

Potential pregnancy days lost: an innovative measure of gestational age

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ABSTRACT

In Brazil, the excess of interventions that anticipate childbirth, such as cesarean sections and labor inductions, has resulted in the shortening of pregnancy, with negative consequences on maternal-infant outcomes. This commentary presents a novel way to measure gestational age: the continuous variable “Potential pregnancy days lost.” Using data from the Live Birth Information System (SINASC), we counted the missing days between the period until childbirth and the average duration of pregnancy (280 days), or the lost weeks. This measure can be used as an outcome variable (socioeconomic-demographic characteristics of the mother, type of childbirth, financing, etc.) or exposure variable (for neonatal, infant, and maternal outcomes). The indicator can be used in municipal and national cohorts and intervention studies to analyze hospitals and regions. We discuss the limits and scope of gestational age measures and, given their inaccuracies, the importance of studying their trends.

DESCRIPTORS: Gestational Age. Infant, Newborn, growth & development. Labor, Induced, adverse effects. Cesarean Section. Iatrogenic Disease. Vital Statistics.

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The Excess of Childbirth Interventions Has Reduced the Duration of Pregnancy

The health promotion of mothers and newborns and the health of next generations is a priority worldwide. One of the main concerns lies in the prevention of preterm birth, since these children usually present more health problems and disabilities, mostly affecting family well-being, in the health system and social costs. The more premature the children, the worse the health outcomes¹. Depending on socioeconomic characteristics, health care and the quality of available data, prematurity rates range from less than 5% to more than 15% worldwide².

For several decades, the “term” period (between 37 and 42 weeks of gestation) was treated as a homogeneous category, as it was believed that childbirth could occur or be initiated safely and without additional risks from its beginning (at 259 days, or 37 full weeks). Currently, we recognize that the traditional binary concept (term *versus* preterm) can mask the continuous effect of fetal immaturity as a predictor of negative outcome³. Thus, we are developing an innovative measure of gestational age (GA), a continuous variable named “potential pregnancy days lost” (PPDL), counting the missing days from the date of childbirth to the date when the average duration of pregnancy (280 days) would be completed, using data from birth records of the Live Birth Information System (SINASC).

Induction of labor and cesarean section are essential resources to achieve optimal maternal and neonatal morbidity and mortality rates, and they should be available in a timely manner for all women who need them. However, when the proportion of cesarean sections in a population exceeds the level between 10% and 15%, these intervention disadvantages tend to outweigh the potential benefits for mothers and infants, especially when performed before the spontaneous onset of labor and the 39 full weeks of gestation^{4,5}. This is the case in Brazil, where GA in childbirth has decreased, as a result of the overestimation of the safety of interventions associated with the abbreviation of pregnancy (cesarean section and induction of labor)^{6,7}.

The reasons why cesarean section is highly accepted in Brazil constitute a complex issue, including cultural, political, and economic aspects related to the barriers faced by the health system in offering a positive experience of childbirth, with humanized and evidence-based care. The high financial convenience of elective cesarean section, both for health professionals and institutions^{6,7}, also has its influence. In Brazil, childbirth before physiological maturity can occur due to clinical and socioeconomic factors, iatrogenic causes or a combination of factors.

Shortening of pregnancy as a Public Health Issue and the New Classification of GA

In the last two decades, robust evidence has indicated that being born at “early term” (37 0/7 weeks to 38 6/7 weeks) is associated with health outcomes more similar to those born at “late-preterm” (34 0/7 to 36 6/7) than with those born with more than 39 weeks^{4,8}. Based on this innovative interpretation, a new categorical classification was adopted, subdividing the period of “term” into “early term”, “full term” (39 0/7 to 40 6/7), and “late term” (41 0/7 to 41 6/7),⁴ according to Figure 1.

An analysis of data from the Birth in Brazil National Inquiry (2011–2012), with 23,940 mother-baby pairs, shows that early term childbirth was associated with an increased risk of neonatal death, neonatal ICU admission, oxygen therapy, hypoglycemia, transient tachypnea, need for phototherapy and lower chances of being breastfed in the first hour of life or during hospitalization⁹. Even with the confirmed pulmonary maturity, early term childbirth is associated with worse neonatal respiratory and hepatic outcomes compared with full-term births^{10,11}. This increase in preventable morbidity and mortality burdens financially and logistically a health system already quite deficient.

Regarding long-term consequences of perinatal interventions, solid pieces of evidence show that cesarean section is associated with an increased risk of chronic diseases

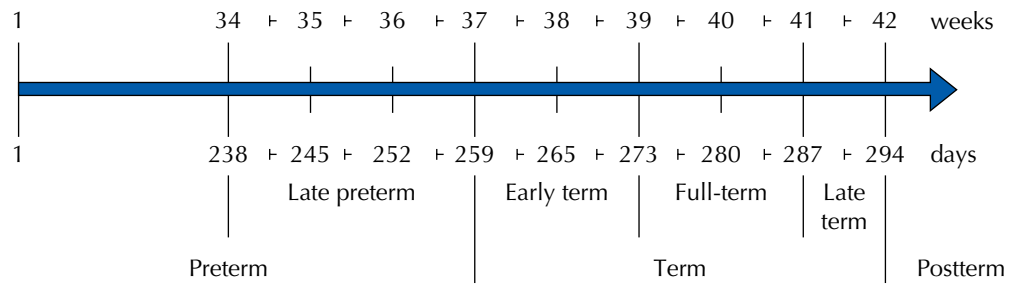


Figure 1. New gestational age classification, according to the American College of Obstetricians and Gynecologists⁴.

in childhood, such as asthma, diabetes, obesity, hypertension, arthritis, neurological problems, allergies, and certain types of cancer such as leukemia¹¹⁻²¹. Excessive use of cesarean section and induction of labor also increases the risks of maternal morbidity and mortality, directly affecting mothers and their children, indirectly^{11,22}.

There is growing evidence about an inverted dose-response effect between GA in full-term newborns and the risk of developmental delays²³. Studies show that, even controlling confounding variables related to sociodemographic aspects and maternal morbidity, an infant born by elective cesarean section, even in the term period, is associated with worse school performance in language and mathematics²⁴. A systematic review of 61 studies covering more than 20 million childbirths showed that caesarean section delivery was significantly associated with autism spectrum disorder and attention-deficit hyperactivity, regardless of cesarean section modality, compared with vaginal birth²³.

Unnecessary shortening of pregnancy affects neonatal mortality and neonatal and maternal morbidity, as well as long-term effects on chronic diseases in children, including neurocognitive development. Thus, this is a relevant and underestimated public health issue, considering its high prevalence, severity, and avoidability (possibility of control) in the Brazilian case.

A total of three interrelated mechanisms are involved in health complications resulting from the excessive use of interventions related to pregnancy abbreviation, even in full-term births (37 to 42 weeks)^{9,10}. Firstly, considering that biological signs of fetal maturity trigger spontaneous labor, elective cesarean section without labor, as well as induction of labor, prevent the baby from achieving this maturity to born, and such techniques should be used with caution, when the benefits clearly outweigh risks^{3,9-12}.

Secondly, the hours of spontaneous labor promote epigenetic expression of genes associated with fetal transition to extrauterine life¹⁰. Nowadays, it is recognized that complex neuroendocrine processes, with the release of catecholamines, oxytocin, and endorphins during the different stages of labor, prepare the immune, respiratory, and gastrointestinal systems of the fetus, in addition to protecting the child's brain from birth stress, reducing vulnerability to hypoxia and fetal distress, resulting in a safer fetal-neonatal transition^{3,11,13}. The physiological release of oxytocin and endorphins is also related to a more comfortable childbirth for the mother and baby, reducing the risk of maternal hemorrhage and facilitating the initiation of breastfeeding¹⁰⁻¹².

Thirdly, in a cesarean section, for the children do not pass through the birth canal, they are deprived of contact with the mother's vaginal bacteria, which is currently recognized as a key element for a healthy colonization of the child's microbiome¹⁰⁻¹². This early contact is associated with a healthier activation of the immune system, better response to infections, and less inflammatory metabolism, leading to greater resilience to chronic diseases

in childhood and adulthood¹¹. In an elective cesarean section, these three protective mechanisms will be impaired.

Advantages and Limitations of GA Measurement in Days

The mean GA of the population at birth, based on spontaneous childbirth, is considered internationally as 40 weeks (280 days) from the first day of the last menstrual period (LMP)²⁵. The estimation of GA can also be carried out by ultrasound, whose accuracy is good at the beginning of pregnancy (considered as the “gold standard” measure), but it can reach three weeks of error or more in the final months. After childbirth, GA can also be estimated by physical examination of the newborn^{19,25-27}. As a reflection of the international change in the understanding of the risks associated with the anticipation of childbirth even within the term period, since 2011 SINASC allows to estimate the GA in weeks and days, based on the date of the last menstrual period, or other estimation methods. Thus, GA can be used as a continuous variable, if there is good completeness, or corrected by linkage of databases or imputation.

The estimate of GA at birth is inaccurate, for the reasons mentioned and for the individual variability of fetal maturation. However, in addition to the accuracy of GA, considering public health, it is relevant to study its temporal changes and trends in the population and associated factors.

Although it is possible to estimate GA in days, in practice we observe a tendency to recategorize GA in weeks of gestation and in the term interval previously defined (37 to 42 weeks), limiting the potential to increase the granularity of data⁶. A qualitative component of this research is exploring the problems related to filling out the form, by ethnographic observation and interviews, to better understand the systematic biases in the information of GA in the declarations of live births and the logic behind them.

It is also advantageous to increase the granularity of data using GA weeks or term fractions (early, full, and late), especially when data in days, based on LMP, are not available. Data from the Birth in Brazil survey, as well as from the São Paulo municipal SINASC, show the apex of the GA curve for vaginal deliveries corresponds to 39 weeks, whereas for cesarean section it is 38 weeks,^{6,7} trends that also apply at national level²⁷. This is an “inversion of the expected disparity,” since socioeconomic factors are decisive for the best maternal-infant outcomes, and historically it is expected that those born from more educated mothers and private sector users are born with higher GA²⁸.

An Innovative Indicator, Based on a New Interpretation of Available Data, to Subsidize Public Policies

From the moment we recognize that each day of pregnancy counts on perinatal health and well-being, we should move towards a “harmfree care”²⁹, making visible not only the number of days and weeks of gestation lost, but also how this loss is potentially harmful. As data often present collection errors, information can be adjusted by considering the parameters of normal distributions, presented by subgroups with GA measured by LMP and “other” methods, as it was successfully performed using data from Birth in Brazil³⁰.

This research aims to develop and test the indicator “potential pregnancy days lost.” We are starting with the SINASC database of the Municipal Health Department of São Paulo, in partnership with the management of this system. We have created new databases using LMP information, transforming GA into days, and potential pregnancy days lost. These databases are linked to the Brazilian Mortality Information System (MIS), enabling the study of the relationships between GA in days with infant and maternal death.

Considering that part of the database does not have LMP data, besides experimenting the imputation of the missing GA data in days, we have used the available information of pregnancy dating by other methods (ultrasound and physical examination), increasing the

granularity of GA using the measurement in weeks and fractions of the term (early, full, late). We are developing machine learning resources to create predictive models related to maternal and neonatal risks, using PPDL as a continuous variable, also testing gestational age values with different granularities.

This project is being conducted in partnership with public managers to provide an alignment of their outcomes to the needs of municipal management and services. Finally, it is expected to introduce and make current the PPDL indicator in the practice and training of health professionals, supporting a safer, more respectful perinatal care, based on the best care practices.

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