Evaluating the Influence of Colorism in the Risk of Pregnancy Loss Among Black, Hispanic, and White American Women

Hana Rose Hurley Brown

A thesis

submitted in partial fulfillment of the

requirements for the degree of

Master of Arts

University of Washington

2024

Committee:

Patricia Louie

Jerald R. Herting

Program Authorized to Offer Degree:

Sociology

University of Washington

Abstract

Evaluating the Influence of Colorism in the Risk of Pregnancy Loss Among Black, Hispanic, and White American Women

Hana Rose Hurley Brown

Chair of the Supervisory Committee:

Patricia Louie

Sociology

Prenatal loss is a common pregnancy outcome, affecting approximately 20% of all pregnancies. While there is a vast literature on the biomedical risk factors of pregnancy loss, potential social determinants have been less extensively or systematically studied. In recent years, an important expansion of research exploring race as a social determinant of health has been a consideration of the health consequences of colorism, defined as skin tone discrimination or stratification. However, explorations of colorism and women's reproductive health are few, and possible colorism effects in pregnancy loss have not been explored to date. In this study, I begin to fill in this gap using data from the National Longitudinal Study of Adolescent to Adult Health (Add Health), which includes information on skin tone and pregnancy experiences of American women born 1974-1983. This study also explores possible racial differences in skin tone effects on pregnancy loss between non-Hispanic Black, non-Hispanic White, and Hispanic women.

An analysis of pregnancies to Add Health participants prior to 2001-02 identifies a "light privilege" pattern in pregnancy loss, in which mothers with medium or dark brown skin were at significantly higher risks of loss than those with light brown skin. Black mothers were at a significantly higher risk of loss than White, though there is insufficient evidence to distinguish between Hispanic and White mothers. This racial effect in pregnancy loss is weakened when skin tone differences are considered. However, race does not seem to modify skin tone effects in pregnancy loss.

A supplementary analysis of pregnancies narrowing focus to non-Hispanic Black and Hispanic mothers prior to 2006-08 provides less support for either skin tone or racial disparities in pregnancy loss, though it does identify maternal age as a risk factor for pregnancy loss, consistent with the biomedical literature. This analysis does not support the hypotheses that such age effects are moderated by either race or skin tone, though further research with considerably larger sample sizes is desired to evaluate the possibility of such moderation more conclusively.

EVALUATING THE INFLUENCE OF COLORISM ON THE RISK OF PREGNANCY LOSS AMONG BLACK, HISPANIC, AND WHITE AMERICAN WOMEN

Hana R.H. Brown

Prenatal loss is a common pregnancy outcome, affecting approximately 20% of all pregnancies. This health adversity has salient personal implications for expectant mothers and their families, including grief resulting from lost hopes, physiological stress and financial strain that characterize any pregnancy, and a potential for feelings of maternal inadequacy and shame (Lazarides et al. 2023; Tian and Solomon 2020). While there is a vast literature on the biomedical risk factors of pregnancy loss, potential social determinants have been less extensively or systematically studied. One exception is Mukherjee et al.'s (2013) study of racial disparities in the risk of miscarriage between non-Hispanic Black and White women from the Southeastern United States, which demonstrates that Black women are at approximately twice the risk of miscarriage relative to White women between 10 and 20 gestational weeks. Little follow-up research has explored race as a social determinant of pregnancy loss in the intervening decade.

In recent years, an important expansion of research exploring race as a social determinant of health has been a consideration of colorism and its health consequences. Colorism, defined as skin tone discrimination or stratification, has become an active area of research over the last quarter century (Dixon and Telles 2017; Hunter 2002, 2005, 2007, 2011). Explorations of colorism and health date as early as 1981 (Costas et al. 1981) but have only gained momentum over the last decade, taking Perreira and Telles (2014) and Monk (2015) as benchmark papers. Explorations of colorism and women's reproductive health are few, with Slaughter-Acey's studies of skin tone effects in prenatal care (PNC) (Slaughter-Acey et al. 2019) and preterm birth (PTB) and low birthweight (LBW) (Slaughter-Acey et al. 2020) among Black American women standing as first contributions in this area of research. To date, possible colorism effects in pregnancy loss have not been explored. While we do not know whether colorism affects pregnancy loss specifically, the demonstrated reality of such effects in other dimensions of health, including maternal health, gives us reason to suspect as much. If such a disparity exists, this would present a further dimension of health disparity along social lines, so understanding it will give us guidance in efforts to mitigate such a problem.

In this study, I begin to fill in this gap using data from the National Longitudinal Study of Adolescent to Adult Health (Add Health) (Harris et al. 2019), which includes information on skin tone and young-life pregnancy experiences of women born 1974-1983. This study also explores possible racial differences in skin tone effects on pregnancy loss between non-Hispanic Black, non-Hispanic White, and Hispanic women. This study is guided by four questions: Does risk of pregnancy loss vary according to skin tone, and if so, how? Does skin tone adjust racial effects in pregnancy loss, and if so, to what degree? Does race moderate skin tone effects in pregnancy loss, and if so, how? Does the rate at which the risk of pregnancy loss increases over age differ for mothers according to skin tone, and if so, which groups experience higher rates of risk accumulation?

COLORISM AND HEALTH

Colorism

Colorism—also known as skin tone stratification, discrimination, or bias—refers to disparities in life outcomes based on the color of one's skin (Dixon and Telles 2017; Hunter 2005, 2007; E. P. Monk Jr. 2021). In many contexts globally, colorism often follows a pattern that has sometimes been labeled "light privilege" in which individuals with lighter skin experience greater advantages in multiple life outcomes than those with darker skin (Dixon and Telles 2017). However, several exceptions to this pattern have been noted, including a "protected middle" pattern in which individuals with medium brown skin experience advantages in particular life outcomes than those at either extreme of the skin tone spectrum, and a "dark privilege" pattern in which individuals with dark skin experience greater advantages than those with light skin. For example, (Hargrove 2018) has demonstrated that Black American men gain BMI and a lower rate than those with light or dark skin. Similarly, (Slaughter-Acey et al. 2019) has demonstrated that Black American women with medium brown skin are more resilient against racial microaggression effects in the probability of delayed PNC than those with light or dark brown skin. Finally, (Slaughter-Acey et al. 2020) has demonstrated that Black American Millennial women (born 1984-1993) with medium or dark brown skin experience lower rates of PTB and LBW than those with light brown skin.

The various labels stratification, discrimination, and bias capture the complexities that account for persistent and sometimes changing patterns of skin tone disparities in life outcomes. Colorism as "skin tone stratification" emphasizes the broad and persistent patterns in disparate life outcomes according to skin tone. This emphasis in colorism research tends to focus on material disparities, for example generational wealth disparities (Abascal and Garcia 2022; Adames 2023; Goldsmith, Hamilton, and Darity 2007; Monk 2015) and different degrees of mobility in the labor market (Han 2020). The material dimension of colorism is expected to impact health in terms of disparate buying power regarding access to high quality food, healthy living environments, and clinical healthcare.

In contrast, colorism as "skin tone discrimination" or "bias" emphasizes the microscale, interpersonal dimensions of colorism, particularly the importance of stereotypes that lead to both subconscious, daily microaggressions and occasional acts of overt hostility. Exposure to or experience of different degrees of discrimination is expected to generate psychosocial stress that may account for skin tone disparities in mental health and may secondarily cascade into physiological stress, accounting for skin tone disparities in physical health as well. Additionally, in clinical settings, clinicians may have biases that lead to unequal treatment of patients according to skin tone. For example, higher rates of maternal mortality among Black American women are often attributed to clinicians' disregard for their patients' expressions of subjective distress and pain. The perception of or concern for such differential treatment may also lead to preemptive avoidance by patients.

Studies of colorism and health initially focused on Hispanic American populations (Calzada, Kim, and O'Gara 2019; Caraballo-Cueto and Godreau 2021; Codina and Montalvo 1994; Costas et al. 1981; Gravlee and Dressler 2005; Gravlee, Dressler, and Bernard 2005; Montalvo and Codina 2001; Perreira and Telles 2014), expanding to include Black Americans beginning in 2015 (Cobb et al. 2016; Hargrove 2018, 2019; Louie 2020; E. P. Monk 2021; Monk 2015; Slaughter-Acey et al. 2019, 2020). Colorism and health has been less widely studied for other racial groups, e.g., Arab Americans (Abdulrahim et al. 2012), and similarly very few studies have explored colorism and health for multiple racial groups simultaneously (Laidley et al. 2019; Perreira, Wassink, and Harris 2019).

Skin tone disparities in several dimensions of health have been explored, separated broadly into physical and mental health. Physical health outcomes include coronary heart disease (Costas et al. 1981), blood pressure (Gravlee and Dressler 2005; Gravlee et al. 2005; Laidley et al. 2019; Monk 2015), general cardiovascular and cardio-metabolic disorders (E. P. Monk 2021), pain-related conditions (E. P. Monk 2021), sensory function (E. P. Monk 2021), morbidity (E. P. Monk 2021), allostatic load (Cobb et al. 2016; Hargrove 2019), BMI (Hargrove 2018; Perreira et al. 2019), and general self-rated health (Caraballo-Cueto and Godreau 2021; Hargrove 2019; Monk 2015; Perreira and Telles 2014; Perreira et al. 2019). Mental health outcomes include depression (Codina and

Montalvo 1994; Louie 2020; Monk 2015; Perreira et al. 2019), psychological distress (Abdulrahim et al. 2012), behavior problems (Calzada et al. 2019), mental disorder (Louie 2020), and general self-rated mental health (Monk 2015). Much of this research demonstrates a "light privilege" pattern in health broadly, though Hargrove (2018) identified a "protected middle" pattern in BMI trajectories among Black American men.

The Stress Process Framework

A long standing and widely used framework that helps explain social disparities in mental health is the Stress Process Model (Pearlin 1989; Pearlin et al. 1981; Pearlin and Bierman 2013). This outlook on the social determination of mental health has several key principles. First, stressors range along an acute-chronic continuum and vary in intensity. Second, primary stressors can proliferate into secondary stressors. Third, one's social status or position often entails different kinds and degrees of stressors than those who hold different social statuses or positions. Fourth, varying kinds and degrees of stressors influence the severity of different mental health outcomes, including psychological distress, depressive symptoms, and mental disorders. Fifth and finally, various resources can serve as mediators of the effect of social difference on mental health (e.g. coping resources, coping behaviors, social support, mastery, belief systems/values/meaning). These resources can also moderate specific stressor effects on mental health outcomes, dampening or exacerbating stressor effects in mental health.

While the stress process model focuses on the social determinants of mental health, the concept of allostatic load proposes that ongoing exposure and adaptation to stressors in turn manifest as a host of physiologically adverse outcomes (McEwen 2006; McEwen Bruce S. 1998; McEwen and Seeman 1999; Seeman et al. 1997). Combining the stress process model and the allostatic load concept entails a useful lens on stress-based accounts of social disparities in physical health outcomes such as pregnancy loss.

Weathering as a Life Course Perspective on the Stress Process Framework

While the stress process and allostatic load concepts assume that the experience of stressors is sustained, escalating into severe health adversity in late life—"death by a thousand cuts" (Boen 2020)—neither framework specifically evaluates how the mental or physical health consequences of sustained stress grow over time in a life course perspective. Efforts to model such growth would fall broadly under the heading of cumulative disadvantage, which asserts that small differences in health or other life outcomes between groups early in life expand over time as a consequence of sustained differences in rates of disadvantage accumulation between groups (DiPrete and Eirich 2006). One of the clearest articulations of this cumulative disadvantage framework in health is Geronimus's weathering hypothesis, which asserts that a higher rate of health deterioration among Black Americans in a "race-conscious society" (Geronimus et al. 2006) accounts for increasingly disparate health adversities between Black and White Americans along multiple dimensions of health (Geronimus 1992; Geronimus et al. 2006). In the domain of reproductive health, this hypothesis has been applied to LBW (Rauh, Andrews, and Garfinkel 2001) and to PTB (Holzman et al. 2009) between Black and White American women. In her analysis of age trajectories in BMI among Black American men and women, Hargrove (2018) exemplified the utility of generalizing a weathering perspective to other dimensions of social difference and health disparity, focusing on widening disparities in BMI increase over age according to skin tone. In particular, she demonstrated that men with light or dark skin gain BMI at a faster rate than those with medium skin and therefore a widening gap over age.

Social Disparities in Maternal Health and Pregnancy Outcomes

A vast empirical literature exists demonstrating racial disparities in PTB and LBW, demonstrating persistent disadvantages especially for Black American women relative to White but more nuanced differences for Latinas (Braveman et al. 2015, 2017; Flores et al. 2012; Gemmill et al. 2019; Holzman et al. 2009; Krieger et al. 2018; Mukherjee et al. 2013; O'Campo et al. 2008; Osypuk and Acevedo-Garcia 2008; Pickett et al. 2002; Rauh et al. 2001; Reagan and Salsberry 2005; Slaughter-Acey et al. 2016; Torche and Sirois 2019). While a small handful of these papers focus on acute stressors, mostly pertaining to the volatile sociopolitical climate of the United States (Gemmill et al. 2019; Krieger et al. 2018; Torche and Sirois 2019), most focus on the impact of chronic stressors on PTB, LBW, small-for-gestational-age, and other dimension of pregnancy health. As noted above, a handful of these studies focus on weathering in pregnancy health (Holzman et al. 2009; Rauh et al. 2001). Shockingly few studies have focused on racial disparities in pregnancy loss, with Mukherjee et al. (2013) presenting a singular exception.

To date, only Slaughter-Acey has investigated colorism effects in reproductive health, including delayed PNC (Slaughter-Acey et al. 2019), PTB and LBW (Slaughter-Acey et al. 2020). The first of these studies demonstrates that perceived microaggression exerts a less disadvantaging influence on the odds of delayed PNC for Black mothers with medium brown skin compared to mothers with light or dark brown skin. The second study finds generational differences in the association between skin tone on the one hand, and PTB and LBW on the other: for Gen-Xers (born 1964-1983), mothers with light brown skin experience lower rates of PTB and LBW than those with medium or dark skin, while for Millennials (born 1984-1993), the pattern is reversed.

HYPOTHESES

Hypothesis 1: Mothers with light skin tone will have lower rates of pregnancy loss than those with darker skin tone. While Slaughter-Acey has identified a “protected middle” pattern in delayed PNC and a “dark privilege” pattern in both PTB and LBW among Millennial mothers (born 1984-1993), she attributes these patterns to the uniquely Black demography of Detroit, which she argues may have shaped the patterns of colorism in maternal health there. If this explanation is correct, then it may not be reasonable to expect it at the scale of the entire United States reflected by Add Health. Consequently I hypothesize here that pregnancy loss conforms to the more prevalent “light privilege” pattern identified in many health outcomes.

Hypothesis 2: Skin tone adjusts racial effects on pregnancy loss. To date, discussion of the relationship between racial and skin tone effects in health and other life outcomes has unfolded largely in theoretical discussions with a dearth of empirical examination. Theoretical reflections on the relationship between these two concepts sometimes conflict. For example, Monk (2015) ties colorism explicitly to the racial project, suggesting that we sort each other into broad or “superordinate” racial categories, then into skin tone “subcategories” that account for many of the behavior-orienting stereotypes informing our interpersonal interactions. In contrast, Dixon and Telles (2017) further decouple the concepts of colorism and racism suggesting that even if these two dimensions of social reality are closely tied in the US context, colorism operates globally even in contexts where race is not a salient dimension of social reality. Importantly, neither of these authors provide empirical explorations of the relationship between colorism and racism operative in particular study contexts. As noted above, few studies have explored colorism in health using datasets combining multiple racial groups, with the exceptions of Perreira et al. (2019) and Laidley et al. (2019). Neither of these two studies considers the possibility that skin tone might adjust the racial effect in health. In the present analyses, I therefore consider Monk’s proposal that skin tone differences explain an important share of racial disparities in health at least in the US context, though I generalize this proposal to consider multiple racial identities.

Hypothesis 3: Race moderates skin tone effects in pregnancy loss. This proposal further elaborates on the understudied relationship between race and skin tone. This suggestion captures the sentiment that not all racial groups experience colorism to the same degree or severity. Both Perreira et al. (2019) and Laidley et al. (2019) do consider the possibility of such racial moderation, using analytical samples drawn from Add Health. For example, Perreira et al. (2019: table 6) stratify their analyses of skin tone effects in physical and mental health according to race, indicating different parameter estimates for skin tone effects between races for several of these dimensions of health. Similarly, Laidley et al. (2019: table 2) compare estimated skin tone effects between models fitted to a full dataset ignoring race and a subset including only Black and Latinx cases, indicating stronger skin tone effects for the Black/Latinx subset than for the full dataset. The moderation hypothesis considered here abstains from suggesting which minority groups experience colorism in pregnancy loss more saliently. It simply considers the possibility that such differences exist.

Hypothesis 4: Mothers with darker skin accumulate risk of pregnancy loss at a higher rate over age than those with lighter skin. This claim extends hypothesis 1 across the life course. It suggests that the forces that give rise to light privilege in pregnancy loss are sustained and cumulative rather than inflicting a one-time penalty. This hypothesis also closely mirrors Hargrove's (2018) observation of light privilege in BMI trajectories for Black American women.

DATA AND METHODS

Data Source

Add Health is a nationally representative longitudinal study following over 20,000 individuals from the United States who were in middle or high school in 1994-95 (Harris et al. 2019). Add Health has collected diverse health information from participants, along with contextual information such as sociodemographic and behavioral information to better understand the many determinants of health. To date, there have been five waves covering their later adolescence and first two+ decades of their adult lives. Wave III (conducted 2001-02) includes both a retrospective pregnancy dataset covering the pregnancy histories of participating mothers throughout their teens and early twenties and an interviewer-assessed skin tone variable. Wave IV (conducted 2008-09) includes a more extensive retrospective pregnancy dataset, including many of the same pregnancies as Wave III as well as subsequent pregnancies to mothers in their later twenties and early thirties. However, pregnancy records present in Wave III are not explicitly linked to pregnancy records in Wave IV, posing a serious obstacle to their combination into a single dataset. The pregnancy data include the outcome of each pregnancy, as well as contextual information about each pregnancy, though the Wave III pregnancy data are more detailed. The skin tone variable is a 5-level ordinal variable ranging between black and white skin tones. The baseline survey at Wave I (conducted 1994-95) includes self-identified race.

Variables

Dependent variable. In Wave III's pregnancy dataset, pregnancy outcome is recorded as a categorical variable including ongoing pregnancy, abortion, miscarriage and stillbirth for singleton pregnancies, partial and complete loss for non-singleton pregnancies, and live birth for both singleton and non-singleton pregnancies. In Wave IV's pregnancy dataset, pregnancy outcome is recorded as a categorical variable including ongoing pregnancy, abortions, miscarriage, stillbirth, ectopic or tubal pregnancy, live birth by Cesarean section, and live birth by vaginal delivery.

Because Wave IV does not distinguish between singleton and non-singleton pregnancies, “live birth” likely includes partial losses for non-singleton pregnancies. For both Wave III and IV analyses, ongoing pregnancy and abortion are treated as incomplete outcomes and omitted. The focus of these analyses is on the physiological process of pregnancy including stress process and allostatic load pathways that influence the outcome of pregnancies, while the decision-making process informing elective abortions complicates the stress framework. The remaining categories are reduced to a binary variable distinguishing between loss and live birth. For Wave III, miscarriage, stillbirth, partial and complete loss are counted as losses. In Wave IV, miscarriage, still births, and ectopic or tubal pregnancies are counted as losses.

Focal variables. Owing to the limited sample size of the analytical sample especially when racial groups are disaggregated according to skin tone, the Wave III skin tone variable is recoded as a 3-level ordinal variable combining “white” and “light brown” into a single category (termed “light brown”), retaining “medium brown” as a separate category, and combining “dark brown” and “black” into a single category (termed “dark brown”).

The Wave I baseline survey includes five options for racial self-identification: White, Black, American Indian or Alaska Native (AIAN), Asian or Pacific Islander (API), or Other. It also includes information on whether participants are of Hispanic origin. Following Massey and Brodmann (2014), Laidley et al. (2019), and Perreira, Wassink, and Harris (2019), individuals who identified as Hispanic are treated as such here regardless of racial self-identification. Individuals who identify as AIAN, API, or Other are omitted from this analysis due to prohibitively small samples for these groups (n = 19, n = 4, and n = 9 pregnancies, respectively). To evaluate whether race moderates skin tone effects in pregnancy loss, these two variables are interacted as follows: White participants are treated as a single group owing to profoundly narrow skin tone variability (346 pregnancies were to White mothers have “white” skin and another 11 were to White mothers with “medium brown” skin according to Add Health's original 5-level skin tone variable, all of which are combined into the "light brown" category in the 3-level scale used here. The analytical sample includes only 1 pregnancy to 1 White mother with "medium brown" skin) and treated as the reference group. Both Black and Hispanic participants are disaggregated according to all three skin tone categories. The Wave III analysis includes White, Black, and Hispanic mothers, while the Wave IV analysis includes only Black and Hispanic mothers.

Maternal age is approximated to the month at beginning of pregnancy for the Wave III pregnancy data and to the year for the Wave IV pregnancy data based on the mother's birth year (and month) reported in Wave I and the pregnancy year (and month) reported in the retrospective pregnancy datasets. Wave III's pregnancy data include month at end of pregnancy as well as gestational duration in weeks, allowing for a more precise approximation of mother's age at beginning of pregnancy than Wave IV. Note that maternal age is counted as a covariate rather than a focal variable for the Wave III analysis because the sample size and reproductive span characterizing the Wave III pregnancy data are regarded to be too small to detect social differences in risk accumulation. For the Wave IV analysis, maternal age is recentered on an origin of eleven years so that the intercept estimates the risk of loss at a reproductively meaningful baseline, especially since the Wave IV analysis explores how the accumulation of risk over age varies between social groups.

Covariates. For the Wave III analysis, several known or suspected risk factors of pregnancy loss are also included as covariates, including mother's age at beginning of pregnancy, singleton pregnancy status, mother's educational attainment at pregnancy, health behaviors (smoking, drinking, and drug use), primiparity, and nativity. All covariates are binary except mother's age which is continuous and education which is coded as a 3-level ordinal variable distinguishing between pre-high school diploma, high school diploma or equivalent, and at least some college.

Many other variables that are commonly included in research on social disparities in pregnancy health are not available in the Wave III retrospective pregnancy data. These include both objective and subjective, self-assessed measures of mother's physical and mental health at the time of pregnancy, perceived discrimination, spatial information at pregnancy, and fetal sex for pregnancies ending in loss. Maternal income and wealth are often included as covariates or mediators, but no such data exist in the Wave III retrospective pregnancy data in large part because many pregnancies represented in this dataset were to mothers during their adolescence. While PNC use/avoidance was considered as a covariate, it was ultimately omitted from this analysis due to the fact that it may be on several separate and possibly antagonistic causal pathways connecting skin tone and pregnancy loss. Finally, while maternal health care coverage (public vs. private insurance vs. out-of-pocket) is available in the Wave III retrospective pregnancy data, this information is limited to those pregnancies either involving PNC use, live birth outcomes, or both, limiting the utility of such variables for this analysis. As a consequence of the unavailability of several such measures, it is challenging to explore mechanisms that might account for skin tone effects in pregnancy loss based on this dataset.

Unlike the Wave III analysis, the Wave IV analysis includes only focal variables, not covariates. This decision is warranted by two main considerations. First, information on several of the risk factors included in the Wave III analysis are unavailable to the Wave IV analysis. Regarding maternal age, this variable has been promoted to the status of focal variable as described above. Unfortunately, the Wave IV pregnancy data do not explicitly distinguish between singleton and non-singleton pregnancies, so this dimension of variability cannot be controlled in the Wave IV analysis. Wave IV's information on health behaviors during pregnancy is also inadequate to be used for two reasons: drug use is not recorded in the Wave IV data at all, while smoking and drinking are recorded only for pregnancies concluding in at least one live birth. Second, the exploration of skin tone moderation of age effects in pregnancy loss introduces considerable model complexity in its own right, creating a risk of model saturation when further burdened with the two remaining covariates primiparity and nativity. The increase in sample size for the Wave IV analysis is not sufficient to offset this saturation.

Analytical Sample

The analytical samples for the analyses of both Waves III and IV include only cases with no missing information for any of the regression models described below. They also only include pregnancies to mothers who identify as White, Black, or Hispanic for Wave III, or as Black or Hispanic for Wave IV. Finally, for the Wave III analysis, duplicate entries for the same pregnancy (i.e., multiple data entries for the same mother, same year, and same month) were identified and excluded to improve data quality. It is much more difficult to identify possibly duplicate pregnancies in the Wave IV analytical sample given that month of pregnancy is not recorded in the Wave IV retrospective pregnancy data. One mother is omitted entirely from the Wave III analysis given a large number of biologically implausible pregnancies attributed to her, for example sequences of ostensible live-birth pregnancies separated by unreasonably short interbirth intervals. The analytical sample used in the Wave III analysis includes 645 pregnancies to 428 mothers. The analytical sample used in the Wave IV analysis includes 781 pregnancies to 321 mothers.

Statistical Analyses

Statistical description. Statistical analysis began with data description. For both analyses, numbers of mothers, pregnancies, and losses, as well as the proportion of losses, are reported. These statistics are summarized by skin tone and by race, as well as by skin tone separately for each racial group. Weighted univariate descriptions of all covariates are also provided for the Wave

III analytical sample. Weighted summary statistics are favored to account for Add Health's probabilistic sampling strategy. Wave III cross-sectional weights are used for the Wave III analysis, while Wave IV longitudinal weights are used for the Wave IV analysis given that skin tone information is used from Wave III.

For the Wave IV analyses, which focus on the importance of maternal age, two kinds of plots are produced: a series of repeated-events plots, and a series of grouped box plots. The repeated-events plots show the age distributions and pregnancy outcome distributions of pregnancies per mother, with each pregnancy represented as a point along a line segment representing an individual mother. The X axis represents maternal age, while point shade represents pregnancy outcome. The grouped box plots show the age distributions of pregnancies separated by pregnancy outcome. Separate repeated-events plots and grouped box plots are shown for different race -skin tone combinations.

Regression analyses. To evaluate whether the risk of pregnancy loss is associated with variability in skin tone and/or racial identity, hierarchical logistic regression is conducted treating pregnancy loss as the dependent variable. A hierarchical, random-intercepts, framework is used because several mothers are represented by multiple pregnancies in the dataset, warranting a need to control for latent heterogeneity in mothers' reproductive health (Bacci et al. 2016; Buhule, Choo-Wosoba, and Albert 2020; Louis et al. 2006; Shih et al. 2015). As described above, several known or suspected risk factors of pregnancy loss are included as covariates in the Wave III but not Wave IV analysis, including mother's age at beginning of pregnancy, singleton pregnancy status, mother's education, health behaviors (smoking, drinking, and drug use), primiparity, and nativity. Models both with and without these covariates were fitted to explore both the unadjusted and adjusted effects of skin tone and race in pregnancy loss. To assess cumulative stress as well as social disparities in rates at which stress accumulates in both the Wave III and IV analyses, maternal age (recentered on age 11 for the Wave IV analysis) is also included as a predictor, either individually or interacted with either race, skin tone, or the race-skin tone interaction.

To understand the association between skin tone and pregnancy loss and race and pregnancy loss, as well as to disentangle the relationship between race and skin tone in their associations with pregnancy loss, a series of models were fitted to the analytical samples. These include a "null" model lacking both skin tone and race (Model 1), a model including only skin tone (Model 2), a model including only race (Model 3), a model including both skin tone and race (Model 4), and a model including the skin tone-race interaction (Model 5). The analyses of weathering also include a model interacting skin tone and maternal age (Model 6), a model interacting race and maternal age (Model 7), a model interacting both skin tone and race with age separately (Model 8), and a model interacting skin tone, race, and maternal age in a three-way interaction (Model 9).

For each analysis, models are compared based on the Bayesian information criterion (BIC) as well as theoretical considerations. While calculation of the BIC is relatively straightforward for single-level datasets based on the sample size of such datasets, hierarchical datasets such as the analytical samples considered here pose a unique challenge: the effective sample size for such datasets falls somewhere between the number of level-one (L1) observations (n, in this case pregnancies) and level-two (L2) observations (J, in this case mothers). Consequently, in the analyses presented here, BIC is calculated twice to provide lower and upper boundaries for a BIC based on effective sample size, a lower boundary based on the number of mothers and the upper boundary based on the number of pregnancies.

Because the Add Health dataset constitutes a probabilistic sample, Wave III cross-sectional weights are used for the Wave III analysis, while Wave IV longitudinal weights are used for the Wave IV analysis, as noted above for statistical description. All analyses are conducted in R. The WeMix package is used to implement sampling weights at both levels of the hierarchical model.

Mothers' sampling weights were rescaled to sum to the number of mothers in the effective sample and these weights were applied both to mothers and their pregnancies in the hierarchical regression analysis.

RESULTS

Weighted Sample Summaries

According to Table 1, after applying sampling weights, Wave III pregnancies to White mothers are the most abundant (n=405.56), followed by those to Black mothers (n=143.68), then Hispanic mothers (n=90.13). 18% of White pregnancies, 27% percent of Hispanic pregnancies, and 31% of Black pregnancies ended in loss. Pregnancy loss proportions are higher for groups with darker skin, both across all races and when disaggregated according to race for both Hispanic and Black pregnancies. Black pregnancies exhibit a higher proportion of loss than Hispanic pregnancies overall, though Hispanic pregnancies exhibit higher proportions of loss than Black pregnancies when skin tone is held constant. This paradox is explained by the fact that Hispanic mothers tend to have lighter skin than Black mothers and that pregnancies to lighter skinned mothers show lower proportions of loss than those to darker skinned mothers in both groups.

Maternal age across all pregnancies both within and between groups is broadly similar with a mean ranging between 18 and 20 years and no clear racial or skin tone differences (Table 1). Proportions of non-singleton pregnancies are also broadly similar ranging between 0 and 2% for White and Hispanic mothers of any skin tone. However, Black mothers with dark brown skin do show a higher incidence of non-singleton pregnancies (6%; Table 1). Maternal educational attainment at pregnancy shows a modal value of high school diploma or equivalent for pregnancies to White and Black mothers, though this decreases to no high school diploma for pregnancies to Black mothers with light and medium brown skin. The modal value for maternal educational attainment at pregnancy for Hispanic mothers is also no high school diploma. There is a noticeably higher rate of first pregnancies in the Hispanic dataset (66%; Table 1) than for White or Black mothers (61% and 57%, respectively; Table 1). White mothers are at a considerably higher risk of smoking during pregnancy than Black or Hispanic mothers; 36% of White mothers with light brown skin relative to 12% of Black mothers with dark brown skin and 18% of Hispanic mothers with light brown skin. The incidence of drinking during pregnancy is broadly similar across all groups, ranging between 4% of Black and Hispanic mothers and 5% for White mothers. The incidence of drug use during pregnancy is noticeably higher for White and Hispanic mothers (6%; Table 1) than for Black (1%; Table 1). Nativity is high for White and Black mothers (98% and 100%, respectively; Table 1) but noticeably lower for Hispanic mothers (78%; Table 1).

Table 2 presents weighted descriptive statistics for the Wave IV analytical sample. As in Wave III, Hispanic and Black mothers show opposite trends in sample size as skin darkens, with exceedingly few Hispanic mothers with dark brown skin. Unlike in Wave III, when skin tone is held constant, Black mothers show higher rates of loss than Hispanic (ignoring Hispanic mothers with dark brown skin). While Wave III shows a consistent pattern of increase in loss as skin tone darkens, the pattern in Wave IV is far less consistent between racial groups. Pregnancies to Black mothers show a decrease in loss as skin darkens. The same could be said for pregnancies to Hispanic mothers if pregnancies to dark brown Hispanic mothers are excluded. Overall, the rate of pregnancy loss increases for pregnancies to mothers with medium brown skin relative to light brown but decreases for pregnancies to mothers with dark brown skin relative to medium brown. This “penalized middle” pattern is a function of the fact that the overall rates of loss by skin tone are weighted averages of race -specific rates, pulled down toward the low rate of loss for Hispanic mothers with light brown skin, up toward the high rate of loss for Black mothers with medium brown skin, and down toward the low rate of loss for Black mothers with dark brown skin.

Figure 1 emphasizes the nested character of pregnancy datasets such as the retrospective pregnancy data analyzed in this study, in this case focusing on the Wave IV analytical sample. It draws attention to the fact that different mothers have different numbers of pregnancies with different timing across the life course and with greater or lesser rates of loss between mothers. Different balances of orange points (pregnancy loss) to green points (live births) visually indicate different rates of loss between race and skin tone groups. However, it should be noted that this type of graph is not amenable to visually representing sample weights, so it is not immediately obvious which mothers are most informative. The same caveat is true of Figure 2.

Figure 2 illustrates the different age distributions of losses and live births, disaggregated by race and skin tone. While the age distributions of losses and live births have similar locations for pregnancies to mothers with light and medium brown skin, pregnancies ending in live birth to mothers with dark brown skin tend to have younger age distributions relative to those ending in loss, though there is still noticeable overlap in these age distributions.

Table 1: Summary statistics for Wave III analytical sample by skin tone, race, and skin tone within race (Add Health; n=645 pregnancies, J=428 mothers).

	Full Sample				White				Black				Hispanic			
	All	Light Brown	Medium Brown	Dark Brown	All	Light Brown	Medium Brown	Dark Brown	All	Light Brown	Medium Brown	Dark Brown	All	Light Brown	Medium Brown	Dark Brown
Sample size																
Mothers	428	302	50	76	237	236	1	—	130	20	37	73	61	46	12	3
Mothers (wtd.)	428.00	335.09	34.61	58.30	272.16	270.46	1.70	—	90.85	11.00	23.33	56.51	64.99	53.63	9.58	1.79
Pregnancies	645	447	71	127	358	357	1	—	198	27	51	120	89	63	19	7
Pregnancies (wtd.)	639.37	492.78	49.27	97.32	405.56	403.87	1.70	—	143.68	16.08	34.23	93.36	90.13	72.83	13.35	3.95
Dependent variable																
No. losses	150	91	20	39	69	69	0	—	53	5	13	35	28	17	7	4
No. losses (wtd.)	141.34	91.11	16.11	34.12	73.12	73.12	0.00	—	44.25	2.48	10.08	31.68	23.97	15.51	6.03	2.43
Proportion losses (wtd.)	0.22	0.18	0.33	0.35	0.18	0.18	0.00	—	0.31	0.15	0.29	0.34	0.27	0.21	0.45	0.62
Covariates (wtd.)																
Age (mean)	19.45	19.50	18.76	19.52	19.68	19.68	18.40	—	19.33	18.97	18.92	19.54	18.59	18.61	18.38	18.97
Age (sd)	2.28	2.21	2.52	2.49	2.17	2.18	—	—	2.44	1.78	2.51	2.51	2.29	2.23	2.76	2.22
Non-singleton	0.02	0.02	0.01	0.05	0.02	0.02	0.00	—	0.04	0.03	0.02	0.06	0.00	0.00	0.00	0.00
Education																
No HS diploma	0.36	0.35	0.44	0.34	0.33	0.33	1.00	—	0.36	0.44	0.40	0.32	0.48	0.48	0.45	0.71
HS diploma or equiv.	0.48	0.48	0.30	0.54	0.51	0.51	0.00	—	0.48	0.36	0.33	0.55	0.32	0.34	0.26	0.29
Some college	0.17	0.17	0.27	0.12	0.16	0.16	0.00	—	0.17	0.20	0.27	0.12	0.19	0.18	0.29	0.00
First pregnancy	0.61	0.62	0.63	0.55	0.61	0.61	1.00	—	0.57	0.56	0.60	0.56	0.66	0.67	0.67	0.45
Smoking	0.26	0.32	0.03	0.11	0.35	0.36	0.00	—	0.08	0.00	0.02	0.12	0.16	0.18	0.06	0.00
Drinking	0.05	0.05	0.02	0.05	0.05	0.05	0.00	—	0.04	0.05	0.01	0.06	0.04	0.04	0.05	0.00
Drug use	0.05	0.06	0.02	0.02	0.06	0.06	0.00	—	0.01	0.00	0.00	0.02	0.06	0.06	0.06	0.00
Nativity	0.96	0.95	0.91	1.00	0.98	0.98	1.00	—	1.00	1.00	1.00	1.00	0.78	0.79	0.66	1.00

Table 2: Summary statistics for Wave IV analytical sample by skin tone, race, and skin tone among Hispanic and Black mothers/pregnancies (Add Health; n=718 pregnancies, J=321 mothers).

Race and skin tone	**J ($J_{,eff}$)**	**N ($n_{,eff}$)**	**n_{losses} ($n_{losses,eff}$)**	**p_{losses} ($p_{losses,eff}$)**
Light brown (LB)	134 (157.12)	287 (332.71)	51 (57.72)	0.18 (0.17)
Medium brown (MB)	70 (53.27)	160 (123.48)	37 (24.70)	0.23 (0.20)
Dark brown (DB)	117 (110.60)	271 (259.16)	49 (47.99)	0.18 (0.19)
Hispanic	110 (140.35)	239 (294.44)	37 (44.39)	0.15 (0.15)
LB	96 (129.34)	200 (265.63)	30 (40.53)	0.15 (0.15)
MB	12 (9.28)	31 (22.24)	5 (1.79)	0.16 (0.08)
DB	2 (1.73)	8 (6.57)	2 (2.07)	0.25 (0.31)
Black	211 (180.65)	479 (420.91)	100 (86.03)	0.21 (0.20)
LB	38 (27.79)	87 (67.09)	21 (17.19)	0.24 (0.26)
MB	58 (43.99)	129 (101.24)	32 (22.91)	0.25 (0.23)
DB	115 (108.87)	263 (252.59)	47 (45.93)	0.18 (0.18)

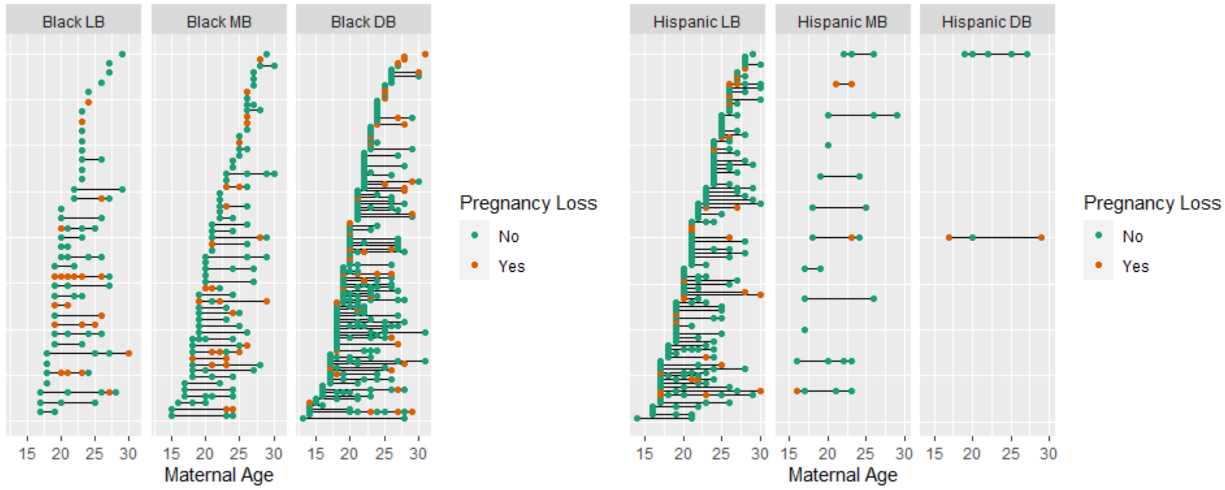

Figure 1: Repeated-events plots describing pregnancy outcomes by maternal age and mother, disaggregated by race and skin tone. Points represent pregnancies. Line segments represent unique mothers.

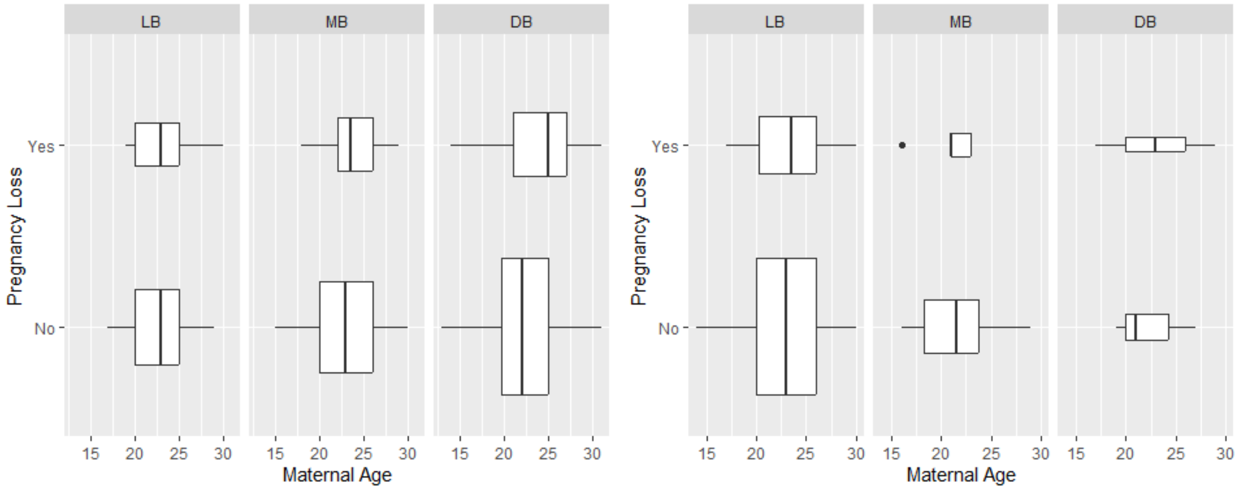

Figure 2: Boxplots describing maternal age distributions for live births and losses, disaggregated by race (Black: facets 1-3; Hispanic: facets 4-6). Box heights are proportional to skin tone and pregnancy outcome combinations within race.

Regression Analyses

Regression models presented in Table 3a reiterate the patterns observed for the Wave III analytical sample in Table 1 for pregnancy loss according to skin tone and race, after adjusting for covariates. (Equivalent analyses unadjusted for covariates are presented in Appendix A, Table A1a. Results are broadly similar.) Model 1 in Table 1 is a "null" model, predicting pregnancy loss without reference to social determinants—either skin tone or race—and is considered as a foil for any model with, one, the other, or both of these predictors. In Model 2 (Table 3a), which explores the association between skin tone and pregnancy loss ignoring racial differences, skin tone effects are significantly different from 1 for both mothers with medium brown and dark brown skin relative to those with light brown. In Model 3 (Table 3a), which explores the association between race and pregnancy loss ignoring skin tone differences, pregnancies to Black mothers are at a significantly higher risk of loss than those to White mothers, while those to Hispanic mothers are not. In Model 4 (Table 3a), which adjusts the skin tone effect for race and vice versa, pregnancies to mothers with dark brown skin remain at a significantly higher risk of loss than those to mothers with light brown skin, while the adjusted effect for mothers with light brown skin becomes insignificant. Similarly, the adjusted effect for Black mothers becomes insignificant. In Model 5 (Table 3a), which interacts race and skin tone, estimated effects for Hispanic mothers of any skin tone are insignificantly different from 1. Only Black mothers with dark brown skin are at a significantly higher risk of pregnancy loss than White mothers.

Table 3b presents models assessing skin tone and/or race weathering effects in pregnancy loss based on the Wave III analytical sample. None of these fitted models provide evidence in support of such effects (Models 6-9; Table 3b). In fact, no odds ratio for any predictor (including covariates) is significantly different from one in any of these models. Confidence intervals for many predictors' odds ratios are also very poorly resolved.

Across all Models 1-9 (Table 3a-b), the null model shows the lowest BIC based on number of pregnancies, followed by the model including only skin tone (Model 2; Table 3a), while this relationship is reversed for BIC based on number of mothers.

Tables 4a-4b present regression models applied to the Wave IV analytical sample mirroring the models presented in Tables 3a-b for the Wave III analytical sample. The key difference between these is that the Wave IV models include only one covariate: maternal age. Unlike the Wave III analysis, none of these models suggest either skin tone or race are predictors of pregnancy loss, whether considered separately, together, or interacted. Also unlike the Wave III analysis maternal age is a positive predictor of pregnancy loss. By BIC, the null model is favored over all other models, followed by the race-only model, then the skin tone-only model.

Table 4b presents fitted regression model estimates for all weathering models applied to the Wave IV analytical sample, expressed on the odds ratio scale as in Tables 3a, 3b, and 4a. All models except Model 8 suggest cumulative stress in that the odds of pregnancy loss increase with maternal age for at least some social groups. Model 6 suggests weathering in the form of an accelerated increase in risk of loss over age for mothers with medium brown skin, while Model 7 does not support weathering for one racial group relative to the other. Model 8 does not support weathering according to either skin tone or race when considered together. Model 9, which includes a three-way interaction between skin tone, race, and maternal age supports the possibility that Black mothers with medium brown skin experience accelerated cumulative stress but no other group. By BIC, the null model (Model 1) is favored over all others, followed by the race weathering model (Model 7), then the skin tone weathering model (Model 6). This is largely a function of the increasing complexities of models that include and interact categorical variables. Nevertheless, the fact that mothers with medium brown skin show accelerated rates of cumulative stress (Models 6 and 9) is suggestive. It is possible that these two models could outperform others by BIC if all other skin tone or skin tone-race groups were combined and contrasted with mothers with medium brown skin. If so, this would present a curious departure from past research on colorism and health, which has tended to demonstrate either a “light privilege” or “protected middle” pattern in health.

Table 3a: Hierarchical logistic regression of pregnancy loss on skin tone, race, and covariates (Add Health; n=645 pregnancies, J=428 mothers). Effects are reported as point estimates and 95% confidence intervals (CI) on the odds ratio scale. Confidence intervals excluding 1 are bolded and italicized. Interactions are denoted with asterisks.

	Model 1			Model 2			Model 3			Model 4			Model 5		
	pt. est.	95% CI		pt. est.	95% CI		pt. est.	95% CI		pt. est.	95% CI		pt. est.	95% CI	
(Intercept)	0.09	0.00	2.22	0.07	0.00	1.52	0.04	0.00	1.32	0.05	0.00	1.37	0.05	0.00	1.40
Skin Tone: Light Brown				Ref.						Ref.					
Skin Tone: Medium Brown				***2.54***	***1.02***	***6.29***				2.95	0.86	10.10			
Skin Tone: Dark Brown				***3.19***	***1.42***	***7.17***				***4.18***	***1.06***	***16.43***			
Race: White							Ref.			Ref.					
Race: Black							***2.58***	***1.25***	***5.32***	0.77	0.21	2.73			
Race: Hispanic							1.71	0.73	4.04	1.35	0.56	3.22			
White*All Skin Tones													Ref.		
Black*Light Brown													0.87	0.15	4.86
Black*Medium Brown													2.39	0.82	6.98
Black*Dark Brown													***3.07***	***1.32***	***7.14***
Hispanic*Light Brown													1.22	0.49	3.05
Hispanic*Medium Brown													4.61	0.87	24.45
Hispanic*Dark Brown													13.01	0.76	223.19
Maternal Age	1.09	0.94	1.26	1.10	0.95	1.26	1.11	0.96	1.28	1.10	0.95	1.27	1.10	0.95	1.27
Non-singleton	2.14	0.45	10.25	1.86	0.36	9.50	1.92	0.37	9.89	1.91	0.37	9.78	1.91	0.37	9.70
Education: No High School Diploma	Ref.			Ref.			Ref.			Ref.			Ref.		
Education: High School or Equivalent	0.60	0.29	1.24	0.63	0.32	1.24	0.63	0.31	1.28	0.64	0.32	1.28	0.64	0.32	1.28
Education: Beyond High School	0.52	0.21	1.26	0.56	0.24	1.32	0.54	0.23	1.31	0.58	0.24	1.36	0.57	0.24	1.36
First Pregnancy	1.20	0.66	2.18	1.24	0.69	2.22	1.25	0.69	2.27	1.23	0.68	2.22	1.24	0.69	2.23
Smoking	0.82	0.42	1.62	1.04	0.53	2.05	1.04	0.53	2.07	1.05	0.53	2.08	1.06	0.54	2.09
Drinking	0.77	0.22	2.66	0.71	0.21	2.34	0.71	0.21	2.37	0.70	0.21	2.30	0.70	0.21	2.32
Drug Use	1.85	0.64	5.32	2.02	0.72	5.69	1.96	0.68	5.62	1.96	0.69	5.55	1.97	0.70	5.57
Nativity	0.44	0.10	1.97	0.40	0.09	1.72	0.48	0.10	2.33	0.50	0.11	2.36	0.49	0.10	2.35
BIC (n_{eff})	**726.8202**			727.0552			731.0029			738.9983			750.6593		
BIC (J_{eff})	722.4052			**721.8374**			725.7851			732.9778			743.8360		

Table 3b: Hierarchical logistic regression of pregnancy loss on skin tone, race, maternal age, and covariates (Add Health; n=645 pregnancies, J=428 mothers). Effects are reported as point estimates and 95% confidence intervals (CI) on the odds ratio scale. Confidence intervals excluding 1 are bolded and italicized. Interactions are denoted with asterisks.

	Model 6			Model 7			Model 8			Model 9		
	pt. est.	95% CI		pt. est.	95% CI		pt. est.	95% CI		pt. est.	95% CI	
(Intercept)	0.06	0.00	2.29	0.03	0.00	2.09	0.03	0.00	2.03	0.03	0.00	2.10
Skin Tone: Light Brown	Ref.						Ref.					
Skin Tone: Medium Brown	46.87	0.04	53435.82				6.14	0.00	99843.35			
Skin Tone: Dark Brown	1.10	0.00	302.74				0.16	0.00	7402.40			
Race: White				Ref.			Ref.					
Race: Black				3.77	0.02	854.02	13.13	0.00	506139.62			
Race: Hispanic				19.21	0.03	12915.41	16.45	0.02	15099.20			
White*All Skin Tones										Ref.		
Black*Light Brown										0.17	0.00	115023.06
Black*Medium Brown										132.39	0.02	778972.04
Black*Dark Brown										1.97	0.00	798.59
Hispanic*Light Brown										24.87	0.02	32589.60
Hispanic*Medium Brown										56.19	0.00	2092167.38
Hispanic*Dark Brown										0.17	0.00	12431858.67
Maternal Age	1.10	0.93	1.31	1.13	0.93	1.38	1.13	0.93	1.38	1.13	0.93	1.38
Maternal Age*Light Brown	Ref.						Ref.					
Maternal Age*Medium Brown	0.86	0.60	1.23				0.96	0.57	1.61			
Maternal Age*Dark Brown	1.06	0.80	1.40				1.19	0.67	2.10			
Maternal Age*White				Ref.			Ref.					
Maternal Age*Black				0.98	0.75	1.29	0.86	0.49	1.51			
Maternal Age*Hispanic				0.88	0.63	1.23	0.88	0.61	1.25			
Maternal Age*White*All Skin Tones										Ref.		
Maternal Age*Black*Light Brown										1.09	0.53	2.24
Maternal Age*Black*Medium Brown										0.81	0.52	1.25
Maternal Age*Black*Dark Brown										1.02	0.76	1.38
Maternal Age*Hispanic*Light Brown										0.85	0.58	1.24
Maternal Age*Hispanic*Medium Brown										0.88	0.51	1.51
Maternal Age*Hispanic*Dark Brown										1.26	0.53	2.99
Non-singleton	1.86	0.35	9.86	1.90	0.36	9.93	1.92	0.36	10.13	1.95	0.37	10.25
Education: No High School Diploma	Ref.			Ref.			Ref.			Ref.		
Education: High School or Equivalent	0.62	0.31	1.24	0.63	0.31	1.28	0.64	0.32	1.28	0.64	0.32	1.27
Education: Beyond High School	0.55	0.23	1.31	0.55	0.23	1.31	0.58	0.24	1.37	0.57	0.24	1.36
First Pregnancy	1.25	0.69	2.26	1.24	0.68	2.24	1.23	0.68	2.22	1.25	0.69	2.25

Smoking	1.03	0.52	2.04	1.03	0.52	2.05	1.04	0.52	2.05	1.04	0.53	2.07
Drinking	0.71	0.21	2.36	0.72	0.22	2.41	0.71	0.21	2.34	0.71	0.22	2.37
Drug Use	2.01	0.70	5.72	1.95	0.67	5.66	1.96	0.68	5.65	1.97	0.69	5.66
Nativity	0.42	0.10	1.80	0.50	0.10	2.42	0.52	0.11	2.53	0.50	0.10	2.49
BIC (n_{eff})	738.8193			743.2443			763.0949			787.2674		
BIC (J_{eff})	732.7988			737.2238			755.4689			778.0359		

Table 4a: Hierarchical logistic regression of pregnancy loss on skin tone, race, and maternal age (Add Health; n=718 pregnancies, J=321 mothers). Effects are reported on the odds ratio scale as point estimates and 95% confidence intervals (CI). Confidence intervals excluding 1 are bolded and italicized. Interactions are denoted with colons.

	Model 1 (W. IV)			Model 2 (W. IV)			Model 3 (W. IV)			Model 4 (W. IV)			Model 5 (W. IV)		
	Est.	95% CI		Est.	95% CI		Est.	95% CI		Est.	95% CI		Est.	95% CI	
Intercept	***0.05***	***0.01***	***0.15***	***0.04***	***0.01***	***0.15***	***0.05***	***0.02***	***0.17***	***0.06***	***0.01***	***0.28***	***0.04***	***0.01***	***0.15***
Maternal Age (Centered)	***1.09***	***1.01***	***1.18***	***1.09***	***1.01***	***1.18***	***1.09***	***1.01***	***1.18***	***1.09***	***1.01***	***1.18***	***1.09***	***1.01***	***1.17***
Light Brown (LB)				Ref.						Ref.					
Medium Brown (MB)				1.10	0.43	2.80				0.78	0.27	2.26			
Dark Brown (DB)				1.33	0.63	2.82				0.88	0.30	2.51			
Black							Ref.			Ref.					
Hispanic							0.66	0.32	1.38	0.59	0.21	1.65			
Hispanic:LB													Ref.		
Hispanic:MB													0.46	0.10	2.15
Hispanic:DB													4.51	0.23	88.24
Black:LB													1.78	0.51	6.21
Black:MB													1.46	0.52	4.07
Black:DB													1.44	0.63	3.26
BIC (*n*)	667.27			679.65			671.95			684.86			696.45		
BIC (*J*)	664.87			675.65			668.75			680.05			690.04		

Table 4b: Hierarchical logistic regression of pregnancy loss on skin tone, race, and maternal age (Add Health; n=718 pregnancies, J=321 mothers). Effects are reported on the odds ratio scale as point estimates (e^b) and 95% confidence intervals (CI). Confidence intervals excluding 1 are bolded and italicized. Interactions are denoted with colons.

	Model 1 (W. IV)			Model 6 (W. IV)			Model 7 (W. IV)			Model 8 (W. IV)			Model 9 (W. IV)		
	e^b	95% CI		e^b	95% CI		e^b	95% CI		e^b	95% CI		e^b	95% CI	
Intercept	***0.05***	***0.01***	***0.15***	***0.10***	***0.02***	***0.43***	***0.03***	***0.01***	***0.13***	***0.07***	***0.01***	***0.79***	***0.09***	***0.02***	***0.50***
Maternal Age (Centered)	***1.09***	***1.01***	***1.18***	1.01	0.91	1.12	***1.14***	***1.03***	***1.27***	1.07	0.91	1.26	1.01	0.89	1.14
Light Brown (LB)				Ref.						Ref.					
Medium Brown (MB)				***0.10***	***0.01***	***0.95***				0.14	0.01	2.17			
Dark Brown (DB)				0.35	0.04	3.07				0.46	0.03	6.49			
LB:Age				Ref.						Ref.					
MB:Age				***1.22***	***1.01***	***1.46***				1.15	0.93	1.41			
DB:Age				1.12	0.95	1.32				1.06	0.88	1.28			
Black							Ref.			Ref.					
Hispanic							2.87	0.41	20.13	1.38	0.12	15.63			
Black:Age							Ref.			Ref.					
Hispanic:Age							0.88	0.76	1.03	0.93	0.79	1.10			
Hispanic LB													Ref.		
Hispanic MB													1.14	0.01	119.39
Hispanic DB													1.72	0.10	28.25
Black LB													1.27	0.04	35.95
Black MB													0.10	0.01	1.05
Black DB													0.36	0.03	3.84
Hispanic LB:Age													Ref.		
Hispanic MB:Age													0.89	0.56	1.44
Hispanic DB:Age													1.09	0.95	1.24
Black LB:Age													1.03	0.81	1.30
Black MB:Age													***1.24***	***1.03***	***1.50***
Black DB:Age													1.12	0.94	1.35
BIC (*n*)	667.27			688.17			675.42			699.98			724.06		
BIC (*J*)	664.87			682.56			671.42			692.76			713.64		

DISCUSSION

Wave III Discussion

For the Wave III analysis, regression Models 2, 4, and 5 suggest a pattern of "light privilege" in risk of pregnancy loss, though significant differences are evident for those with medium or dark brown skin in Model 2, but only those with dark brown skin in Model 4 and only for Black mothers with dark brown skin in Model 5. Focusing on Model 2, mothers with medium brown skin are at a 154% higher odds of pregnancy loss than those with light brown, and mothers with dark brown skin are at a 219% higher odds than those with light brown. Model 3 suggests a racial disparity disadvantaging Black mothers with a 158% greater odds of pregnancy loss than White mothers, but Model 4 suggests skin tone variability may be the proximate driver of such disparities. The analytical sample does not provide sufficient evidence to support a difference in the risk of pregnancy loss between Hispanic and White mothers, though this may have more to do with a modest sample size for this racial group and therefore limited statistical power. Alternatively, it is possible that this constitutes another example of the Hispanic Paradox, in which Hispanic individuals demonstrate levels of health comparable to those of White individuals despite socially and economically disadvantaging forces that often confront Hispanic people (Flores et al. 2012). While racial moderation of skin tone disparities in pregnancy loss is reasonable as a hypothesis, the model that evaluates this is not warranted by BIC. Once again, sample size limits this analysis, affecting precision in confidence interval estimation, detection of significant skin tone and/or racial effects, and model comparison based on BIC.

The observation that the racial effect in pregnancy loss is adjusted by skin tone supports Monk's theoretical outlook that observations of skin tone refine racial effects in health. Monk argues that the cognitive process of sorting people into meaningful social groups involves two phases. In the first step, we sort each other into "superordinate" categories such as race and sex.

This cognitive process occurs subconsciously and almost instantaneously. This triggers stereotypes that influence how we treat each other. However, such snap judgements are coarse-grained and warrant a finer-grained second pass that is equally quick and subconscious that focus on specific phenotypic traits such as skin tone variability. These cues are more informative, triggering more specific stereotypes, and are harder to resist. Between these two aspects of social sorting, sorting according to specific phenotypic traits accounts for much of the variability in socially reproduced health disparities. The Wave III analysis suggests that phenotypic sorting according to skin tone might account for a major share of racial effects in pregnancy loss. However, the claim that skin tone adjusts the race-pregnancy association out of existence and should be regarded with caution given limited sample size.

The pursuit of signs of weathering in the Wave III dataset provides no support for such widening disparities over age, or in fact even for maternal age effects in pregnancy loss at all. This is not surprising since the Wave III retrospective pregnancy data cover the early part of girls' and women's reproductive biographies, before the divergence in risk of loss has had a chance to develop between groups, and since the sample size is too small to support the model complexities entailed by weathering models. This category of model involves interactions between nominal or ordinal social status variables and age, implying a need to estimate several additional model parameters.

Wave IV Discussion

The Wave IV analysis supports neither the hypothesis that pregnancy loss varies by skin tone, nor that race moderates skin tone effects in pregnancy loss, nor that pregnancy loss varies race. However, increasing age predicts an increasing rate of pregnancy loss: the odds of pregnancy loss increases by a factor of about 1.09 for each additional year of age. While this odds ratio does not appear to be very different from 1, it accumulates multiplicatively over time so that a 31-year-old, for example, has 5.6 times the odds of experiencing a pregnancy loss relative to that of an eleven year old. On one hand, this observation is not surprising because age is a well-known predictor of pregnancy loss and as such is often included as a covariate in analyses of pregnancy loss and other adverse birth outcomes. On the other hand, age's positive association with pregnancy loss is coherent with cumulative stress and therefore opens room to consider social differences in the rate at which stress accumulates, in other words weathering.

However, evidential support for weathering is inconclusive. Considered in isolation, both Models 6 and 9 assume weathering according to skin tone differences (Model 9 moderated by race). Model 6 suggests that medium brown mothers accumulate risk of loss at a significantly faster rate than light brown mothers. Model 9 suggests the same pattern though only for Black mothers relative to Hispanic mothers with light brown skin. However, when any model including any kind of weathering is compared to the null model with none, the null model is favored. Consequently, no clear evidence supports skin tone weathering in pregnancy loss. In any case, if the "penalized middle" pattern observed in Models 6 and 9 (Table 4a) is real, this pattern would beg the development of new theory to account for this new pattern. By the same token, mothers with medium brown skin are at a lower risk of loss at age 11 (a "protected middle" pattern), complicating the narrative even further.

Synthesis

The analyses in this study have been conducted to clarify our understanding of potential colorism effects in pregnancy loss, with an emphasis on three main questions: is there any relationship between skin tone and pregnancy loss, how do racial differences nuance this relationship, and does this relationship change with age?

Regarding the first question, the Wave III and IV analyses appear to tell different stories. The Wave III analysis suggests two things: first, pregnancy loss exhibits a "light privilege" pattern; and second, skin tone appears to account for an important share of the association between race and pregnancy loss. In contrast, the Wave IV analysis does not support a "light privilege" or any pattern of skin tone variability in pregnancy loss. Nor does it support racial differences in rates of pregnancy loss. Consequently, it also does not suggest that skin tone adjusts race-pregnancy loss associations.

Regarding the second question, neither analysis provides evidence in support of racial moderation of skin tone effects on pregnancy loss. It is true that the interaction model in the Wave III analysis (Model 5) suggests Black mothers with dark brown skin do experience a higher rate of loss than any other intersection of race and skin tone, but the interaction models in both analyses are simply disfavored in terms of BIC.

The Wave III and IV analyses differ in one other respect: maternal age exhibits a significant effect in Wave IV but not Wave III. It is worth noting that while not significant, the age effect is positive in both waves, with point estimates of the odds ratio ranging between 1.05 and1.07 and equaling 1.09 in Models 1 through 5 in the Wave IV analyses.

The observations that these analyses tell different stories is especially troublesome given that the two analytical samples include reproductive biographies from many of the same women at least during the earlier part of their reproductive biographies. At least four reasons for these apparent differences may be offered:

First, while there is some overlap in the mothers and pregnancies included in both analyses, it cannot be overlooked that the Wave IV analytical sample represents 7 to 9 additional years in participants'' reproductive biographies and that these are peak years of reproduction for many women. If the racial and/or skin tone disparities in pregnancy are considerably different during these women's reproductive careers than in the early phase covered by Wave III, this could account for the apparent absence of such differences unless age effects are accounted for.

Second, several of the covariates included in Wave III are unavailable in Wave IV, including non-singleton status and the three health behaviors drinking, smoking, and drug use. Only first pregnancy and nativity indicators could be added to the Wave IV analysis or excluded from the Wave III analysis for the sake of closer equivalence.

Third, while the dependent variable in both analyses—a pregnancy loss indicator—appears identical between the two analyses, there are two differences, one unavoidable. First, Wave IV includes an additional category of pregnancy outcome—ectopic or tubal pregnancy—that is not recorded in Wave III. Second, because the Wave IV pregnancy data do not distinguish between singleton and non-singleton pregnancies, Wave III's "non-singleton partial losses" must be reckoned as Wave IV's live births. In contrast, the Wave III analysis here treated this pregnancy outcome among the losses because of the pathological nature of this category of pregnancy outcome. This outcome could be recoded as a live birth in the Wave III analysis for the sake of closer equivalence.

Fourth, perhaps one of the most consequential differences in approach between the two analyses was the choice to include pregnancies to White mothers in the Wave III analysis but to exclude them in the Wave IV analysis. This decision also has implications for the reference categories against which other categories are compared in several models: while White mothers are treated as the reference category in Wave III's Models 3 and 4, Black mothers have this status in the equivalent models in the Wave IV analysis. Similarly, while White mothers are treated as the reference category in Wave III's race-skin tone interaction model (Model 5), Hispanic mothers with light brown skin have this status in the equivalent model in the Wave IV analysis. Additionally, exclusion of White mothers from the Wave IV analysis noticeably depletes the effective sample sizes of mothers with light brown skin and pregnancies to these mothers in the Wave IV analysis, with a reduction of 177.97 mothers with light brown skin and a reduction of 160.07 pregnancies to these mothers. This reduction in sample size is also relevant given that mothers with light brown skin are the reference category in Models 2 and 4 of both the Wave III and IV analysis. In contrast, the numbers of mothers with both light and dark brown skin and pregnancies to these mothers increase from the Wave III to the Wave IV analytical sample.

At present, it is not possible to say which of these four factors account for the apparent discrepancies between the Wave III and IV analyses. Some of these differences cannot be resolved, for example the absence of several covariates from Wave IV included in Wave III, but two differences could be subject to sensitivity analyses: the treatment of Wave III partial losses as losses versus live births, and the exclusion of White mothers from the Wave IV analysis (or inclusion of White mothers in the Wave III analysis).

Limitations and Future Research

An important limitation of the analyses presented here is that they leave questions of mechanism in a black box, owing to a dearth of suitable variables in the Wave III and especially the Wave IV retrospective pregnancy data. Multiple mechanisms may be at play here, which can be broadly associated with either of two definitions of colorism—skin tone discrimination or skin tone stratification. On the discrimination side, we can hypothesize that interpersonal, skin tone-related microaggressions and overt hostilities cause psychosocial stress that manifests in physiological adversity, including pregnancy loss, through a stress pathway. On the stratification side, we can hypothesize that skin tone is associated with both inherited and achieved socioeconomic disadvantages (Abascal and Garcia 2022; Adames 2023; Goldsmith et al. 2007), which in turn lead to less well managed pregnancies and a higher incidence of poor pregnancy outcomes by consequence.

While the exclusion of pregnancies ending in elective abortion from the analytical sample is intended to narrow the focus of this study to the largely unconscious, involuntary dimensions of stress pathways linking skin tone and race to pregnancy loss, this analytical decision may in fact lead to a systematic underestimation of skin tone and/or racial effects in pregnancy loss. It may be that the increased risk of physiological stress and poorer reproductive outcomes explained by social differences also leads to a higher incidence of deliberate preemptive interventions in the form of elective abortion. If this is the case, then those at the highest risk of involuntary loss are also those who are most likely to be disproportionately underrepresented in the analytical sample due to omitted abortions. Consequently, while such biased estimation is undesirable, in this case the estimates reported here should be regarded as lower limits on skin tone and racial effects in risk of pregnancy loss. Even if no such bias affects the present analysis, the demonstrated social disparities in risk of pregnancy loss should be expected to increase in social and health salience for many American women living in states with abortion restrictions and bans following the Supreme Court’s decision in Dobbs v. Jackson Women’s Health Organization.

CONCLUSION

This study sought to explore the relationship between skin tone and pregnancy loss, motivated by the concept of colorism. It also explored the nuanced relationship between race and skin tone in this health outcome in greater empirical detail than previous research on colorism and health, first of all by asking whether skin tone adjusts a possible association between race and pregnancy loss, then by asking whether race moderates the association between skin tone and pregnancy loss. Finally, it explored the possibility of growing skin tone disparities in pregnancy loss over maternal age, coherent with the concept of weathering.

The analysis of Add Health Wave III retrospective pregnancy data supports the identification of a "light privilege" pattern in pregnancy loss, with mothers with medium or dark brown skin at significantly higher risks of loss than those with light brown skin. This analysis also supports the claim that Black mothers are at a significantly higher risk of loss than White, though there is insufficient evidence to distinguish between Hispanic and White mothers. It does provide evidential support for a pivotal role of skin tone regarding racial disparities in risk of pregnancy loss. Conversely, this analysis does not support the claim that race moderates skin tone effects in pregnancy loss. It also does not identify signs of either skin tone or racial weathering in the risk of pregnancy loss, which is not surprising given the young age of mothers in this dataset, the limited statistical power afforded by this relatively small sample, and the complexity of weathering models relative to sample size.

Analysis of the Add Health Wave IV retrospective pregnancy data provides little support for either skin tone or racial disparities in pregnancy loss. In part, this may be due to a narrowed focus on non-Hispanic Black and Hispanic mothers, omitting White mothers. It does indicate maternal age as a risk factor for pregnancy loss unlike the Wave III data, but consistent with the biomedical literature. While models that consider skin tone weathering suggest that mothers with medium brown skin accumulate a risk of loss at a faster rate, such a "penalized middle" pattern is unprecedented in the literature on colorism and health. Such models are also disfavored relative to the Null model. Further research with considerably larger sample sizes are desired to evaluate the possibility of skin tone weathering more conclusively.

The demonstration of skin tone disparities in pregnancy loss indicates a further target for public health interventions intending to improve social equity in reproductive health. In the post-

Dobbs United States, denial of access to abortion is expected to disproportionately impact racial minorities. This study has indicated that racial minorities with dark skin should also expect to experience disproportionally high rates of pregnancy loss. Because the same groups who are expected to be the most impacted by reduced access to abortion in many parts of the US are also at an elevated risk of pregnancy loss, it is reasonable to predict an even higher burden of loss among these groups where abortion is restricted or banned. Such widening of an already problematic disparity in maternal and reproductive health further accentuates the need to understand and mitigate skin tone disparities in pregnancy loss.

REFERENCES

Abascal, Maria, and Denia Garcia. 2022. "Pathways to Skin Color Stratification: The Role of Inherited (Dis)Advantage and Skin Color Discrimination in Labor Markets." *Sociological Science* 9:346–73. doi: 10.15195/v9.a14.

Abdulrahim, Sawsan, Sherman A. James, Rouham Yamout, and Wayne Baker. 2012. "Discrimination and Psychological Distress: Does Whiteness Matter for Arab Americans?" *Social Science & Medicine* 75(12):2116–23. doi: 10.1016/j.socscimed.2012.07.030.

Adames, Alexander. 2023. "The Cumulative Effects of Colorism: Race, Wealth, and Skin Tone." *Social Forces* 102(2):539–60. doi: 10.1093/sf/soad038.

Bacci, Silvia, Francesco Bartolucci, Liliana Minelli, and Manuela Chiavarini. 2016. "Preterm Birth: Analysis of Longitudinal Data on Siblings Based on Random-Effects Logit Models." *Frontiers in Public Health* 4.

Boen, Courtney. 2020. "Death by a Thousand Cuts: Stress Exposure and Black–White Disparities in Physiological Functioning in Late Life." *The Journals of Gerontology: Series B* 75(9):1937–50. doi: 10.1093/geronb/gbz068.

Braveman, Paula A., Katherine Heck, Susan Egerter, Kristen S. Marchi, Tyan Parker Dominguez, Catherine Cubbin, Kathryn Fingar, Jay A. Pearson, and Michael Curtis. 2015. "The Role of Socioeconomic Factors in Black–White Disparities in Preterm Birth." *American Journal of Public Health* 105(4):694–702. doi: 10.2105/AJPH.2014.302008.

Braveman, Paula, Katherine Heck, Susan Egerter, Tyan Parker Dominguez, Christine Rinki, Kristen S. Marchi, and Michael Curtis. 2017. "Worry about Racial Discrimination: A Missing Piece of the Puzzle of Black-White Disparities in Preterm Birth?" *PloS One* 12(10):e0186151. doi: 10.1371/journal.pone.0186151.

Buhule, Olive D., Hyoyoung Choo-Wosoba, and Paul S. Albert. 2020. "Modeling Repeated Labor Curves in Consecutive Pregnancies: Individualized Prediction of Labor Progression from Previous Pregnancy Data." *Statistics in Medicine* 39(8):1068–83. doi: 10.1002/sim.8462.

Calzada, Esther J., Yeonwoo Kim, and Jaimie L. O'Gara. 2019. "Skin Color as a Predictor of Mental Health in Young Latinx Children." *Social Science & Medicine* 238:112467. doi: 10.1016/j.socscimed.2019.112467.

Caraballo-Cueto, Jose, and Isar P. Godreau. 2021. "Colorism and Health Disparities in Home Countries: The Case of Puerto Rico." *Journal of Immigrant and Minority Health* 23(5):926–35. doi: 10.1007/s10903-021-01222-7.

Cobb, Ryon J., Courtney S. Thomas, Whitney N. Laster Pirtle, and William A. Darity. 2016. "Self-Identified Race, Socially Assigned Skin Tone, and Adult Physiological Dysregulation: Assessing Multiple Dimensions of 'Race' in Health Disparities Research." *SSM - Population Health* 2:595–602. doi: 10.1016/j.ssmph.2016.06.007.

Codina, G. Edward, and Frank F. Montalvo. 1994. "Chicano Phenotype and Depression." *Hispanic Journal of Behavioral Sciences* 16(3):296–306. doi: 10.1177/07399863940163007.

Costas, R., M. R. Garcia-Palmieri, P. Sorlie, and E. Hertzmark. 1981. "Coronary Heart Disease Risk Factors in Men with Light and Dark Skin in Puerto Rico." *American Journal of Public Health* 71(6):614–19. doi: 10.2105/AJPH.71.6.614.

DiPrete, Thomas A., and Gregory M. Eirich. 2006. "Cumulative Advantage as a Mechanism for Inequality: A Review of Theoretical and Empirical Developments." *Annual Review of Sociology* 32(1):271–97. doi: 10.1146/annurev.soc.32.061604.123127.

Dixon, Angela R., and Edward E. Telles. 2017. "Skin Color and Colorism: Global Research, Concepts, and Measurement." *Annual Review of Sociology* 43(1):405–24. doi: 10.1146/annurev-soc-060116-053315.

Flores, Marie E. S., Sara E. Simonsen, Tracy A. Manuck, Jane M. Dyer, and David K. Turok. 2012. "The 'Latina Epidemiologic Paradox': Contrasting Patterns of Adverse Birth Outcomes in U.S.-Born and Foreign-Born Latinas." *Women's Health Issues: Official Publication of the Jacobs Institute of Women's Health* 22(5):e501-507. doi: 10.1016/j.whi.2012.07.005.

Gemmill, Alison, Ralph Catalano, Joan A. Casey, Deborah Karasek, Héctor E. Alcalá, Holly Elser, and Jacqueline M. Torres. 2019. "Association of Preterm Births Among US Latina Women With the 2016 Presidential Election." *JAMA Network Open* 2(7):e197084. doi: 10.1001/jamanetworkopen.2019.7084.

Geronimus, A. T. 1992. "The Weathering Hypothesis and the Health of African-American Women and Infants: Evidence and Speculations." *Ethnicity & Disease* 2(3):207–21.

Geronimus, Arline T., Margaret Hicken, Danya Keene, and John Bound. 2006. "'Weathering' and Age Patterns of Allostatic Load Scores Among Blacks and Whites in the United States." *American Journal of Public Health* 96(5):826–33. doi: 10.2105/AJPH.2004.060749.

Goldsmith, Arthur H., Darrick Hamilton, and William Darity. 2007. "From Dark to Light: Skin Color and Wages Among African-Americans." *Journal of Human Resources* XLII(4):701–38. doi: 10.3368/jhr.XLII.4.701.

Gravlee, Clarence C., and William W. Dressler. 2005. "Skin Pigmentation, Self-Perceived Color, and Arterial Blood Pressure in Puerto Rico." *American Journal of Human Biology* 17(2):195–206. doi: 10.1002/ajhb.20111.

Gravlee, Clarence C., William W. Dressler, and H. Russell Bernard. 2005. "Skin Color, Social Classification, and Blood Pressure in Southeastern Puerto Rico." *American Journal of Public Health* 95(12):2191–97. doi: 10.2105/AJPH.2005.065615.

Han, JooHee. 2020. "Does Skin Tone Matter? Immigrant Mobility in the U.S. Labor Market." *Demography* 57(2):705–26. doi: 10.1007/s13524-020-00867-7.

Hargrove, Taylor W. 2018. "BMI Trajectories in Adulthood: The Intersection of Skin Color, Gender, and Age among African Americans." *Journal of Health and Social Behavior* 59(4):501–19. doi: 10.1177/0022146518802439.

Hargrove, Taylor W. 2019. "Light Privilege? Skin Tone Stratification in Health among African Americans." *Sociology of Race and Ethnicity* 5(3):370–87. doi: 10.1177/2332649218793670.

Harris, Kathleen Mullan, Carolyn Tucker Halpern, Eric A. Whitsel, Jon M. Hussey, Ley A. Killeya-Jones, Joyce Tabor, and Sarah C. Dean. 2019. "Cohort Profile: The National Longitudinal Study of Adolescent to Adult Health (Add Health)." *International Journal of Epidemiology* 48(5):1415–1415k. doi: 10.1093/ije/dyz115.

Holzman, Claudia, Janet Eyster, Mary Kleyn, Lynne C. Messer, Jay S. Kaufman, Barbara A. Laraia, Patricia O'Campo, Jessica G. Burke, Jennifer Culhane, and Irma T. Elo. 2009. "Maternal Weathering and Risk of Preterm Delivery." *American Journal of Public Health* 99(10):1864–71. doi: 10.2105/AJPH.2008.151589.

Hunter, Margaret. 2007. "The Persistent Problem of Colorism: Skin Tone, Status, and Inequality." *Sociology Compass* 1(1):237–54. doi: 10.1111/j.1751-9020.2007.00006.x.

Hunter, Margaret L. 2002. "'If You're Light You're Alright': Light Skin Color as Social Capital for Women of Color." *Gender & Society* 16(2):175–93. doi: 10.1177/08912430222104895.

Hunter, Margaret L. 2005. *Race, Gender, and the Politics of Skin Tone*. New York: Routledge.

Hunter, Margaret L. 2011. "Buying Racial Capital: Skin-Bleaching and Cosmetic Surgery in a Globalized World." 4(4).

Krieger, Nancy, Mary Huynh, Wenhui Li, Pamela D. Waterman, and Gretchen Van Wye. 2018. "Severe Sociopolitical Stressors and Preterm Births in New York City: 1 September 2015 to 31 August 2017." *J Epidemiol Community Health* 72(12):1147–52. doi: 10.1136/jech-2018-211077.

Laidley, Thomas, Benjamin Domingue, Piyapat Sinsub, Kathleen Mullan Harris, and Dalton Conley. 2019. "New Evidence of Skin Color Bias and Health Outcomes Using Sibling Difference Models: A Research Note." *Demography* 56(2):753–62. doi: 10.1007/s13524-018-0756-6.

Lazarides, Claudia, Nora K. Moog, Glenn Verner, Manuel C. Voelkle, Wolfgang Henrich, Christine M. Heim, Thorsten Braun, Pathik D. Wadhwa, Claudia Buss, and Sonja Entringer. 2023. "The Association between History of Prenatal Loss and Maternal Psychological State in a Subsequent Pregnancy: An Ecological Momentary Assessment (EMA) Study." *Psychological Medicine* 53(3):855–65. doi: 10.1017/S0033291721002221.

Louie, Patricia. 2020. "Revisiting the Cost of Skin Color: Discrimination, Mastery, and Mental Health among Black Adolescents." *Society and Mental Health* 10(1):1–19. doi: 10.1177/2156869318820092.

Louis, Germaine Buck, Vanja Dukic, Patrick J. Heagerty, Thomas A. Louis, Courtney D. Lynch, Louise M. Ryan, Enrique F. Schisterman, and Ann Trumble. 2006. "Analysis of Repeated Pregnancy Outcomes." *Statistical Methods in Medical Research* 15(2):103–26. doi: 10.1191/0962280206sm434oa.

Massey, Douglas S., and Stefanie Brodmann. 2014. *Spheres of Influence: The Social Ecology of Racial and Class Inequality*. New York, NY: Russell Sage Foundation.

McEwen Bruce S. 1998. "Protective and Damaging Effects of Stress Mediators." *New England Journal of Medicine* 338(3):171–79. doi: 10.1056/NEJM199801153380307.

McEwen, Bruce S. 2006. "Protective and Damaging Effects of Stress Mediators: Central Role of the Brain." *Dialogues in Clinical Neuroscience* 8(4):367–81. doi: 10.31887/DCNS.2006.8.4/bmcewen.

McEwen, Bruce S., and Teresa Seeman. 1999. "Protective and Damaging Effects of Mediators of Stress: Elaborating and Testing the Concepts of Allostasis and Allostatic Load." *Annals of the New York Academy of Sciences* 896(1):30–47. doi: 10.1111/j.1749-6632.1999.tb08103.x.

Monk, Ellis P. 2015. "The Cost of Color: Skin Color, Discrimination, and Health among African-Americans." *American Journal of Sociology* 121(2):396–444. doi: 10.1086/682162.

Monk, Ellis P. 2021. "Colorism and Physical Health: Evidence from a National Survey." *Journal of Health and Social Behavior* 62(1):37–52. doi: 10.1177/0022146520979645.

Monk, Ellis P., Jr. 2021. "The Unceasing Significance of Colorism: Skin Tone Stratification in the United States." *Daedalus* 150(2):76–90. doi: 10.1162/daed_a_01847.

Montalvo, Frank F., and G. Edward Codina. 2001. "Skin Color and Latinos in the United States." *Ethnicities* 1(3):321–41. doi: 10.1177/146879680100100303.

Mukherjee, S., D. R. Velez Edwards, D. D. Baird, D. A. Savitz, and K. E. Hartmann. 2013. "Risk of Miscarriage Among Black Women and White Women in a US Prospective Cohort Study." *American Journal of Epidemiology* 177(11):1271–78. doi: 10.1093/aje/kws393.

O'Campo, Patricia, Jessica G. Burke, Jennifer Culhane, Irma T. Elo, Janet Eyster, Claudia Holzman, Lynne C. Messer, Jay S. Kaufman, and Barbara A. Laraia. 2008. "Neighborhood Deprivation and Preterm Birth among Non-Hispanic Black and White Women in Eight Geographic Areas in the United States." *American Journal of Epidemiology* 167(2):155–63. doi: 10.1093/aje/kwm277.

Osypuk, Theresa L., and Dolores Acevedo-Garcia. 2008. "Are Racial Disparities in Preterm Birth Larger in Hypersegregated Areas?" *American Journal of Epidemiology* 167(11):1295–1304. doi: 10.1093/aje/kwn043.

Pearlin, L. I., M. A. Lieberman, E. G. Menaghan, and J. T. Mullan. 1981. "The Stress Process." *Journal of Health and Social Behavior* 22(4):337–56.

Pearlin, Leonard I. 1989. "The Sociological Study of Stress." *Journal of Health and Social Behavior* 30(3):241–56. doi: 10.2307/2136956.

Pearlin, Leonard I., and Alex Bierman. 2013. "Current Issues and Future Directions in Research into the Stress Process." Pp. 325–40 in *Handbook of the Sociology of Mental Health*, *Handbooks of Sociology and Social Research*, edited by C. S. Aneshensel, J. C. Phelan, and A. Bierman. Dordrecht: Springer Netherlands.

Perreira, Krista M., and Edward E. Telles. 2014. "The Color of Health: Skin Color, Ethnoracial Classification, and Discrimination in the Health of Latin Americans." *Social Science & Medicine* 116:241–50. doi: 10.1016/j.socscimed.2014.05.054.

Perreira, Krista M., Joshua Wassink, and Kathleen Mullan Harris. 2019. "Beyond Race/Ethnicity: Skin Color, Gender, and the Health of Young Adults in the United States." *Population Research and Policy Review* 38(2):271–99. doi: 10.1007/s11113-018-9503-3.

Pickett, Kate E., Jennifer E. Ahern, Steve Selvin, and Barbara Abrams. 2002. "Neighborhood Socioeconomic Status, Maternal Race and Preterm Delivery: A Case-Control Study." *Annals of Epidemiology* 12(6):410–18. doi: 10.1016/S1047-2797(01)00249-6.

Rauh, Virginia A., Howard F. Andrews, and Robin S. Garfinkel. 2001. "The Contribution of Maternal Age to Racial Disparities in Birthweight: A Multilevel Perspective." *American Journal of Public Health* 91(11):1815–24. doi: 10.2105/AJPH.91.11.1815.

Reagan, Patricia B., and Pamela J. Salsberry. 2005. "Race and Ethnic Differences in Determinants of Preterm Birth in the USA: Broadening the Social Context." *Social Science & Medicine (1982)* 60(10):2217–28. doi: 10.1016/j.socscimed.2004.10.010.

Seeman, Teresa E., Burton H. Singer, John W. Rowe, Ralph I. Horwitz, and Bruce S. McEwen. 1997. "Price of Adaptation—Allostatic Load and Its Health Consequences: MacArthur Studies of Successful Aging." *Archives of Internal Medicine* 157(19):2259–68. doi: 10.1001/archinte.1997.00440400111013.

Shih, Joanna H., Paul S. Albert, Pauline Mendola, and Katherine L. Grantz. 2015. "Modelling the Type and Timing of Consecutive Events: Application to Predicting Preterm Birth in Repeated

Pregnancies." *Journal of the Royal Statistical Society: Series C (Applied Statistics)* 64(5):711–30. doi: 10.1111/rssc.12100.

Slaughter-Acey, Jaime C., Tony N. Brown, Verna M. Keith, Rhonda Dailey, and Dawn P. Misra. 2020. "A Tale of Two Generations: Maternal Skin Color and Adverse Birth Outcomes in Black/African American Women." *Social Science & Medicine* 265:113552. doi: 10.1016/j.socscimed.2020.113552.

Slaughter-Acey, Jaime C., Shawnita Sealy-Jefferson, Laura Helmkamp, Cleopatra H. Caldwell, Theresa L. Osypuk, Robert W. Platt, Jennifer K. Straughen, Rhonda K. Dailey-Okezie, Purni Abeysekara, and Dawn P. Misra. 2016. "Racism in the Form of Micro Aggressions and the Risk of Preterm Birth among Black Women." *Annals of Epidemiology* 26(1):7-13.e1. doi: 10.1016/j.annepidem.2015.10.005.

Slaughter-Acey, Jaime C., Devon Sneed, Lauren Parker, Verna M. Keith, Nora L. Lee, and Dawn P. Misra. 2019. "Skin Tone Matters: Racial Microaggressions and Delayed Prenatal Care." *American Journal of Preventive Medicine* 57(3):321–29. doi: 10.1016/j.amepre.2019.04.014.

Tian, Xi, and Denise Haunani Solomon. 2020. "A Relational Turbulence Theory Perspective on Women's Grief Following Miscarriage." *Journal of Social and Personal Relationships* 37(6):1852–72. doi: 10.1177/0265407520910792.

Torche, Florencia, and Catherine Sirois. 2019. "Restrictive Immigration Law and Birth Outcomes of Immigrant Women." *American Journal of Epidemiology* 188(1):24–33. doi: 10.1093/aje/kwy218.

APPENDIX A

Tables A1a and A1b present fitted regression models analogous to those presented in Tables 3a and 3b above for Wave III, unadjusted for covariates included in Tables 3a and 3b. These results are broadly in line with those presented in Tables 3a and 3b, with two notable exceptions: intercepts for Models 1-5 in Table A1a are significantly lower than 1 whereas they are statistically indistinguishable from 1 in Table 3a; and Hispanic mothers with medium brown skin are at a significantly higher risk of loss than White mothers in Model 5 in Table A1a, while they are not in Table 3a.

Table A1a: Hierarchical logistic regression of pregnancy loss on skin tone, and race (Add Health; n=645 pregnancies, J=428 mothers). Effects are reported as point estimates and 95% confidence intervals (CI) on the odds ratio scale. Confidence intervals excluding 1 are bolded and italicized. Interactions are denoted with asterisks.

	Model 1			Model 2			Model 3			Model 4			Model 5		
	pt. est.	95% CI		pt. est.	95% CI		pt. est.	95% CI		pt. est.	95% CI		pt. est.	95% CI	
(Intercept)	***0.19***	***0.12***	***0.29***	***0.15***	***0.09***	***0.25***	***0.14***	***0.08***	***0.25***	***0.15***	***0.08***	***0.25***	***0.15***	***0.09***	***0.25***
Skin Tone: Light Brown				Ref.						Ref.					
Skin Tone: Medium Brown				***2.46***	***1.01***	***6.03***				3.01	0.89	10.18			
Skin Tone: Dark Brown				***2.88***	***1.36***	***6.10***				***4.29***	***1.15***	***16.05***			
Race: White							Ref.			Ref.					
Race: Black							***2.34***	***1.20***	***4.57***	0.68	0.20	2.31			
Race: Hispanic							1.88	0.86	4.10	1.46	0.66	3.23			
White*All Skin Tones													Ref.		
Black*Light Brown													0.77	0.15	3.91
Black*Medium Brown													2.12	0.75	6.00
Black*Dark Brown													***2.82***	***1.28***	***6.21***
Hispanic*Light Brown													1.34	0.58	3.10
Hispanic*Medium Brown													***5.19***	***1.04***	***25.79***
Hispanic*Dark Brown													12.28	0.80	187.48
BIC (n_{eff})	**676.9102**			677.3611			680.7201			688.1589			699.9528		
BIC (J_{eff})	676.1075			**675.7556**			679.1146			685.7507			696.7419		

Table A1b: Hierarchical logistic regression of pregnancy loss on skin tone, race, and maternal age (Add Health; n=645 pregnancies, J=428 mothers). Effects are reported as point estimates and 95% confidence intervals (CI) on the odds ratio scale. Confidence intervals excluding 1 are bolded and italicized. Interactions are denoted with asterisks.

	Model 6			Model 7			Model 8			Model 9		
	pt. est.	95% CI		pt. est.	95% CI		pt. est.	95% CI		pt. est.	95% CI	
(Intercept)	0.08	0.00	1.54	0.04	0.00	1.20	0.04	0.00	1.16	0.04	0.00	1.18
Skin Tone: Light Brown	Ref.						Ref.					
Skin Tone: Medium Brown	31.67	0.02	47803.94				4.89	0.00	104208.04			
Skin Tone: Dark Brown	0.62	0.00	145.10				0.16	0.00	9057.69			
Race: White				Ref.			Ref.					
Race: Black				2.35	0.01	451.67	8.33	0.00	408642.67			
Race: Hispanic				31.19	0.05	21334.60	26.95	0.03	21681.19			
White*All Skin Tones										Ref.		
Black*Light Brown										0.25	0.00	115271.31
Black*Medium Brown										58.89	0.01	455105.10
Black*Dark Brown										1.25	0.00	422.36
Hispanic*Light Brown										37.22	0.03	42056.55
Hispanic*Medium Brown										85.99	0.00	4848439.17
Hispanic*Dark Brown										0.58	0.00	21005524.04
Maternal Age	1.03	0.89	1.20	1.07	0.90	1.27	1.07	0.90	1.27	1.07	0.90	1.27
Maternal Age*Light Brown	Ref.						Ref.					
Maternal Age*Medium Brown	0.87	0.60	1.27				0.97	0.57	1.66			
Maternal Age*Dark Brown	1.08	0.82	1.42				1.19	0.67	2.11			
Maternal Age*White				Ref.			Ref.					
Maternal Age*Black				1.00	0.77	1.30	0.88	0.50	1.56			
Maternal Age*Hispanic				0.86	0.61	1.22	0.86	0.60	1.22			
Maternal Age*White*All Skin Tones										Ref.		
Maternal Age*Black*Light Brown										1.06	0.53	2.14
Maternal Age*Black*Medium Brown										0.84	0.54	1.32
Maternal Age*Black*Dark Brown										1.04	0.78	1.39
Maternal Age*Hispanic*Light Brown										0.84	0.58	1.22
Maternal Age*Hispanic*Medium Brown										0.86	0.48	1.54
Maternal Age*Hispanic*Dark Brown										1.18	0.52	2.70
BIC (n_{eff})	695.0653			698.3012			717.8159			742.2510		
BIC (J_{eff})	692.2557			695.4917			713.4008			736.2305		