitus. Diabet Med 2010;27(8):882–6.
[29] Infanti JJ, O'Dea A, Gibson I, McGuire BE, Newell J, Glynn LG, et al. Reasons for participation and non-participation in a diabetes prevention trial among women with prior gestational diabetes mellitus (GDM). BMC Med Res Methodol 2014;14:13.
[30] Kitzmiller JL, Dang-Kilduff L, Taslimi MM. Gestational diabetes after delivery. Short-term management and long-term risks. Diabetes Care 2007;30(Suppl 2):S225–35.
[31] American Diabetes Association. Diagnosis and classification of diabetes mellitus. Diabetes Care 2004;27(Supplement 1):S5–S10.
[32] Kwong S, Mitchell RS, Senior PA, Chik CL. Postpartum diabetes screening: adherence rate and the performance of fasting plasma glucose versus oral glucose tolerance test. Diabetes Care 2009;32(12):2242–4.

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