OBSTETRICS

Preventable health and cost burden of adverse birth outcomes associated with pregestational diabetes in the United States

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OBJECTIVE: Preconception care for women with diabetes can reduce the occurrence of adverse birth outcomes. We aimed to estimate the preconception care (PCC)—preventable health and cost burden of adverse birth outcomes associated with diagnosed and undiagnosed pregestational diabetes mellitus (PGDM) in the United States.

STUDY DESIGN: Among women of reproductive age (15-44 years), we estimated age- and race/ethnicity-specific prevalence of diagnosed and undiagnosed diabetes. We applied age and race/ethnicity-specific pregnancy rates, estimates of the risk reduction from PCC for 3 adverse birth outcomes (preterm birth, major birth defects, and perinatal mortality), and lifetime medical and lost productivity costs for children with those outcomes. Using a probabilistic model, we estimated the reduction in adverse birth outcomes and costs associated with universal PCC compared with no PCC among women with PGDM. We did not assess maternal outcomes and associated costs.

RESULTS: We estimated 2.2% of US births are to women with PGDM. Among women with diagnosed diabetes, universal PCC might avert 8397 (90% prediction interval [PI], 5252-11,449) preterm deliveries, 3725 (90% PI, 3259-4126) birth defects, and 1872 (90% PI, 1239-2415) perinatal deaths annually. Associated discounted lifetime costs averted for the affected cohort of children could be as high as $4.3 billion (90% PI, 3.4-5.1 billion) (2012 US dollars). PCC among women with undiagnosed diabetes could yield an additional $1.2 billion (90% PI, 951 million-1.4 billion) in averted cost.

CONCLUSION: Results suggest a substantial health and cost burden associated with PGDM that could be prevented by universal PCC, which might offset the cost of providing such care.

Key words: diabetes mellitus, economic analysis, pregnancy complications

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Women with preexisting, or pregestational, diabetes mellitus (PGDM) have increased risk of adverse birth outcomes.[1-8] PGDM refers to women with type 1, type 2, or secondary diabetes before pregnancy, excluding gestational diabetes. Preconception care (PCC) for women with PGDM reduces the frequency of such outcomes, most likely by improving glycemic control before and during the critical first weeks of pregnancy.[9-12] Preconception care refers to a range of interventions to improve women's health before conception and thereby improve pregnancy-related outcomes.[13,14] A recent US study reported significant variation in indicators within several PCC health domains, including general health status, health insurance status, tobacco, and alcohol use, and contraceptive use based on geographic location and women's age and race/ethnicity.[15] The American Diabetes Association recommends that PCC for women with PGDM include contraception until optimal glycemic control is achieved, appropriate diet and exercise, folic acid supplementation, discontinued use of potentially teratogenic medications, screening, and treatment for diabetic complications, screening for rubella immunity, and risk counseling.[16] Previous

EDITORS' ★ CHOICE

From the National Center on Birth Defects and Developmental Disabilities (Drs Peterson, Grosse, Razzaghi, and Gilboa) and National Center for Chronic Disease Prevention and Health Promotion (Drs Li and Sharma), Centers for Disease Control and Prevention (CDC), and US Public Health Service Commissioned Corps (Dr Sharma), Atlanta, GA; Oak Ridge Institute for Science and Education (Dr Razzaghi), Oak Ridge, TN; and Departments of Internal Medicine and Epidemiology (Dr Herman), University of Michigan Medical School, Ann Arbor, MI. Dr Peterson is now with the CDC's National Center for Injury Prevention and Control.

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studies of a variety of small-scale PCC interventions among women with PGDM reported that PCC cost-effectively improved birth outcomes.[17-22]

Given PCC's proven clinical effectiveness in reducing adverse birth outcomes among women with PGDM, we aimed to estimate the preventable health and cost burden of adverse birth outcomes associated with diagnosed and undiagnosed PGDM in the United States. To our knowledge this is the first study to produce such estimates.

Materials and Methods

No single publicly available US dataset contains all information necessary to directly estimate the potential impact of identifying and treating all women with PGDM before they conceive. Such a dataset hypothetically would report long-term clinical data and associated health care payment information for women and their children, as well as laboratory results from pregnancy to identify previously undiagnosed PGDM.[23] Given the limitations of available data, we compiled existing information from a variety of sources as inputs for a mathematical model. All model inputs are described in detail below and reported in Table 1.

Model inputs included the current population size of US women of reproductive age (defined as 15-44 years[24]), age- and race/ethnicity-specific prevalence of diagnosed and undiagnosed diabetes, age- and race/ethnicity-specific live birth rates, the effectiveness of PCC for women with PGDM (hereafter referred to simply as PCC) in terms of reducing adverse birth outcomes, and the associated lifetime cost of those birth outcomes. The main outcome measures were the total reduction in number of adverse birth outcomes and costs achievable for a cohort of US women of reproductive age through universal PCC compared with no PCC among all women with diagnosed and undiagnosed PGDM. This analysis examined birth outcomes and costs for affected children with a lifelong time horizon from a societal perspective, including both discounted direct (medical and other services) and indirect (lost productivity) costs. We did not assess the costs of PCC or maternal outcomes and associated costs. This study used publicly available data, did not include human subjects, and was exempt from Institutional Review Board approval.

Population size and birth rate

Current population estimates of women of reproductive age were obtained from the US Census.[25] Age- and race/ethnicity-specific live birth rates were obtained from the National Vital Statistics System.[24] The live birth rate among women with diabetes was assumed to be similar to the general population.[26,27]

Diabetes prevalence

An estimated 2.9% (95% confidence interval [CI], 2.7−3.2) of women of reproductive age (defined as 18-44 years in the source publication) have diagnosed diabetes.[28] This estimate is based on self-report among study participants in the nationally representative 2009 Behavioral Risk Factor Surveillance System (BRFSS). Another study estimated a 0.5% prevalence (no measure of dispersion was reported because of limited sample size) of undiagnosed diabetes among US women of reproductive age (defined as 15-44 years in the source publication) using the nationally representative 1999-2010 National Health and Nutrition Examination Survey (NHANES).[29] We used sex-, age-, and race/ethnicity-specific data on diagnosed diabetes from the BRFSS to estimate the number of women of reproductive age with diagnosed and undiagnosed diabetes by selected age and race/ethnicity categories (Table 1).[30]

Impact of preconception care

A systematic review and meta-analysis of 12 observational cohort studies (n = 2502 participants) examined the health impact of PCC interventions among women with PGDM.[10] Interventions in original studies included a combination of some or all of the following: pharmacologic or dietary glycemic control, blood glucose monitoring, counseling or education on the risks of diabetes in pregnancy, screening and treatment of diabetic complications, and contraception until glycemic control was achieved. The metaanalysis reported the frequency of the following adverse birth outcomes among women with PGDM who did not receive PCC services: 41.4% delivered preterm (n = 155/374 women in 4 original studies), 7.3% had children with birth defects (n = 110/1512 women in 11 original studies), and 4.4% had children who died in the perinatal period (n = 28/634 women in 5 original studies).[10] Preterm deliveries were infants born before 37 weeks' gestation; birth defects were not defined in the metaanalysis and the contributing studies used a variety of definitions. Because of overlap among outcomes in source publications (eg, a child with birth defects could have been born preterm), the metaanalysis did not report rates of adverse birth outcomes on a per-newborn basis. We are not aware of similar US studies with which to compare these estimates. A 1996-2004 population-based UK study of women with known PGDM (n = 1258 pregnancies) reported 3.7% perinatal mortality and 9.0% of live born children had birth defects; the preterm birth rate was not reported.[31] However, no information was provided on women's PCC status or glycemic control in the UK study; therefore, these results are not directly comparable.

Results of the metaanalysis indicated PCC was associated with statistically significant reductions in preterm delivery, birth defects, and perinatal mortality (Table 1). There was no significant association reported between PCC and cesarean delivery, preeclampsia, spontaneous abortion, macrosomia, neonatal hypoglycemia, respiratory distress syndrome, or newborns' small for gestational age status.[10] In the metaanalysis, PCC was associated with a significantly higher risk of maternal hypoglycemia, although we did not evaluate maternal outcomes in the present study.

Lifetime cost of adverse birth outcomes

We used published estimates of the lifetime costs of preterm birth and 17 selected birth defects.[32,33] These estimates included separately reported medical, special education, developmental services, and lost productivity