Small-for-Gestational-Age Births are Associated with Maternal Relationship Status: A Population-Wide Analysis

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Abstract

*Objectives:*

To examine the association between maternal relationship status during pregnancy and infant birth outcomes.

*Methods:*

Observational study of longitudinal data on a cohort of women from the National Longitudinal Survey of Youth 1979, a nationally representative sample of 12,686 men and women between the ages of 14 and 21. We used data from surveys between 1979 and 2004. We defined relationship status as the maternal relationship with an opposite-sex partner in the birth year of the child. Cohabitation was defined as unmarried but living with an opposite-sex partner. Stability was defined as the consistency in relationship status in the years surrounding the birth. We defined term small-for-gestational-age (SGA) with an established standard using gestational age and birth weight. We applied random effects logistic regression models to control for confounding by maternal race, infant sex, history of miscarriage, employment, maternal age, year, poverty, and tobacco use, and to account for repeated birth outcomes to the same woman.

*Results:*

The study included 4439 women with 8348 live births. In fully adjusted models, term SGA infants were more commonly born to cohabitating women (OR 1.81; 95% CI 1.20 - 2.73) and unmarried women (OR 1.82; CI 1.34-2.47; LRT P-value 0.0001), compared to married women. SGA infants were also more commonly born in unstable relationships (OR: 1.72; 95% CI 1.14 - 2.63; LRT P-value 0.01) compared to stable relationships.

*Conclusion:*

Maternal relationship status and stability during pregnancy is independently associated with increased risk of SGA infant birth.

Significance

*What is already known?*

Maternal relationship status affects infant health. Unmarried are at greater risk for SGA than married women. Finnish mothers in relationships were shown to have fewer PTB and cases of infant mortality than their unpartnered counterparts, and women who were living with their partner had similar birth outcomes to their married peers.

*What this study adds?*

To our knowledge this is the first large, US population-based study to demonstrate an association between maternal relationship status and SGA, and between maternal relationship stability and the birth of SGA infants. Relationship status and stability affect birth outcomes.

Key words

Social Stress; Relationship Status; Small for Gestational Age (SGA); National Longitudinal Survey of Youth 1979.

Introduction

In the US, births to unmarried mothers have increased over the past several decades[1]. The proportion of births to unmarried mothers in the US increased by 26% between 2002 and 2007, and in 2012, 40.7% of live births were to unmarried mothers[1, 2]. Prior studies suggested an association between births to unmarried mothers and increased risk for both small-for-gestational age (SGA) and preterm birth (PTB). SGA and PTB are associated with fetal, neonatal and infant death, and increased lifetime morbidities. In addition to negative clinical outcomes, SGA and PTB have been shown to diminish individuals’ school performance, long-term productivity, economic, emotional stability and social potential[3-5]. Having an SGA infant can cause increased emotional distress in families[6].

 SGA is a commonly used proxy measure for intrauterine growth restriction [3], defined as “the failure of a fetus to reach their biological growth potential because of a pathological slow-down in the fetal growth pace [p.525, 7].” SGA is defined as birth weight below the 10th percentile of a sex-specific weight-for-gestational age standard. Standards for the 10th percentile vary and the measure captures both infants with IUGR and clinically healthy, constitutionally small infants[8].

 Both relationship status (e.g., married, cohabiting, single) and relationship stability have been hypothesized as social determinants of poor birth outcomes (Figure 1; [9, 10]). In this analysis, relationship Status was defined as the relationship of the mother with a male romantic partner the year birth. Relationship Status had four categories: Married, legally married to an opposite-sex partner; Cohabiting, unmarried but living with an opposite-sex partner; Partnered, unmarried, in a relationship with an opposite-sex partner but living separately; No Partner, no opposite-sex partner. The social determinants construct, first developed by Marmot, places maternal relationship status in a sociocultural, multifactorial context. In the model, the socioeconomic and cultural factors are associated with PTB and SGA independently of relationship status and through relationship status. The biological expressions construct describes how a person’s social support, as experienced through their romantic partner, might have implications for their physical health[11].

Sociology literature associates increasing levels of relationship commitment with increased overall well-being and decreased depression and psychosocial distress; both are associated with SGA and PTB [3, 7, 12, 13]. This literature describes the heterogeneity of each relationship category, considers the quality of relationships, and the potential oversimplification of relationship status categories that vary between and within cultures and across time[12].

In health and sociology literature, the association between births to unmarried mothers and PTB and SGA has been attributed to lack of psychosocial support, greater likelihood of alcohol/drug use, stigmatization of unmarried mothers and decreased home stability[14]. The age of the mother, her financial independence, the sociocultural significance of having a child unmarried, and other social support structures vary across demographic groups and time[15].

The theorized biological association between relationship status and SGA/PTB are illustrated in Figure 1[16-19]. Although it is beyond the scope of this analysis to explore these biological mechanisms, the mechanisms were used to help identify confounders, effect modifiers and factors on the causal pathway for analysis.

Few studies have examined the association between increased risk of poor birth outcomes and subcategories of marital status[20]. A 2011 Shah et al., meta-analysis of maternal marital status and birth outcomes found unpartnered women were at the greatest risk of SGA, followed by cohabiting women when compared to married women[20]. US-based studies have mixed results comparing married to cohabitating, and married to partnered individuals. A 1994 analysis of the National Maternal and Infant Health Survey (NMIH) found only a modest effect of family structure on birth outcomes, with most effect acting through adequate or inadequate prenatal care[21]. A 2000 analysis of the National Survey of Family Growth (NSFG) found that among non-Hispanic black women relationship status showed no association with low birth weight (LBW), among Hispanic women marriage was protective, and among non-Hispanic white women marriage was associated with greater risk of LBW[22]. These studies did not consider interaction or confounding by key variables like alcohol and drug use, maternal BMI, relationship stability, in the NSFG poverty status, and in the NMIH study smoking[21, 22]. Neither distinguish between PTB and SGA, using only LBW. Most studies in the meta-analysis have low power and small sample sizes [22, 23].

With an increasing number of unmarried women having children, there is a need for a better understanding of the role of relationship status in SGA and PTB. This is among one of the first studies to consider a ternary relationship status as a primary exposure variable and to measure stability as a potential risk for SGA and PTB in a US population-based study.

Methods

*Design*

This was logistic regression analysis of a retrospective study of a longitudinal cohort of a representative sample of women in the US examining the association between maternal relationship status and stability during pregnancy and SGA.

*Sampling*

This study uses data from the NLSY79 cohort. The NLSY includes data from annual surveys of a cohort of 12,686 young people aged 14-21 in 1979 collected in interviews by the US Bureau of Labor Statistics. The same cohort of individuals was interviewed each year up to 1994 and then biannually with a 90% retention rate among participants for the first 16 rounds and 80% thereafter[24]. All infant births that could be matched with maternal information in the NLSY database between 1979-2004 were included in the analysis. The date range was based on NLSY data availability. Due to their increased risk of birth anomalies, births to women over 40 years (six in total) were excluded[25].

*Measures and Definitions*

*Relationship Status, the primary exposure variable, was defined as the relationship of the mother with an opposite-sex partner in the year of the birth of the child.*

Relationship Status was initially divided into four categories: Married, legally married to an opposite-sex partner; Cohabiting, unmarried but living with an opposite-sex partner; Partnered, unmarried, in a relationship with an opposite-sex partner but living separately; No Partner, no opposite-sex partner. This categorization is consistent with health literature on relationship status and reflects NLSY data availability [20]. The analysis considered each category with equipoise and no category is presumed to be protective. Due to the low number of partnered women, Partnered and Cohabiting women were combined into a single category, “Cohabiting,” for the analysis. Data on same sex couples could not be analyzed because the NLSY did not ask questions regarding same sex relationships in the years analyzed.

*Relationship Stability, the secondary exposure variable, was defined as the constancy in relationship status in the years surrounding the birth of the participant’s child.*

A mother’s relationship status was defined as stable if it remained the same the year before, the year of and the year after the birth, or if the mother’s relationship status increased in commitment from the year before to the year of and/or the year after the birth (e.g. Relationship Status in year before birth: No Partner, relationship status year of: Partnered, relationship status after: Cohabiting). Relationship was defined as unstable if the participant’s relationship status decreased in apparent commitment in any year surrounding the birth (*Appendix)*.

*Small-for-Gestational-Age (SGA), the primary outcome, was assessed based on infants’ gestational age, their birth weight and the Alexander et al. US reference for fetal growth[26].*

Infants were categorized as SGA if they were below the 10th percentile for weight for their gender and gestational age. The secondary outcome, preterm birth (PTB) included all births before 37 weeks of gestation.

Other social and demographic factors assessed included birth year, maternal race, maternal alcohol consumption during pregnancy, maternal tobacco use during pregnancy, maternal income, maternal history of miscarriage, maternal employment, maternal BMI, maternal poverty status, maternal age, and infant sex. The NLSY did not collect information on several variables known to be associated with SGA and PTB -- including parity, comprehensive socioeconomic position birth anomalies, and elective/medically required cesarean sections that would have been used in analysis. In the literature, SEP is a composite variable of wealth, education and occupation among other factors[27]. Poverty, employment, income and race were used as metrics to partially capture SEP.

All measures were self-reported in interviews conducted by the US Bureau of Labor Statistics except SGA, stability, and BMI. These variables were calculated from the recorded birth weight and gestation time, the relationship status over a three-year period, and the height and weight of the mother the year of the birth respectively.

*Analysis*

We developed a directed acyclic graph (DAG) that illustrated the presumed causal relationships between exposure variables and outcomes (Figure 1) based on health and sociology literature [15-19]. We used logistic regression with random effects (RE) to account for potential confounders and effect modifiers for all steps in analysis. RE were used to account for within-woman correlation for infants born to the same mother.

Trends in outcomes, exposures and variables were assessed using cross-tabulations, logistic regression with RE and Likelihood Ratio Tests (LRTs). Univariate analysis was performed for all variables identified with the DAG. Variables with more than 50% missing data were not kept in analysis beyond the univariate analysis (Variables: Education). Unadjusted odds ratios (ORs) of the association between exposures and outcomes accounting for missing data were compared to OR adjusted for individual confounders. Changes in effect estimates between the unadjusted and adjusted OR, and the effect of missing data informed the model selection process. Variables with more than 40% missing data were excluded after the adjusted analysis (SGA: none; PTB: Cocaine & Marijuana). We considered unadjusted or adjusted associations with P<0.05 to be statistically significant.

To assess the effect of missing data, three models were built and effect estimates were compared. Model 1, a fully adjusted model included all potential confounders identified through the DAG, except those missing more than 40% of possible values. Model 2 included only potential confounders with less than 10% missing data. Model 3 only included variables that changed the effect estimate when comparing the unadjusted and adjusted OR in the Adjusted Analysis. A change in the effect estimate greater than 10% in any of the adjusted OR was used to select variables for this model. The result N values reflect the number of individuals that met the criteria of the model. Individuals were excluded if they did not have a recorded value for a confounder adjusted for in the model.

All analyses were performed using STATA 13[28]. A quadrature check followed each analysis with RE.

[FIGURE 1]

Results

For the years 1979 to 2004, the NLSY entire sample included 12,686 individuals aged 14 to 21, of whom 6,283 were women (Figure 2).

[FIGURE 2]

Among these women, 4439 experienced a live birth, accounting for a total of 8348 live births. Of the participants, 1790 (40%) had one child, 1751 (39%) had two children, 639 (14%) had three children and 259 (6%) had four or more children. The age range for the participants during births was 14-40. The women had diverse racial, economic and health backgrounds (Table 1). In total 24% of the births were to women below the US Federal Poverty Line in the year of the birth[29]. The participants’ relationship status at the time of each birth included 5480 (66%) married women, 505 (6%) cohabiting women, 47 (0.6%) partnered women and 1959 (24%) women without partners. Of the births, 749 (9%) were PTBs. Of term births, 716 (14%) were SGA.

Birth weight data were missing for 2418 (32%) full-term infants. Almost all factors related to SGA and PTB had missing data, with Education and Income having the highest percentages of missing values.

 In unadjusted analyses, increased odds of term SGA was associated with Cohabiting and having No Partner compared to married (OR 2.08; 95% CI 1.40 - 3.11; No Partner OR 2.55; 95% CI 1.95 - 3.34; LR Test p-value <0.0001; Table 2). Increased odds of term SGA was associated with maternal relationship instability (OR 1.59; 95% CI 1.05 - 2.38); LRT p-value: 0.03). Other maternal characteristics associated with increased risk of infant SGA included race (OR 2.46; 95% CI 1.88 - 3.23; LR Test p value <0.0001; comparing mothers who were black to those who were non-black non-Hispanic and to those who were Latino), Poverty (OR 1.93; 95% CI 1.46 - 2.55; LR Test p value <0.0001), Tobacco use (OR 2.98; 95% CI 2.30 - 3.85; LR Test p value <0.0001), Cocaine use (OR 3.27; 95% CI 1.12 - 9.57; LR Test p value 0.04) and BMI (Reference Group: Underweight (BMI <18.5); OR Normal (BMI 18.5-25) 0.53; 95% CI 0.3 - 0.95; OR Overweight (BMI>25) 0.35; 95% CI 0.19 - 0.63; LR Test p value 0.0001).

[TABLE 1]

 In adjusted models, increased odds of infant SGA remained associated with maternal Relationship Status (Table 2, Figure 3). Model 1, which adjusted for all potential confounders identified through the directed acyclic diagram (Race, Sex, Relationship Stability, Age, Year, Income, Poverty, Alcohol, Tobacco, Employment, Depression, History of Miscarriage, & BMI), showed no evidence of an association between relationship status and SGA (LRT P-value 0.16). Model 2, which included all potential confounders missing fewer than 10% of their total values (Race, Sex, Relationship Stability, History of Miscarriage, Employment, Age & Year), identified increased odds of infant SGA among Cohabiting women (OR: 1.81, CI: 1.20-2.73) and unpartnered women (OR: 1.82, CI: 1.34-2.47; LRT P-value 0.0001). Model 3, which included all variables that changed the effect estimate when comparing the unadjusted and adjusted OR in the Adjusted Analysis (Race, Stability, Poverty, & Tobacco), identified increased odds of infant SGA among Cohabiting women (OR: 1.71, CI: 1.08-2.70) and unpartnered women (OR: 1.56, CI: 1.09- 2.23; LR Test P value 0.02). Models 2 and 3 showed an association between infant SGA and maternal relationship stability (Model 2 OR: 1.72; 95% CI 1.14-2.63, LR Test P-Value 0.01; Model 3 OR 1.47; CI 0.99 - 2.22; LR Test P-Value 0.07). The fully adjusted model showed no evidence of an association, (OR 1.54; 95% CI 0.78 - 3.03, LR Test P-value 0.2).

[TABLE 2]

[FIGURE 3]

 When applying the same analyses to preterm birth (PTB), we found no evidence for an unadjusted association between PTB and Relationship Status (LR Test p value: 0.78) or PTB and Stability (LR Test p value: 0.98). However we did find that PTB was associated with several other factors including age, year, education, income, tobacco, marijuana and employment. There was no evidence of an association between race and PTB. This conflicts with known frequencies of PTB among different racial groups[3, 30, 31]. Stability was neither crudely associated with PTB nor associated with PTB after adjustment. Although the models each contained different numbers of observations they all showed increased odds among women with no partner. None of the models provided evidence that odds differed between cohabiting women and married women. Model 2 (7531 observations; 96%), and the Model 3 (5340 observations; 68%) both showed evidence for association (Model 2: OR No Partner 1.33; 95% CI 1.29 - 2.00; LR Test p 0.02; Model 3: OR NO Partner 1.74; 95% CI 1.27 - 2.39; LR Test p value 0.003).

Discussion

*Conclusion*

This is one of the first US population-based studies to demonstrate an independent association between maternal relationship status and SGA, and the first to examine the impact of maternal relationship stability. Two studies have explored the association between relationship status and LBW in American populations, but did not adjust fully for SEP nor evaluate relationship stability [20-22, 32-35]. In our study, mothers cohabiting or with no partner had increased odds of giving birth to a SGA infant, compared to their married peers.Those in unstable relationships had increased odds of SGA relative to those with stability. The NLSY data allowed for control of important factors such as age, employment, smoking, and an abbreviated measure of SEP, among other things.

This study builds on the body of literature related to relationship status and birth outcomes. Studies often categorize women as either married or unmarried, but as our results demonstrate, unmarried cohabitating women might not be at greater risk for SGA and PTB. The results differ from those in a prior meta-analysis, which found that unpartnered and cohabiting women had increased odds of SGA compared to married women, and that women with no partner were at the greatest risk for SGA[20]. In contrast, our study found little difference between cohabiting and unpartnered women regarding SGA. Other studies have looked at the quality and length of relationships evaluated. Bird et al found no association between relationship duration and LBW [22]. Bloch et al found a dose effect between relationship quality and maternal health, and weak statistical evidence for differences in LBW between married women in poor quality relationships and unmarried in good quality relationships[36]. Sociology literature similarly emphasizes the importance of relationship quality and demonstrates that married women of negative quality, like those with abuse, have greater health risk than those in higher quality relationships of varying commitment levels[12, 13].

The study results differed from a Finnish study that had similar measures and outcomes. Their adjusted results showed single women at a greater risk for LBW and PTB and that cohabiting women were at similar risk to married women. They had a large sample size, 46,000, and more complete information on confounders[37]. The sociocultural and policy differences between the US and Finland limit the comparability between the studies.

Limitations of the study include NLSY measurements errors, residual confounding, and missing data.The data were collected through in-person interviews. Birth weight and gestational weeks were subject to recall error. We found evidence of an association between maternal relationship status and preterm birth, but the lack of ethnic disparities in reported PTB rates for this sample cast doubt on the validity of reported PTB rates. Due to missing data and variables, a partnered status and relationship quality could not be assessed and a more robust measure of economic status and income, which had both missing data and insufficiently detailed categories, was not possible. As in any large cohort, residual confounding may remain and the effect estimates may be inflated. The Bureau of Labor Statistics took steps to minimize sampling bias and loss-to-follow-up, and the population-level estimates that remained in the final models, including SGA rates, are similar to those reported in other large, US, population-based studies [24]. Between 1979-1993 and 1994-2000, respondent retention was greater than 90% and 80% respectively[24].

*Implications for Health Systems and Policy*

The etiology of SGA is still largely undetermined and known interventions to diminish SGA would only result in an 8% reduction in the US[30]. Potential sources of stress, including unhealthy relationships, need to be further explored as possible explanatory mechanisms[38]. Our findings suggest that pregnant women, especially those in unstable relationships, deserve health policies that support their health and the health of their future infant while acknowledging the heterogeneity of each relationship category. The findings suggest these policies should extend to unmarried, partnered, cohabiting, and married women because instability increases risk of SGA. These findings do not endorse specific health benefits (or health risks) from traditional marriage during pregnancy.

Public policy can address this need by expanding federal requirements for maternity leave, Medicaid and insurance coverage for preconception and prenatal care, and funding for home-nurse visits. President Obama recognized this need early in his 2008 campaign and has increased funding for the Nurse-Family Partnership to $8.6 billion over 10 years[39]. He frequently discusses the importance of supporting single mothers who often do not receive the benefits of policies currently in place. The Nurse-Family Partnership specifically provides psychosocial and medical support for unmarried women during pregnancy through home-nurse visits, and has been associated with reduced health risks to unmarried mothers and their infants[40]. A growing body of evidence demonstrates the benefits of these services for all women [38, 41-43] and in particular the importance of supporting pregnant women exposed to unstable relationships, including those in married relationships [38].

Health care systems and physicians may address this need by advocating for those patients at increased risk of unhealthy relationships. Programs like Prenatal Health Nurse-Family Partnership only reach a fraction of eligible participants and often do not reach women with relationship instability who do not meet eligibility criteria of the program. Professionals should screen for relationship stability and appropriately direct women to support groups or services for those whose relationships present a risk for their health.

To continue to assess the efficacy of such efforts, future observation and intervention research should rigorously evaluate the affect of relationship status on birth outcomes in a modern population and match interventions to appropriate target populations. The societal and cultural context of births continues to change. We partially captured this by controlling for year, but the present environment needs to be further evaluated. Currently all observational studies on relationship status and birth outcomes cover years prior to 2010[23]. As relationship status and norms around pregnancy change, studies need to cover more up-to-date populations, explore potential mechanisms of association and account for variation within relationship categories.

To date, intervention studies related to birth outcomes and relationship status poorly match the health risk to the study population, leading to exposure misclassification and a dilution of effect estimates[44]. Rigorous evaluation of interventions addressing different aspects of unstable or unhealthy relationships need to identify the niche these services could occupy in prenatal care. Methods to simulate the benefits of married relationships or decrease health risks associated with being pregnant but not married might present a new intervention strategy.

While many risk factors for poor birth outcomes remain elusive, support for mothers in unstable or unhealthy relationships represent an important target for prenatal healthcare and policy.

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