Life Course Indicator: Small for Gestational Age

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: Small for Gestational Age (LC-11)

Brief description: Proportion of singleton live-born infants whose birth weight is at or below the 10th percentile for a given gestational age

Indicator category: Community Well-being

Indicator domain: Risk/Outcome

Numerator: Singleton live-born infants whose birth weight is at or below the 10th percentile for a given gestational age

Denominator: Total number of singleton live births

Potential modifiers: Race/ethnicity, age, educational attainment, income, rural vs. urban

Data source: National Vital Statistics System (NVSS) Records

Notes on calculation: Small for Gestational Age (SGA) was defined as sex-specific birth weight <10th percentile at each week of gestation as measured using the last menstrual period. The 10th percentile cut points of birth weight was derived from the 1990 live births in the United States as a baseline (i.e. internal reference norms). This indicator should be calculated using the methodology from Oken, E., Kleinman, K. P., Rich-Edwards, J., & Gillman, M. W. (2003). A nearly continuous measure of birth weight for gestational age using a United States national reference. BMC pediatrics, 3(1), 6.

Similar measures in other indicator sets: None

Life Course Criteria

Introduction

SGA is defined as an infant smaller in size than normal after taking gender and gestational age into account. The standard criteria for SGA are birth weight below the 10th percentile for a given gestational age. The measurement of SGA compares infant birth weight with a national distribution of live births so that weights are relative to infants of the same gestational age. If an infant is not small at birth due to genetic factors, SGA is a measure of intrauterine growth restriction. The two components of SGA are gestational age and birth weight; an infant can be preterm but an appropriate weight for that gestational age, and therefore not SGA. Conversely, an infant can be born at less than 2500 grams at any gestational age and not necessarily considered SGA; SGA criteria include the combination of low birth weight for gestational age. The proportion of infants born low birth weight in the United States has been increasing since 1990 but has remained relatively constant in recent years. In 1990, 7.0 percent of live births were low birth weight and between 2004 and 2010, percentages ranged from 8.1 percent to 8.3 percent (Future of children, 2013). SGA is reflective of life course science in that birth weight is influenced by maternal health and social factors prior to pregnancy, and has implications for the health of the infant through childhood and into adulthood. Infants with birth weight below the 10th percentile have likely been severely growth restricted and are at an increased risk for infant morbidity and mortality, permanent deficits in growth and neurocognitive development in childhood, and at an increased risk for development of adult chronic disease.

Implications for equity

Disparities in experience of SGA exist among various racial and ethnic groups in the United States (Collins et al, 1997, Schempf, Kaufman & Messer, 2011). In 2008-2010, African American mothers had almost twice the rate of low birth weight infants (13.6 percent) compared to that of White (7.2 percent) and Hispanic (7.0 percent) mothers (March of Dimes, 2013). A study performed in North Carolina found that African American women were twice as likely to deliver a term SGA infant compared with non-Hispanic White women. Disparities remained even after controlling for individual socioeconomic factors and neighborhood characteristics (Schempf et al, 2011). Another study found college educated African American women were three times as likely to deliver a SGA infant than college educated White women (Collins et al, 1997).

As socioeconomic disadvantage increases, so does the risk for SGA. Beard et al (2009) found nearly half of the increased risk for SGA in socioeconomically disadvantaged women was accounted for by maternal smoking and delayed entry into antenatal care, however, a strong relationship between socioeconomic disadvantage and SGA remained after controlling for both of these covariates as well as race. Other research has found markers of socioeconomic disadvantage influence SGA outcomes. Parents who did not complete high school or equivalent have an increased risk of delivering a low birth weight infant. Parents without a high school diploma or equivalent are often unable to find adequate employment resulting in low income and socioeconomic status (The Future of Children, 2013). Moreover, many low-income parents experience food insecurity due to their lower wages compared to middle and upper-income families. Lack of adequate nutrition during pregnancy is a risk factor for SGA. Therefore, birth weight of infants is influenced, in part, by the social gradient of health whereby lower income families experience a higher prevalence of poor health outcomes. Environmental toxins present in the home and at work also have an influence of whether a mother will give birth to a low birth weight infant (CDC, 2012).

Young mothers (less than age 18) and older mothers (greater than age 35) also are at higher risk for delivering a SGA baby (Kozuki et al, 2013, Odibo et al, 2006, Fraser and Ward, 1995). Inadequate prenatal care and sociodemographic risk factors do not entirely explain the association between teen birth and SGA, which may be partially driven by biologic immaturity (Fraser and Ward, 1995). In addition to social and economic challenges teenagers face after giving birth (Elfenbein and Felice, 2003), SGA-related health outcomes can further affect health over the life course of the mother and child. After the age of 35, a dose response relationship exists with age and SGA, justifying indication for ultrasound screening in older mothers (Odibo et al, 2006).

Public health impact

Birth weight is often used as a measure of current and future population-level health due to the high correlation between birth weight and infant morbidity and mortality and adult chronic disease, mental health, and socioeconomic status (Margerison-Zilko, 2014). SGA is a contributor to low birth weight costs in the United States, which total $5.4 billion per year. Many low birth weight infants often need lengthy stays in neonatal intensive care units and require rehospitalizations and special education services, all of which add an additional cost of $500 million per year (Lewit, 1995; Environmental Protection Agency).

SGA is associated with the development of costly, prevalent chronic disease in adulthood including coronary heart disease, stroke, hypertension and type II diabetes (Salam, Honeycutt, & Thompson, 2001). Research also found possible links between SGA and future development of osteoporosis and depression (Salam et al, 2001). The increased risk for these diseases may be long-term effects of abnormal nutrient supply to the fetus (Salam et al, 2001). Where future projections show 40.5 percent of the U.S. population will have some form of cardiovascular disease by 2030 (Heidenreich et al, 2011) and type II diabetes prevalence will increase by 165 percent by 2050 (Boyle et al, 2001), reducing risk factors for these diseases is of high public health concern.

Leverage or realign resources

Medicaid is a key partner in lowering SGA rates. Medicaid covers 40 percent of all births in the United States and the added costs of low birth weight complications are in the millions (NCSL, 2011). In Wisconsin, the average estimated cost of health care for babies with a very low birth weight is $61,902 compared to $7,260 for a baby born at normal weight (NCSL, 2011). The Colorado Prenatal Plus program provides pregnant Medicaid-eligible women with comprehensive services and an evaluation of the program showed an estimated $2.9 million in Medicaid savings (ASTHO, 2012). In Virginia, the Partners in Pregnancy program provides a “medical home” intervention to pregnant women enrolled in Medicaid and has achieved a medical cost savings of $2,287 for each mother and newborn enrolled in the program (NCSL, 2011).

Many existing interventions target upstream or potential contributors of SGA, including tobacco use during pregnancy, drug and alcohol use during pregnancy, inadequate weight gain during pregnancy, prenatal case management, and support during pregnancy. Significant reductions in low birth weight have been observed in smoking cessation interventions; however, inconclusive or equivocal findings have been reported for nutrition education interventions aimed at improving maternal weight gain during pregnancy, prenatal case management programs, and alcohol and illicit drug use programs (Murray, 2009; da Silva, n.d.). The Collaborative Improvement & Innovation Network (CoIIN) to Reduce Infant Mortality is a public-private partnership between the Health Resources and Services Administration Maternal and Child Health Bureau and state Title V MCH programs to reduce infant mortality and improve birth outcomes (HRSA n.d.). In addition to learning from one another and national experts, sharing best practices and lessons learned, and tracking progress toward shared benchmarks, participants are encouraged to engage stakeholders outside of their usual MCH and public health partnerships to implement strategies that will ultimately improve birth outcomes. Strategies currently used by the states participating in CoIIN that could reduce SGA include promoting smoking cessation, expanding access to interconception care (between pregnancies) through Medicaid, and addressing the social determinants of health. While infant mortality was not selected as a life course indicator, SGA was because of the risk of mortality for severely growth-restricted infants. Legislators could support continual and new allocation of funds to programs or initiatives that focus on improving the health of maternal and child populations within their communities.

Partnering with organizations and initiatives to reduce maternal smoking before and during pregnancy should improve rates of SGA. The *Patient Protection and Affordable Care Act* requires Medicaid to cover counseling and pharmacotherapy for tobacco cessation for pregnant women (Adams et al, 2013). Coverage of these interventions significantly reduces smoking rates among women (Adams et al, 2013). In clinical practice, physicians are an important partner to engage to employ evidence-based interventions such as the “5 A’s” model recommended by the Agency for Healthcare Research and Quality. The intervention advises clinicians to ask pregnant women about tobacco use, advise them to quit, assess their willingness to attempt to quit, assist them in quitting and arrange follow-up regarding their smoking status (AHRQ, 2012).

Early intervention (EI) services, including early childhood development, family support services and pediatric follow-up to reduce developmental and behavioral problems in low birth weight infants, was studied in the Infant Health and Development Program (IHDP) in the 1980s. Results showed EI was an important strategy to improve developmental and health outcomes in low birth weight infants (Mallik & Spiker, 2004). High-quality group care for low birth weight infants starting at 12 months of age enhanced cognitive development and reduced behavioral problems (Mallik & Spiker, 2004).

Social services and the education sector also have a stake in improving SGA. Low birth weight infants are twice as likely as normal-weight babies to be placed in foster care and to be maltreated during their early years of life (Lee, 2009) thereby potentially placing added burdens on social services. The Healthy Families New York (HFNY) prenatal home-visitation program focuses on social support, health education, and access to services. Among participants randomized to the HFNY program during years 2000 to 2002 (n=236), 5.1 percent delivered a low birth weight baby in 2007 compared to 9.8 percent in the control group (Lee, 2009). Infants born low birth weight or SGA have an increased risk of receiving costly special education services (Lewit, 1995; Environmental Protection Agency) and thus may have some influence on realigning resources in the education sector. Targeting prevention of teen pregnancy in the education sector may reduce rates of SGA births due to the association between young maternal age and SGA.

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

SGA is an indicator that can predict individual health outcomes at each stage of the life course and in future generations. In infancy, intrauterine growth restriction, a main driving cause behind SGA, is associated with a wide range of infant morbidities including metabolic, thermal, and hematological problems. Infants born with weight between the third and 10th percentile are at a higher risk for mortality than infants born with weights in the 25th-50th percentile (Grisaru-Granovsky et al, 2012). Higher infant mortality rates have been found in both term and preterm SGA infants (Grisaru-Granovsky et al, 2012). Additionally, low birth weight infants are at increased risk of health problems, developmental delays, physical disabilities, and maltreatment, which influence health status throughout their life, school success and employability later in life (Lee 2009).

In childhood, birth weight is a predictor of developmental delays and cognitive problems resulting in lower IQ test scores, lower educational attainment and adulthood lower incomes compared to normal birth weight infants (Promising Practices Network, 2013; CDC 2012). Studies focused primarily on birth weight have demonstrated that a mother who was born low birth weight is more likely to have a child born low birth weight (Emanuel 1986). According to David J. Barker, MD in his research on the fetal origins of disease, birth weight is a predicator of poor life course trajectories such as chronic health conditions (hypertension, coronary artery disease and diabetes), depression and suicide ideation (Barker et al 1993). Further, low birth weight is a multi-generational issue. Mothers who were born low birth weight are more likely to give birth to a low birth weight infant independent of factors such as receipt of adequate prenatal care, thereby continuing this cycle into future generations (Coutinho et al 1997, Collins et al 2003). Poor maternal health increases the risk of delivering a low birth weight baby, creating intergenerational health issues. Maternal asthma, diabetes, and high blood pressure are all associated with increased risk of low birth weight (Hayes et al, 2014). Obese mothers have a higher risk of having a baby small for gestational age with greater chance of needing intensive care after birth (Radulescu et al, 2013).

Mothers of low birth weight infants may fall into a mental state of depression due to the burden of intensive caring for their infant (Poehlmann et al, 2009). Burdens such as financial hardships, food insecurity, and health complications concerning their infant weigh down the mother mentally increasing the risk of maternal morbidity (e.g. increase risk of smoking and consuming alcohol to alleviate pain) (Feeding America, 2013).

Data Criteria

Data availability

The National Vital Statistics System is an intergovernmental sharing of data whose relationships, standards, and procedures form the mechanism by which the National Center for Health Statistics (NCHS) collects and disseminates the nation's official vital statistics. Vital event data are collected and maintained by the jurisdictions that have legal responsibility for registering vital events; these entities provide the data via contracts to NCHS. Vital events include births, deaths, marriages, divorces and fetal deaths. In the United States, legal authority for the registration of these events resides individually with the 50 states, two cities (Washington, DC and New York City), and five territories (Puerto Rico, the Virgin Islands, Guam, American Samoa and the Commonwealth of the Northern Mariana Islands). Vital Statistics data are available online in downloadable public use files, through pre-built tables in VitalStats, and through the ad-hoc query system CDC WONDER (Wide-ranging Online Data for Epidemiologic Research). Birth certificate data is available in WONDER for 1995-2010, and death certificate data by underlying cause of death (detailed mortality) is available for 1999-2010.

Birth weight data are readily available for all U.S. states, Washington, DC, counties, and other jurisdictions (e.g. major metropolitan areas) through the Vital Statistics birth records. The data sets do not require linkage for calculation. The numerator is calculated as the number of infants with a sex-specific birth weight below the 10th percentile for each week of gestation and is retrieved from the birth certificate. Date of last menstrual period (LMP) has been collected on the birth certificate since 1968, with minor revisions to the instructions for birth attendants in calculating LMP in the years since its implementation. The 1989 revision of the birth certificate included a new field – clinical estimate of gestation to be used as a source of information on gestational age when the LMP data item contains invalid or missing information. The 2003 revision of the birth certificate replaced 'clinical estimate of gestation' with the 'obstetric estimate of gestation at delivery' to further clarify that this estimate should not be computed from information obtained during the neonatal exam but rely primarily on perinatal factors and assessments. In 2006, instructions for birth attendants further clarified that the preferred method of determining the obstetric estimate is through ultrasound taken early in pregnancy (Weir, Pearl & Kharrazi, 2010). Despite the improvements in the accuracy of the obstetric estimate, for the purposes of this indicator, gestational age as calculated from the clinical or obstetric estimate is not recommended. While the ideal methodology would be to use a national standard for small for gestational age that is based on the obstetric estimate of gestational age, there is no existing gestational age-based national standard to calculate percentiles using obstetric estimate of gestational age; the most common methodologies use a national standard that estimates gestational age using the date of LMP. Analysts in states who would prefer to calculate this indicator using the obstetric estimate of gestational age will need to create a standard using internal state-based obstetric estimate of gestational age; any time the indicator estimate is shared, it should be clearly described which estimate of gestational age was used. Partners in national organizations are encouraged to create a new national standard for future use. The denominator is the number of live births for the same reporting period.

Data quality

Standard forms for the collection of the data and model procedures for the uniform registration of the events are developed and recommended for state use through cooperative activities of the states and NCHS. As reported in the NCHS publication *U.S. Vital Statistics System, Major Activities and Developments, 1950-1995*, efforts to improve the quality and usefulness of vital statistics data are ongoing. NCHS uses techniques such as testing for completeness and accuracy of data, querying incomplete or inconsistent entries on records, updating classifications, improving timeliness and usefulness of data, and keeping pace with evolving technology and changing needs for data. Work with state partners to improve the timeliness of vital event reporting is ongoing, and NCHS is working closely with National Association of Public Health Statistics and Information Systems and the Social Security Administration to modernize the processes through which vital statistics are produced in the United States, including implementation of the 2003 revised certificates.

According to the National Vital Statistics Report Births: Final Data for 2011, thirty-six states, the District of Columbia, and two territories implemented the revised birth certificate as of Jan. 1, 2011. The jurisdictions implementing the revisions represent 83 percent of all 2011 U.S. births. The revised reporting areas are: California, Colorado, Delaware, the District of Columbia, Florida, Georgia, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Michigan, Missouri, Montana, Nebraska, Nevada, New Hampshire, New Mexico, New York (including New York City), North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Utah, Vermont, Washington, Wisconsin, Wyoming, Puerto Rico and the Northern Marianas. Two states, Massachusetts and Minnesota, and one territory, Guam, implemented the revised birth certificate in 2011, but after Jan. 1.

The number of infants born SGA is collected from birth certificate data and is considered to be an accurate measure of what is contained in the medical record. Reliability can be determined by comparing various methods of measurements to see if the results contain similar values via equivalence assessments. Buescher et al (1993) compared birth certificates and medical records of 395 cases in 42 North Carolina hospitals. The birth weight, Apgar score, and delivery methods had 91.9 percent to 100 percent agreement (Northam & Knapp, 2006).

Simplicity of indicator

The complexity of calculation of SGA is moderate to complex. The complexity comes in comparing the birth weight for age of infants born in a given jurisdiction to the reference percentiles to determine whether an infant is below the 10th percentile. SGA is better known among maternal and child health professionals than among other public health audiences or wider stakeholder groups and will require explanation of the way SGA is determined; the evidence to support how SGA can negatively impact the infant's life course and family members is summarized above to facilitate these discussions.

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