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Life course variation in the relation between maternal marital status and preterm birth

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Abstract

Purpose—Maternal marriage is protective against preterm birth (PTB), while advanced maternal age is associated with increased PTB risk. As relations between social factors and health may vary over the life course, we assessed how the relation between marital status and PTB risk may change with maternal age.

Methods—We assessed the interaction between marital status and maternal age as a determinant of PTB among all live singleton births in Michigan between 1995–2006. We also fit stratified models by race. We calculated absolute differences in predicted PTB as well as odds ratios of PTB by marital status for each age group.

Results—In adjusted models, there was a significant interaction ($p_{\text{interaction}} < 0.001$) between marital status and maternal age. The predicted probability of PTB by marital status was marginally different among mothers aged 20–25 years (absolute difference of 1.5%); this difference was substantially higher (3.9% or higher) after 31 years of age. Odds of PTB followed a similar trajectory. Findings were similar among Black and White mothers.

Conclusion—The relationship between marriage and PTB may vary with maternal age suggesting that the influence of social factors on risk for adverse birth outcomes may differ through the maternal life trajectory. We discuss plausible explanations for these findings.

Keywords

Preterm birth; maternal age; marital status; life course

Introduction

Preterm birth (PTB) is defined as birth before 37 completed weeks of gestation, or 259 days since the first day of a woman's last menstrual period. PTB is an important contributor to

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serious neonatal morbidity, severe childhood disability, and perinatal and neonatal mortality (1,2). While 6-10% of all births in wealthy countries are preterm, more than two-thirds of all neonatal deaths in this context are to preterm infants (2).

It is well-documented that unmarried mothers have higher risk than married mothers for PTB (1, 3-12) along with other adverse perinatal outcomes, which include low birth weight (LBW) (3,4,13,14), small-for-gestational-age (SGA) (3,4,13,15,16), and fetal and neonatal mortality (4,17). Marriage may operate through increased access to healthcare (12,18), financial security (19-21), and social support (22-27) to confer perinatal advantage.

Maternal age has also been shown to predict risk for PTB. Teenage mothers and mothers older than 35 years have been demonstrated to have higher risk for PTB than their counterparts between 20 and 35 years old (28-33).

There is emerging evidence that the impact of maternal social experience on risk for adverse birth outcomes may change over the life course (34), resulting in differing relations between social factors and adverse birth outcomes at different ages (35). For example, in a study among all singleton births to Black and White mothers aged 15-34 in a US state in 1989, Geronimus (36) showed that increasing maternal age was associated with more drastic increases in odds of LBW and very LBW among Black mothers relative to White mothers. The author reasoned that the disparity in the reproductive health of Black mothers relative to White mothers by age was the physiological manifestation of the accumulation of years of social marginalization among Black mothers (36), coining this effect as “weathering”. These findings have since been supported in other studies (37, 38).

Building on this literature, it would follow that other social exposures may operate similarly through the maternal life course to widen inequalities in adverse birth outcomes as mothers age. In particular, the key mechanisms that have been proposed to explain the relation between marital status and risk of PTB, including financial security, social support, and access to healthcare (12,18-27), all may plausibly change over the life course suggesting that the relation between marital status and risk of PTB may change with maternal age. In this study, we used data about all live singleton births in Michigan between 1995-2006 to analyze differences in the relation between marital status and PTB risk by maternal age. In this way, we sought to further characterize the changing influence of social factors on risk for PTB through the maternal life course.

Methods

Data

We obtained data from the Michigan Department of Community Health (MDCH) about all live singleton births in Michigan between January 1, 1995 and December 31, 2006, from the birth records of the state of Michigan (N=1,529,159 births of a total 1,582,454 births).

Our primary health indicator of interest was PTB. Date of last menstrual period was used to calculate gestational age, and gestational age below 37 weeks was considered preterm (39). Covariates of interest included maternal marital status at parturition (married vs. unmarried); maternal age at parturition (<20 years, 20-25 years, 26-30 years, 31-35 years, 36-40 years, or over 40 years); maternal education (<12 years vs. general equivalency diploma (GED) or higher education); parity (0 previous children, 1 previous child, or 2+ previous children); study year (1995-1997, 1998-2000, 2001-2003, or 2004-2006), and maternal race (White, Black, or Other). All covariates were derived from self-reported information on infant birth certificates.

This study was reviewed by the Institutional Review Board of the Michigan Department of Community Health and the Health Science Institutional Review Board of the University of Michigan.

Analysis

First, we calculated univariate statistics to describe our sample. Second, we conducted bivariate chi-square tests between descriptor covariates of interest and PTB, as well as between descriptor covariates and marital status to identify significant associations ($\alpha < 0.05$).

Third, we fit a multivariable logistic regression model of PTB by marital status and age, adjusted for all covariates associated with PTB in bivariate analyses. Fourth, we assessed the interaction between marital status and maternal age by fitting a multivariable logistic regression model of PTB, including main effects of marital status and age as well as an interaction term between them. We repeated this model, also adjusting for all covariates associated with PTB in bivariate analyses. Further adjusted models stratified by race were also fit to assess for heterogeneity in the interaction between marital status and maternal age by maternal race. To test the statistical significance of interactions, we conducted likelihood ratio tests comparing each model including the interaction term vs. excluding the interaction term. Statistical significance for the likelihood ratio tests was set at the $\alpha < 0.05$ level.

Fifth, we used coefficient estimates from the adjusted multivariable models described above to predict the probability of PTB among mothers by age, stratified by marital status as well as odds ratios of PTB among unmarried mothers relative to married mothers by age group. Sixth, we calculated absolute differences in predicted probability of PTB by marital status in each age group.

SAS 9.2 was used to carry out all statistical analyses.

Results

Table 1 shows the distributions of covariates of interest and bivariate chi-square tests of all covariates by PTB. 9.2% of births in this sample were preterm. Among unmarried mothers, 12.0% of births were preterm, which was significantly higher ($p < 0.001$) than among married mothers (7.7%). Among mothers younger than 20 years old at parturition, 12.0% of births were preterm as compared to 9.4% among mothers between 20-25 years old, 8.2% among mothers 26-30 years old, 8.4% among mothers 31-35 years old, 9.8% among mothers 36-40 years old, and 11.6% among mothers older than 40 years ($p < 0.001$). Two or greater previous children, and Black race were also predictive of higher PTB risk ($p < 0.001$).

Table 2 shows bivariate chi-square tests between all predictor covariates and marital status. Marital status was associated with each predictor covariate (parity, education, study year, and race) ($p < 0.001$). Birth out of wedlock was highest among mothers aged < 20 years (87.4%), and lowest among mothers aged 31-35 years (13.8%). Mothers with a high school diploma or greater education were more likely to be married (68.2%) than their less educated counterparts (59.2%). The prevalence of births out of wedlock increased as the study progressed ($p < 0.001$). The lowest prevalence occurred between 1989-1992 (33.9%), and the highest occurred between 2003-2006 (37.1%). Black mothers also had a substantially higher likelihood of birth out of wedlock (75.4%) than Whites (26.1%) and Others (26.7%) ($p < 0.001$).

Table 3 shows a multivariable logistic regression model of PTB by marital status and maternal age adjusted for potential confounders. Unmarried mothers had higher odds of PTB

(1.38, 95% CI 1.36-1.40) than married mothers. Mothers aged <20 years had higher odds of PTB (1.14, 95% CI 1.12-1.17) than mothers aged 26-30, as did mothers in each of the older age categories, with the highest odds among mothers aged 41 or older (1.45, 95% CI 1.40-1.50).

In both unadjusted multivariable logistic regression models as well as those adjusted for education, parity, study year, and maternal race, the interaction between marital status and maternal age was significant ($p_{\text{interaction}} < 0.001$) (not shown). This interaction was also significant in both models stratified by race (not shown). Table 4 shows odds ratios of PTB among unmarried mothers relative to married mothers with 95% confidence intervals by year adjusted for education, parity, study year, and maternal race. At among mothers younger than 20 years, the odds ratio of PTB among unmarried mothers relative to married mothers was 1.17 (95% CI 1.12-1.24), increasing to 1.70 (95% CI, 1.64-1.78) by the age of 36-40 years, and then decreasing slightly to 1.58 (95% CI, 1.45-1.71) among mothers aged 41 years or older.

Figure 1 shows predicted probabilities of PTB among mothers by age, stratified by marital status and adjusted for education, parity, study year, and maternal race and assuming modal values for each of these adjusted covariates. The predicted probability of PTB by marital status was marginally different among mothers aged 20-25 years (absolute difference of 1.5%); this difference generally increased with age, and was substantially higher (3.9% or higher) after 31 years of age.

Figure 2 shows absolute differences in the predicted probability of PTB among mothers by marital status for each age category. Figure 3 shows odds ratios of PTB among unmarried mothers relative to married mothers by year. Values in both figures are adjusted for education, parity, study year, and maternal race, and each figure shows similar curves stratified by race (Black and White). The figures show similar trends. Generally, both the absolute risk difference and the odds ratios of PTB among unmarried relative to married mothers increased with age, with a slight decrease after 40 years of age.

Discussion

In a study of over 1.5 million live singleton births between 1995-2006, we found that the risk of PTB was higher among unmarried mothers in all age groups. Both absolute and relative differences in PTB risk among unmarried relative to married mothers were greater among mothers older than 26 years compared to younger mothers. We also found that marital status was most protective against PTB among mothers aged 36-40 years. The most substantial increases in both the absolute difference in predicted PTB and odds of PTB among unmarried relative to married mothers occurred between the ages of 26 and 35.

We know of three potential explanations for our observations. First, psychosocial stress has been shown to be associated with higher risk for adverse birth outcomes (22, 40-41), and higher levels of social support and better mental health may mediate the relation between being married and having lower risk of PTB (22-27). It is plausible that the advantage of married mothers with respect to PTB risk is a reflection of the role of marriage in buffering social stressors that may increase in volume or become more difficult to cope with as a woman ages. This might occur as responsibilities around work and provision for children increase with age as unmarried women become less able to rely on parents or other supports for material resources or to derive social support from networks of friends, an increasing number of whom are taking on competing social obligations. It follows that marriage would become more protective against PTB risk with increasing age.

Second, it is possible that our findings could be explained by marital selection. There is evidence to suggest that healthier women are more likely to marry and stay married than their less healthy counterparts (42, 43), which can, in part, explain the relation between unmarried status and poor health. It is plausible that as mothers age, the pool of unmarried mothers declines in health as the healthiest at each age group have a higher probability of becoming married. Therefore, marital selection may, in part, explain the overall trend of increasing PTB risk among unmarried mothers relative to married mothers with age. Supporting this explanation is the observation that the added risk of PTB associated with birth out of wedlock is proportional to the percentage of women who are married in each age group. This suggests that concentration of less healthy women in the unmarried pool may account for the higher risk of PTB among them.

A third possible explanation could rest in the cumulative exposure to stressors, or, the “weathering” hypothesis, coined by Geronimus (36, 44). Although we did not collect data about the length of time that mothers spent married or unmarried, it has been shown that age is associated with cumulative years of marriage among married women (44). It is plausible that older married mothers would have benefited from potential health protective corollaries of marriage, such as financial security (19-21), social support (22-27), and better access to healthcare (12,18), for a longer cumulative time than younger married mothers. In the same vein, older unmarried mothers would have lived a longer cumulative time without these benefits. Thus, age would magnify health differences owing to relative disparities in financial security, social support, and access to healthcare between married and unmarried mothers, thereby explaining why marriage may be more protective among older vs. younger mothers.

Our study is the first, of which we are aware, to demonstrate an interaction between marital status and maternal age in determining risk for PTB. However, we know of one study that has considered differences in the relation between marriage and risk for LBW by maternal age. Rich-Edwards and colleagues (45) analyzed data from over 96,000 births in Chicago between 1994-1996, and found that marriage was more strongly protective against LBW among mothers aged 40 than among mothers aged 20.

Our study broadly agrees with the findings of Rich-Edwards and colleagues (45), and furthers our understanding of differences in the relation between marital status and adverse birth outcome by maternal age in several ways. The present study explored the interaction between marital status and maternal age as a determinant of PTB rather than LBW, which is a less specific indicator of perinatal health. While the study by Rich-Edwards and colleagues (45) considers births in Chicago, a primarily urban context, from 1994-1996, our work is derived from a larger, more temporally and contextually diverse sample, including all singleton births in the state of Michigan from 1995-2006. Moreover, our data analyzed *all* births in one context, while data from the study by Rich-Edwards and colleagues (45) only considered births to two racial groups: White and Black mothers. The added spatial, temporal, and ethnic diversity in our study sample may strengthen conclusions drawn about differences in the relation between marital status and adverse birth outcomes by age.

There are several limitations that should be considered when interpreting our findings. First, it is plausible that multiple births to one mother may have been included in our dataset, violating the assumption of independence of observations, and potentially introducing bias via interpregnancy interval, which has been shown to predict PTB risk (46). However, while we chose not to show them here for parsimony, similar analyses among nulliparae did not show appreciable differences. Second, we analyzed data from only one US state. Therefore, caution should be taken when generalizing these findings to other contexts within the US or globally. Nevertheless, there is no convincing reason why the relations between marriage,

age, and PTB would differ in Michigan relative to other states in the US. Third, our covariate set was limited; of particular note, because these covariates are not included on state birth records, we did not adjust for maternal anthropometric data or previous health issues. Therefore, the relation between marital status and PTB risk with age may be confounded by unmeasured factors. However, because maternal anthropometric and health changes are likely important components of the causal chain between maternal aging and adverse birth outcomes, these may be more appropriately considered as mediators rather than confounders of the relationships considered here. Fourth, we classified PTB based on data about last menstrual period, which is highly subject to recall bias. However, the other available option was the clinical estimate of gestational age—given the sensitivity of this metric to access to health resources, which is likely to be highly correlated with marital status, we chose the last menstrual period estimate to minimize the potential for differential misclassification bias.

Despite their limitations, our findings have important implications for our understanding of the social determinants of adverse birth outcomes through the maternal life trajectory. While it has been repeatedly demonstrated that social factors, such as marriage, contribute to health indicators, such as PTB (1, 3-12), the roles of social determinants on adverse birth outcomes may not be static through the maternal life trajectory, and may exert their impact differently throughout the life course. Our findings add to a growing body of literature that supports a “life course” approach to understanding the complex causes of adverse birth outcomes (47, 48).

In that vein, our findings have two central implications for future research in this area. First, our findings further suggest that the influence of social predictors on PTB may change with maternal age. Therefore, future research about changes in the relations between other social factors, including maternal education, ethnicity, social class, and neighborhood context, and PTB is in order. Second, research seeking to disentangle the mechanisms underlying changes in the relation between marriage and PTB through the maternal life course may be fruitful.

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Abbreviations

PTB	preterm birth
LBW	low birth weight
SGA	small-for-gestational age
GED	General Equivalency Diploma

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Figure 1.
Predicted probability of preterm birth by age group stratified by marital status among all live singleton births in Michigan between 1995-2006
*Adjusted for education, parity, study year, and maternal race, which were all assumed to be the mode value in predicted probability calculations

Figure 2.

Absolute difference in predicted probability of preterm birth* between unmarried and married mothers by age group overall and stratified by race among all live singleton births in Michigan between 1995-2006

*Adjusted for education, parity, study year, and maternal race, which were all assumed to be the mode value in predicted probability calculations

Figure 3.

Adjusted* odds ratios of preterm birth among unmarried relative to married mothers by age group overall and stratified by race among all live singleton births in Michigan between 1995-2006

*Adjusted for education, parity, study year, and maternal race (race adjusted only in overall analysis)

Table 1

Bivariate chi-square tests between all covariates and preterm birth among all live singleton births in Michigan between 1995-2006

Maternal descriptive statistics	%	Preterm birth *	χ^2 p
Total	100.0 (1,529,159)	9.2	
Marital status			<0.001
Married	65.1	7.7	
Unmarried	34.9	12.0	
Maternal age			<0.001
<20 years	10.9	12.0	
20-25 years	24.2	9.4	
26-30 years	28.8	8.2	
31-35 years	23.9	8.4	
36-40 years	10.2	9.8	
41+ years	2.0	11.6	
Parity			<0.001
0 previous	39.6	9.3	
1 previous	35.0	8.2	
2+ previous	25.4	10.8	
Education			<0.001
HS diploma or greater	65.8	9.0	
< 12 years	34.2	9.6	
Study year			<0.001
1995-1997	25.5	9.3	
1998-2000	25.5	9.5	
2001-2003	24.8	9.6	
2004-2006	24.2	8.3	
Maternal race			<0.001
White	70.9	7.9	
Black	17.7	14.8	
Other	11.4	8.3	

* Indicate proportions born preterm in each row category

Table 2

Bivariate chi-square tests between all predictor covariates and marital status among all live singleton births in Michigan between 1995-2006

Maternal descriptive statistics	Marital status		χ^2 p
	Married	Unmarried	
Maternal age			<0.001
<20 years	12.6	87.4	
20-25 years	44.2	55.8	
26-30 years	76.4	23.6	
31-35 years	86.2	13.8	
36-40 years	85.8	14.2	
41+ years	82.9	17.1	
Parity			<0.001
0 previous	57.2	42.8	
1 previous	70.3	29.7	
2+ previous	64.9	35.1	
Education			<0.001
HS diploma or greater	68.2	31.8	
< 12 years	59.2	40.8	
Study year			<0.001
1995-1997	66.1	33.9	
1998-2000	66.1	34.0	
2001-2003	65.4	34.6	
2004-2006	62.9	37.1	
Maternal race			<0.001
White	73.9	26.1	
Black	24.6	75.4	
Other	73.3	26.7	

Table 3

Adjusted* multivariable logistic regression model of preterm birth by marital status and maternal age among all live singleton births in Michigan between 1995-2006

	OR	95% CI
Marital status		
Married	Reference	Reference
Unmarried	1.38	1.36-1.40
Maternal age		
<20 years	1.14	1.12-1.17
20-25 years	1.00	0.99-1.02
26-30 years	Reference	Reference
31-35 years	1.07	1.05-1.09
36-40 years	1.24	1.22-1.27
41+ years	1.45	1.40-1.50

* Adjusted for education, parity, study year and maternal race

Table 4

Adjusted* odds ratios with 95% confidence intervals of preterm birth among unmarried relative to married mothers by age group among all live singleton births in Michigan between 1995-2006

	Adjusted Odds Ratio	Adjusted 95% Confidence Intervals
Unmarried* <20 years	1.18	1.12, 1.24
Unmarried* 20-25 years	1.20	1.17, 1.23
Unmarried* 26-30 years	1.38	1.35, 1.41
Unmarried* 31-35 years	1.61	1.57, 1.66
Unmarried* 36-40 years	1.70	1.64, 1.78
Unmarried* 41-45 years	1.58	1.45, 1.71

* Adjusted for education, parity, study year and maternal race