Life Course Indicator: Gestational Diabetes

The Life Course Metrics Project

As MCH programs begin to develop new programming guided by a life course framework, measures are needed to determine the success of their approaches. In response to the need for standardized metrics for the life course approach, AMCHP launched a project designed to identify and promote a set of indicators that can be used to measure progress using the life course approach to improve maternal and child health. This project was funded with support from the W.K. Kellogg Foundation.

Using an RFA process, AMCHP selected seven state teams, Florida, Iowa, Louisiana, Massachusetts, Michigan, Nebraska and North Carolina, to propose, screen, select and develop potential life course indicators across four domains: Capacity, Outcomes, Services, and Risk. The first round of indicators, proposed both by the teams and members of the public included 413 indicators for consideration. The teams distilled the 413 proposed indicators down to 104 indicators that were written up according to three data and five life course criteria for final selection.

In June of 2013, state teams selected 59 indicators for the final set. The indicators were put out for public comment in July 2013, and the final set was released in the Fall of 2013.

Basic Indicator Information

Name of indicator: Gestational Diabetes (LC-49)

Brief description: Percent of adult women with diagnosed diabetes during pregnancy, only

Indicator category: Reproductive Life Experiences

Indicator domain: Risk/Outcome

Numerator: Total women with diabetes only during pregnancy

Denominator: Total population of mothers

Potential modifiers: Age, race, pre-pregnancy weight, family history of diabetes, previous pregnancies with gestational diabetes

Data source: Pregnancy Risk Assessment Monitoring System (PRAMS)

Notes on calculation: Analysts who use the raw datasets should apply the appropriate survey weights to generate the final estimates.

Similar measures in other indicator sets: None

Life Course Criteria

Introduction

Gestational diabetes mellitus (GDM) is impaired glucose tolerance with onset during pregnancy.[24] GDM differs from type 1 and type 2 diabetes in causes, biologic processes, affected life stages, and health implications both on the individual and intergenerational level. Issues surrounding GDM are discussed in the current narrative while a separate narrative, LC-26 "Diabetes," discusses issues over the life course caused by type 1 and type 2 diabetes. GDM, unlike type 1 diabetes, which is caused by a lack of insulin, is caused by insulin resistance.[30] Hormones produced during pregnancy block the body's effective use of insulin causing insulin resistance, and subsequently, high blood sugar.[30] GDM affects the health of women, children and families in negative ways. Women with GDM are at a higher risk for pregnancy complications including preeclampsia and cesarean delivery.[5,14] A history of GDM also puts women at higher risk for morbidity later in life through increased likelihood of type 2 diabetes, metabolic syndrome, and cardiovascular disease.[25] Infants of mothers with GDM are at a higher risk for congenital birth defects, macrosomia, respiratory distress syndrome, and overall neonatal mortality.[17,26,27] In childhood and adolescence, offspring of mothers with GDM are at an increased risk for both obesity and type 2 diabetes.[9] Proposed programs and policies can help reduce GDM and prevent the morbidity and mortality women, children, and families experience due to diabetes and other health complications.

Implications for equity

In the United States, the prevalence of GDM has been measured between 4.6 percent – 9.2 percent.[24] Prevalence of GDM is higher in Black, Hispanic, Native American, and Asian women compared to non-Hispanic White women.[6] Only 1.5–2.0 percent of White women develop GDM, whereas Native Americans from the southwestern United States may have rates as high as 15 percent, but there is great variability across tribes in the United States.[6] For example, Zuni Indian women have a prevalence of about 15 percent compared to Navajo Indian women with a prevalence of 10.4 percent.[6] In Hispanic, Black, and Asian populations, the incidence is 5 percent – 8 percent.[7] Asian/Pacific Islander women also have a high prevalence of GDM with some studies measuring prevalence in this population as high as 14 percent, which is comparable or higher than some American Indian populations.[20,21] Women may experience a number of social, economic, and political barriers to accessing high-quality health care in which they will receive screening and treatment for GDM. Income, ethnicity, marital status, age, and educational attainment all affect a woman's ability to obtain health care and many poor, minority women are left without comprehensive care coverage.[6]

Not only are there disparities in development of GDM, but disparities also exist in negative health outcomes associated with GDM. A study of Kaiser Permanente health plan beneficiaries found while the risk of GDM was highest in Asian/Pacific Islander women, non-Hispanic Black women who developed GDM had the highest risk of any race for developing diabetes after GDM.[19] Another study found while GDM rates were similar in non-Hispanic Black women (6.1 percent) and non-Hispanic White women (6.3 percent), non-Hispanic Black women were more likely to deliver a large for gestational age infant than non-Hispanic White women.[22]

Janevic and colleagues (2010) assessed whether the number of healthy food outlets (e.g. supermarkets, and fruit/vegetable and natural food stores) and unhealthy food outlets (e.g. fast food, pizza, and convenience stores) in New York City communities were correlated with GDM, but did not find a significant association.[8] While the exact reasons behind the disparities in GDM and GDM outcomes remain unclear, certain factors including race/ethnicity, previous overweight or obesity, and pre-diabetes are associated with increased risk of GDM.[30] The disparities that exist have implications for equity due to the health consequences over the life course that exist for mothers and infants affected by GDM.

Public health impact

GDM remains a public health concern because it negatively affects the health of mothers, infants, and families and can be prevented or managed through alterations in life style. An important factor in reducing the negative effects of GDM is providing preconception health care to women of childbearing age. Since overweight and obesity are risk factors for GDM,[30] helping women maintain a healthy weight before pregnancy can reduce their chances of developing GDM. There also are opportunities for improvement in prevention, detection, and management of GDM through improving knowledge of family history of diabetes when considering having children.[9] Family history of diabetes need not preclude having children but rather it increases the awareness of both the woman and her providers of the opportunities to improve preconception health and the potential need for control or management prenatally.

Complications and health issues from GDM lead to avoidable health care costs for women and infants. GDM increases the likelihood of having a cesarean delivery. In 2008, the average cost per stay for a cesarean delivery with no complications was $4,700 compared to $2,900 per stay for vaginal deliveries with no complications. The costs increase drastically if complications are present.[14] In addition to delivery costs, women who have GDM are at a higher risk for developing type 2 diabetes later in life,[25] while offspring of women with GDM have a higher risk of developing impaired glucose tolerance and metabolic complications.[27] Chen et al (2007) estimated pregnancy and newborn complications due to GDM increased medical costs in the United States by a total of $636 million ($596 million dollars in maternal costs and $40 million in neonatal costs) in 2007 alone.[23] Reducing prevalence of GDM could result in significant cost savings to Medicaid as approximately 36 percent of these costs ($230 million) were paid for by government programs, mainly Medicaid.[23] Glucose screenings are important tools for early detection and treatment.[10,11] In January 2014, the U.S. Preventive Services Task Force released a statement recommending screening for GDM in all asymptomatic pregnant women after 24 weeks of gestation, concluding there was sufficient evidence for the benefits of this practice.[32]

GDM increases a woman's risk for developing type 2 diabetes and cardiovascular disease (CVD), which is the leading cause of death of women in the United States.[25] Women who progress to type 2 diabetes after having GDM have a higher risk of CVD than women who had GDM that did not progress to type 2 diabetes.[25] Metabolic syndrome, which is a group of CVD risk factors including obesity, hypertension, dyslipidemia, and insulin resistance also is more prevalent in women who have had GDM.[25] There are opportunities to reduce risk of CVD in women through prevention of GDM and through healthy lifestyle interventions or medications that prevent development of type 2 diabetes in women who have experienced GDM.[25]

Leverage or realign resources

There are many diabetes prevention programs on the national and state level that include community resources as well as local employers to provide services and promote healthy lifestyles[12] In New York, the "Creating Healthy Places to Live, Work, and Play" initiative works with communities and employers to provide safe places to be physically active to residents and workers, increase accessibility of fresh fruits and vegetables, and improve the nutritional value of foods offered at local restaurants and corner stores.[31] Initiatives such as these could decrease risk factors for GDM or decrease the risk for progressing to type 2 diabetes after experiencing GDM. In addition, partnerships with schools could help prevent children exposed to GDM in utero from developing diabetes later on in childhood by providing health education, healthy meals, and regular exercise throughout the school year.

Medicaid would particularly benefit by addressing GDM because the program currently covers costs for 44 percent of all births in the United States.[35] A disproportionate percentage of Medicaid insurance holders are underrepresented groups, who are at an increased risk of GDM. This is particularly true for many individuals of Native American tribes, and Medicaid is now the primary payer for Indian Health Services.[15] Also, as Medicaid coverage is expanding under the Affordable Care Act, more women will be eligible, which will likely increase costs without better prevention and health management strategies. Prevention programs for GDM in female Medicaid beneficiaries, such as programs to help maintain healthy weight, could have additional health benefits. If overweight and obese women were able to attain a healthy weight before pregnancy, an estimated 50 percent reduction in GDM could be achieved.[29]

Improving the GDM indicator is an important opportunity for collaboration between chronic disease (CD) programs focused on diabetes prevention and management and maternal and child health (MCH) programs focused on improving the health of women before, during, and after pregnancy and improving birth outcomes. These programs can work together to address a woman's increased risk of developing type 2 diabetes in the future as well as the increased risk of the child developing diabetes later in life. The Centers for Disease Control and Prevention (CDC), AMCHP and the National Association of Chronic Disease Directors (NACDD) piloted this type of collaboration around GDM through support of three states in modeling effective collaboration of MCH and CD programs in developing diabetes prevention initiatives. For some participating state teams, the GDM initiative was the first time there was a formal collaboration between the MCH and CD programs, and this was an innovative way to tackle an issue that was important for both programs without being duplicative; participants cited this project as a model for future work between the programs and potentially for other areas of the health agency as well. In 2010, the Ohio Gestational Diabetes Mellitus Collaboration was founded as an effort between CD and MCH departments. The program aims to educate the public and health care providers about health complications in women with a history of GDM and promote regular screenings to prevent these

complications.[13] The collaboration has attempted to raise awareness about GDM through radio public service announcements, social media messages, partnering with text4baby, and publishing a data book on GDM in Ohio.[13]

Predict an individual's health and wellness and/or that of their offspring

Approximately 2 – 5 percent of pregnant women will develop GDM, and type 2 diabetes may develop after pregnancy.[5] Mothers that have GDM have a 35 percent to 60 percent chance of developing diabetes over the next 10 to 20 years.[12] Type 2 diabetes in women with a history of GDM creates a significant risk for CVD.[25] Women who have had GDM have been found to have a 70 percent increased risk of CVD than women who have not had GDM.[25] Risk of CVD increases with the development of type 2 diabetes, metabolic syndrome, and obesity.[25]

GDM affects maternal health in both the current pregnancy and future pregnancies. Once a woman has had one pregnancy with GDM, there is an increased risk that she will develop GDM in subsequent pregnancies.[6, 9] Also, during pregnancy a mother with GDM is at a much greater risk for developing preeclampsia, which can be life-threatening for the mother and infant.[5] There are a few known risk factors for preeclampsia but very little can be done to prevent the condition; it is therefore important to take advantage of opportunities to reduce risk through prevention of conditions like GDM.

The health of infants is also affected by GDM. GDM is associated with higher levels of fetal death / stillbirth, especially in cases that were not treated throughout the pregnancy.[16] GDM has been linked to some forms of congenital defects of the central nervous system.[17] Comorbidities in the mother add increased risk of fetal health issues. Women who suffer from both obesity and GDM have a significantly higher risk of congenital birth defects than women who have only obesity or only GDM.[17]

A frequent outcome of GDM is giving birth to infants larger than 4,000 to 4,500 g (eight pounds 13 ounces to nine pounds four ounces) which is termed macrosomia. Due to their large size, infants of mothers with GDM are much more likely to suffer trauma during birth, and mothers have an increased risk of having a cesarean delivery.[9] Cesarean delivery increases a mother's recovery time after birth and can delay initiation of breastfeeding.[34]

GDM is a major risk factor for neonatal respiratory distress syndrome (RDS).[26] RDS ranges from mild to severe cases and occurs in 25 to 38 percent of infants born to mothers with GDM.[27] The precise reasons for increased risk of respiratory problems in infants born to mothers with GDM are not known for sure, but the higher risk may be related to a number of complex biologic processes resulting from hyperinsulinemia.[26,27] Offspring born to mothers with GDM also have an elevated risk for obesity and developing type 2 diabetes during childhood or adolescence[9]. The increased risk for becoming obese and developing diabetes at a young age means many female children of mothers with GDM will already suffer from diabetes or obesity by their childbearing years, which fuels a cycle of intergenerational health issues.[28]

Data Criteria

Data availability

PRAMS, initiated in 1987, is an ongoing population-based surveillance system designed to identify and monitor selected maternal experiences and behaviors that occur before and during pregnancy and during the child's early infancy. Forty states and New York City currently participate in PRAMS, representing approximately 78 percent of all U.S. live births. Six other states previously participated. The CDC maintains a combined dataset with information from all participating PRAMS states, which represents approximately 87 percent of all live births in the United States. The CDC PRAMS Online Data for Epidemiologic Research (CPONDER) is a Web-based query system created to access data collected through PRAMS surveys.

The length of time between an event and entry into the sampling frame is typically two to six months. Because PRAMS data are weighted to the final birth file, there is a data availability lag between the close of a calendar year and access to the final PRAMS dataset. As of July 2013, the most current year of data available in CPONDER was 2008.

Although the 40 states and one city that participate in PRAMS have access to their own state data, only states where the minimum response rates have been met are included in CPONDER. For 2000-2006, this required response rate was 70 percent, and for 2007-08 it was 65 percent. The required response rate may limit the availability of a "national" estimate through CPONDER, but states with PRAMS are encouraged to use their own data whenever possible.

The PRAMS survey consists of core questions that all states must include and standard, pilot-tested questions that states may choose to add. In addition, PRAMS allows states to design and add their own questions, and the state is responsible for completing question testing before the question can be included. PRAMS data is available from CDC by submitting a proposal for and data sharing agreement to CDC. Data from a single state can be requested from the state PRAMS coordinator.

The number of women with diabetes only during pregnancy is derived from self-reported PRAMS survey information in which women are asked "During your most recent pregnancy, were you told by a doctor, nurse, or other health care worker that you had gestational diabetes (diabetes that started during this pregnancy)?" and the denominator (total number of mothers) is calculated from Vital Statistics Data, which are supplied annually.[1] For those states without PRAMS, data from birth certificates, inpatient records, county health department records, or the Behavioral Risk Factor Surveillance System (BRFSS) data may be considered for use for this indicator, but with limitations. Prevalence estimates from BRFSS would likely be lower than estimates from PRAMS because BRFSS data is derived from the general U.S. population and the question asks about whether the woman has "ever" had diabetes diagnosed only during pregnancy.

Data quality

PRAMS is a mixed-mode surveillance system that combines mail and telephone surveillance. Each year's sample is weighted to represent all births that meet the inclusion criteria before reporting. Unlike many health surveys, the PRAMS project has a wealth of information from the birth certificate on those who do not respond by either mode of contact, and therefore weighting can be effective at minimizing differences between respondents and non-respondents.

Since the PRAMS survey is completed retrospectively by a woman two to six months after her birth outcome, some bias may occur due to self-reporting and recall. PRAMS is sampled from live births only, so the data do not include information on other pregnancy outcomes such as abortions, miscarriages, or stillbirths; the data do include responses from women who have experienced an infant death. PRAMS is sampled among singleton, twin, and triplet births, and therefore it is not representative of higher order births.

This indicator may be subject to recall bias because mothers are being asked about GDM after their pregnancies.[1] However, studies of PRAMS data quality have found a high agreement (93.8 percent) between birth certificates and self-reports of GDM on PRAMS. The Kappa was only 0.53 but the Prevalence-Adjusted Bias-Adjusted Kappa (PABAK), which adjusts the kappa for imbalances caused by differences in the prevalence and bias[18], was 0.88, which indicates a high level of agreement.[4]

Simplicity of indicator

The GDM indicator is easy to calculate and straightforward, especially when acquiring the weighted and adjusted data from CPONDER. The indicator is calculated by dividing the number of pregnant women with gestational diabetes over the total number of pregnant women. This indicator is easy to understand and explain to stakeholders.

References

[1] CDC. (2012). PRAMS. Retrieved from http://www.cdc.gov/prams/

[2] CDC. (2013). Behavioral Risk Factor Surveillance Survey. Retrieved from http://www.cdc.gov/brfss

[3] Broussard et all. (2011). Core State Preconception Health Indicators: A Voluntary, Multi-state Selection Process. *Maternal and Child Health Journal, 15, 158- 168.* doi: 10.1007/s10995-010-0575-x

[4] Hosler AS, Nayak SG, & Radigan, AM. (2010). Agreement between self-report and birth certificate for gestational diabetes mellitus: New York State PRAMS. *Maternal and Child Health Journal, 14,* 786- 789. doi: 10.1007/s10995-009-0529-3.

[5] CDC (n.d). Diabetes and Pregnancy: Gestational Diabetes. Retrieved from http://www.cdc.gov/pregnancy/documents/Diabetes_and_Pregnancy508.pdf

[6] CDC. (2001). Diabetes and Women's Health Across the Life Stages: A Public Health Perspective. Retrieved from http://www.cdc.gov/diabetes/pubs/pdf/womenshort.pdf

[7] Moore, Thomas R. (2012). Diabetes Mellitus and Pregnancy: Gestational Diabetes. Retrieved from http://emedicine.medscape.com/article/127547-overview

[8] Janevic, T. et all. (2010). Neighbourhood food environment and gestational diabetes in New York City. *Paediatric Perinatal Epidemiology, 24(3),* 249-254. doi: 10.1111/j.1365-3016.2010.01107.x.

[9] Centers for Disease Control and Prevention. (n.d.). Gestational Diabetes. Retrieved from http://www.cdc.gov/diabetes/pubs/pdf/gestationalDiabetes.pdf

[10] U.S. Preventative Services Task Force. (2008). Screening for Gestational Diabetes Mellitus. Retrieved from http://www.uspreventiveservicestaskforce.org/uspstf08/gestdiab/gdrs.htm

[11] Community Preventive Services Task Force. (2012). Diabetes Prevention and Control. Retrieved from http://www.thecommunityguide.org/diabetes/index.html

[12] Centers for Disease Control and Prevention. (2011). National Diabetes Fact Sheet, 2011. Retrieved from http://www.cdc.gov/diabetes/pubs/pdf/ndfs_2011.pdf

[13] Ohio Department of Health. (2012). Ohio Gestational Diabetes Collaboration. Retrieved from http://www.healthyohioprogram.org/diabetes/programs/gdmc.aspx

[14] Podulka, Jennifer, Stranges, Elizabeth & Steiner, Claudia. (2011). Hospitalizations Related to Childbirth, 2008. Retrieved from http://www.hcup-us.ahrq.gov/reports/statbriefs/sb110.jsp

[15] American Public Health Association. (n.d.) Medicaid, Prevention, and Public Health: Invest Today for a Healthier Tomorrow. Retrieved from http://www.apha.org/NR/rdonlyres/675F96CD-7701-4049-89BD-D96625A6A3BE/0/MedicaidReport.pdf

[16] Kjos, Siri L. & Buchanan, Thomas A. (1999). Gestational Diabetes Mellitus. *The New England Journal of Medicine, 341,* 1749- 1756. doi: 10.1056/NEJM199912023412307

[17] Anderson, James L. et all. (2005). Maternal Obesity, Gestational Diabetes, and Central Nervous System Birth Defects. *Epidemiology,16(1),* 87- 92. Retrieved from http://www.jstor.org.ezproxy.lib.usf.edu/stable/pdfplus/20486004.pdf?acceptTC=true

[18] Byrt T, Bishop J, Carlin JB. (1993): Bias, prevalence and kappa. Journal of Clinical Epidemiology 46:423-429.

[19] Xiang, A., Li, B., Black, M., Sacks, D., Buchanan, T., Jacobsen, S., & Lawrence, J. (2011). Racial and ethnic disparities in diabetes risk after gestational diabetes mellitus. *Diabetologia*, *54*(12), 3016-3021. doi:10.1007/s00125-011-2330-2

[20] Hunsberger, M., Rosenberg, K., & Donatelle, R. (2010). Racial/Ethnic Disparities in Gestational Diabetes Mellitus: Findings from a Population-Based Survey. *Women's Health Issues*, *20*(5), 323-328. doi:10.1016/j.whi.2010.06.003

[21] Thorpe, L., Berger, D., Ellis, J., Bettegowda, V., Brown, G., Matte, T., & ... Frieden, T. (2005). Trends and racial/ethnic disparities in gestational diabetes among pregnant women in New York City, 1990-2001. *American Journal Of Public Health*, *95*(9), 1536-1539. doi:10.2105/AJPH.2005.066100

[22] Hunt, K., Marlow, N., Gebregziabher, M., Ellerbe, C., Mauldin, J., Mayorga, M., & Korte, J. (2012). Impact of maternal diabetes on birthweight is greater in non-Hispanic blacks than in non-Hispanic whites. *Diabetologia*, *55*(4), 971-980. doi:10.1007/s00125-011-2430-z

[23] Chen, Y., Quick, W., Yang, W., Zhang, Y., Baldwin, A., Moran, J., & ... Dall, T. (2009). Cost of gestational diabetes mellitus in the United States in 2007. *Population Health Management*, *12*(3), 165-174. doi:10.1089/pop.2009.12303

[24] DeSisto, C., Kim, S., & Sharma, A. (2014). Prevalence estimates of gestational diabetes mellitus in the United States, Pregnancy Risk Assessment Monitoring System (PRAMS), 2007-2010. *Preventing Chronic Disease*, *11* E104. doi:10.5888/pcd11.130415

[25] Sullivan, S., Umans, J., & Ratner, R. (2012). Gestational diabetes: implications for cardiovascular health. *Current Diabetes Reports*, *12*(1), 43-52. doi:10.1007/s11892-011-0238-3

[26] Vignoles, P., Gire, C., Mancini, J., Bretelle, F., Boubli, L., Janky, E., & Carcopino, X. (2011). Gestational diabetes: a strong independent risk factor for severe neonatal respiratory failure after 34 weeks. *Archives Of Gynecology And Obstetrics*, *284*(5), 1099-1104. doi:10.1007/s00404-010-1810-9

[27] Jones, C. (2001). Gestational diabetes and its impact on the neonate. *Neonatal Network: NN*, *20*(6), 17-23.

[28] Dabelea, D. (2007). The predisposition to obesity and diabetes in offspring of diabetic mothers. *Diabetes Care*, *30 Suppl 2*S169-S174. doi:10.2337/dc07-s211

[29] Centers for Disease Control and Prevention. Preventing and managing chronic disease to improve the health of women and infants. Accessed on August 14, 2014, at http://www.cdc.gov/reproductivehealth/WomensRH/PDF/ChronicDisease_FactSheet.pdf.

[30] John Hopkins Medicine. Health Library: Gestational Diabetes Mellitus(GDM). Accessed on August 14, 2014 at http://www.hopkinsmedicine.org/healthlibrary/conditions/diabetes/gestational_diabetes_mellitus_gdm_85,P00337/.

[31] New York State Department of Health (NYSDOH). Creating Healthy Places to Live, Work, and Play. Accessed on August 18, 2014 at https://www.health.ny.gov/prevention/nutrition/healthy_places.htm

[32] United States Preventive Services Task Force. Screening for Gestational Diabetes Mellitus. Accessed on August 18, 2014 at http://www.uspreventiveservicestaskforce.org/uspstf13/gdm/gdmfinalrs.htm

[33] Turok DK, Ratcliffe, SD, Baxley, EG. Management of Gestational Diabetes Mellitus. American Family Physician. November 1, 2003;68(9):1767-1773.

[34] Dewey, K., Nommsen-Rivers, L., Heinig, M., & Cohen, R. (2003). Risk factors for suboptimal infant breastfeeding behavior, delayed onset of lactation, and excess neonatal weight loss. *Pediatrics*, *112*(3), 607-619.

[35] Centers for Disease Control and Prevention. National Vital Statistics Report: Source of Payment for the Delivery: Births in a 33-state and District of Columbia Reporting Area, 2010. December 19, 2013;(62)5.

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