Original Study

Modifying Effect of Prenatal Care on the Association Between Young Maternal Age and Adverse Birth Outcomes

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A B S T R A C T

Objectives: The objectives were to investigate the prevalence of adverse birth outcomes according to maternal age range in the city of Rio de Janeiro, Brazil, in 2002, and to evaluate the association between maternal age range and adverse birth outcomes using additive interaction to determine whether adequate prenatal care can attenuate the harmful effect of young age on pregnancy outcomes.
Methods: A cross-sectional analysis was performed in women up to 24 years of age who gave birth to live children in 2002 in the city of Rio de Janeiro. To evaluate adverse outcomes, the exposure variable was maternal age range, and the outcome variables were very preterm birth, low birth weight, prematurity, and low 5-minute Apgar score. The presence of interaction was investigated with the composite variable maternal age plus prenatal care. The proportions and respective 95% confidence intervals were calculated for adequate schooling, delivery in a public maternity hospital, and adequate prenatal care, and the outcomes according to maternal age range. The chi-square test was used. The association between age range and birth outcomes was evaluated with logistic models adjusted for schooling and type of hospital for each prenatal stratum and outcome. Attributable proportion was calculated in order to measure additive interaction.
Results: Of the 40,111 live births in the sample, 1.9% corresponded to children of mothers from 10-14 years of age, 38% from 15-19 years, and 59.9% from 20-24 years. An association between maternal age and adverse outcomes was observed only in adolescent mothers with inadequate prenatal care, and significant additive interaction was observed between prenatal care and maternal age for all the outcomes.
Conclusion: Adolescent mothers and their newborns are exposed to greater risk of adverse outcomes when prenatal care fails to comply with current guidelines.
Key Words: Teenage pregnancy, Adverse outcomes, Pre-natal care, Rapid repeat pregnancy, Additive interaction

Introduction

Although studies in recent years have indicated a downward trend in teenage pregnancy in countries like the United States, Canada, Italy, and England, statistics in Brazil and other countries reveal a situation that is far from ideal.[1–4] According to the Pan-American Health Organization (2007),[5] from 2000-2008 the specific fertility rate in women 15-19 years of age remained relatively stable in Argentina, Brazil, Canada, Cuba, Mexico, and the United States, whereas Brazil showed the highest rates and Canada the lowest rates in all the years studied.

Pregnancy in this age group involves multiple factors, and studies on this issue in different countries have generally shown similar findings. Adolescent pregnancy is related to poverty, lower education level, lack of work prospects and educational plans, early menarche, sexual initiation without family orientation or sex education in school, and family history of adolescent pregnancy.[6–12] Adolescent mothers have a higher risk of living in poverty, being socially excluded, and having less schooling. These unfavorable socioeconomic conditions may be both the cause and consequence of adolescent pregnancy. In fact, many adolescent mothers drop out of school, thus feeding a cycle of poverty and adverse status.[13] However, other studies have shown that many adolescents have dropped out of school even before becoming pregnant.

Adolescent pregnancy is associated with higher rates of maternal mortality[13] and adverse obstetric outcomes like prematurity,[11,14–18] low birth weight,[9,11,16–19] small for gestational age newborns,[14,18,20,21] low Apgar score,[11,17] and neonatal mortality,[17,21,22] whereas the highest risk is in mothers under 15 years of age. Two hypotheses have been raised to explain the higher rate of adverse birth events in adolescents: biological immaturity and the association between adolescent pregnancy and low socioeconomic status. According to the hypothesis of biological immaturity, adolescents are not adequately physiologically prepared to carry a pregnancy.[18] The latter hypothesis contends that low socioeconomic status, generally observed in pregnant adolescents, could lead to greater exposure to risk

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situations like drinking, smoking, and illicit drug use,[19] and especially to worse prenatal care.[20] Despite this controversy, there appears to be a consensus that prenatal care, as in other age ranges,[11,23–26] reduces the occurrence of adverse outcomes in adolescent pregnancy.[9,11] However, as far as we know, no study has formally investigated the modifying effect of prenatal care on the association between maternal age and adverse birth events, using the calculation of additive interaction for this purpose. The objective of this study was to evaluate the association between maternal age range (10-14, 15-19, and 20-24 years) and adverse pregnancy outcomes (very preterm birth, prematurity, low birth weight, and low 5-minute Apgar score), verifying whether prenatal care can attenuate the harmful effect of early pregnancy on birth outcomes.

Materials and Methods

Data Source and Study Population

The data came from a live birth database in the city of Rio de Janeiro, Brazil, for the year 2002 (N = 87,358). Records were selected for children of mothers 24 years old or younger, and records for twin births were excluded (N = 57), thus totaling 40,011 live births. The study was approved by the Institutional Review Board of the Institute for Collective Health Studies at the Federal University in Rio de Janeiro (IESC/UFRJ). The reference year was chosen because it was the baseline of a longitudinal study aimed to determine risk factors for rapid repeated pregnancies among adolescents, and the interval between 2002 and 2004 was covered by the only dataset with identifiable data, a fundamental requisite for the linkage process.

Variables

The exposure variable was maternal age range (10-14, 15-19, and 20-24 years), and the co-variables were mode of delivery, adequate schooling for age (adequate vs inadequate), type of maternity hospital (public vs private), and prenatal care (adequate, 7 or more consults, vs inadequate, fewer than 7 consults, as recommended by the Ministry of Health[27]). For mothers over 19 years of age, adequate schooling was defined as 12 years of schooling or more, whereas for younger mothers it was defined as having the minimum expected years of schooling for their age.[18] The outcome variables were very preterm birth (gestation < 32 weeks), prematurity (gestation < 37 weeks), low birth weight ($< 2{,}500$ g), and low 5-minute Apgar score (< 7). In the absence of better proxies for income, we used a binary classification based on the source of funding for the hospital, public or private, assuming that the former would be associated with lower income and the latter with higher income. The rationale is that although the Brazilian health system is supposed to provide universal care, the existence of a multi-tiered system means that those with better income tend to not use the public facilities and rely on health insurance or out-of-pocket purchase of services, whereas those with lower income will use the public-funded facilities. Health care establishments that operated with both public and private maternity beds were classified as belonging to the public sector.

Data Analysis

The proportions of adverse birth events (low birth weight, very preterm birth, prematurity, and low 5-minute Apgar score) and their respective 95% confidence intervals were calculated according to maternal age range within each prenatal care stratum (adequate, ≥ 7 prenatal visits, vs inadequate, < 7 visits). Differences according to maternal age range were evaluated by the chi-square test for linear trend. The association between maternal age range and adverse birth events was evaluated by specific logistic models for each prenatal care stratum and outcome, further adjusted for adequate maternal schooling for age and delivery in a public maternity hospital (proxy for income).

In order to test for possible additive interaction between maternal age (adolescent vs young adult) and prenatal care (adequate vs inadequate) in relation to adverse birth outcomes, a 4-level variable was created, as follows: young adult mothers with adequate prenatal care; adolescent mothers with adequate prenatal care; young adult mothers with inadequate prenatal care; and adolescent mothers with inadequate prenatal care. This variable was then included in logistic models separately adjusted for each outcome, using adult mothers with adequate prenatal care as the reference category and further adjusting for delivery in a public maternity hospital (proxy for income). To measure additive interaction, we calculated the attributable proportion owing to interaction Attributable proportion (AP) as follows: $(RR_{11}\text{-}RR_{10}\text{-}RR_{01}+1)/RR_{11}$, where RR = relative risk; first subscript = adolescent (1 = yes; 0 = no) and second subscript = inadequate prenatal (1 = yes; 0 = no). This measure expresses the proportion of the outcome attributable to the interaction between young mother age and inadequate prenatal care; AP = 0 indicates no interaction between the exposure factors. We calculated AP using the odds ratio as an estimator of relative risk. We used the AP index because it has been shown to be the most appropriate measure of additive interaction when using odds ratio instead of the relative risk as a measure of effect.[28]

Results

Of the live births in the study sample, 768 (1.9%) corresponded to children of mothers from 10-14 years of age, 15,327 (38.2%) 15-19 years, and 24,016 (59.9%) 20-24 years. Table 1 shows the socioeconomic and prenatal care characteristics for the mothers, according to the target age ranges. When compared to mothers 20-24 years of age, adolescent mothers showed a higher proportion of adequate schooling for age and a higher proportion of deliveries in hospitals affiliated with the Unified National Health System (SUS), whereas there was a significant decrease in the latter proportion with increasing age ($P < .001$). Adolescents mothers exhibited lower proportion of cesarean delivery ($P < .001$). As for prenatal care, adolescent mothers showed a lower proportion of adequate