Life Course Indicator: Preterm Birth

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: Preterm Birth (LC-55)

Brief description: Percent of live births born < 37 weeks gestation

Indicator category: Reproductive Life Experiences

Indicator domain: Risk/Outcome

Numerator: Number of live births born prior to 37 weeks gestation

Denominator: Total number of live births

Potential modifiers: Maternal age, race/ethnicity, educational attainment, nativity, marital status, sex of infant, household income, parity, previous preterm birth, geography (urban versus rural), multiple gestation, maternal smoking, fertility treatment, early induction of labor, obesity, payer source

Data source: National Vital Statistics System (NVSS) Records

Notes on calculation: None

Similar measures in other indicator sets: HP 2020 Focus area MICH-9

Life Course Criteria

Introduction

Nearly one in eight babies are born preterm (before 37 weeks of gestation) in the United States. Preterm birth is the leading cause of infant death for babies born to non-Hispanic Black mothers and the preterm-mortality rate for Black infants is more than three-fold that of White infants, producing much of the racial and ethnic disparity in infant mortality in the nation. In addition to being one of the leading causes of death in the first year of life, preterm birth can be associated with lifelong health, emotional, economic, and social consequences for the child, mother, family, and community. Numerous national and state initiatives focus on and have a significant interest in reducing preterm births, including, to name a few, Healthy People 2020, the March of Dimes' 39+ Weeks and Healthy Babies are Worth the Wait campaigns, the Health Resources and Services Administration (HRSA) Regional Collaborative Innovation and Improvement Networks (CoIINs), and the Centers for Medicare and Medicaid Services Strong Start for Mothers and Newborns Initiative. A life course indicator for preterm birth unites these more national initiatives – which use different processes including quality improvement, public education, public policy, and health care financing reform – with more behaviorally focused efforts like smoking cessation programs or anti-poverty and anti-discrimination reforms in housing, nutrition, education, and the workforce to reduce exposure to stressors across the life span of women. Reducing the rate of preterm births in the United States and their associated disparities will require a multi-faceted effort. While recent advances in clinical care (17P, elimination of early elective deliveries) and reducing behavioral risk factors for preterm birth are promising, they are not sufficient to overcome the persistent and historically unexplained disparities in preterm birth. Improving women's health across the life span and the social context and inequitable distribution of resources and services (including support systems) across race/ethnicities and class will need to guide future program and policy development.

Implications for equity

Various social, psychosocial, economic and environmental factors are associated with preterm birth, and in turn contribute to complex disparities across races and ethnicities and socioeconomic status.

Racial/ethnic and class disparities in preterm births are strong: non-Hispanic Black women have higher odds of having a preterm infant (Vanderweele et al., 2012), and nationally, the preterm birth rate for non-Hispanic Black women is 17.1 percent in comparison to 10.8 percent and 11.8 percent seen in non-Hispanic White and Hispanic women, respectively (Martin et al. 2012). Perhaps most significantly, in the United States, the number one cause of infant death for infants born to non-Hispanic White women is congenital anomalies, whereas for non-Hispanic Black women, complications associated with short gestation and low birthweight are the primary cause of infant death. This difference in preterm-related infant mortality explains much of the higher risk for infant mortality for babies born to Black mothers: the preterm-related infant mortality rate for non-Hispanic Black women in 2009 was 540 deaths per 100,000 live births, whereas for Non-Hispanic White women, the rate was 164 deaths per 100,000 live births (more than a three-fold difference) and for all races, the rate was 226 deaths per 100,000 live births (Mathews and MacDorman, 2013). Evidence suggests that the disparity in preterm birth-related infant mortality is increasing.

Inequities in preterm birth in women of lower socioeconomic status cut across race and ethnicity. Living in socioeconomically disadvantaged census tracts, like high poverty tracts, or in areas characterized by low educational attainment, high unemployment, and low proportion of managerial or professional occupation have been found to have a significant association with preterm birth (Messer et al., 2008). The effects of these factors were seen for Black as well as White women. Further, a study by Mason, Messer, Laraia, and Mendola (2009) found increased odds of preterm birth in both White and Black women if they resided in predominantly Black tracts. Vinikoor-Imler and colleagues (2011) found increased odds for preterm births in areas with high levels of physical incivilities and low levels of walkability for non-Hispanic White women, but not for non-Hispanic Black women. Additionally, high material and social deprivation has been associated with a higher risk of preterm birth (Auger, Park, Gamache, Pampalon, and Daniel, 2012).

Maternal factors such as age and chronic disease diagnosis or health status also are associated with differences in risk for preterm birth (Vanderweele, Lantos, & Lauderdale, 2012). Martin and colleagues found that preterm birth rates are highest among women aged 45-54 years at 25.9 percent, followed by 21.8 percent in teenagers younger than 15 years (2012). When women experience delayed access to care, women with diabetes and hypertension (Sibai et al., 2000) and genital tract infections (French, McGregor, & Parker, 2006) have been found to be at higher risk for preterm birth. Finally, environmental factors also are associated with higher rates of preterm births, with researchers finding that women who have increased exposure to particulate matter ($PM_{2.5}$) (Kloog, Melly, Ridgway, Coull, & Schwartz, 2012) and sulfur dioxide (SO2) (Le et al., 2012) are at increased risk for delivering preterm.

Disparities in risk for preterm birth discussed thus far have focused on racial, socioeconomic, age, and health status factors, however the processes associated with stress, mental health, and well-being, and how these experiences 'get under the skin' remain some of the most complex and persistent sources of risk for adverse infant health outcomes. In a prospective study of Black women in Baltimore city, women who characterized themselves as 'somewhat or not at all satisfied with their lives' were more likely to have preterm infants, with an adjusted odds ratio of 1.6 (Orr, Orr, James, & Blazer, 2012). In another recent study, Straub and colleagues found that women with antenatal depression, as measured by those with thoughts of self-harm, had significant increases in preterm births for all categories of weeks of gestation (2012). Further, researchers have known for more than 15 years that stressful life events (Hedegaard, Henriksen, Secher, Hatch, & Sabroe, 1996) are associated with a higher likelihood of having a preterm infant and recently, higher perceived stress at 10 to 20 weeks of gestation has been found to be associated with increased preterm birth (Roy-Matton, Moutquin, Brown, Carrier, & Bell, 2011). Extreme examples of stressful life events that have been associate with preterm birth include the Sept. 11, 2001, terrorist attacks (Lipkind, Curry, Huynh, Thorpe, & Matte, 2010) and domestic violence (Shah & Shah, 2010). Given numerous associations between stress and preterm birth, a hypothesis that has been generated as a result of the effect of psychosocial factors, mental health, and chronic stress on adverse maternal and infant health outcomes and their disproportionate distribution and impact across races is the weathering hypothesis. Lu and Halfon (2003) describe how chronic social stressors and their disproportionate distribution and impact lead to weathering of the body's allostatic systems over the years, contributing to the disparities in birth outcomes, including preterm birth. To intervene in improving the health of Black women across the life span, Lu and colleagues (2010) proposed a 12-point plan to reduce Black-White disparities in birth outcomes using a life course approach.

Public health impact

In 2010, the rate of preterm birth in the United States was 12.0 percent of live births (Martin et al. 2012), affecting approximately one in eight births. Preterm birth is associated with potentially life-threatening health problems in the first year of life, and is the primary cause of infant death for babies born to non-Hispanic Black mothers and the second leading cause of death for all infants in the United States. Poor outcomes for the baby, mother, and family have been found across the spectrum of gestational age, from babies born extremely preterm (less than 25 weeks gestation, the group for which there are the poorest outcomes for survival and lifelong disability), to very, moderately, and late preterm. Further, the group of 'early term' infants – babies born just a few weeks early – is receiving national attention due to troubling high rates of early elective deliveries and associations of those deliveries with increased morbidity for the mother and child.

Beyond the immediate health concerns, preterm birth is associated with tremendous economic costs for the family and society as a whole. The total economic cost for medical care (65 percent), maternal delivery (seven percent), early intervention (two percent), special education services (four percent), and lost household and labor market productivity (22 percent) was estimated to be $51,600 per preterm birth in the United States in 2005 (Behrman & Butler(Eds.), 2007), totaling $26 billion annually The Institute of Medicine report from which these figures were developed also specifies that in the first year of life, the medical costs for an infant born preterm are ten times that of an infant born at term.

Preterm birth is a birth outcome with complex causation and requiring a socioecological and life course approach to improve the preconception health of women. However, public health interventions focusing of specific risk factors (e.g. maternal smoking, age, previous preterm birth) have proven effective in particular communities. For example, pooled data from 21 trials of smoking cessation programs during pregnancy (Lumley et al., 2009) showed a significant reduction in preterm births with a relative risk of 0.86 (95 percent Confidence interval: 0.72-0.98). Smoking, as well as alcohol and illicit drug use, are risk factors that have been prime targets for behavioral interventions. Other risk factors for preterm birth include certain medical conditions. The Syracuse Healthy Start program that included screening, treatment and rescreening of women to reduce bacterial vaginosis was found to be associated with reduced preterm births (Koumans et al., 2011).

Other interventions have focused on improving social support and resources and entry into prenatal care. A Centering Pregnancy Program found that providing group prenatal care to pregnant women resulted in preterm infants being larger than those who received individual prenatal care (Ickovics et al., 2003). Such programs can address the psychological, environmental stressors, and socio-economic factors that have been found to play a role in increased preterm births. The CenteringPregnancy group prenatal care model will receive additional funds from the W.K. Kellogg Foundation and the CMS Strong Start Initiative to expand its programs and reach, given the success of the model (CenteringHealthcare, 2013). However, these successes cannot be extended to all health education programs including those targeting preterm birth. Historically, preterm birth prevention educational programs have had little effect on reducing preterm births and may increase rates of preterm labor diagnoses (Hueston, Knox, Eilers, Pauwels, & Londsdorf, 1995).

Recent efforts to prevent preterm births have focused on women who have had a previous preterm birth. In particular, the prenatal administration of progesterone (hydroxyprogesterone caproate injection, commonly known as 17P, or in the form of progesterone gel) has proven effective in reducing the risk of perinatal mortality, preterm birth less than 34 weeks, infant birthweight less than 2500 g, and a number of other poor infant health outcomes (Dodd et al, 2013). Questions remain regarding the cost effectiveness of the intervention and access to the intervention, especially for low income patients, given the cost of the injections.

Reducing the rate of preterm births in the United States and their associated disparities will require a multi-faceted effort. While recent advances in clinical care (17P, elimination of early elective deliveries) and reducing behavioral risk factors for preterm birth are promising, they are not sufficient to overcome the persistent and historically unexplained disparities in preterm birth. Improving women's health across the life span and the social context and inequitable distribution of resources and services (including support systems) across race/ethnicities and class will need to guide future program and policy development.

Leverage or realign resources

Numerous and diverse partners have a stake in building programs and services to reduce preterm births and influence the health of infants, women, families and communities across the life span. An indicator for preterm birth articulated as a measure of life course health offers a uniting concept through which each organization and initiative can impact health across a continuum of services and supports. The following are key national efforts and priorities to reduce preterm births:

- One of the objectives of the Healthy People 2020–MICH-9 is to reduce preterm births. The MICH-9.1 objective is to reduce the proportion of births that are preterm to 11.4 percent. MICH-9.2 objective is to reduce late preterm or live births at 34 to 36 weeks of gestation to 8.1 percent. The MICH-9.3 objective pertains to reduction of the proportion of live births at 32 to 33 weeks of gestation to 1.4 percent and the MICH-9.4 objective is to reduce the proportion of very preterm or live births at less than 28 weeks of gestation to 1.8 percent (HealthyPeople.gov, 2012). The Institute of Medicine (IOM) report on "Preterm birth: Causes, Consequences, and Prevention" proposed a research agenda to investigate preterm birth that includes establishment of multidisciplinary research centers, improving research by better definition of the problem, investigation into the etiology, epidemiology, and clinical and health service research for preterm birth, and eventually inform public policies to reduce preterm birth rates (Behrman & Butler (Eds.), 2007).
- The Maternal and Child Health Bureau (MCHB) CoIIN (Collaborative Improvement & Innovation Network) is a public-private partnership to reduce infant mortality and improve birth outcomes in 13 southern states comprising HRSA Regions IV and VI (U.S. Department of Health and Human Services, Health Resources and Services Administration, Maternal and Child Health Bureau, 2013), which was recently expanded to also include Region V and with plans for a national expansion. States selecting priorities for quality improvement initiatives are focusing on outcomes like early elective deliveries to make an impact on preterm birth rates and other birth outcomes.
- The March of Dimes began a "Prematurity Research Initiative" to investigate the causes of prematurity and have declared the month of November as "Prematurity Awareness Month" to specifically focus on preterm births (March of Dimes, 2013). For decades the March of Dimes has been at the forefront of building awareness of and funding research into the causes of, and treatments for, preterm birth. Recent efforts receiving national attention include the Healthy Babies are Worth the Wait (HBWW) and the 39+ weeks campaign. The HBWW initiative is both a model of collaboration among local- and state-level clinical and public health partners and a national public awareness campaign. As a collaboration model, HBWW engages the community in efforts to achieve its goals of decreasing preterm births, implementing preventable strategies against preterm births and changing the attitudes and behaviors of providers and consumers. There are five core components (the five Ps) of the HBWW model: 1) partnerships and collaborations, 2) provider initiatives, 3) patient support, 4) public engagement, and 5) measuring progress. With regard to the 39+ weeks campaign, in response to the Joint Commission's perinatal care core measure set that includes the number of elective deliveries performed >37 and <39 weeks, the March of Dimes and partners created a quality improvement toolkit for professionals: Elimination of Non-medically Indicated Deliveries Before 39 Weeks. The

toolkit focuses on scientific evidence, implementation efforts, data collection, and education. Both of these March of Dimes initiatives focus on collaborations between public health and clinical care, including hospitals and care institutions, and speak to the role of health care professionals in achieving public health goals.

- The Centers for Medicare and Medicaid Services launched the Strong Start for Mothers and Newborns Initiative (U.S. Department of Health and Human Services, 2013). With an overall goal to reduce the risk of significant complications and long-term health problems for both expectant mothers and newborns, the initiative utilizes two strategies -Public-Private Partnership to Reduce Early Elective Deliveries and Funding Opportunity for Testing New Approaches to Prenatal Care. The Public-Private Partnership to Reduce Early Elective Deliveries will examine ways to promote best practices and support providers in reducing early elective deliveries prior to 39 weeks. The Funding Opportunity for Testing New Approaches to Prenatal Care will fund opportunities for providers, states and other eligible applicants to test the effectiveness of three enhanced prenatal care approaches (enhanced Prenatal Care through Centering/Group Visits, at Birth Centers or Maternity Care Homes) to reduce preterm births for Medicaid covered women at risk for preterm births. Twenty-seven Strong Start awardees were announced in February 2013.
- Further investments in prematurity prevention include the efforts of the Association of State and Territorial Health Officials (ASTHO), which partnered with the March of Dimes to launch the Healthy Babies President's Challenge to help states prevent preterm birth and infant mortality. The challenge asks state health officials to sign a pledge to: publicly announce a goal to reduce the rate of premature birth by eight percent by 2014 (measured against 2009 data); initiate and support programs and policies that reduce the premature birth rate; and build wider awareness of prematurity rates and other related maternal and child health indicators. The ASTHO challenge represents an important collaboration at the level of the state health official to raise awareness of preterm birth and to collaborate to implement prevention strategies.

A life course indicator for preterm birth unites these national initiatives – which use different processes including quality improvement, public education, public policy, and health care financing reform – with more behaviorally focused efforts like smoking cessation programs or anti-poverty and anti-discrimination reforms in housing, nutrition, education, and the workforce to reduce exposure to stressors across the life span of women. In addition to national initiatives, states can consider how different processes and approaches can work synergistically to achieve collective impact in reducing preterm births. The AMCHP Compendium, *Forging a Comprehensive Initiative to Improve Birth Outcomes and Reduce Infant Mortality: Policy and Program Options for State Planning (2012),* offers seven recommendations (and specific state case examples) for implementing state policy and programming options, many specific to reducing preterm births. These seven recommendations include the following:

1. Implement health promotion efforts
2. Ensure quality of care for all women and infants
3. Improve maternal risk screening for all women of reproductive age
4. Enhance service integration for women and infants
5. Improve access to health care for women before, during, and after pregnancy
6. Develop state data systems to understand and inform efforts
7. Promote social equity

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

Preterm birth has implications for the health of the child born preterm, the mother, and the family unit.

Babies born preterm face a spectrum of health challenges that may begin shortly after birth, and are associated with how early the baby is born (extremely preterm, very preterm, or moderate to late preterm). Of greatest concern is the increased risk for mortality in the first year of life, as preterm birth is the leading cause of infant mortality in the United States (Centers for Disease Control and Prevention, 2013). Health problems preterm babies may face soon after delivery include apnea, respiratory distress syndrome, intraventricular hemorrhage, patent ductus arteriosis, necrotizing enterocolitis, retinopathy of prematurity, jaundice, anemia, bronchopulmonary dysplasia, and a number of infections due to their immature immune systems (March of Dimes, 2012). Many of these conditions require admittance to the neonatal intensive care unit (NICU) that drives up health care costs for the family and society.

Additionally, these health conditions and features of the preterm newborn have been associated with longer-term health problems and disabilities. Long-term impacts of preterm birth on the infant include increased risk of autism, intellectual disabilities, cerebral palsy, lung problems, and vision and hearing loss. For example, de Kievet, Zoetebier, van Elburg, Vermeulen, and Oosterlaan (2012) found that very preterm infants have a total brain volume 0.58 standard deviations lower than term infants, which has been associated with reduced cognitive functioning. Furthermore, in addition to potential respiratory distress syndrome after birth, children born extremely preterm have been found to have significant impairment of lung function, particularly in those who have had bronchopulmonary dysplasia (Bolton et al., 2012). These children also were found to have an increased use of bronchodilators, inhaled corticosteroids, and leukotriene antagonists. With regard to vision loss, extremely preterm infants with severe retinopathy of prematurity were found to have significant reduction in vision, despite using prescription glasses, compared to those born without abnormal blood vessel growth in the eyes characterized by retinopathy of prematurity (Farooqi, Hagglof, Sedin, & Serenius, 2011). Additionally, preterm infants who have had necrotizing enterocolitis were found to have elevated levels of circulating IL-6 in the neonatal period that is associated with higher rates of poor growth (height, weight) and neurodevelopmental disability at 24-28 months (Lodha, Asztalos, & Moore, 2010).

Short and long term health problems associated with being born preterm are not limited to the more rare and extreme cases: infants born moderately or late preterm have been found to face a number of health and development problems. Preterm infants have increased odds of hyperactivity- impulsivity symptoms as well as inattention symptoms when assessed from 17 months to eight years (Galera et al., 2011). Late preterm infants have been found to grow up to face psychological development problems and behavioral and emotional disturbances, be less likely to attain university or post-secondary education, and have lower scores for reading and math in school (Ramachandrappa & Jain, 2009). Preterm infants are more likely to need early intervention and special education services across the life span. These deficits in learning can have ripple effects in educational attainment, future income and economic opportunity, and speak to the interrelationship between health and education.

Preterm birth also is an indicator for the individual health of the mother. Chronic adult diseases like diabetes (Rich-Edwards et al., 2005), obesity (Ravelli, Stein, & Susser, 1976), and coronary artery disease (Barker, 1997) have been found to precipitate preterm deliveries (Sibai et al., 2000). Other conditions associated with preterm birth in the mother include genital tract infections (French, McGregor, & Parker, 2006). Timely treatment of genital tract infections like bacterial vaginosis can reduce preterm births (Koumans et al., 2011). However, untreated infections is not only associated with preterm deliveries but signify potential challenges in accessing care. Maternal depression (Straub, Adams, Kim, & Silver, 2012) and stress (Hedegaard, Henriksen, Secher, Hatch, & Sabroe, 1996) also have been associated with preterm birth and are a reflection of maternal well-being, as are women who continue to smoke or use alcohol or illicit drugs during their pregnancy.

Exposure to stress, racism and discrimination, and prolonged deprivation for women and families also is associated with preterm birth, and recent research pursues these mechanisms as increasing the allostatic load and lifetime exposure to risk factors that precipitate preterm birth (Lu & Halfon, 2003). Kramer, Dunlop, and Hogue (2013) recently published an innovative and persuasive study using longitudinally linked vital records to describe exposure to cumulative neighborhood deprivation as associated with preterm birth. It is in this vein that preterm birth as an indicator of life course health must be considered an indicator of the health of the infant, the mother, and the community and context in which that family lives.

Data Criteria

Data availability

Data for calculating preterm births are collected from the vital registration systems in the individual States and territories that are legally responsible for registration of vital events, including births. They are responsible for maintaining registries of vital events and for issuing copies of birth certificates (National Center for Health Statistics [NCHS], Division of Vital Statistics, 2000).

Historically, pre-term birth, or a birth prior to 37 weeks gestation, has been determined primarily through gestational age calculated from last menstrual period (LMP) and infant date of birth as reported in the birth certificate. The first standard birth certificate in the United States was developed by the Census Bureau in 1900. Since that time there have been 12 revisions of the birth certificate, with the most recent revision released in 2003 (NCHS, Division of Vital Statistics, 2000). 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.

Date of 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). For the purposes of this indicator, gestational age as calculated from the clinical or obstetric estimate is recommended. This estimate is available on the birth certificate for each state,

Birth certificates from the states that have not implemented the 2003 revision of the U.S. Standard Certificates of Live Birth lack information about certain potential modifiers like multiple racial groups, smoking status of mother, principal source of payment, and the highest education attained by the mother. The certificate, however, has a checkbox for indicating the principal source of payment for the delivery including private insurance, Medicaid, self-payment and any other source to be specified which can be used as a proxy for income.

The data source, National Vital Statistics System-Natality, also gives annual county–level data for preterm birth (Health Indicators Warehouse, 2012). 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 collects and disseminates the Nation's official vital statistics. Vital event data are collected and maintained by the jurisdictions which 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.

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 (NAPHSIS) 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.

In recent years, epidemiologists have begun to focus on the use of clinical or obstetric estimate as the population-based standard for gestational age, given a number of limitations associated with the accuracy of the LMP. LMP as a marker for gestational age is prone to recall bias and also fails to account for the variability in the pre-ovulatory interval. Moreover, LMP data has a higher frequency of missing data. Women tend to overestimate their LMPs when the length of recall is more than three weeks (Wegienka & Baird, 2005); and Alexander et al. (1995) found that the LMP on birth certificates either overestimated or underestimated gestational age as compared to clinical estimate. In a study comparing LMP on birth certificates and LMP from California's Expanded Alpha-fetoprotein Screening Program, 46 percent of gestational age discrepancies using the LMP on birth certificates were due to clerical or digit preference errors (Pearl, Wier, & Kharrazi, 2007). The majority of clerical errors were due to whole month deliveries (47.7 percent) and 10-day deviations (47.8 percent). Despite these limitations, LMP remained the standard for gestational age calculation. Parker and Schoendorf (2002) reported that the criteria by Alexander et al or Zhang et al can be used to correct for implausible gestational ages. The researchers found that if the criteria by Alexander et al is used, wherein records with implausible gestational age combinations are excluded, then less than 0.5 percent records would be excluded; whereas three times as many birth records were modified or excluded using Zhang et al criteria (for records with implausible birth weight/gestational age combinations clinical estimate of gestational age was substituted and records with implausible combinations but no clinical estimates are excluded). For preterm births less than 32 weeks, the calculation for national rate was 1.3, 1.2, and 1.6 according to Alexander and Zhang criteria and National Center for Health Statistics (NCHS), respectively.

To overcome questions raised about the accuracy of LMP as a population-based standard for assessing gestational age, Callaghan and Dietz (2010) explored how different methods of assigning gestational age in vital records data affect distributions of birth weight for gestational age. Using the 2005 public-use U.S. Natality file from NCHS, they compared four measures of gestational age: LMP, the clinical estimate, the obstetric estimate, and a gold standard they developed from a subcohort of births. This "gold standard" for gestational age measurement included those births for which the records had no more than a one week difference in LMP and either clinical or obstetric estimate, no record of a congenital anomaly, and the mother began prenatal care in the third month of pregnancy or earlier. The research team found that both clinical and obstetric estimates of gestational age resulted in birth weight distributions virtually identical to the gold standard, whereas the distribution derived from LMP was substantially different. It is for this reason the authors concluded that clinical or obstetric estimates may be preferable for establishing population-based size-for-gestational age norms. Additionally, researchers have found that clinical estimate tends to be more highly correlated with birthweight than LMP, and fewer birthweight-inconsistent gestational age values exist within birth files (Alexander et al., 1995; Mustafa & David, 2001).

Despite the aforementioned potential advantages, clinical assessments of gestational age may be inaccurate in instances in which postnatal measures are used or in instances where size-based gestational age estimates are used (fundal height, ultrasound measures, or maturity-focused assessments that use clinical sign, such as quickening) and that can't take into account different rates of growth or maturation or different characteristics of the mother or the maternal environment (smoking, obesity, etc.). Such inaccuracies are hoped to be reduced with the transition to obstetric estimate. In an Indiana study (Zollinger, Przybylski , & Gamache, 2006) that compared birth certificates with hospital birth records, the measure of agreement between the clinical estimate of gestation in the birth certificate and hospital birth records was "moderate," at a kappa of 0.660, better than the measure of agreement for date last normal menses began (0.630).

Recently, clinical or obstetric estimate as the standard for gestational age calculation has been utilized by States in designing interventions to improve maternal and infant health outcomes, including the Hawaii Department of Health, among others (Hayes et al., 2013).

Simplicity of indicator

The complexity of calculating preterm birth is associated with the selection of a standard method for gestational age estimate. The use of clinical or obstetric estimate as the method for estimating gestational age is a new, though believed to be improved, method from the use of LMP (clinical or obstetric estimate has been used in instances in which LMP is missing, implausible, or believed to inaccurate). Moreover, the method for calculating the indicator is substantially easier. Hall, Folger and Kelly (2013) evaluated the impact of three methods of gestational age estimate (LMP, obstetric estimate, and a combined measure using obstetric estimate if LMP is missing or inconsistent) on the calculation of the preterm birth rate in Ohio and found that disagreement in gestational age led to a 1.8 percentage point difference in preterm birth calculations (11.0 percent using obstetric and 12.8 percent using combined estimates). The findings of the study underscore the importance of clarity and consistency when describing gestational age and its use in calculating preterm birth rates, including for subcategories.

Upon selection of the gestational age estimate method, a data cleaning procedure must be implemented for instances in which a clinical or obstetric estimate is missing or implausible. In the Ohio study mentioned above, over the four year study period, the LMP variable had the greatest number of missing values, with 18.2 percent of records missing an estimate of LMP-based gestational age. For obstetrical estimate, only 0.3 percent of records were missing an obstetrical estimate of gestational age. In the event clinical or obstetrical estimate data is missing or implausible, data users may implement an algorithm to determine the record's exclusion, substitution for LMP, or substitution using an estimate based on sociodemographic characteristics.

With a clear and consistent method for estimating gestational age and a validated cleaning procedure, preterm birth is simple to calculate and does not involve any complex formula, data weighting, or data indexing. The numerator, number of live births born prior to 37 weeks of gestation, as calculated by clinical or obstetric estimate, and the denominator, number of live births, are easy to understand and explain.

References

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