



Early and Late Preterm Birth Rates Among US-Born Urban Women: The Effect of Men's Lifelong Class Status

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Abstract

Objective To ascertain the relation of men's lifelong class status (as measured by neighborhood income) to the rates of early (< 34 weeks) and late (34–36 weeks) preterm birth (PTB).

Methods Stratified and multilevel, multivariable binomial regression analyses were computed on the Illinois transgenerational birth-file of infants (born 1989–1991) and their parents (born 1956–1976) with appended U.S. census income information. The median family income of men's census tract residence at two-time periods were utilized to assess lifelong class status (defined by residence in either the lower or upper half of neighborhood income distribution).

Results In Cook County Illinois, the preterm rate for births ($n = 8115$) to men with a lifelong lower class status was twice that of births ($n = 10,330$) to men with a lifelong upper class status: 13% versus 6.0%, $RR = 2.2$ (2.0, 2.4). This differential was greatest in early PTB rates: 3.9% versus 1.4%, $RR = 3.0$ (2.5, 3.7). The relation of men's lifelong class status to both PTB components persisted among non-teens, married, college-educated, and non-Latina White women, respectively. The adjusted (controlling for maternal demographic characteristics) RR of early and late PTB for men with a lifelong lower (versus upper) class status were 1.4 (1.1, 1.9) and 1.2 (1.0, 1.4), respectively. The population attributable risk of early PTB for men's lifelong lower class status equaled 16%.

Conclusions Men's lifelong lower (versus upper) class status is a novel risk factor for early preterm birth regardless of maternal demographic characteristics. This intriguing finding has public health relevance.

Keywords Preterm birth · Fathers class status · Men's class status

Significance

What is known about this subject

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Prior publications emphasize that a better understanding of health inequity based on class has public health relevance to the United States' elevated preterm birth (< 37 weeks, PTB) rate. US-born women's lower class status is a known risk factor for PTB.

What this study adds

Men's lower class status is a novel risk factor for early (< 34 weeks) preterm birth independent of maternal age, education attainment, marital status, and race/ethnicity. A sizeable percentage of early preterm births are reflective of men's lower class status in US-born urban women. These findings highlight the public health relevance of men's class status to PTB.

Although the physiologic determinants of preterm (< 37 weeks) and normal labor are medical mysteries, there is tremendous variation in preterm birth (PTB) rates among developed countries with the United States consistently ranking in the lower tier with the greatest rates (MacDorman et al. 2014; Kochanek et al. 2014). While lifelong

underserved minority status is a well-recognized social determinant of preterm labor and consequent PTB among US-born women, the PTB rate of US-born White women is greater than that of White women in Europe (Martin et al. 2008; Muglia et al. 2010; Martin et al. 2010; Beck et al. 2010; Schroeder 2007; David and Messer 2011). Interestingly, Schroeder (2007) estimated that only 10% of population health differences are attributable to health care. He noted that upstream factors account for the bulk of health outcome differences among large social groups defined by country or race/ethnicity (Schroeder 2007). A better understanding of health inequity based on class may have particular public health relevance to the elevated PTB rate of US-born women (David and Messer 2011; Issacs and Schroeder 2004; Braveman et al. 2010; David and Collins 2014).

While US-born women's lower class status is a known risk factor for PTB (Braveman et al. 2010; David and Collins 2014; Croteau et al. 2007; Meyer et al. 2007), few published studies have considered the contribution of men's class status beyond that captured by marital status to PTB rates (Shah et al. 2011; Shah 2010; Misra et al. 2010). Blumenshine et al. (2011) found that men's low education level (as reported by the mother) correlated with increased PTB rates. A more recent study found that men's lifelong class status (as objectively defined by neighborhood income) correlated with low birth weight (<2500 g, LBW) rates regardless of women's demographic status, including education attainment and marital status (Collins et al. 2016)). However, LBW infants are a heterogeneous group of growth restricted and preterm infants. The contribution of men's lifelong class status to PTB rates is incompletely understood.

The first year mortality rate of early (<34 week) preterm infants dramatically exceeds that of late (34–36 week) preterm infants (Martin et al. 2015). Most pertinent, early PTB rates have been particularly resistant to public health intervention strategies (Martin et al. 2010). This finding suggests the presence of disparate upstream risk factors for early PTB rates. We are unaware of published data that disentangles the contribution of men's lifelong class status to rates of both early and late PTB.

For these reasons, we performed a cross-sectional analysis of Illinois birth certificates and US census income information to determine (1) the relation of men's lifelong class status to the rates of early and late PTB, and (2) the proportion of preterm births secondary to men's lifelong lower (compared to upper) class status in urban women. We hypothesized that a significant percentage of <34 week preterm infants are the result of men's lifelong lower (compared to upper) class status among urban born women in Illinois.

Methods

Illinois Transgenerational Birth-File

We analyzed the Illinois transgenerational birth file (TGBF) of infants (born 1989–1991) and their parents (born 1956–1976) with appended US census income data (Collins et al. 2016; David et al. 2010). Illinois birth records have been computerized since 1956. There were approximately 328,000 singleton infants born in Illinois between 1989 and 1991 with women who were born in Illinois between 1956 and 1976. On the basis of women's full maiden name and date of birth, we linked 79% ($n = 267,303$) of maternal birth certificates to infant birth certificates. Eighty-one percent ($n = 216,468$) of these infants had men acknowledged on their birth records. Seventy-eight percent ($n = 169,450$) had men born in Illinois; 86% ($n = 145,940$) had men born 1956–1976. Based on men's name and date of birth, we matched 86% ($n = 125,949$) of men's birth records to the mother-infant records (David et al. 2010).

For the infants (1989–1991) born in Cook County, IL, we linked 1990 US census income (median family income) data to each vital record based on census tract of residence listed on the birth certificate within the city of Chicago and town or village of residence in the surrounding suburbs. For the men (1956–1965) born in Chicago, we linked 1960 US census income to each vital record by community area (1956–1960) or census tract for years where valid tracts were available (1961–1965); for the 1966–1975 birth cohort born in Chicago, we linked the 1970 US census income to each birth record by census tract. Because of the non-availability of income data for small geographic areas among births outside of Cook County, the study sample was restricted to infants with residence in Chicago or suburban Cook County at the time of their birth whose men were born in Chicago ($n = 27,593$). The institutional review board of Ann & Robert H. Lurie Children's Hospital of Chicago approved the investigational protocol.

Men's Lifelong Class Status

Census tracts are small geographic ranges formed to track physical urban borders (e.g., expressways and railroad grades). Chicago contains 873 census tracts. They tend to comprise nearly homogeneous populations varying from 1500 to 8000 in number and with few exceptions census tract geography has remained constant over time (David et al. 2010). Community areas were designed to mirror naturally occurring neighborhoods. There are 77 community areas which include approximately 11 census tracts

(range 1–36). They provide information on social context for the 1956–1960 cohort's birth certificates which lacked census tract level data. Suburban Cook County contains 30 towns and villages.

The median family income of men's (1) census tract [or community area (for the 1956–1960 cohort)] residence at birth and (2) census tract or town/village (for the Suburban Cook County cohort)] residence at the time of his infant's delivery were used to objectively define men's lifelong class status (Collins et al. 2016; David et al. 2010). This continuous measure was empirically divided into halves separately for neighborhood income at the time birth (i.e. early-life) and at the time of his infant's birth (i.e. adulthood). As such, men's lifelong class status was defined at two time points on a contextual level. The median income (adjusted for inflation to 1989-dollar amounts) cut-points for "early-life" and "adulthood" equaled \$27,327 and \$35,427, respectively.

Analytic Sample

The study sample was restricted to singleton infants ($n = 18,448$) born to non-Latina White, non-Latina African-American, and Mexican–American women with men who were acknowledged on the birth certificate and had a lifelong residence in either the lower half (empirically defined as lifelong lower class status) or upper half (empirically defined as lifelong upper class status) of the neighborhood income distribution.

Statistical Analyses

Early and late PTB rates were computed by men's lifelong class status. Because maternal age, education, marital status, and race/ethnicity are well known risk factors for PTB, we determined the distribution of these variables according to men's lifelong class status. In each strata of men's lifelong class status, we then computed the rates of early and late PTB rates according to the level of measured maternal variables. Relative risks (RR) and 95% Confidence Intervals (CIs) for the relation of men's lifelong class status to PTB (including its early and late components) were computed (SAS 2000).

Multilevel, multivariable log binomial regression analyses were run to better assess the relationship between men's lifelong class status and PTB rates, adjusted for measured maternal characteristics (Snijders and Bosker 1999). The adjusted RR and 95% CIs were calculated from final models according to the antilogarithm of the beta-coefficients for the independent variable and the CIs for those measurements (Snijders and Bosker 1999).

The population attributable risk percent (PAR %) was calculated to determine the proportion of early and late preterm

births reflective of men's lifelong lower (compared to upper) class status (Rothman 1998).

Results

Infants born to men with a lifelong lower (compared to upper) class status had a greater percentage of women with measured high-risk demographic characteristics (Table 1). Twenty-seven percent of births to acknowledged men with a lifelong lower class status occurred to women with < 12 years of education compared to only 5% of births to acknowledged men with a lifelong upper class status. Among the paternal lifelong lower class cohort approximately 50% of the parents were unmarried compared to only 9% among the paternal lifelong upper class cohort. There was also a stark difference in the distribution of maternal race with 65% of births to acknowledged men with a lifelong lower class status were to African-American women while nearly 93% of births to acknowledged men with a lifelong upper class status were to non-Latina White women.

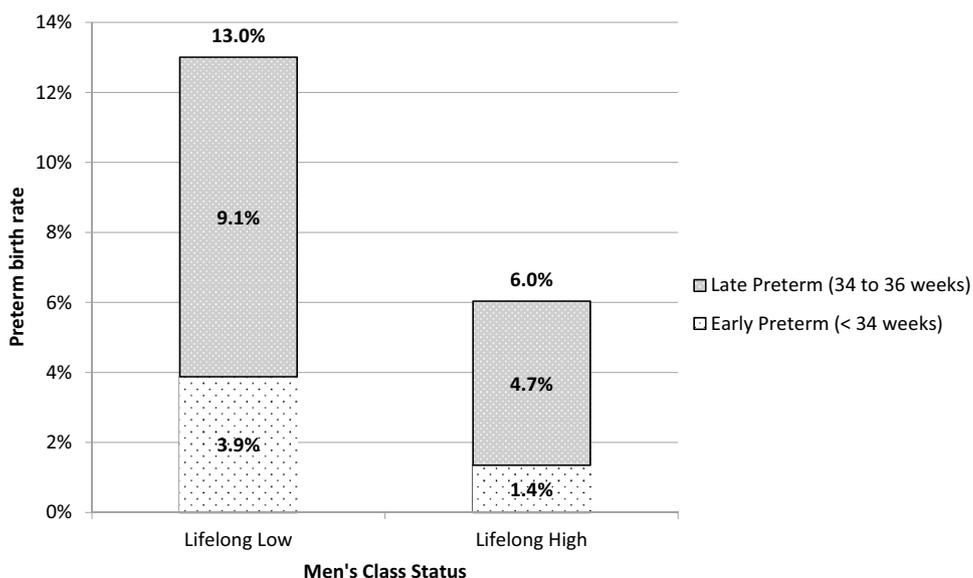
The Fig. 1 shows that the PTB (< 37 weeks) rate for births ($n = 8115$) to acknowledged men with a lifelong lower class status exceeded that of births ($n = 10,330$) to acknowledged men with a lifelong upper class status: 13.0% versus 6.0%,

Table 1 Distribution of maternal demographic characteristics by men's lifelong class status, Cook County, IL, Transgenerational birthfile, 1956–1976, 1989–1991

| | Men's class status | |
|--------------------------------------|------------------------------|--------------------------------|
| | Lifelong lower $n = 8115$ | Lifelong upper $n = 10,330$ |
| Maternal demographic characteristics | % | % |
| Maternal age (years)* | | |
| < 20 | 19.7 | 5.6 |
| 20–24 | 32.6 | 18.1 |
| 25–29 | 33.6 | 46.5 |
| 30–35 | 14.1 | 29.9 |
| Maternal education (years)* | | |
| < 12 | 27.0 | 5.4 |
| 12 | 41.0 | 39.3 |
| > 12 | 32.1 | 55.2 |
| Marital status* | | |
| Unmarried | 51.2 | 9.2 |
| Married | 48.8 | 90.8 |
| Race/ethnicity* | | |
| African American | 64.9 | 4.0 |
| Non-Latina White | 20.1 | 92.8 |
| Mexican–American | 15.1 | 3.2 |

* $p < 0.0001$

Fig. 1 Preterm (<37 weeks) birth rate components [early (<34 weeks) and late (34–36 weeks)] according to men’s lifelong class status, Cook County, IL; Transgenerational birth-file, 1956–1976, 1989–1991. The RR (95% CI) of early and late PTB for men with a lifelong low (versus high) class status equaled 3.03 (2.48, 3.69) and 2.0 (1.79, 2.23), respectively



respectively; RR = 2.16 (1.96, 2.37). This differential was greatest for the early PTB component (Fig. 1).

Table 2 shows rates of early and late PTB by men’s lifelong class status and measured maternal demographic variables. With the exception of the relation of African-American race to late PTB rates, all of the point estimates

for men’s lifelong lower (compared to upper) class status and the PTB components exceeded unity; however, a few of the 95% CI included one (Table 2). The early and late PTB risk associations with men’s lifelong lower (compared to upper) class status existed among low risk (based on measured demographic characteristics) women including

Table 2 Early (<34 weeks) and late (34-36 weeks) preterm birth rates according to men’s lifelong class status and selected maternal demographic characteristics, Cook County, IL; Transgenerational birth-file, 1956–1976, 1989–1991

| Maternal demographic characteristics | Men’s class status | | | | | | | |
|--------------------------------------|----------------------------|-------------------|--------------|-------------------|------------------------------|-----|--------------|-----|
| | Lifelong lower n = 8115 | | | | Lifelong upper n = 10,330 | | | |
| | Early preterm | | Late preterm | | Early preterm | | Late preterm | |
| % | RR (95% CI)* | % | RR (95% CI)* | % | RR (95% CI) | % | RR (95% CI) | |
| Maternal age (years) | | | | | | | | |
| <20 | 4.6 | 1.62 (0.97, 2.72) | 11.5 | 1.37 (1.02, 1.85) | 3.0 | Ref | 8.5 | Ref |
| 20–24 | 4.0 | 2.40 (1.63, 3.52) | 9.1 | 1.99 (1.57, 2.52) | 1.8 | Ref | 4.7 | Ref |
| 25–29 | 3.3 | 3.08 (2.21, 4.30) | 8.2 | 1.82 (1.52, 2.18) | 1.1 | Ref | 4.6 | Ref |
| 30–35 | 3.8 | 3.47 (2.23, 5.39) | 8.3 | 2.07 (1.61, 2.68) | 1.1 | Ref | 4.1 | Ref |
| Maternal education (years) | | | | | | | | |
| < 12 | 4.6 | 1.89 (1.09, 3.28) | 10.9 | 1.39 (1.03, 1.89) | 2.5 | Ref | 8.0 | Ref |
| 12 | 3.5 | 2.66 (1.94, 3.64) | 9.2 | 1.96 (1.65, 2.34) | 1.4 | Ref | 4.8 | Ref |
| > 12 | 3.8 | 3.26 (2.40, 4.41) | 7.6 | 1.81 (1.51, 2.17) | 1.2 | Ref | 4.3 | Ref |
| Marital status | | | | | | | | |
| Unmarried | 4.9 | 1.55 (1.07, 2.26) | 10.3 | 1.04 (0.84, 1.28) | 3.2 | Ref | 10.1 | Ref |
| Married | 2.8 | 2.53 (1.95, 3.29) | 8.0 | 1.96 (1.69, 2.26) | 1.2 | Ref | 4.1 | Ref |
| Race/ethnicity | | | | | | | | |
| African American | 4.6 | 1.46 (0.84, 2.53) | 9.8 | 0.90 (0.68, 1.20) | 3.1 | Ref | 11.0 | Ref |
| Non-Latina White | 2.0 | 1.66 (1.14, 2.44) | 6.3 | 1.47 (1.19, 1.81) | 1.2 | Ref | 4.3 | Ref |
| Mexican–American | 3.2 | 1.57 (0.71, 3.48) | 10.1 | 1.54 (0.99, 2.38) | 2.1 | Ref | 6.6 | Ref |

*Compared to term birth (≥ 37 weeks); reference group is lifelong upper class status

those in the college-educated, and non-Latina White subgroups. These findings strongly suggest that these variables did not singularly explain the association of men's lifelong class status and PTB components. There was no evidence of effect modification for the selected maternal demographic characteristics.

In multilevel, multivariable log binomial regression models with men's class status at the time of the baby's birth as the random effect, the adjusted (controlling for maternal demographic status) RR of early and late PTB for men with a lifelong lower (compared to upper) class status were 1.44 (1.08, 1.93) and 1.18 (0.99, 1.41), respectively.

The PAR of early PTB among acknowledged men with a lifelong lower (versus upper) class status was 16%.

Discussion

In the current study, we demonstrate a relationship between acknowledged men's lifelong (as defined by early-life and adulthood neighborhood income) class status and the PTB components among urban women in the US. We found that acknowledged men's lifelong lower (versus upper) class status is associated with a three-fold greater early PTB rate and a two-fold greater late PTB rate. Our stratified and log binomial regression analyses show that acknowledged men's lifelong lower class status is a risk factor for early PTB regardless of women's age, marital status, education, and race/ethnicity. Interestingly, 16% of early preterm births among urban women appears secondary to acknowledged men's lifelong lower (compared to upper) class status independent of traditional maternal demographic characteristics.

The high PTB rate among US-born women explains the bulk of US enduring low international ranking in infant mortality rates (MacDorman et al. 2010). Few studies have examined contribution of men's class to PTB rates (Misra et al. 2010; Blumenshine et al. 2011). Our data show that paternal lifelong lower (versus upper) class status correlates with increased rates of early PTB rates. Although infants born to men with a lifelong lower class status have a greater percentage of women with low education attainment, unmarried status, and African-American race than their lifelong upper class counterparts, the association of men's lifelong lower (versus upper) class status and PTB rates is greatest in the lowest risk women. The relationship between men's lifelong lower class status and early PTB rates weakens but persists when women's characteristics are mathematically taken into account. A causal association is conceivable. In addition to reduced financial resources available to the mother and the lack of social support (Garfield et al. 2014; West et al. 2014), we speculate that pregnancy related behaviors (i.e. prenatal care usage, weight gain, cigarette smoking), parity, and concurrent medical conditions (i.e. pregnancy

associated hypertension) serve as intermediates linking men's class status and early PTB rates. More detailed studies are warranted to further explore this conceptual model.

The present study suggests that acknowledged men's lifelong lower (compared to upper) class status may be an independent risk factor for late PTB. Although the association between men's lifelong class status and late PTB rates exists among women with the lowest risk characteristics (i.e. non-teens, college-educated, married, and non-Latina White) and the adjusted (controlling for the traditional maternal demographic characteristics) point estimate exceeds unity, the lower limit 95% CI derived from the mathematical model approximates one. As such, additional investigations with larger sample sizes are needed to confirm the association of paternal lifelong SEP and late PTB rates.

Sixteen percent of early preterm births among urban-born women in the US appears attributable to men's lifelong lower (compared to upper) class status independent of maternal age, education, marital status, and race/ethnicity. We encourage maternal and child health policy makers to take men's lifelong class status into account when designing initiatives to reduce the number of early PTB among urban women. This should include the identification and the elimination of the root causes of men's lifelong lower class status.

To our knowledge the Illinois TGBF is the only US derived database of infant–maternal–paternal vital records (David et al. 2010). Because of the addition of US census income information to each birth certificate, it uniquely allows for the investigation of men's lifelong class status (as objectively defined by neighborhood income at two time points) and PTB rates; however, it has pertinent limitations (David et al. 2010). First, the study sample was limited to infants whose men were named on their birth certificate. The absence of named or acknowledged men is associated with an increased risk of poor pregnancy outcome, including PTB (Alio et al. 2010). Therefore, our findings may not be generalizable to the higher risk births without named or acknowledged men (approximately 20% of our mother-infant linked births) (Collins et al. 2016; David et al. 2010). Second, we used men's early-life and adulthood neighborhood income to objectively define their lifelong class status. The former is a strong proxy of inherited wealth and provides considerable improvement over prior studies which used only adulthood markers of class status. Notwithstanding, the addition of men's late childhood/early adolescence neighborhood income and adulthood individual-level variables such as level of education attainment, occupation, and wealth would provide the most complete indicator of lifelong class status. Third, we chose conservative cut-points to define men's lifelong class status. This restricted our ability to detect the impact of subtle differences in men's class status on PTB rates. Fourth, maternal risk factors examined were limited to well-known demographic variables. Lastly, our

PTB rates were from a 1989–1991 birth cohort and may not be generalizable to contemporary infant outcome.

In summary, we provide the first evidence that men's life-long lower (versus upper) class status is associated with a 16% increased risk of early PTB independent of US-born women's demographic characteristics.

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