DIABETES RESEARCH AND CLINICAL PRACTICE 141 (2018) 200–208

Contents available at ScienceDirect

Diabetes Research and Clinical Practice

journal homepage: www.elsevier.com/locate/diabres

Prevalence of gestational diabetes and subsequent Type 2 diabetes among U.S. women

Sarah Stark Casagrande [a,*], Barbara Linder [b], Catherine C. Cowie [b]

[a] Social & Scientific Systems, Inc., 8757 Georgia Ave., Silver Spring, MD 20910, USA

[b] National Institute of Diabetes and Digestive and Kidney Diseases, 6707 Democracy Blvd, Bethesda, MD 20892, USA

ARTICLE INFO

Article history:
Received 5 December 2017
Received in revised form
13 April 2018
Accepted 8 May 2018

Keywords:
Gestational diabetes
U.S. women
Diabetes
Risk factors

ABSTRACT

Aims: The true prevalence of gestational diabetes (GDM) in the United States is unknown. This study determined the prevalence of GDM and a subsequent diagnosis of diabetes in a nationally representative sample of U.S. women.

Methods: The crude and age-adjusted prevalence of GDM and subsequent diabetes were evaluated by sociodemographic and health-related characteristics among women age ≥20 years in the National Health and Nutrition Examination Surveys, 2007–2014 (N = 8185). Logistic regression analyzed independent factors associated with GDM and subsequent diabetes.

Results: The prevalence of GDM was 7.6%. Women who were Mexican American (vs. non-Hispanic white), had ≥4 live births (vs. 1), had a family history of diabetes, or were obese (vs. normal weight) had a higher age-standardized prevalence of GDM (each $p < 0.04$). Among women with a history of GDM, 19.7% had a subsequent diagnosis of diabetes; subsequent diabetes diagnosis was higher for those with health insurance, more time since GDM diagnosis, greater parity, family history of diabetes, and obesity, and lower for those with higher education and income (all $p \leq 0.005$). By logistic regression, significant factors associated with GDM were age at first birth, parity, family history of diabetes, and obesity; significant factors for subsequent diabetes were older age, greater years since GDM diagnosis, less education, family history of diabetes, and obesity (each $p < 0.01$).

Conclusions: The prevalence of GDM in the U.S. was 7.6%, with 19.7% of these women having a subsequent diabetes diagnosis. Women with a history of GDM, family history of diabetes, and obesity should be carefully monitored for dysglycemia.

1. Introduction

Gestational diabetes (GDM), defined as glucose intolerance first identified during pregnancy, has increased substantially over the past several decades corresponding to the increase in diabetes mellitus in the United States [1–3]. It is estimated that 1–14% of all pregnancies in the United States are diagnosed annually with GDM [4,5]. Estimating the prevalence of GDM is difficult since some women may have undiagnosed diabetes before pregnancy rather than hyperglycemia induced by pregnancy and because of variability in reporting methods. Younger, asymptomatic women without diabetes risk factors may not be screened for diabetes; thus, it may be first diagnosed during prenatal care visits [6]. In the United

* Corresponding author.
E-mail address: scasagrande@s-3.com (S.S. Casagrande).

https://doi.org/10.1016/j.diabres.2018.05.010

States, the Pregnancy Risk Assessment Monitoring Systems (PRAMS), a surveillance project which covers approximately 83% of all U.S. births, found that the prevalence of GDM in 2007–2010 was 4.6% based on birth certificates, 8.7% as reported by questionnaire, and 9.2% based on either method [7]. However, this study was limited to states that adopted the 2003 revised birth certificate and provided PRAMS data, which represented approximately one-third of births in 2010 and, therefore, may not be representative of the entire United States. In addition, a nationally representative inpatient survey conducted in hospitals across the United States found that the age-standardized prevalence of GDM was 5.57 per 100 deliveries in 2009 [8].

Risk factors for GDM include advanced maternal age, non-white race, family history of diabetes, overweight and obesity, polycystic ovary syndrome, hypertension, and hyperlipidemia [3,5,9,10]. In addition to the potential pregnancy complications of GDM (e.g., infant macrosomnia, large for gestational age, neonatal hypoglycemia, shoulder dystocia, and cesarean delivery [11–13]), women who have had GDM are at an increased risk of developing Type 2 diabetes after pregnancy. A systematic review found that the risk of developing Type 2 diabetes was sevenfold higher for those with GDM compared to those who had a pregnancy without GDM [14]. Furthermore, women with a history of GDM have been shown to have poorer self-rated health compared to those without a history of GDM; the difference in self-rated health was mostly explained by the higher prevalence of obesity in those with GDM [15]. Although women with GDM should be tested for diabetes 4–12 weeks postpartum, a previous study estimated that only half of women with GDM were tested between 6 and 12 weeks postpartum [16,17].

The objective of this study was to determine the prevalence of self-reported GDM in all U.S. women and the prevalence of a subsequent diagnosis of Type 2 diabetes. In addition, we assessed factors associated with a history of GDM as well as a subsequent diagnosis of diabetes.

2. Materials and methods

2.1. Study design

The National Health and Nutrition Examination Survey (NHANES) is a stratified multistage probability cluster survey conducted in the non-institutionalized civilian U.S. population [18]. Participants are interviewed in their home for demographic and health information and then visit a mobile examination center (MEC) for physical examinations and laboratory measures [19,20]. Written informed consent was obtained from all participants and was approved by the National Center for Health Statistics Institutional Review Board.

2.2. Study participants and study measures

Our analysis included women age ≥20 years who had had at least one live birth or were currently pregnant at ≥28 weeks gestation (N = 8185, NHANES 2007–2014). Women had gestational diabetes (GDM) if they answered "yes" when asked during the MEC visit whether a physician or other health care professional ever told them that they had diabetes, sugar diabetes, or GDM during pregnancy (n = 568); age at diagnosis of GDM was self-reported. During the in-home interview, women self-reported a physician or health professional diagnosis of diabetes that occurred at a time other than during pregnancy and the age at diagnosis. Women were considered to have had Type 2 diabetes that developed subsequent to the occurrence of GDM if the age of diagnosis of diabetes was older than the age of diagnosis for GDM. There were no participants with GDM who were considered to have subsequent diagnosis of Type 1 diabetes (age of diabetes diagnosis <30 years, started insulin treatment within one year of diagnosis, and currently taking insulin).

Participants self-reported age at interview, race/ethnicity, education, household income, country of birth, health insurance status, healthcare access, age of first live birth, parity, family history of diabetes (father, mother, or siblings), sedentary activity at work and leisure time, and alcohol use. Participants without a diagnosis of diabetes at the time of the examination self-reported whether a doctor had told them they had health conditions or a medical or family history that increased their risk for diabetes. Height and weight were measured by trained health technicians during the MEC visit to determine body mass index (BMI; normal weight, BMI < 25.0 kg/m^2; overweight, BMI 25.0–29.9 kg/m^2; obese, ≥30.0 kg/m^2) [21]. Health technicians were assisted by a data recorder during the body measures examination. Height and weight were measured once with the participant wearing only underwear, a paper gown, and foam slippers.

2.3. Statistical analysis

The distributions (percent, standard error) of sociodemographic and health characteristics were evaluated by history of GDM. The crude and age-standardized prevalence (percent, standard error) of GDM, as well as a subsequent diagnosis of diabetes among those with a history of GDM, were assessed by sociodemographic and health-related characteristics. Logistic regression (odds ratio, 95% confidence interval) was used to determine the odds of having a history of GDM in the total population of women, or a subsequent diagnosis of diabetes among those with a history of GDM. Backwards stepwise selection was used to define the most parsimonious model with variables having a statistical significance level at $p < 0.05$. A priori, age at first live birth were retained when assessing the odds of having a history of GDM, and age at interview and years since GDM diagnosis were retained when assessing a subsequent diagnosis of diabetes. All statistical analysis used sample weights and accounted for the cluster design using SUDAAN (SUDAAN User's Manual, Release 9.2, 2008; Research Triangle Institute). Sample weights were used to account for unequal probabilities of selection and non-response in order to provide estimates representative of the non-institutionalized US population.