

DEMOGRAPHIC RESEARCH

A peer-reviewed, open-access journal of population sciences

DEMOGRAPHIC RESEARCH

VOLUME 43, ARTICLE 31, PAGES 929–968

PUBLISHED 16 SEPTEMBER 2020

<https://www.demographic-research.org/Volumes/Vol43/31/>

DOI: 10.4054/DemRes.2020.43.31

Research Article

An extended evaluation of the weathering hypothesis for birthweight

Samuel Fishman

© 2020 Samuel Fishman.

This open-access work is published under the terms of the Creative Commons Attribution 3.0 Germany (CC BY 3.0 DE), which permits use, reproduction, and distribution in any medium, provided the original author(s) and source are given credit.

See <https://creativecommons.org/licenses/by/3.0/de/legalcode>.

Contents

1	Introduction	930
2	Literature review	931
2.1	Weathering across racial/ethnic minorities	931
2.2	Fertility timing selection	933
2.3	Variation by nativity	935
3	Sociodemographic covariates	935
4	Theory and hypotheses	936
5	Data	938
6	Measures	938
7	Methods	939
8	Results	940
8.1	Fertility timing across race/ethnicity-nativity	940
8.2	Multivariable analyses	941
8.3	First births	945
9	Discussion and conclusion	946
	References	949
	Appendix	958

An extended evaluation of the weathering hypothesis for birthweight

Samuel Fishman¹

Abstract

BACKGROUND

Prior weathering research finds that US-born Black women experience more rapidly deteriorating birthweight outcomes at older ages than US-born White women.

OBJECTIVE

The present study extends this literature by evaluating maternal age–birthweight associations across a variety of racial/ethnic-nativity groups.

METHODS

Race/ethnicity-nativity stratified average marginal effects of maternal age on low and very low birthweight are estimated using data from 2014 through 2018 US cohort natality files.

RESULTS

Older maternal ages at birth are associated with higher probabilities of low and very low birthweight for most racial/ethnic-nativity groups. Consistent with the weathering hypothesis, birth at older maternal ages (e.g., 30–34 or 40+) is more predictive of low and very low birthweight for US-born Black, American Indian/Alaskan Native, and US-born Mexican American women than for US-born Whites. In contrast, some foreign-born populations exhibit relatively weak relationships between maternal age and low birthweight, suggesting the role of healthy immigrant selection.

CONTRIBUTION

Some disadvantaged racial/ethnic-nativity groups – US-born Black, American Indian/Alaskan Native, and US-born Mexican American women – exhibit more rapid increases in the risk of low birthweight at older maternal ages than US-born White women. These patterns are consistent with the weathering hypothesis. Future research may benefit from using linked family data and sibling modeling approaches to estimate causal models of weathering.

¹ Duke University, USA. Email: samuel.fishman@duke.edu.

1. Introduction

Prior research has documented the racial divergence of birthweight patterns at older maternal ages in the United States (Geronimus 1992, 1996; Holzman et al. 2009; Love et al. 2010; Rauh, Andrews, and Garfinkel 2001; Rich-Edwards et al. 2003). This weathering pattern – seen in US-born Black women’s growing risk of low birthweight at older ages relative to White women – is connected with the wear and tear from persistent racial inequality in the United States (Forde et al. 2019; Geronimus 1992, 1996; Geronimus et al. 2006). For example, Geronimus (1996) found that Black women ages 15 through 19 have 80% higher odds of low birthweight than White women of the same age. In contrast, Black women ages 30 through 34 have 190% higher odds of low birthweight than White women of the same age. Weathering literature on the relationship between maternal age and birthweight among other racial/ethnic minority groups is relatively sparse and less clear. For example, birthweight research on Mexican Americans (Collins, Rankin, and Hedstrom 2012; Wildsmith 2002) – using 30-year-old data – conflicts with infant mortality research using more recent data (Cohen 2016; Powers 2013). Examination of such patterns among Central and South Americans in the United States, East Asian Americans, foreign-born Blacks, and American Indian/Alaskan Natives (AI/AN) is quite limited (Dennis 2019; Kim 2016). Moreover, the weathering literature often focuses on differences between specific minority groups and Whites (e.g., Black–White, Mexican–White), making comparisons between minority populations (e.g., AI/AN–Black, Mexican American–East Asian) somewhat difficult (Forde et al. 2019). Thus, the weathering literature may be extended with a unified analysis of the relationship between maternal age and birthweight across a variety of racial/ethnic groups using current population data.

The relationship between maternal age at birth and birthweight is of key societal importance for understanding racial/ethnic inequality. Birthweight not only impacts the risk of infant mortality (Frisbie 2005; Hummer et al. 1999) but also influences developmental and mobility outcomes across the life course (Behrman and Rosenzweig 2004; Conley and Bennett 2000, 2001; Pinto-Martin et al. 2004; Reichman 2005). Thus, inequality in birthweight connected with weathering may have long-term consequences for racial/ethnic stratification in the United States.

Much weathering research has assumed that cross-sectional associations accurately reflect underlying relationships between maternal age and birthweight. However, recent research suggests that the relationship between maternal age and birthweight may be largely driven by selection rather than a causal relationship between aging and birthweight (Goisis et al. 2017). Although this paper does not resolve the omitted variable problems from cross-sectional models, it carefully considers the role of social selection and makes proposals for improving accuracy in future weathering research.

This research extends social science knowledge on weathering by examining heterogeneity in the relationship between maternal age at birth and birthweight across a broad set of racial/ethnic groups in the United States. In addition, the paper provides updated estimates and theory on the weathering hypothesis by discussing recent concerns about fertility selection and nativity while using current data and statistical methods. First, this paper reviews the relevant literature on the relationship between maternal age at birth and birthweight, and proposes hypothesized patterns. Second, models of the association between maternal age at birth, low birthweight, and very low birthweight are estimated using data from 2014 through 2018 birth records. Third, the paper addresses theoretical implications of the findings, incorporating key knowledge from European and US research on fertility timing selection.

2. Literature review

2.1 Weathering across racial/ethnic minorities

Young (e.g., under 20) and old (e.g., 35+) maternal ages at birth are associated with increased risk of low birthweight (Astolfi and Zonta 1999; Goisis et al. 2017; Kenny et al. 2013; Liu, Zhi, and Li 2011). After adjustment for sociodemographic characteristics, this U-shaped relationship becomes positive and linear (Dennis and Mollborn 2013; Geronimus 1996; Goisis et al. 2017; Lee et al. 1988). The linear pattern is consistent with knowledge of biological aging (Belsky et al. 2015).

Weathering theory contends that Black women age more rapidly than White women because of the accumulation of social disadvantages (e.g., socioeconomic status, discrimination, stress) across the life course (Geronimus 1996; Geronimus et al. 2006, 2010; Levine and Crimmins 2014). For example, Geronimus and colleagues observed diverging scores of allostatic load at older ages among Black and White women, implicating the role of life course stress processes (2006). Other research has found that Black populations may be biologically older than White populations of the same chronological age, as indicated in shorter telomere lengths and biomarkers indicating accelerated aging (Geronimus et al. 2010; Levine and Crimmins 2014). In turn, Black women's quicker aging results in a widening Black-White gap in low birthweight as women age (Forde et al. 2019; Geronimus 1992, 1996). Thus, weathering theory extends other research on maternal age and birthweight, hypothesizing a race-moderated causal relationship between maternal age and birthweight.

Mexican American populations, like US-born Blacks, are socioeconomically disadvantaged relative to Whites (Fishman, Morgan, and Hummer 2018), and US-born

Mexican Americans have higher metabolic allostatic load scores than Whites and foreign-born Mexican Americans, suggesting the possibility of a weathering pattern (Peek et al. 2010). What little research has examined Mexican American birthweight patterns yields no evidence of weathering (Collins, Rankin, and Hedstrom 2012; Wildsmith 2002). However, these studies use older data and techniques. For example, Wildsmith – using data from 1989 through 1991 – relied primarily on unadjusted estimates. Similarly, Collins and colleagues (2012) used Illinois-based data with small sample sizes from 1989 through 1991. These findings conflict with weathering patterns in infant mortality research using more recent nationally representative population data (1995–2002, 2013) (Cohen 2016; Powers 2013). Thus, future research on Mexican American weathering patterns in birthweight would benefit from updated data and methods.

Research on the weathering hypothesis, however, has not examined other racial/ethnic groups, including Central and South Americans in the United States, AI/ANs, and East Asian Americans. The accumulation of race/ethnicity-related stressors across the life course may lead to variation in the relationship between maternal age at birth and birthweight. For example, Central and South Americans – like Mexican Americans – experience socioeconomic disadvantage and stigmatization in the United States (Fishman, Morgan, and Hummer 2018; Flores and Schachter 2018), and Hispanics – in aggregate – accumulate higher disability rates than Whites in later life (Hayward et al. 2014). These processes may result in expanding birthweight gaps with White women at older maternal ages, such as those experienced by US-born Black women.

Similarly, persistent socioeconomic disadvantage and historical and current experiences of trauma among AI/AN populations may result in the accumulation of health-impacting stressors across the life course (Brave Heart and DeBruyn 1998; Edmunds 1995; Jones 2006; Whitbeck et al. 2004). In turn, these processes manifest in higher rates of low birthweight and infant mortality compared with Whites (Hwang et al. 2013; Tomashek et al. 2006; Wong et al. 2014). As with US-born Black women, the accumulation of life course stressors among AI/AN women may lead to more rapid physical decline and increasing risk of low birthweight with older maternal ages relative to White women.

Dennis (2019) examined the relationship between maternal age at birth and adverse birthweight outcomes among AI/AN women. Citing the problem of high rates of gestational diabetes, which increase rates of heavy births (above 4,000 grams), the author focused on the number of “normal” weight births (2,500–4,000 grams) while controlling for gestational diabetes. Using this approach, Dennis found modest evidence of weathering among AI/AN women. Although the association between heavy births and infant death is relatively low for Whites, the rate of heavy births is relatively higher

for AI/AN women (Tomashek et al. 2006). Therefore, the increased incidence of heavy births may be problematic for population health. Dennis' work, however, does not examine if AI/AN women experience weathering with low and very low birthweights. Given their strong relationship with health and developmental outcomes, it is justifiable to study weathering in low and very low birthweights among AI/AN populations. Low birthweights are also much stronger predictors of infant mortality risk than a 4,000-gram heavy birth benchmark (Gage et al. 2013; Solis, Pullum, and Frisbie 2000). For example, for AI/AN women, the risk of infant death among infants of 1,500 to 2,499 and 1,000 to 1,499 grams are around two and ten times higher, respectively, than the mortality risk of infants ranging from 4,500 to 7,999 grams (Tomashek et al. 2006). Therefore, examining the relationship between maternal age and low and very low birthweight outcomes may complement prior research on AI/AN weathering patterns (Dennis 2019).

In contrast with Black, Mexican American, Central and South American, and AI/AN populations, East Asian Americans (e.g., Chinese, Korean, and Japanese Americans) are known for having relatively high levels of socioeconomic status (Feliciano and Lanuza 2017; Xie and Goyette 2004). Despite their economic resources, many East Asian Americans report experiencing discrimination, resulting in heightened stress levels and negatively impacted health (Gee and Ponce 2010; Mereish, Liu, and Helms 2012). One study found that (aggregated ethnicity) Asian American women have a lower risk of low birthweight than White women before age 20 and at ages 40 and above (Kim 2016). However, they have a higher risk of low birthweight than White women in their late 20s and 30s. The author argued that this pattern may be consistent with weathering. Other studies have not specifically examined weathering patterns among East Asian Americans.

2.2 Fertility timing selection

Recent research – primarily from Europe – has called into question the causal relationship between maternal age and birthweight. Drawing on Finnish register data, Goisis et al. (2017) found that maternal age does not predict low birthweight after controlling for the selection of parents. The authors' analysis suggests that both young and older maternal ages select on women with worse health but that maternal age has no causal influence on birthweight. Their estimation strategy, sibling fixed effects, is the preferred method for obtaining accurate estimates of the relationship between maternal age and offspring's social and health outcomes (Barclay and Myrskylä 2016; Fishman and Min 2018; Goisis et al. 2017; Myrskylä, Barclay, and Goisis 2017). Recent scholarship has given greater attention to the selection of parents by maternal

age. For example, Goisis, Schneider, and Myrskylä (2018) found that the association between advanced maternal age and low birthweight declined from the 1950s through the early 2000s in the United Kingdom. The authors attributed these changes to the shifting social selection of older parents. Similarly, Fishman and Min (2018) hypothesize that young and older mothers may be selected on increased propensity for unobservable disadvantaged social characteristics, which may be signaled in increased rates of risk-taking and unintended births. In sum, current literature casts some doubt on the causal association between maternal age at birth and birthweight, suggesting that the patterns are more closely connected with social selection than underlying relationships. Unfortunately, US national birth record data do not link families like the Scandinavian register data commonly used for the sibling fixed effects strategy (Barclay and Myrskylä 2016; Goisis et al. 2017). In lieu of improved data, US weathering research must rely on prior knowledge of fertility timing selection.

Heterogeneity in fertility timing selection across race/ethnicity may be responsible for diversity in the relationship between maternal age at birth and birthweight (Stevens-Simon 2002). For example, East Asian Americans have clear patterns of older maternal ages in comparison with other racial/ethnic groups (Cai and Morgan 2019). East Asian Americans' high education levels (Feliciano and Lanuza 2017) may play an important role in delaying fertility (Sohn and Lee 2019; Tropf and Mandemakers 2017). Distinct East Asian American maternal age–birthweight associations may provide indirect evidence of the important role of social selection in the relationship between maternal age at birth and birthweight. In contrast, Black, Hispanic American, and AI/AN populations have considerably younger maternal ages than White populations (Snipp 1997; Sweeney and Raley 2014). For example, Mexican American immigrant and AI/AN women have higher age-specific fertility rates in ages 15 through 24, and fertility during these ages comprises a larger percentage of cumulative fertility than for Whites (Choi 2014; Snipp 1997). These social selection patterns in fertility timing are important for understanding weathering.

Stevens-Simon and colleagues (Stevens-Simon 2002; Sheeder, Lezotte, and Stevens-Simon 2006) proposed the possibility of Black–White differences in the selection of maternal age at birth, arguing that if early childbearing is adaptive for Black women, then Black women with older maternal ages at birth may be more likely to select on subfecundity than White women with the same maternal ages. Alternatively, rare teenage fertility may be more negatively selective on maternal health for East Asian Americans than for populations with high rates of teenage fertility. Common fertility at ages 40 and above among East Asian American women may indicate a lower level of negative health selection than among populations with low rates of fertility at ages 40 and above. Thus, East Asian American women may have a weaker relationship between maternal age and low birthweight than White and Black

women. To note, racial/ethnic variation in maternal age at birth is only one type of fertility timing selection that may impact maternal age–birthweight estimates.

2.3 Variation by nativity

Healthy immigrant selection may account for Mexican Americans' and Central and South Americans' (in the United States) low rates of low birthweight, even after accounting for health behaviors (Fishman, Morgan, and Hummer 2018; Landale, Oropesa, and Gorman 1999). Foreign-born Black women may also benefit from healthy immigrant selection. For example, foreign-born Black women have higher rates of low birthweight than Whites but considerably lower rates of low birthweight than US-born Black women (David and Collins Jr. 1997; Elo, Vang, and Culhane 2014; Pallotto, Collins Jr., and David 2000). However, foreign-born Black women's health advantage dissipates with more time living in the United States. This pattern is attributed to the accumulation of common US health behaviors and increased exposure to racial stratification (Antecol and Bedard 2006; Doamekpor and Dinwiddie 2015). Thus, it is possible that foreign-born Black women – like US-born Black women – have a weathering pattern in birthweight. Chinese Americans also show a healthy immigrant pattern in low birthweight (Landale, Oropesa, and Gorman 1999).

Selection into fertility timing may also vary by nativity, thereby possibly impacting birthweight. For example, foreign-born Mexican American women may have younger maternal ages than US-born Mexican American women (Batson 2013; Parrado 2011). Similarly, research on East Asian American fertility timing discusses the possibilities of convergence with Whites in later generations or, alternatively, persistent patterns across generations (Cai and Morgan 2019). Although some weathering research has disaggregated race/ethnicity by nativity (Dennis and Mollborn 2013; Powers 2013; Wildsmith 2002), most weathering studies do not disaggregate (Dennis 2019; Forde et al. 2019; Kim 2016). In sum, disaggregation by nativity may provide important information on the role of selection in low birthweight patterns.

3. Sociodemographic covariates

Other sociodemographic factors may influence the relationship between maternal age and birthweight. Comparable studies on maternal age and birthweight account for maternal socioeconomic characteristics, such as maternal education (Geronimus 1996). Accounting for socioeconomic background is important because many women from minority racial/ethnic-nativity groups have fewer socioeconomic resources than Whites

due to long-standing racial/ethnic stratification in the United States (Hummer et al. 1999; Markides and Eschbach 2011; Phelan and Link 2015). In addition, the relationship between education and low birthweight may vary by race/ethnicity-nativity (Acevedo-Garcia, Soobader, and Berkman 2005, 2007). Thus, stratification by race/ethnicity-nativity may be preferable to including interaction terms, because stratification leaves the relationship between education and low birthweight unconstrained.

Prior research on race/ethnicity and birthweight also controls for demographic characteristics (Elder, Goddeeris, and Haider 2011; Hummer et al. 1999), such as marital status and birth order – which may also be related to fertility timing (Addo, Sassler, and Williams 2016; Goisis et al. 2017; Luke and Brown 2007). Black and Hispanic women have higher rates of births among unmarried women and younger fertility ages than Whites (Sweeney and Raley 2014), yet Hispanic women generally have low birthweight rates that are similar to or lower than those of Whites (Acevedo-Garcia, Soobader, and Berkman 2007), while Black women have much higher rates (Acevedo-Garcia, Soobader, and Berkman 2005). Lastly, health behaviors, such as prenatal smoking and initiation of prenatal care, have often been included in weathering research (Dennis 2019; Dennis and Mollborn 2013; Geronimus 1996; Kim 2016). For example, Black, Mexican American, Central and South American, and Asian American women have lower prenatal smoking rates than White women, while American Indian women have somewhat higher rates than White women (Dennis 2019; Fishman, Morgan, and Hummer 2018; Kim 2016). On the other hand, Black, Mexican American, Central and South American, and AI/AN women may have reduced access to health care compared to White women, leading to later prenatal care initiation (Gadson, Akpovi, and Mehta 2017; Hummer et al. 1999; Johnson, Call, and Blewett 2010).

4. Theory and hypotheses

The present study presents hypotheses on racial/ethnic-nativity variation in the relationship between maternal age at birth and low birthweight. Although some research contends that delaying childbearing is beneficial for social environment (Kalmijn and Kraaykamp 2005; Powell, Steelman, and Carini 2006) – thus, older age may be associated with lower rates of low birthweight – most health research demonstrates that older maternal ages are associated with higher rates of low birthweight upon adjustment for sociodemographic covariates (Dennis and Mollborn 2013; Geronimus 1996; Goisis et al. 2017; Lee et al. 1988). If including these covariates adequately accounts for social selection, then the residual (positive) relationship may reflect biological aging.

The relationship between maternal age at birth and birthweight may vary by race/ethnicity and nativity. The weathering hypothesis argues that this pattern reflects accelerated biological aging among Black women due to accumulating social disadvantages (Geronimus 1992, 1996; Geronimus et al. 2006, 2010; Levine and Crimmins 2014). A weathering pattern would result in a widening Black–White gap in low birthweight at older maternal ages. One possibility is that weathering also occurs among other minority populations, such as Mexican American, Central and South American, East Asian American, and American Indian women (Kim 2016; Powers 2013). If weathering occurs among these populations, their residual associations between maternal age and low birthweight would be stronger than for White women. Again, the weathering hypothesis assumes that this age–birthweight relationship accurately reflects biological aging.

However, the relationship between maternal age and birthweight may also reflect fertility timing selection (Goisis et al. 2017; Goisis, Schneider, and Myrskylä 2018; Sheeder, Lezotte, and Stevens-Simon 2006; Stevens-Simon 2002). Fertility timing varies considerably by race/ethnicity and nativity. Therefore, age variation in the distribution of births in each racial/ethnic-nativity group may bias estimates. For example, East Asian Americans delay fertility, resulting in an older distribution of births (Cai and Morgan 2019). Thus, East Asian American women – and other populations with older maternal age distributions – may have a weaker residual association between maternal age and low birthweight than White women if older births are less negatively selected. Likewise, populations with early fertility (e.g., Mexican American and AI/AN women) may have more negative health selection among older births (Sheeder, Lezotte, and Stevens-Simon 2006; Stevens-Simon 2002), resulting in stronger residual associations between maternal age and low birthweight than for Whites. Strong evidence of fertility timing selection may serve as an alternative explanation to the weathering hypothesis.

Immigrant health selection may also play an important role in weathering (Powers 2013). Foreign-born populations – including those with old and young maternal age distributions – may exhibit weak associations between maternal age and low birthweight. This pattern would suggest that immigrants – possibly due to health selection (Elo, Vang, and Culhane 2014; Fishman, Morgan, and Hummer 2018; Landale, Oropesa, and Gorman 1999) – experience less detrimental consequences from birth at older ages. Unlike a finding of fertility timing selection, evidence of immigrant health selection would not weaken the weathering hypothesis.

5. Data

For analysis, the present study uses population data from the 2014 through 2018 US cohort natality files (National Center for Health Statistics 2015, 2016, 2017, 2018, 2019). These data represent individual-level files of the population of births from these years in the United States. The analysis focuses on six racial/ethnic groups: White, Black, Mexican American, Central and South American in the United States, East Asian American, and American Indian/Alaskan Native women. Each group is disaggregated by nativity (US- or foreign-born) – except for AI/AN. These restricted data were obtained from the National Center for Health Statistics (NCHS), featuring information on nativity not included in the public access files. To be consistent with prior weathering research (Geronimus 1996), only singleton births are included in the analyses. The primary analyses are conducted using data from all birth orders. Although weathering studies have often focused on first births (Geronimus 1992, 1996; Kim 2016), more recent studies have used all birth orders or called for future research to look at higher birth orders (Dennis 2019; Dennis and Mollborn 2013; Powers 2013). Supplemental files have estimates from first births (Figures B-1 and B-2). Cases missing birthweight (< 1%) are dropped from the analysis. Missing data in covariates are recovered using five rounds of chained multiple imputation. The imputation models include all right-hand covariates in the model and an indicator of raw birthweight (grams). The raw birthweight indicator was chosen because it may provide more precision in modeling the predictors than the binary birthweight indicators (low and very low birthweight). Moreover, including both low and very low birthweight indicators may lead to collinearity in the imputation models. No meaningful difference between the imputed and non-imputed data was observed. The final file includes 15,813,918 births. See Table A-1 for descriptive statistics.

6. Measures

The outcome of interest is birthweight. Two binary indicators are used: low and very low birthweight. Low birthweight is a standard indicator of birthweight in public health and demographic literature (Acevedo-Garcia, Soobader, and Berkman 2007; Fishman, Morgan, and Hummer 2018; Goisis et al. 2017; Lauderdale 2006), with infants under 2,500 grams labeled low birthweight and infants at or above 2,500 grams labeled non-low birthweight. Similarly, infants under 1,500 grams are labeled very low birthweight (Hack et al. 2002). Very low birthweight is a relatively rare outcome and serves as a stronger indicator of adverse long-term developmental outcomes than the standard low

birthweight indicator (de Kieviet et al. 2012; Hack et al. 2002; Howell et al. 2008; Litt et al. 2005; Wilcox and Russell 1986).

The stratifying variable is a combined measure of maternal race/ethnicity-nativity. Six racial/ethnic groups are included the analysis (see above). All groups are then disaggregated by nativity (US- and foreign-born) except for AI/AN. The final variable has 11 categories: non-Hispanic US-born White (N = 9,006,110), non-Hispanic foreign-born White (N = 577,626), non-Hispanic US-born Black (N = 2,168,361), non-Hispanic foreign-born Black (N = 379,673), US-born Mexican American (N = 1,360,830), foreign-born Mexican American (N = 1,182,883), US-born Central and South American (N = 109,928), foreign-born Central and South American (N = 547,668), non-Hispanic US-born East Asian (Chinese, Korean, and Japanese) (N = 52,340), non-Hispanic foreign-born East Asian (N = 277,627), and non-Hispanic American Indian/Alaskan Native (N = 150,872).

The predictor of interest is maternal age at birth. Maternal age at birth is divided into six categories: under 20 (referent), 20 through 24, 25 through 29, 30 through 34, 35 through 39, and 40 and above. Teenage births are treated as the referent because weathering literature argues that birthweight patterns diverge across race/ethnicity with increasing maternal age at birth. Although many earlier weathering studies concentrate primarily on the 20s and 30s (Geronimus 1996; Love et al. 2010), recent research has included indicators for older ages (35+ or 40+) as well (Dennis 2019; Dennis and Mollborn 2013; Kim 2016; Powers 2013).

The analysis also includes information on maternal education. This variable is divided into five categories: less than high school (referent), high school, some college, bachelor's degree, and more than a bachelor's degree. Maternal education serves as a proxy for socioeconomic status. A binary indicator of marital status and a categorical indicator of birth order (1 [referent], 2, 3–4, 5+) are also included in the analyses. The models also include health behavior indicators for the initiation of prenatal care and prenatal smoking. Initiation of prenatal care is divided into three categories: first trimester (referent), second trimester, and third trimester or none. The prenatal smoking indicator is dichotomized: prenatal smoking and none (referent). Marital status is also dichotomized: married and unmarried (referent). Similar indicators were used in recent weathering research (Cohen 2016; Kim 2016).

7. Methods

The analysis uses binary logistic regression models of low birthweight and very low birthweight, stratified across eleven racial/ethnic-nativity groups. Low birthweight models are estimated such that

$$\text{LN}(P_{\text{LBW}}/1-P_{\text{LBW}}) = \beta_0 + \beta_1 \text{mage} + \beta_2 \mathbf{X},$$

where low birthweight is regressed on maternal age at birth and a series of covariates, \mathbf{X} (maternal education, marital status, birth order, initiation of prenatal care, and prenatal smoking).

Unlike regression coefficients (log odds or odds ratios) and predicted probabilities at the mean used in prior weathering research (Cohen 2016; Geronimus 1996; Kim 2016), average marginal effects (AMEs) can be used to compare binary outcomes across groups (Breen and Karlson 2013; Mood 2010). AMEs also offer an advantage over average predicted probabilities as they solely focus on contrasts in maternal age at birth in its relationship with low birthweight. Predicted probabilities display contrasts in the race/ethnicity-nativity intercept, making the direct comparison of maternal age associations somewhat more complicated. Thus, estimates from logistic regressions are used to calculate AMEs.

AMEs represent the average discrete change in the probability of a binary outcome for one population relative to the reference group. These AMEs treat births to a woman under age 20 as the reference group. For example, the AME of low birthweight for births to women ages 40 or above ($\text{mage}_{40+} = 1$) is the difference in the average predicted probability (APr) of low birthweight relative to women under age 20 ($\text{mage}_{<20} = 1$, omitted), such that

$$\text{AME of } \text{mage}_{40+} = \text{APr}(y = 1 | \text{mage}_{40+}, \text{mage}_{40+} = 1) - \text{APr}(y = 1 | \text{mage}_{<20}, \text{mage}_{<20} = 1).$$

Drawing on estimates from an adjusted logistic regression equation, the AMEs account for covariates. The AMEs are then compared across race/ethnicity-nativity using 95% confidence intervals. The weathering hypothesis would be supported if the maternal age–low birthweight association is greater for a racial/ethnic-nativity minority group than for US-born Whites. The primary analyses are displayed as figures. Additional descriptive tables and figures, cross-tabulations, and AME point estimates are displayed in Appendix A. Supplemental figures are displayed in Appendix B.

8. Results

8.1 Fertility timing across race/ethnicity-nativity

The distribution of maternal ages at birth varies considerably across race/ethnicity-nativity. For example, for US-born White women, teenage births are relatively uncommon (4.3%); most births occur at ages 25–29 (30.5%) or at ages 30–34 (30.5%)

(Table 1). Births at ages 35–39 (13.4%) and at ages 40+ (2.5%) are also somewhat uncommon among US-born White women. US-born Black, Mexican American, Central and South American, and AI/AN women, in contrast, have much younger maternal ages, with around 10% of births before age 20 and around 30% of births between ages 20–24. In turn, few of these populations' births occur after age 34. For example, 8.8% and 2.0% of births to US-born Black women occur at ages 35–39 and at ages 40+, respectively. Similarly, 8.7% and 1.9% of births to AI/AN women occur at ages 35–39 and at ages 40+, respectively. Foreign-born White, foreign-born Black, and East Asian women, however, have considerably older maternal ages, with more than 25% of births at ages 35+. Foreign-born Mexican American and Central and South American women also have higher rates of older births than US-born White women. In these instances, the older distribution may be driven by fertility continuation rather than delay. The diversity in maternal age at birth suggests heterogeneity in the selection into maternal age at birth across race/ethnicity and nativity.

Table 1: Maternal age at birth across race/ethnicity-nativity (%)

	< 20	20–24	25–29	30–34	35–39	40+	N
US-White	4.27	18.88	30.46	30.48	13.40	2.51	9,006,110
FB-White	1.14	10.44	27.06	34.43	21.19	5.74	577,626
US-Black	9.44	31.74	29.56	18.54	8.76	1.96	2,168,361
FB-Black	1.46	10.30	26.25	33.92	21.34	6.73	379,673
US-Mexican	12.49	32.59	28.34	17.55	7.62	1.41	1,360,830
FB-Mexican	4.92	18.46	27.59	27.33	16.67	5.03	1,182,883
US-C and S American	9.36	27.51	29.83	21.75	9.51	2.04	109,928
FB-C and S American	5.49	17.02	26.13	28.19	18.20	4.96	547,668
US-East Asian	0.42	3.09	15.01	45.59	29.94	5.94	52,340
FB-East Asian	0.15	2.96	22.05	39.89	27.45	7.50	277,627
AI/AN	10.23	29.71	30.03	19.49	8.66	1.88	150,872

Data: 2014–2018 natality files.

Notes: N = 15,813,918. AI/AN refers to American Indian/Alaskan Native women. All cases are singleton births.

8.2 Multivariable analyses

Next, average marginal effects of maternal age on low birthweight are estimated, stratified by race/ethnicity-nativity (Figure 1). The logistic regression models used to obtain these estimates adjust for maternal education, marital status, initiation of prenatal care, prenatal smoking, and birth order. Among all racial/ethnic-nativity groups, increased maternal age is associated with higher risk of low birthweight; this pattern is

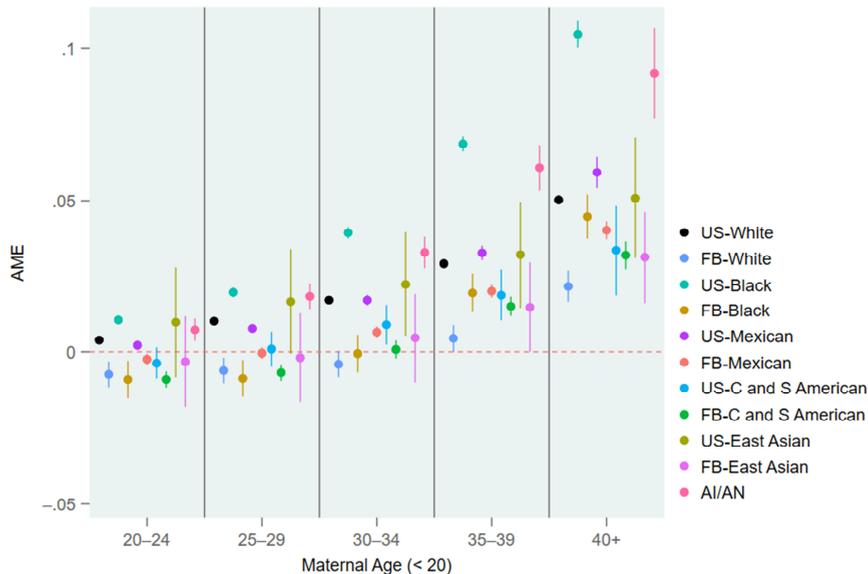
consistent with adjusted models from prior research (Geronimus 1996; Goisis et al. 2017). This increased risk of low birthweight is gradual. Among US-born White women, for example, AMEs increase from .0038 at ages 20–24 to .0171 at ages 30–34 to .0503 at ages 40+. Additional analyses reveal the expected inverse U-shaped relationship prior to adjustment (Figure A-1). Thus, accounting for observed social selection has a considerable influence on estimates.

A gap in AMEs between US-born White and Black women is observed across the maternal age distribution. For example, US-born Black women's AMEs of low birthweight increase from .0105 at ages 20–24 to .0393 at ages 30–34 to .1047 at ages 40+. Thus, US-born Black–White gaps in AMEs range from around .0067 (.7%) at ages 20–24 to .0544 (5.4%) at ages 40+. This pattern is quite consistent with the weathering hypothesis.

Some evidence of weathering is observed for AI/AN and US-born Mexican American women. For AI/AN women, a gap with US-born White women in low birthweight AMEs emerges at ages 20–24 and expands across the life course. For example, AI/AN women have AMEs of .0072, .0327, and .0918 at ages 20–24, 30–34, and 40+, respectively. Therefore, the AI/AN–US-born White gap expands from around .0034 (.3%) at ages 20 through 24 to .0416 (4.2%) at ages 40+. For US-born Mexican Americans, the birthweight gap emerges only at ages 35–39 and persists at ages 40+. At ages 40+ US-born Mexican American women have an AME .0089 (.9%) higher than US-born White women. No evidence of weathering is observed among other racial/ethnic-nativity groups. US-born Central and South American and US-born East Asian women have associations between maternal age at birth and low birthweight that are similar to those for US-born White women at most ages. In contrast, foreign-born White, Mexican American, Central and South American, and East Asian women have weaker relationships between maternal age at birth and low birthweight than do US-born White women at older ages. Foreign-born white women specifically have a much weaker association between maternal age and low birthweight from ages 20 and older than that observed among US-born White women. Foreign-born Black women have lower AMEs of low birthweight than US-born Whites until ages 40+.

In general, racial/ethnic-nativity groups fall into the three following patterns. US-born White, Central and South American, and East Asian American women have a gradual increase in low birthweight at older ages. Foreign-born populations, on the other hand, have a slower increase in risk of low birthweight at older ages. The third group – US-born Black, AI/AN, and US-born Mexican American women – experiences a pattern consistent with weathering. This group exhibits steep maternal age–low birthweight relationships. US-born Black women stand out with the strongest relationship between maternal age and low birthweight risk.

Figure 1: Average marginal effects (AME) of maternal age on low birthweight with 95% confidence intervals



Data: 2014–2018 natality files.

Notes: N = 15,813,918. AI/AN refers to American Indian/Alaskan Native women. The models are stratified by race/ethnicity-nativity. The AMEs represent discrete changes in the probability of low birthweight infants relative to births under age 20. An AME of zero represents the AME under age 20 for each racial/ethnic-nativity group. The models used to estimate the AMEs account for education, marital status, birth order, smoking, and initiation of prenatal care. All cases are singleton births. See estimates in Table A-4.

Results from equivalent very low birthweight models reveal similar patterns (Figure 2). Again, most racial/ethnic-nativity groups exhibit increased probability of very low birthweight at older maternal ages at birth. For example, among US-born White women, there are AMEs of .0000, .0028, and .0096 at ages 20–24, 30–34, and 40+, respectively, suggesting a gradual biological aging pattern with some acceleration at older ages. The gap between US-born Blacks and US-born White women persists and widens across the life course. For example, US-born Black women have AMEs of .0181 and .0356 at ages 30–34 and 40+, respectively. Therefore, there are .0153 and .0260 US-born Black–White gaps in the AMEs of very low birthweight at ages 30–34 and 40+, respectively.

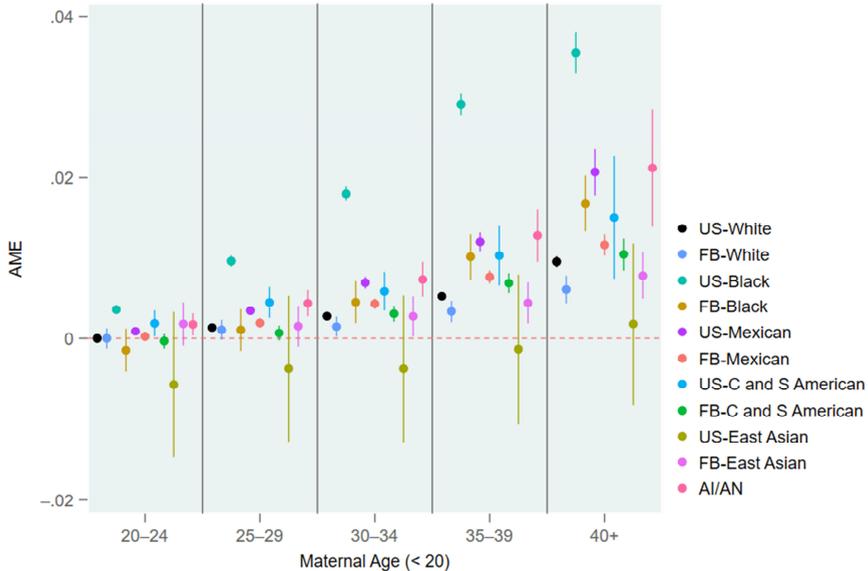
Similar—but less prominent—weathering patterns are observed for US-born Mexican American, AI/AN, and foreign-born Black women. For US-born Mexican

American and AI/AN women, a gap with US-born White women in AMEs already emerges by ages 20–24. In contrast, a gap with US-born White women in AMEs emerges at ages 35–39 for foreign-born Black women. Again, this gap widens at older ages. At ages 40+ these three populations have AMEs ranging from .0168 to .0212, considerably higher than the US-born White AME (.0096).

Other racial/ethnic-nativity groups – foreign-born Mexican American, Central and South American, and East Asian American women – have associations between maternal age and very low birthweight that are similar to those for US-born White women. For US-born East Asian women, there is no difference in the relationship between maternal age at birth and low birthweight across all ages. However, at each age, the wide confidence intervals overlap with the AMEs from US-born White women. In contrast, foreign-born White women have a consistently weaker maternal age–very low birthweight association than US-born White women. This pattern – like that observed for moderately low birthweight – is consistent with the fertility timing selection hypothesis, as foreign-born White women have older maternal ages at birth than most other populations.

Again, the racial/ethnic-nativity groups could be summarized as falling into three categories: gradual increase, slower increase, and quicker increase of very low birthweight risk with maternal age. Most populations exhibit similar gradual increases in the risk of very low birthweight with older maternal ages. Foreign-born White women exhibit a slower increase in risk of very low birthweight. Lastly, US-born Black, AI/AN, US-born Mexican American, and foreign-born Black women have quicker increases in risks of very low birthweight with older ages, consistent with the weathering hypothesis. Among these populations, US-born Black women’s weathering pattern is – by far – the most distinct and consistent.

Figure 2: Average marginal effects (AME) of maternal age on very low birthweight with 95% confidence intervals



Data: 2014–2018 natality files.

Notes: N = 15,813,918. AI/AN refers to American Indian/Alaskan Native women. The models are stratified by race/ethnicity-nativity. The AMEs represent discrete changes in the probability of very low birthweight infants relative to births under age 20. An AME of zero represents the AME under age 20 for each racial/ethnic-nativity group. The models used to estimate AMEs account for education, marital status, birth order, smoking, and initiation of prenatal care. All cases are singleton births. See estimates in Table A-4.

8.3 First births

Models of first births reveal patterns similar to those from the primary analyses. Although estimates from the low birthweight models are nearly the same – but with somewhat wider confidence intervals – some differences in the very low birthweight models are observed (Figures B-1 and B-2). Namely, for women ages 40+, foreign-born Black women have tightly overlapping confidence intervals with US-born White women in very low birthweight models. This finding may be considered evidence against weathering among this population. Due to small numbers of births to older women, AI/AN women’s bottom of the confidence interval overlaps with US-born White women’s AME in very low birthweight models at ages 35–39 and 40+. Thus, the

results demonstrate that the weathering hypothesis likely holds for US-born Black, AI/AN, and US-born Mexican American women for birthweight.

9. Discussion and conclusion

This paper extends knowledge on the weathering hypothesis by examining racial/ethnic-nativity variation in the relationship between maternal age at birth and birthweight. The analysis concentrates on two birthweight indicators: low birthweight and very low birthweight. Strong evidence of weathering, or increased birthweight penalty for childbearing at older maternal ages, is observed among US-born Black women, consistent with a large body of literature (Forde et al. 2019; Geronimus 1992, 1996). The analysis also reveals more modest evidence of weathering for AI/AN, US-born Mexican American, and (in some specifications) foreign-born Black women. For example, US-born White women ages 40 and above average a 5% higher increase in risk of low birthweight in comparison with their peers who give birth in their teenage years when adjusting for sociodemographic background. In contrast, AI/AN women ages 40 and above average a 9% higher risk of low birthweight relative to their peers who give birth in their teenage years in adjusted estimates. These contrasts are consistent with the weathering hypothesis. Weathering among US-born Black women – in particular – has strong prior evidence from research using birthweight and biological outcomes (Geronimus 1996; Geronimus et al. 2006, 2010; Holzman et al. 2009; Levine and Crimmins 2014; Love et al. 2010; Rauh, Andrews, and Garfinkel 2001; Rich-Edwards et al. 2003). These results suggest that some other disadvantaged racial/ethnic-nativity groups may experience increased birthweight penalties from older maternal ages compared to US-born White women, indicative of accumulating social inequality across the life course. Given the relationship between low birthweight and infant mortality (Frisbie 2005; Hummer et al. 1999) and adverse developmental and mobility outcomes (Behrman and Rosenzweig 2004; Conley and Bennett 2000, 2001; Pinto-Martin et al. 2004; Reichman 2005), these findings are concerning for the population health and socioeconomic opportunities of these racial/ethnic minority populations.

In contrast, some foreign-born populations exhibit somewhat weaker associations between older maternal ages and low birthweight than US-born White women. In low birthweight models, this weak association is observed among foreign-born White, Mexican American, Central and South American (in the United States), and East Asian American women, suggesting the role of immigrant selection. First, these findings suggest that immigrant status may be protective against negative consequences of older maternal ages at birth. One possibility is that immigration selects women who

experience slower biological aging – at least in terms of birthweight – than the average US-born population. Alternatively, unobserved healthy immigrant behaviors could buffer aging (Powers 2013). This evidence for healthy immigrant selection does not conflict with the weathering hypothesis. Rather, it primarily demonstrates that immigrant status may have countervailing influence on the relationship between maternal age and birthweight to social disadvantage for racial/ethnic minorities.

However, only foreign-born White women have slower increases in very low birthweight with older maternal ages. Foreign-born White women have relatively few teenage births (1.1%) and a large population of births at ages 40 and above (5.7%). This pattern provides some support for the fertility timing selection argument. Other populations with older maternal ages at birth – US- and foreign-born East Asian American and foreign-born Black women – have more mixed findings. For example, foreign-born East Asian American women have a weaker relationship between maternal age and low birthweight than US-born White women but have a similar association in very low birthweight estimates. At the same time, most populations with a young distribution of births (e.g., US-born Black, US-born Mexican American, and AI/AN women) have a weathering pattern, consistent with the selection hypothesis (Sheeder, Lezotte, and Stevens-Simon 2006; Stevens-Simon 2002) and the weathering hypothesis. In sum, the absence of a clear relationship suggests only a modest role of social selection on racial/ethnic-nativity groups' maternal age distribution in the relationship between maternal age at birth and birthweight. Thus, the analysis provides stronger support for the weathering hypothesis.

Moreover, the analysis cannot rule out of the possibility of biased estimates from other types of fertility timing selection. Future research should use sibling fixed effects models (Goisis et al. 2017) – or other sibling modeling methods, such as correlated multi-equation models (Kravdal 2019) – to control for unobserved selection. Ideally, US researchers would link full and half siblings using a full population of birth records, akin to Scandinavian register data. Given the unlikelihood of this option, future US research should consider using innovative data sources to estimate sibling models, such as linking birth records by families across years or the use of US data registers – as seen in the Utah Population Database's or the North Carolina Education Research Data Center's linked administrative data. One alternative is estimating sibling models across women who have completed childbearing, with multiple births, in longitudinal studies, such as the National Longitudinal Study of Adolescent to Adult Health or the Panel Study of Income Dynamics. Unfortunately, survey-based data in combination with this conservative modeling strategy may offer limited statistical power to test the weathering hypothesis. Although the case for weathering among US-born Black women is strong – and consistent with prior theoretical and empirical support – weaker and less consistent weathering patterns among other populations (e.g., US-born Mexican

Americans) may be more closely tied to selection than to causal processes. Thus, future US weathering research should aim to estimate more accurate causal models of birthweight, relying on innovative population data sources to control for fertility timing selection.

References

- Acevedo-Garcia, D., Soobader, M.J., and Berkman, L.F. (2007). Low birthweight among US Hispanic/Latino subgroups: The effect of maternal foreign-born status and education. *Social Science and Medicine* 65(12): 2503–2516. doi:10.1016/j.socscimed.2007.06.033.
- Acevedo-Garcia, D., Soobader, M.-J., and Berkman, L.F. (2005). The differential effect of foreign-born status on low birth weight by race/ethnicity and education. *Pediatrics* 115(1): e20–e30. doi:10.1542/peds.2004-1306.
- Addo, F.R., Sessler, S., and Williams, K. (2016). Reexamining the association of maternal age and marital status at first birth with youth educational attainment. *Journal of Marriage and Family* 78(5): 1252–1268. doi:10.1111/jomf.12360.
- Antecol, H. and Bedard, K. (2006). Unhealthy assimilation: Why do immigrants converge to American health status levels? *Demography* 43(2): 337–360. doi:10.1353/dem.2006.0011
- Astolfi, P. and Zonta, L.A. (1999). Risks of preterm delivery and association with maternal age, birth order, and fetal gender. *Human Reproduction* 14(11): 2891–2894. doi:10.1093/humrep/14.11.2891.
- Barclay, K. and Myrskylä, M. (2016). Advanced maternal age and offspring outcomes: Reproductive aging and counterbalancing period trends. *Population and Development Review* 42(1): 69–94. doi:10.1111/j.1728-4457.2016.00105.x.
- Batson, C.D. (2013). Contemporary fertility patterns and first-birth timing among Mexican-origin women. *Hispanic Journal of Behavioral Sciences* 35(2): 174–193. doi:10.1177/0739986312468086.
- Behrman, J.R. and Rosenzweig, M.R. (2004). Returns to birthweight. *Review of Economics and Statistics* 86(2): 586–601. doi:10.1162/003465304323031139.
- Belsky, D.W., Caspi, A., Houts, R., Cohen, H.J., Corcoran, D.L., Danese, A., Harrington, H., Israel, S., Levine, M.E., and Schaefer, J.D. (2015). Quantification of biological aging in young adults. *Proceedings of the National Academy of Sciences* 112(30): E4104–E4110. doi:10.1073/pnas.1506264112.
- Brave Heart, M.Y.H. and DeBruyn, L.M. (1998). The American Indian holocaust: Healing historical unresolved grief. *American Indian and Alaska Native Mental Health Research* 8(2): 56. doi:10.5820/aian.0802.1998.60.

- Breen, R. and Karlson, K.B. (2013). Counterfactual causal analysis and nonlinear probability models. In: Morgan, S.L. (ed.). *Handbook of causal analysis for social research*. Cham: Springer: 167–187. doi:10.1007/978-94-007-6094-3_10
- Cai, Y. and Morgan, S.P. (2019). Persistent low fertility among the East Asia descendants in the United States: Perspectives and implications. *China Population and Development Studies* 2: 384–400. doi:10.1007/s42379-019-00024-7.
- Choi, K.H. (2014). Fertility in the context of Mexican migration to the United States: A case for incorporating the pre-migration fertility of immigrants. *Demographic Research* 30(24): 703–738. doi:10.4054/DemRes.2014.30.24.
- Cohen, P.N. (2016). Maternal age and infant mortality for white, black, and Mexican mothers in the United States. *Sociological Science* 3: 32–38.
- Collins, J.W., Rankin, K.M., and Hedstrom, A.B. (2012). Exploring weathering: The relation of age to low birth weight among first generation and established United States-born Mexican–American women. *Maternal and Child Health Journal* 16(5): 967–972. doi:10.1007/s10995-011-0827-4.
- Conley, D. and Bennett, N.G. (2000). Is biology destiny? Birth weight and life chances. *American Sociological Review* 65(3): 458–467. doi:10.2307/2657467.
- Conley, D. and Bennett, N.G. (2001). Birth weight and income: Interactions across generations. *Journal of Health and Social Behavior* 42(4): 450–465. doi:10.2307/3090189.
- David, R.J. and Collins Jr, J.W. (1997). Differing birth weight among infants of US-born blacks, African-born blacks, and US-born whites. *New England Journal of Medicine* 337(17): 1209–1214. doi:10.1056/NEJM199710233371706.
- de Kieviet, J.F., Zoetebier, L., Van Elburg, R.M., Vermeulen, R.J., and Oosterlaan, J. (2012). Brain development of very preterm and very low-birthweight children in childhood and adolescence: A meta-analysis. *Developmental Medicine and Child Neurology* 54(4): 313–323. doi:10.1111/j.1469-8749.2011.04216.x.
- Dennis, J.A. (2019). Birth weight and maternal age among American Indian/Alaska Native mothers: A test of the weathering hypothesis. *SSM-Population Health* 7: 100304. doi:10.1016/j.ssmph.2018.10.004.

- Dennis, J.A. and Mollborn, S. (2013). Young maternal age and low birth weight risk: An exploration of racial/ethnic disparities in the birth outcomes of mothers in the United States. *The Social Science Journal* 50(4): 625–634. doi:10.1016/j.soscij.2013.09.008.
- Doamekpor, L.A. and Dinwiddie, G.Y. (2015). Allostatic load in foreign-born and US-born blacks: Evidence from the 2001–2010 National Health and Nutrition Examination Survey. *American Journal of Public Health* 105(3): 591–597. doi:10.2105/AJPH.2014.302285.
- Edmunds, R.D. (1995). Native Americans, new voices: American Indian history, 1895–1995. *The American Historical Review* 100(3): 717–740. doi:10.2307/2168602.
- Elder, T.E., Goddeeris, J.H., and Haider, S.J. (2011). A deadly disparity: A unified assessment of the Black-White infant mortality gap. *The BE Journal of Economic Analysis and Policy* 11(1). doi:10.2202/1935-1682.2821.
- Elo, I.T., Vang, Z., and Culhane, J.F. (2014). Variation in birth outcomes by mother’s country of birth among non-Hispanic black women in the United States. *Maternal and Child Health Journal* 18(10): 2371–2381. doi:10.1007/s10995-014-1477-0.
- Feliciano, C. and Lanuza, Y.R. (2017). An immigrant paradox? Contextual attainment and intergenerational educational mobility. *American Sociological Review* 82(1): 211–241. doi:10.1177/0003122416684777.
- Fishman, S.H. and Min, S. (2018). Maternal age and offspring’s educational attainment. *Journal of Marriage and Family* 80(4): 853–870. doi:10.1111/jomf.12490.
- Fishman, S.H., Morgan, S.P., and Hummer, R.A. (2018). Smoking and VARIATION in the Hispanic paradox: A comparison of low birthweight across 33 US States. *Population Research and Policy Review* 37(5): 795–824. doi:10.1007/s11113-018-9487-z.
- Flores, R.D. and Schachter, A. (2018). Who are the “Illegals”? The social construction of illegality in the United States. *American Sociological Review* 83(5): 839–868. doi:10.1177/0003122418794635.
- Forde, A.T., Crookes, D.M., Suglia, S.F., and Demmer, R.T. (2019). The weathering hypothesis as an explanation for racial disparities in health: A systematic review. *Annals of Epidemiology* 33: 1–18.e3. doi:10.1016/j.annepidem.2019.02.011.

- Frisbie, W.P. (2005). Infant mortality. In: Poston, D.L. and Micklin, M. (eds.). *Handbook of population*. Cham: Springer: 251–282. doi:10.1007/0-387-23106-4_10.
- Gadson, A., Akpovi, E., and Mehta, P.K. (2017). Exploring the social determinants of racial/ethnic disparities in prenatal care utilization and maternal outcome. *Seminars in Perinatology* 41(5): 308–317. doi:10.1053/j.semperi.2017.04.008
- Gage, T. B., Fang, F., O’Neill, E., and DiRienzo, G. (2013). Maternal education, birth weight, and infant mortality in the United States. *Demography* 50(2): 615–635. doi:10.1007/s13524-012-0148-2.
- Gee, G.C. and Ponce, N. (2010). Associations between racial discrimination, limited English proficiency, and health-related quality of life among 6 Asian ethnic groups in California. *American Journal of Public Health* 100(5): 888–895. doi:10.2105/AJPH.2009.178012.
- Geronimus, A.T. (1992). Teenage childbearing and social disadvantage: Unprotected discourse. *Family Relations* 41(2): 244–248. doi:10.2307/584840.
- Geronimus, A.T. (1996). Black/white differences in the relationship of maternal age to birthweight: A population-based test of the weathering hypothesis. *Social Science and Medicine* 42(4): 589–597. doi:10.1016/0277-9536(95)00159-X.
- Geronimus, A.T., Hicken, M., Keene, D., and Bound, J. (2006). ‘Weathering’ and age patterns of allostatic load scores among blacks and whites in the United States. *American Journal of Public Health* 96(5): 826–833. doi:10.2105/AJPH.2004.060749.
- Geronimus, A.T., Hicken, M.T., Pearson, J.A., Seashols, S.J., Brown, K.L., and Cruz, T.D. (2010). Do US black women experience stress-related accelerated biological aging? *Human Nature* 21(1): 19–38. doi:10.1007/s12110-010-9078-0.
- Goisis, A., Remes, H., Barclay, K., Martikainen, P., and Myrskylä, M. (2017). Advanced maternal age and the risk of low birth weight and preterm delivery: A within-family analysis using Finnish population registers. *American Journal of Epidemiology* 186(11): 1219–1226. doi:10.1093/aje/kwx177.
- Goisis, A., Schneider, D.C., and Myrskylä, M. (2018). Secular changes in the association between advanced maternal age and the risk of low birth weight: A cross-cohort comparison in the UK. *Population Studies* 72(3): 381–397. doi:10.1080/00324728.2018.1442584.

- Hack, M., Flannery, D.J., Schluchter, M., Cartar, L., Borawski, E., and Klein, N. (2002). Outcomes in young adulthood for very-low-birth-weight infants. *New England Journal of Medicine* 346(3): 149–157. doi:10.1056/NEJMoa010856.
- Hayward, M.D., Hummer, R.A., Chiu, C.-T., González-González, C., and Wong, R. (2014). Does the Hispanic paradox in US adult mortality extend to disability? *Population Research and Policy Review* 33(1): 81–96. doi:10.1007/s11113-013-9312-7.
- Holzman, C., Eyster, J., Kleyn, M., Messer, L.C., Kaufman, J.S., Laraia, B.A., O’Campo, P., Burke, J.G., Culhane, J., and Elo, I.T. (2009). Maternal weathering and risk of preterm delivery. *American Journal of Public Health* 99(10): 1864–1871. doi:10.2105/AJPH.2008.151589.
- Howell, E.A., Hebert, P., Chatterjee, S., Kleinman, L.C., and Chassin, M.R. (2008). Black/white differences in very low birth weight neonatal mortality rates among New York City hospitals. *Pediatrics* 121(3): e407–e415. doi:10.1542/peds.2007-091.
- Hummer, R.A., Biegler, M., De Turk, P.B., Forbes, D., Frisbie, W.P., Hong, Y., and Pullum, S.G. (1999). Race/ethnicity, nativity, and infant mortality in the United States. *Social Forces* 77(3): 1083–1117. doi:10.1093/sf/77.3.1083.
- Hwang, M., Shrestha, A., Yazzie, S., and Jackson, M.L. (2013). Preterm birth among American Indian/Alaskan natives in Washington and Montana: Comparison with non-Hispanic Whites. *Maternal and Child Health Journal* 17(10): 1908–1912. doi:10.1007/s10995-012-1215-4.
- Johnson, P.J., Call, K.T., and Blewett, L.A. (2010). The importance of geographic data aggregation in assessing disparities in American Indian prenatal care. *American Journal of Public Health* 100(1): 122–128. doi:10.2105/AJPH.2008.148908.
- Jones, D.S. (2006). The persistence of American Indian health disparities. *American Journal of Public Health* 96(12): 2122–2134. doi:10.2105/AJPH.2004.054262.
- Kalmijn, M. and Kraaykamp, G. (2005). Late or later? A sibling analysis of the effect of maternal age on children’s schooling. *Social Science Research* 34(3): 634–650. doi:10.1016/j.ssresearch.2004.04.008.
- Kenny, L.C., Lavender, T., McNamee, R., O’Neill, S.M., Mills, T., and Khashan, A.S. (2013). Advanced maternal age and adverse pregnancy outcome: Evidence from a large contemporary cohort. *PloS One* 8(2): e56583.

- Kim, S. (2016). Asian/White differences in the relationship of maternal age to low birth weight: Analysis of the PRAMS Survey, 2004–2011. *Asian/Pacific Island Nursing Journal* 1(4): 138–148.
- Kravdal, Ø. (2019). Taking birth year into account when analysing effects of maternal age on child health and other outcomes: The value of a multilevel-multiprocess model compared to a sibling model. *Demographic Research* 40(43): 1249–1290. doi:10.4054/DemRes.2019.40.43.
- Landale, N.S., Oropesa, R.S., and Gorman, B.K. (1999). Immigration and infant health: Birth outcomes of immigrant and native-born women. In: Hernandez, D.J. (ed.). *Children of immigrants: Health, adjustment and public assistance*. Washington, D.C.: National Academies Press: 244–285.
- Lauderdale, D.S. (2006). Birth outcomes for Arabic-named women in California before and after September 11. *Demography* 43(1): 185–201. doi:10.1353/dem.2006.0008.
- Lee, K., Ferguson, R.M., Corpuz, M., and Gartner, L.M. (1988). Maternal age and incidence of low birth weight at term: A population study. *American Journal of Obstetrics and Gynecology* 158(1): 84–89. doi:10.1016/0002-9378(88)90783-1.
- Levine, M.E. and Crimmins, E. (2014). Evidence of accelerated aging among African Americans and its implications for mortality. *Social Science and Medicine* 118: 27–32. doi:10.1016/j.socscimed.2014.07.022.
- Litt, J., Taylor, H.G., Klein, N., and Hack, M. (2005). Learning disabilities in children with very low birthweight: Prevalence, neuropsychological correlates, and educational interventions. *Journal of Learning Disabilities* 38(2): 130–141. doi:10.1177/00222194050380020301.
- Liu, Y., Zhi, M., and Li, X. (2011). Parental age and characteristics of the offspring. *Ageing Research Reviews* 10(1): 115–123. doi:10.1016/j.arr.2010.09.004.
- Love, C., David, R.J., Rankin, K.M., and Collins Jr, J.W. (2010). Exploring weathering: Effects of lifelong economic environment and maternal age on low birth weight, small for gestational age, and preterm birth in African-American and white women. *American Journal of Epidemiology* 172(2): 127–134. doi:10.1093/aje/kwq109.
- Luke, B. and Brown, M.B. (2007). Contemporary risks of maternal morbidity and adverse outcomes with increasing maternal age and plurality. *Fertility and Sterility* 88(2): 283–293. doi:10.1016/j.fertnstert.2006.11.008.

- Markides, K.S. and Eschbach, K. (2011). Hispanic paradox in adult mortality in the United States. In: Rogers, R.G. and Crimmins, E.M. (eds.). *International handbook of adult mortality* (Vol. 2). Dordrecht: Springer: 227–240. doi:10.1007/978-90-481-9996-9_11.
- Mereish, E.H., Liu, M.M., and Helms, J.E. (2012). Effects of discrimination on Chinese, Pilipino, and Vietnamese Americans' mental and physical health. *Asian American Journal of Psychology* 3(2): 91. doi:10.1037/a0025876.
- Mood, C. (2010). Logistic regression: Why we cannot do what we think we can do, and what we can do about it. *European Sociological Review* 26(1): 67–82. doi:10.1093/esr/jcp006.
- Myrskylä, M., Barclay, K., and Goisis, A. (2017). Advantages of later motherhood. *Der Gynäkologe* 50(10): 767–772. doi:10.1007/s00129-017-4124-1.
- National Center for Health Statistics (2015). *2014 Natality Historic File Documentation*. Centers for Disease Control.
- National Center for Health Statistics (2016). *2015 Natality Historic File Documentation*. Centers for Disease Control.
- National Center for Health Statistics (2017). *2016 Natality Historic File Documentation*. Centers for Disease Control.
- National Center for Health Statistics (2018). *2017 Natality Historic File Documentation*. Centers for Disease Control.
- National Center for Health Statistics (2019). *2018 Natality Historic File Documentation*. Centers for Disease Control.
- Pallotto, E.K., Collins Jr, J.W., and David, R.J. (2000). Enigma of maternal race and infant birth weight: A population-based study of US-born Black and Caribbean-born Black women. *American Journal of Epidemiology* 151(11): 1080–1085. doi:10.1093/oxfordjournals.aje.a010151.
- Parrado, E.A. (2011). How high is Hispanic/Mexican fertility in the United States? Immigration and tempo considerations. *Demography* 48(3): 1059–1080. doi:10.1007/s13524-011-0045-0.
- Peek, M.K., Cutchin, M.P., Salinas, J.J., Sheffield, K.M., Eschbach, K., Stowe, R.P., and Goodwin, J.S. (2010). Allostatic load among non-Hispanic Whites, non-Hispanic Blacks, and people of Mexican origin: Effects of ethnicity, nativity, and acculturation. *American Journal of Public Health* 100(5): 940–946. doi:10.2105/AJPH.2007.129312.

- Phelan, J.C. and Link, B.G. (2015). Is racism a fundamental cause of inequalities in health? *Annual Review of Sociology* 41: 311–330. doi:10.1146/annurev-soc-073014-112305.
- Pinto-Martin, J., Whitaker, A., Feldman, J., Cnaan, A., Zhao, H., Rosen-Bloch, J., McCulloch, D., and Paneth, N. (2004). Special education services and school performance in a regional cohort of low-birthweight infants at age nine. *Paediatric and Perinatal Epidemiology* 18(2): 120–129. doi:10.1111/j.1365-3016.2003.00541.x.
- Powell, B., Steelman, L.C., and Carini, R.M. (2006). Advancing age, advantaged youth: Parental age and the transmission of resources to children. *Social Forces* 84(3): 1359–1390. doi:10.1353/sof.2006.0064.
- Powers, D.A. (2013). Paradox revisited: A further investigation of racial/ethnic differences in infant mortality by maternal age. *Demography* 50(2): 495–520. doi:10.1007/s13524-012-0152-6.
- Rauh, V.A., Andrews, H.F., and Garfinkel, R.S. (2001). The contribution of maternal age to racial disparities in birthweight: A multilevel perspective. *American Journal of Public Health* 91(11): 1815–1824. doi:10.2105/AJPH.91.11.1815.
- Reichman, N.E. (2005). Low birth weight and school readiness. *The Future of Children* 15(1): 91–116. www.jstor.org/stable/1602664.
- Rich-Edwards, J.W., Buka, S.L., Brennan, R.T., and Earls, F. (2003). Diverging associations of maternal age with low birthweight for black and white mothers. *International Journal of Epidemiology* 32(1): 83–90. doi:10.1093/ije/dyg008.
- Sheeder, J., Lezotte, D., and Stevens-Simon, C. (2006). Maternal age and the size of white, black, Hispanic, and mixed infants. *Journal of Pediatric and Adolescent Gynecology* 19(6): 385–389. doi:10.1016/j.jpag.2006.09.012.
- Snipp, C.M. (1997). The size and distribution of the American Indian population: Fertility, mortality, migration, and residence. *Population Research and Policy Review* 16(1–2): 61–93. doi:10.1023/A:1005784813513.
- Sohn, H. and Lee, S.-W. (2019). Causal impact of having a college degree on women’s fertility: Evidence from regression Kink designs. *Demography* 56(3): 969–990. doi:10.1007/s13524-019-00771-9.
- Solis, P., Pullum, S.G., and Frisbie, W.P. (2000). Demographic models of birth outcomes and infant mortality: An alternative measurement approach. *Demography* 37(4): 489–498. doi:10.1353/dem.2000.0011.

- Stevens-Simon, C. (2002). The weathering hypothesis. *American Journal of Public Health* 92(4): 507-a. doi:10.2105/AJPH.92.4.507-a.
- Sweeney, M.M. and Raley, R.K. (2014). Race, ethnicity, and the changing context of childbearing in the United States. *Annual Review of Sociology* 40: 539–558. doi:10.1146/annurev-soc-071913-043342.
- Tomashek, K.M., Qin, C., Hsia, J., Iyasu, S., Barfield, W.D., and Flowers, L.M. (2006). Infant mortality trends and differences between American Indian/Alaska Native infants and white infants in the United States, 1989–1991 and 1998–2000. *American Journal of Public Health* 96(12): 2222–2227. doi:10.2105/AJPH.2004.053744.
- Tropf, F.C. and Mandemakers, J.J. (2017). Is the association between education and fertility postponement causal? The role of family background factors. *Demography* 54(1): 71–91. doi:10.1007/s13524-016-0531-5.
- Whitbeck, L.B., Adams, G.W., Hoyt, D.R., and Chen, X. (2004). Conceptualizing and measuring historical trauma among American Indian people. *American Journal of Community Psychology* 33(3–4): 119–130. doi:10.1023/B:AJCP.0000027000.77357.31.
- Wilcox, A.J. and Russell, I.T. (1986). Birthweight and perinatal mortality: III. Towards a new method of analysis. *International Journal of Epidemiology* 15(2): 188–196. doi:10.1093/ije/15.2.188.
- Wildsmith, E.M. (2002). Testing the weathering hypothesis among Mexican-origin women. *Ethnicity and Disease* 12(4): 470–479.
- Wong, C.A., Gachupin, F.C., Holman, R.C., MacDorman, M.F., Cheek, J.E., Holve, S., and Singleton, R.J. (2014). American Indian and Alaska Native infant and pediatric mortality, United States, 1999–2009. *American Journal of Public Health* 104(S3): S320–S328. doi:10.2105/AJPH.2013.301598.
- Xie, Y. and Goyette, K. (2004). *Asian Americans: A demographic portrait*. New York, NY: Russell Sage Foundation.

Appendix A: Estimates from primary analysis

Table A-1: Descriptive statistics from 2014–2018 natality files

	Freq.	%
LBW		
No	14,815,832	93.7
Yes	998,086	6.3
VLBW		
No	15,645,210	98.9
Yes	168,708	1.1
Race/Ethnicity-nativity		
US-White	9,006,110	57.0
FB-White	577,626	3.7
US-Black	2,168,361	13.7
FB-Black	379,673	2.4
US-Mexican	1,360,830	8.6
FB-Mexican	1,182,883	7.5
US-C and S American	109,928	0.7
FB-C and S American	547,668	3.5
US-East Asian	52,340	0.3
FB-East Asian	277,627	1.8
AI/AN	150,872	1.0
Maternal age		
< 20	885,582	5.6
20–24	3,327,974	21.0
25–29	4,642,815	29.4
30–34	4,379,455	27.7
35–39	2,115,935	13.4
40+	462,157	2.9
Maternal education		
< HS	2,164,535	13.9
HS	3,991,071	25.6
SC	4,598,624	29.5
BA	3,106,584	19.9
> BA	1,751,596	11.2
Marital status		
Unmarried	6,083,605	40.23
Married	9,038,475	59.8

Table A-1: (Continued)

	Freq.	%
Initiation of prenatal care		
1st Trimester	11,769,813	77.1
2nd Trimester	2,556,014	16.7
3rd Trimester or None	938,992	6.2
Prenatal smoking		
Yes	13,979,006	89.6
No	1,627,829	10.4
Birth order		
1	6,035,080	38.3
2	5,025,677	31.9
3-4	3,879,868	24.6
5+	814,141	5.2

Table A-2: Probabilities of low birthweight across maternal age by race/ethnicity-nativity

	US-White	FB-White	US-Black	FB-Black
< 20	0.0760	0.0759	0.1300	0.1013
20–24	0.0601	0.0483	0.1193	0.0775
25–29	0.0495	0.0412	0.1142	0.0658
30–34	0.0458	0.0388	0.1230	0.0662
35–39	0.0527	0.0440	0.1438	0.0803
40+	0.0714	0.0598	0.1724	0.1016
	US-Mexican	FB-Mexican	US-C and S Amer.	FB-C and S Amer.
< 20	0.0700	0.0633	0.0777	0.0751
20–24	0.0578	0.0505	0.0609	0.0529
25–29	0.0550	0.0465	0.0558	0.0487
30–34	0.0587	0.0504	0.0566	0.0522
35–39	0.0700	0.0621	0.0613	0.0628
40+	0.0933	0.0808	0.0728	0.0772
	US-East Asian	FB-East Asian	AI/AN	
< 20	0.0721	0.0537	0.0646	
20–24	0.0661	0.0402	0.0587	
25–29	0.0573	0.0362	0.0612	
30–34	0.0542	0.0390	0.0688	
35–39	0.0574	0.0457	0.0888	
40+	0.0743	0.0609	0.1126	

Figure A-1: Probabilities of low birthweight across maternal age by race/ethnicity-nativity

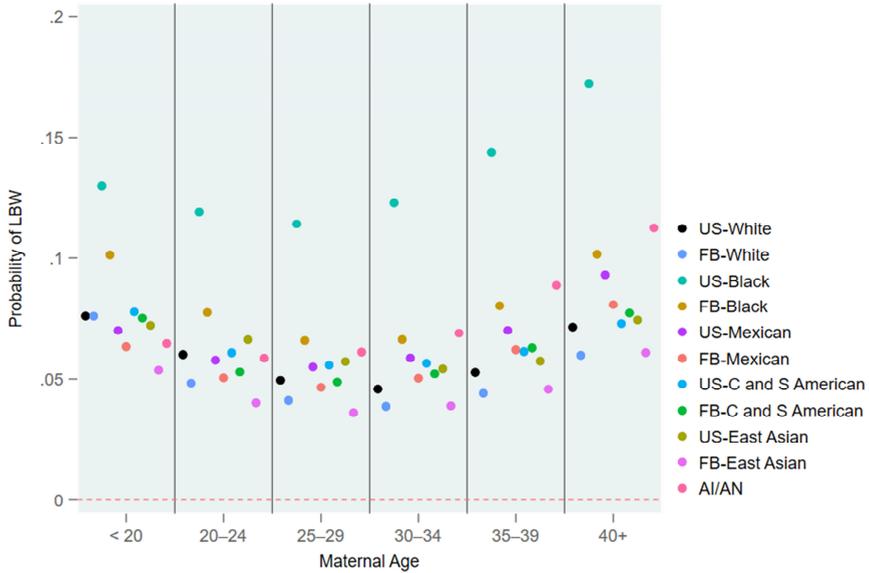


Table A-3: Probabilities of very low birthweight across maternal age by race/ethnicity-nativity

	US-White	FB-White	US-Black	FB-Black
< 20	0.0127	0.0087	0.0239	0.0182
20–24	0.0087	0.0062	0.0226	0.0146
25–29	0.0072	0.0059	0.0237	0.0148
30–34	0.0067	0.0054	0.0279	0.0161
35–39	0.0081	0.0066	0.0348	0.0198
40+	0.0115	0.0091	0.0390	0.0250
	US-Mexican	FB-Mexican	US-C and S Amer.	FB-C and S Amer.
< 20	0.0104	0.0092	0.0097	0.0095
20–24	0.0085	0.0074	0.0097	0.0075
25–29	0.0089	0.0077	0.0100	0.0073
30–34	0.0105	0.0090	0.0095	0.0088
35–39	0.0135	0.0115	0.0119	0.0116
40+	0.0199	0.0147	0.0152	0.0143
	US-East Asian	FB-East Asian	AI/AN	
< 20	0.0225	0.0024	0.0097	
20–24	0.0068	0.0041	0.0092	
25–29	0.0069	0.0030	0.0101	
30–34	0.0054	0.0039	0.0118	
35–39	0.0069	0.0054	0.0155	
40+	0.0097	0.0087	0.0218	

Figure A-2: Probabilities of very low birthweight across maternal age by race/ethnicity-nativity

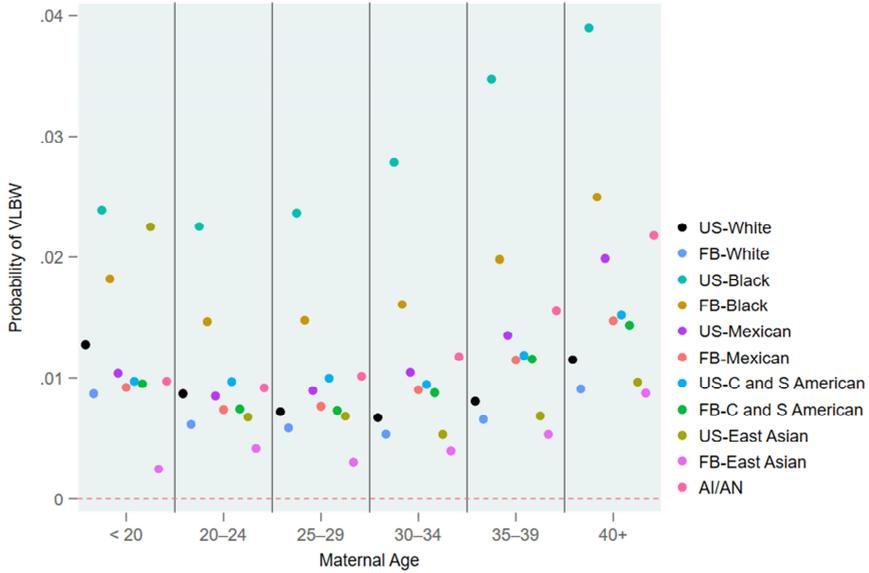


Table A-4: Average marginal effects (AMEs) of maternal age on low birthweight with 95% confidence intervals

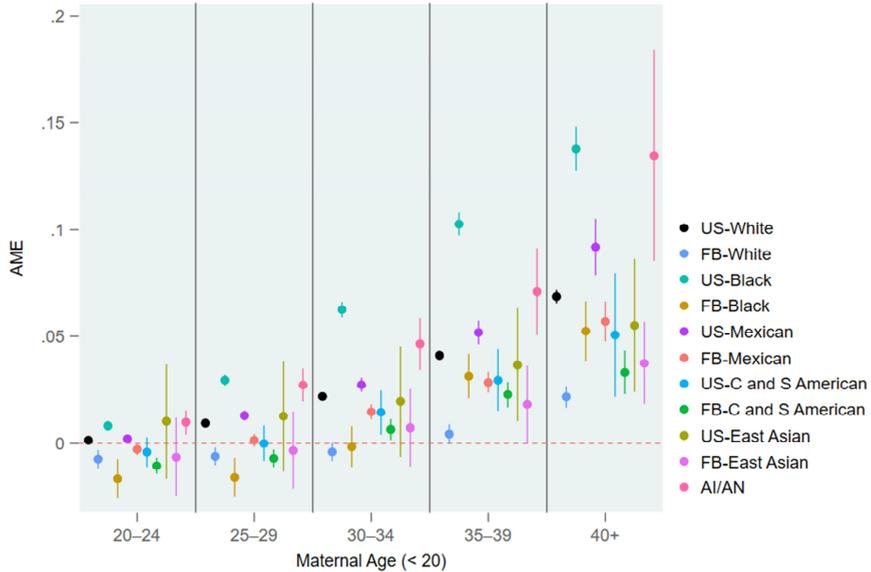
	AME	Low	High	AME	Low	High	AME	Low	High
	US-White			FB-White			US-Black		
< 20	--			--			--		
20–24	0.0038	0.0032	0.0043	-0.0074	-0.0116	-0.0031	0.0105	0.0090	0.0119
25–29	0.0101	0.0095	0.0107	-0.0061	-0.0103	-0.0019	0.0197	0.0181	0.0213
30–34	0.0171	0.0165	0.0178	-0.0040	-0.0083	0.0002	0.0393	0.0374	0.0412
35–39	0.0290	0.0282	0.0298	0.0044	0.0000	0.0088	0.0686	0.0661	0.0711
40+	0.0503	0.0488	0.0517	0.0217	0.0166	0.0268	0.1047	0.1002	0.1091
	FB-Black			US-Mexican			FB-Mexican		
< 20	--			--			--		
20–24	-0.0091	-0.0152	-0.0029	0.0021	0.0009	0.0033	-0.0024	-0.0042	-0.0006
25–29	-0.0087	-0.0148	-0.0027	0.0077	0.0062	0.0091	-0.0004	-0.0022	0.0014
30–34	-0.0006	-0.0067	0.0055	0.0171	0.0154	0.0189	0.0064	0.0046	0.0083
35–39	0.0195	0.0131	0.0259	0.0326	0.0302	0.0350	0.0201	0.0180	0.0222
40+	0.0447	0.0373	0.0520	0.0592	0.0541	0.0643	0.0402	0.0371	0.0432
	US-C and S American			FB-C and S American			US-East Asian		
< 20	--			--			--		
20–24	-0.0037	-0.0088	0.0014	-0.0090	-0.0117	-0.0064	0.0097	-0.0084	0.0278
25–29	0.0009	-0.0048	0.0066	-0.0068	-0.0095	-0.0041	0.0166	-0.0006	0.0338
30–34	0.0089	0.0023	0.0155	0.0008	-0.0021	0.0036	0.0224	0.0052	0.0395
35–39	0.0188	0.0104	0.0272	0.0151	0.0119	0.0183	0.0320	0.0145	0.0495
40+	0.0335	0.0187	0.0482	0.0318	0.0273	0.0364	0.0508	0.0309	0.0707
	FB-East Asian			AI/AN					
< 20	--			--					
20–24	-0.0032	-0.0180	0.0117	0.0072	0.0035	0.0109			
25–29	-0.0019	-0.0165	0.0127	0.0184	0.0141	0.0226			
30–34	0.0046	-0.0101	0.0192	0.0327	0.0275	0.0379			
35–39	0.0148	0.0001	0.0294	0.0607	0.0533	0.0682			
40+	0.0312	0.0162	0.0462	0.0918	0.0770	0.1067			

Table A-5: Average marginal effects (AMEs) of maternal age on very low birthweight with 95% confidence intervals

	AME	Low	High	AME	Low	High	AME	Low	High
	US-White			FB-White			US-Black		
< 20	--			--			--		
20–24	0.0000	-0.0002	0.0002	0.0000	-0.0012	0.0013	0.0036	0.0030	0.0042
25–29	0.0014	0.0011	0.0016	0.0011	-0.0002	0.0023	0.0096	0.0089	0.0103
30–34	0.0028	0.0025	0.0030	0.0015	0.0002	0.0027	0.0181	0.0172	0.0190
35–39	0.0053	0.0050	0.0056	0.0034	0.0020	0.0047	0.0291	0.0278	0.0304
40+	0.0096	0.0089	0.0102	0.0061	0.0044	0.0079	0.0356	0.0330	0.0381
	FB-Black			US-Mexican			FB-Mexican		
< 20	--			--			--		
20–24	-0.0014	-0.0041	0.0012	0.0009	0.0005	0.0013	0.0002	-0.0003	0.0008
25–29	0.0011	-0.0015	0.0037	0.0035	0.0029	0.0040	0.0019	0.0013	0.0025
30–34	0.0045	0.0019	0.0072	0.0070	0.0063	0.0077	0.0043	0.0037	0.0050
35–39	0.0102	0.0074	0.0130	0.0120	0.0109	0.0132	0.0077	0.0069	0.0085
40+	0.0168	0.0133	0.0202	0.0207	0.0179	0.0235	0.0116	0.0103	0.0130
	US-C and S American			FB-C and S American			US-East Asian		
< 20	--			--			--		
20–24	0.0019	0.0002	0.0035	-0.0003	-0.0012	0.0006	-0.0057	-0.0147	0.0033
25–29	0.0045	0.0026	0.0065	0.0007	-0.0003	0.0016	-0.0037	-0.0128	0.0054
30–34	0.0059	0.0035	0.0083	0.0031	0.0021	0.0041	-0.0037	-0.0129	0.0054
35–39	0.0103	0.0066	0.0140	0.0069	0.0057	0.0082	-0.0013	-0.0106	0.0080
40+	0.0151	0.0075	0.0227	0.0105	0.0085	0.0124	0.0018	-0.0082	0.0118
	FB-East Asian			AI/AN					
< 20	--			--					
20–24	0.0018	-0.0009	0.0045	0.0017	0.0004	0.0031			
25–29	0.0015	-0.0010	0.0041	0.0044	0.0028	0.0061			
30–34	0.0028	0.0002	0.0053	0.0074	0.0053	0.0095			
35–39	0.0045	0.0019	0.0070	0.0128	0.0095	0.0161			
40+	0.0079	0.0050	0.0107	0.0212	0.0139	0.0285			

Appendix B: Supplemental analyses

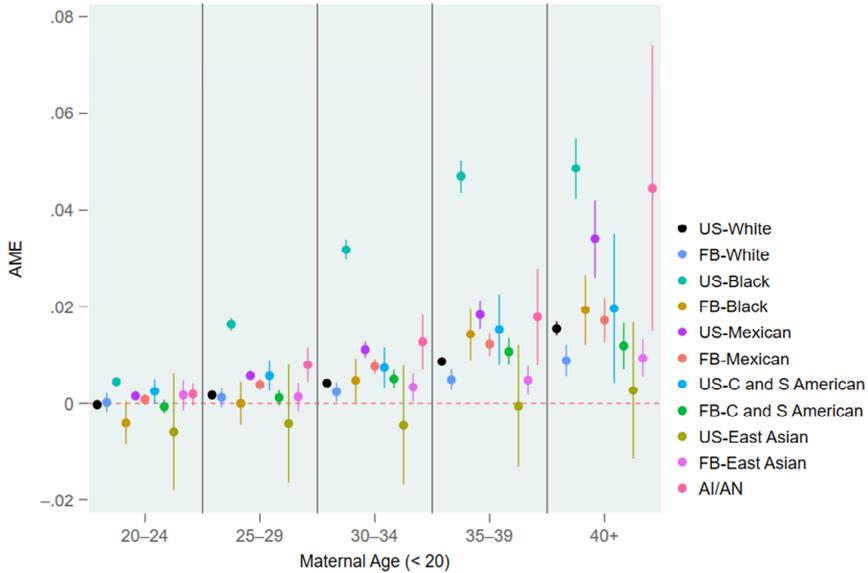
Figure B-1: Average marginal effects (AMEs) of maternal age on low birthweight with 95% confidence intervals: First births



Data: 2014–2018 natality files.

Notes: N = 6,171,224. The models are stratified by race/ethnicity-nativity. The AMEs represent discrete changes in the probability of low birthweight infants relative to births under age 20. An AME of zero represents the AME under age 20 for each racial/ethnic-nativity group. The models used to estimate the AMEs account for education, marital status, birth order, smoking, and initiation of prenatal care. All cases are singleton births.

Figure B-2: Adjusted average marginal effects (AMEs) of maternal age on very low birthweight with 95% confidence intervals: First births



Data: 2014–2018 natality files.

Notes: N = 6,171,224. The models are stratified by race/ethnicity-nativity. The AMEs represent discrete changes in the probability of very low birthweight infants relative to births under age 20. An AME of zero represents the AME under age 20 for each racial/ethnic-nativity group. The models used to estimate the AMEs account for education, marital status, birth order, smoking, and initiation of prenatal care. All cases are singleton births.

Fishman: An extended evaluation of the weathering hypothesis for birthweight