Low Infant Birth Weight in Brazil

A Historical Data Analysis Approach

Cassia Roth

2024-03-15

# 1. Summary/Abstract

This cross-sectional study uses a linear regression model to understand disparities in infant birth weight in relation to maternal race, age, gestational status (parity or gravidity), and nationality in Rio de Janeiro, Brazil’s first public maternity hospital, the Maternidade Laranjeiras (now Maternidade Escola) in the 1920s. I will use a linear model to estimate the relationship of maternal variables on infant birth weight. I hypothesize that infants born to women of color (either Black or “*preta*” or mixed-race or “*parda*”) will have lower birth weights than infants born to White women, whether Brazilian or immigrant, given the historical legacies of slavery, only abolished in 1888, on population health in Brazil.

# 2. Introduction

Public health and medical research over the past twenty years has shown that while race is a biological fiction, its social consequences have far-reaching influences on public health outcomes, particularly in countries with high levels of race-based inequality (1). Studies in Brazil have shown that non-White mothers give birth to infants at lower birth weights than their White counterparts (4). Mothers with lower education levels and lower socioeconomic status also give birth to infants at lower birth weights (4). Understanding these patterns is important as low birth weight is associated with higher rates of infant mortality in the first year of life (4).

These trends hold true in the United States, as well, where Black newborns have lower birth weights than White newborns, and these trends have worsened over time (7). Racism is a major factor in these outcomes (8), as studies demonstrate that U.S.-born Black women have infants with lower birth weights and higher rates of pre-term birth than Black immigrant women (11). Other racial groups, whether U.S. or foreign-born, also face similar trends, although more research is needed to understand confounding factors (12).

Scholars across disciplines have argued that health disparities in countries with histories of race-based chattel slavery are longstanding and tied to the unequal and violent social relations produced under that institution (16). In Brazil, most historical studies remain descriptive in nature and have not tested any quantitative associations between the legacies of slavery, including racism, and maternal-infant health outcomes (16). This study aims to fill that gap.

It looks at infant birth weight in relation to maternal race, age, gestational status (parity or gravidity), and nationality in Brazil’s first public maternity hospital, the Maternidade Laranjeiras (now Maternidade Escola), opened in 1904 to provide free gynecological and obstetric care to the city’s poorest women.

It relies on a unique sample of infant birth weight data from the country’s first public maternity hospital, opened in 1904 in the then-capital city of Rio de Janeiro. Brazil was the last country in the Western Hemisphere to abolish slavery (1888), and it had, and still has, the largest number of African-descended peoples in the world outside of Nigeria (19). Around 55% of country’s population today is of African-descent (20).

## 2.1 Background

Brazil imported over 4 million enslaved Africans during the nearly four centuries of the existence of chattel slavery in the country (21). It was also the last country to abolish slavery (1888). Healthcare outcomes under chattel slavery were poor for enslaved individuals, evidenced by the lack of endogenous growth among the enslaved population and enslavers’ continued reliance on the transatlantic slave trade (until its abolition in 1850) for new enslaved laborers as mortality rates outpaced fertility rates (23).

In the immediate aftermath of the abolition of slavery, which coincided with the implementation of a republican form of government in 1889, no state-run efforts to incorporate formerly enslaved, African-descended peoples into civil and political life occurred (24). Scholars have shown how Black and mixed-race Brazilians were incarcerated at higher rates, had lower educational and literacy levels, and had worse health outcomes including infant mortality than their White and White immigrant counterparts (15).

Yet recent studies also show an overall improvement in human welfare during this period, measured in increased height at the population level (27). The early twentieth century was a period of advancement in both the provision of clinical care and the implementation of public health initiatives in Brazil and across the globe. Improved sanitation measures helped stem infectious disease outbreaks and improve quality of life (28). But the major advancements in clinical medicine, that improved maternal mortality and infant mortality rates, including blood transfusions and antibiotics, did not come about until the late 1930s and early 1940s. Worldwide, the combination of advancements in medical care and overall improvements in nutrition resulted in dramatic and sustained drops in maternal and infant mortality after World War II (30).

By the 1920s, at least in Brazil’s large cities, public maternity hospitals, established in the previous three decades, had grown in number and size as obstetricians and public health officials worked to hospitalize labor and delivery (15). Dedicated maternity hospitals such as Laranjeiras were central to this hospitalization process. In hospitals, obstetricians and gynecologists began implementing surgical advances in the realm of women’s medicine, including new cesarean section techniques (37). Underlying these structural and technological changes was the scientific motherhood movement, supported by both physicians and elite women, which harnessed advances in medical knowledge and public health infrastructure to support a technocratic model towards pregnancy, delivery, and motherhood. This ideology relied on essentialized notions of gender, foregrounding physicians’ scientific authority (14).

Laranjeiras, which was the teaching hospital for the obstetrics and gynecology program at Rio de Janeiro’s medical school, was ground zero for the intersection of these forces. Maternidade Laranjeiras provided gynecological and obstetric care free of charge; thus, its clientele came from the city’s poor and working classes (15). The majority of patients were women of color defined as either Black or mixed race, and the majority of White patients were immigrants.

## 2.2 Data: Description and Sources

In this paper, I analyze a unique sample of 2845 recorded clinical visits to Maternidade Laranjeiras between June 1922 and May 1926. I extracted the sample from Brazil’s major obstetrics and gynecology journal in the first half of the twentieth century, the *Revista de Gynecologia e d’Obstetricia* (RGO). The RGO was associated with the country’s medical association, the National Academy of Medicine (Academia Nacional de Medicina, ANM) and the Brazilian Society of Obstetrics and Gynecology (Sociedade de Obstetricia e Gynecologia do Brasil), both based in Rio de Janeiro. The journal started in August 1907 as the *Revista de Gynecologia e D’Obstetricia do Rio de Janeiro*. In 1919, it changed to the *Revista de Gynecologia, D’Obstetricia e de Pediatria*. In 1922, it became the *Revista de Gynecologia e D’Obstetricia*.

The journal published obstetricians’ and gynecologists’ clinical observations, analyses of new surgical techniques, and ANM proceedings. Between June 1922 and May 1926, RGO also published the monthly clinical reports of all women treated at the Maternidade Laranjeiras. I was unable to locate vol. 18, nos. 4, 5, 6, 8 (1924) and vol. 20, no. 4 (1926). From the available issues, I recorded the following information, when available, for all patients: patient number, gravidity and parity, skin color, age, nationality, type of delivery (natural, interventionist, operative), maternal outcome (death, discharge, transferal to separate hospital), birth outcome (spontaneous abortion, stillbirth, live birth, or neonatal death), and the mother’s reproductive history. Gravidity refers to the total number of pregnancies a woman has, regardless of duration. Parity refers to a woman’s number of past pregnancies that reached viability and have been delivered, regardless of the number of children (41).

Clinical notes only sporadically included infant demographic information for spontaneous abortions or stillbirths. For spontaneous abortions, stillbirths, and live births, I recorded, when available, infant sex, weight, length. I followed the original clinical categorizations for type of delivery in the following cases: natural, indicating minimal medical intervention; interventionist, indicating medium medical intervention through the use of forceps; and operatory, indicating a cesarean section or embryotomy. However, I recategorized external manipulations including version and Mauriceau (used during breech deliveries) ((42)), coded as operatory or natural by physicians, as interventionist.

In the initial months of publication, the reports included more complete information, including labor time or detailed descriptions of surgical procedures. Over time, clinical notes became streamlined. When physicians intervened in birth, the notes included the type of intervention, the indication, and the obstetrician. For more information on this as a source, see my other publications (43).

The journal is held at the Biblioteca Nacional (BN), the Maternidade Escola, Rio de Janeiro (ME-UFRJ), and the Biblioteca de Biomedicina-A, Universidade Estadual do Rio de Janeiro (BBA-UERJ), all in Rio de Janeiro, Brazil. Between January 2012 and July 2013, I manually digitized the journal by photographing each volume. Then, between January and August 2017, I manually input the data into Excel from the digital reproductions. I then converted this into a .csv file for upload into R.

## 2.3 Questions and Hypotheses

I ask: Did the legacy of slavery affect the health of infants born in the first public maternity hospital in Brazil? I quantify how maternal race, nationality, age, and gravidity or parity explain racial disparities in infant birth weight in Rio de Janeiro, Brazil’s first public maternity hospital, the Maternidade Laranjeiras, in the 1920s. I hypothesize that infants born to women of color, defined as mixed-race (*parda*) or Black (*preta*), will have lower birth weights than infants born to White women, whether Brazilian or immigrant, given the historical legacies of slavery on population health in Brazil.

The outcome I will measure is infant birth weight. The World Health Organization (WHO) currently classifies birth weight into the following categories: extremely low (<999g); very low (1000-1499g); low (1500-2499g); normal (2500-3999g); and high (≥4000g) (44). I am employing birthweight as a continuous variable, so these categories are not relevant for the linear models but can help understand the skew of the data.

# 3. Methods

I use a linear model to estimate the relationship of maternal variables on infant birth weight.

## 3.1 Study Measures

The outcome of interest, birth weight measured in grams, was measured as a continuous variable. Due to the lack of comprehensive information on gestational age in these data, I do not consider birth weight in reference to gestational age, as is often done in current studies (45). Infant length was recorded in centimeters. Maternal age was recorded in years.

The original data categorized maternal racial categories as White (*branca*), the reference group here; mixed-race (*parda*); and Black (*preta*). I maintained this categorization. However, I also created a new dummy variable for skin color, combining Black and Mixed-Race patients into one category, Afro-Descent and all White patients into a Euro-Descent category. Racial terminology in Brazil was, and continues to be, complex and dynamic (1). Racial categories and skin color exist on a spectrum rather than a Black-White binary as in the United States (47). Analyzing both specific categories of skin color and more general categories of ancestry is also in line with recent studies, which look at all African-descended peoples as a group and then stratify by racial mixing (3).

Gestational status was divided into parity and gravidity, with categories for first, multiple, and none for each. Please see the exploratory data analysis code in this paper’s Github repository for further information on this category’s reclassifications.

For maternal nationality, I created categories based on individual country and categories based on region. The latter broad categories, which I will use in the linear model, include: Brazilian; Latin American (Argentine, Paraguayan, Uruguayan); European (Austrian, French, German, Italian, Polish, Portuguese, Romanian, Russian, Spanish, and Swiss); and Middle Eastern (Syrian).

Clinical outcomes were classified as spontaneous abortion, natural (normal delivery), interventionist (interventionist delivery), and operative (surgical delivery). Spontaneous abortion data points are included in the exploratory analysis but excluded from the statistical analysis. I also excluded any live births weighing <500 grams to exclude any possible stillbirths not recorded as such (48).

## 3.2 Schematic of workflow

If reproducing this analysis, please run code in the following order: 1) processingfile-v1.qmd and processingcode.R in the processing-code folder; 2) eda-v1.qmd or edacode.R in the eda-cde folder; 3) introanalyis-v1.qmd or introanalysis.R in the analysis-code folder; 4) fullanalysis-v1.qmd or fullanalysiscode.R in the analysis-code folder.

## 3.3 Data import and cleaning

The GitHub repository for this project includes all relevant materials. All discussions of data import are detailed in the files processingfile-v1.qmd and processingcode.R in the processing-code folder. The original raw data, the codebook, and the processed data are available in the data folder.

## 3.4 Exploratory/Descriptive analysis

I performed the exploratory analysis on the ML\_summary dataset with n = 2845 observations and 14 variables. Please see the Codebook for more details on variables.

There are three continuous variables: maternal age, infant birth weight, and infant length. There are nine categorical variables: skin color; ancestry; parity or gravidity; nationality; combined nationality; birth outcome; maternal outcome; fetal outcome; and fetal sex.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table 1: Table 1   | **Characteristic** | **N** | **N = 2,845**1 | | --- | --- | --- | | Color | 2,695 |  | | Black |  | 763 (28%) | | Mixed Race |  | 788 (29%) | | White |  | 1,144 (42%) | | Ancestry | 2,695 |  | | Afro-Descent |  | 1,551 (58%) | | Euro-Descent |  | 1,144 (42%) | | Parity or Gravidity | 2,836 |  | | Multigravida |  | 666 (23%) | | Multipara |  | 1,015 (36%) | | Primigravida |  | 1,084 (38%) | | Nulipara |  | 4 (0.1%) | | Primipara |  | 67 (2.4%) | | Maternal Age | 2,783 | 24.0 (21.0, 29.0) | | Nationality | 2,773 |  | | German |  | 19 (0.7%) | | Argentine |  | 8 (0.3%) | | Austrian |  | 1 (<0.1%) | | Brazilian |  | 2,342 (84%) | | Spanish |  | 22 (0.8%) | | French |  | 4 (0.1%) | | Italian |  | 15 (0.5%) | | Paraguayan |  | 1 (<0.1%) | | Polish |  | 3 (0.1%) | | Portuguese |  | 330 (12%) | | Romanian |  | 4 (0.1%) | | Russian |  | 16 (0.6%) | | Swiss |  | 2 (<0.1%) | | Syrian |  | 3 (0.1%) | | Uruguayan |  | 3 (0.1%) | | Combined Nationality | 2,773 |  | | European |  | 416 (15%) | | Latin American |  | 12 (0.4%) | | Middle Eastern |  | 3 (0.1%) | | Brazilian |  | 2,342 (84%) | | Birth Outcome | 2,761 |  | | Abortion |  | 89 (3.2%) | | Interventionist |  | 183 (6.6%) | | Natural |  | 2,429 (88%) | | Operative |  | 60 (2.2%) | | Maternal Outcome | 2,829 |  | | Discharged |  | 2,802 (99%) | | Death |  | 23 (0.8%) | | Hospital transferal |  | 4 (0.1%) | | Fetal Outcome | 2,666 |  | | Live Birth |  | 2,440 (92%) | | Stillbirth or Neonatal Death |  | 226 (8.5%) | | Sex | 2,534 |  | | F |  | 1,153 (46%) | | M |  | 1,381 (54%) | | Infant Birthweight (grams) | 2,384 | 3,150 (2,800, 3,450) | | Infant Birth Length (centimeters) | 2,405 | 49.0 (47.0, 50.0) | | 1 n (%); Median (IQR) | | | |

For maternal race (sample size n = 2695), the majority of the sample is White (*branca*), with 42.45% of the sample. Mixed-race (*parda*) comprises 29.2%, and Black (*preta*) comprises 28.32%. If comparing White patients to all patients of color by combining Black and mixed-race categories, of the clinic patients, 1551 (57.6%) were of African descent (defined as *preta* or *parda*) and 1144 (42.4%) were of European descent (*branca*).

Of all reproductive outcomes (sample size n = 2761), 88% were natural deliveries. Yet, this also includes abortions. If abortion is excluded (sample size n = 2672), 91% of outcomes were natural deliveries. The remaining 9% were interventionist or operative deliveries.

For patients who went to the clinic to deliver their infant (thus excluding those suffering from spontaneous abortions or receiving postpartum care after an at-home delivery), 23 died. The Maternal Mortality Ratio (MMR), calculated as:

where maternal deaths (MD) are divided by 10,000 live births (LB), was 94.26%. For those same years, the MMR for the city of Rio de Janeiro was 65.65% (15).But differential levels of recording must be taken into account. These rates could reflect a registration effect, as all births and deaths were recorded in the hospital, whereas accurate reporting at the city level was less reliable (29). Rio de Janeiro’s vital statistics were still poorly defined and intermittently collected in the 1920s. Thus, the city’s rates were probably higher. Nonetheless, the difference demonstrates that delivering in the presence of licensed clinicians did not necessarily improve outcomes for the mother.

The mean stillbirth rate (SBR) (excluding spontaneous abortion but including intrapartum death defined here as stillbirth) for the hospital, calculated as:

where the total number of stillbirths (SB) is divided by 1000 total births (TB). The SBR is 84.8% in this specific clinic. We can compare this to the mean SBR for the city of Rio de Janeiro for the same period, which was 73.68% ((15), (18)). Again, registration effects could explain the higher rates in the hospital ((29)).

The sex ratio at birth (SRaB) is calculated as:

where the total number of live male births (M) is divided by by 100 live female births (F) in a given period.

The sex ratio is 1.2: there were 120 male live births per 100 female live births at this specific clinic. This is much higher than the current range of between 103 and 107 male births per 100 female births (49). Historically, a skewed sex ratio suggests that preferential infanticide or abortion was occurring - parents were more likely to terminate a pregnancy or kill an infant if it was a female. Contrary to popular belief, this practice occurred in both Asian and European countries, although no evidence of it exists for the Americas (50). However, this explanation does not hold for a maternity clinic in which women were seeking care to deliver their infants. The skewed sex ratio deserves further study.

To better understand our outcome of interest, birth weight, my exploratory analysis includes various visual explorations. First, there is a histogram of the birth weight data, with the two dotted red lines marking the upper and lower limits of what the WHO defines as normal birth weight (44).

|  |
| --- |
| Figure 1: Histogram of birth weight |

Birth length is less important for our analysis, but we might want to look at the relationship between weight and length. Below we can see a histogram of the distribution of birth lengths in the sample. The red line marks the average birth length for both male and female infants (49 centimeters).

|  |
| --- |
| Figure 2: Histogram of birth length |

Finally, I have visualized the relationship between infant weight and length. Unsurprisingly, birth weight and length are positively correlated.

|  |
| --- |
| Figure 3: Scatterplot of birth weight by length |

Finally, since male infants are usually slightly heavier than females, let’s look at a scatterplot of birth weight by length, stratified by sex.

|  |
| --- |
| Figure 4: Scatterplot of birth weight by length stratified by sex |

## 3.5 Basic statistical analysis

For the basic statistical analysis, I ran three linear models to understand the relationship between maternal factors and infant birth weight. The first model is a simple linear regression with outcome variable (birth weight in grams) and exposure variable maternal ancestry (Euro-descent or Afro-descent1).

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table 2: Table 2   | **Characteristic** | **Beta** | **SE**1 | **Statistic** | **95% CI**1 | **p-value** | | --- | --- | --- | --- | --- | --- | | (Intercept) | 3,171 | 17.7 | 179 | 3,137, 3,206 | <0.001 | | ModifiedColor | -88 | 23.1 | -3.79 | -133, -42 | <0.001 | | R² | 0.007 |  |  |  |  | | Adjusted R² | 0.007 |  |  |  |  | | No. Obs. | 1,944 |  |  |  |  | | 1 SE = Standard Error, CI = Confidence Interval | | | | | | |

The second simple bivariate linear analysis, looks at infant birth weight as a function of maternal age.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table 3: Table 3   | **Characteristic** | **Beta** | **SE**1 | **Statistic** | **95% CI**1 | **p-value** | | --- | --- | --- | --- | --- | --- | | (Intercept) | 2,944 | 52.0 | 56.6 | 2,842, 3,046 | <0.001 | | Age | 7.0 | 2.01 | 3.46 | 3.0, 11 | <0.001 | | R² | 0.006 |  |  |  |  | | Adjusted R² | 0.006 |  |  |  |  | | No. Obs. | 1,944 |  |  |  |  | | 1 SE = Standard Error, CI = Confidence Interval | | | | | | |

The third and final exploratory statistical model is a multilinear regression, looking at the relationship between maternal age, nationality, and gestational status on infant birth weight.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table 4: Table 4   | **Characteristic** | **Beta** | **SE**1 | **Statistic** | **95% CI**1 | **p-value** | | --- | --- | --- | --- | --- | --- | | (Intercept) | 3,174 | 71.4 | 44.4 | 3,034, 3,314 | <0.001 | | ModifiedColor |  |  |  |  |  | | Euro-Descent | — | — | — | — |  | | Afro-Descent | -82 | 27.1 | -3.01 | -135, -28 | 0.003 | | Age | 0.28 | 2.31 | 0.122 | -4.2, 4.8 | >0.9 | | ModifiedStatus |  |  |  |  |  | | Multigravida | — | — | — | — |  | | Multipara | 80 | 30.7 | 2.60 | 20, 140 | 0.009 | | Primigravida | -80 | 30.1 | -2.65 | -139, -21 | 0.008 | | Nulipara | 53 | 289 | 0.183 | -513, 619 | 0.9 | | Primipara | -20 | 76.5 | -0.264 | -170, 130 | 0.8 | | ModifiedNationality |  |  |  |  |  | | European | — | — | — | — |  | | Latin American | 86 | 169 | 0.513 | -244, 417 | 0.6 | | Middle Eastern | 498 | 499 | 0.997 | -482, 1,478 | 0.3 | | Brazilian | -13 | 36.6 | -0.355 | -85, 59 | 0.7 | | R² | 0.027 |  |  |  |  | | Adjusted R² | 0.022 |  |  |  |  | | No. Obs. | 1,944 |  |  |  |  | | 1 SE = Standard Error, CI = Confidence Interval | | | | | | |

In the first and third models, there appears to be an association between maternal skin color and infant birth weight, with Euro-descended women (the reference group) having infants with higher birth weights than Afro-descended women. In the second model, older mothers are associated with giving birth to infants with higher birth weights.

For all three models, the r-squared is very small (0.0073, 0.0061, and 0.027), indicating that the model does not explain much of the variance in birth weight. This is likely due to the fact that birth weight is a complex trait influenced by many factors, including genetic, environmental, and social factors.

Moreover, this study is not trying to explain which general factors are influencing birth weight. Rather, it is exploring if maternal skin color is associated with lower infant birth weight during this specific time period in Rio de Janeiro, Brazil. For example, the gestational age probably explains much of the variation in the model, yet the gestational age variable was only included in very few observations in the published clinic data from which I created this dataset (please see the Codebook and the processingfile-v1.qmd for information on this variable).

Given my hypothesis, that the legacies of slavery affected maternal-fetal health, then maternal skin color, however, is also probably associated with premature birth, which is correlated to infant birth weight.

## 3.6 Full analysis

# 4. Discussion

## 4.1 Summary and Interpretation

## 4.2 Strengths and Limitations

## 4.3 Conclusions

# 5. References

1. Travassos C, Williams DR. [The concept and measurement of race and their relationship to public health: A review focused on Brazil and the United States](https://doi.org/10.1590/S0102-311X2004000300003). Cadernos de Saúde Pública. 2004 Jun;20:660–78.

2. Nyarko KA, Lopez-Camelo J, Castilla EE, Wehby GL. Explaining Racial Disparities in Infant Health in Brazil. American Journal of Public Health. 2013;103(9):1675–84.

3. Wehby GL, Gili JA, Pawluk M, Castilla EE, López-Camelo JS. [Disparities in birth weight and gestational age by ethnic ancestry in South American countries](https://doi.org/10.1007/s00038-014-0639-6). International Journal of Public Health. 2015 Mar;60(3):343–51.

4. Vilanova CS, Hirakata VN, de Souza Buriol VC, Nunes M, Goldani MZ, da Silva CH. [The relationship between the different low birth weight strata of newborns with infant mortality and the influence of the main health determinants in the extreme south of Brazil](https://doi.org/10.1186/s12963-019-0195-7). Population Health Metrics. 2019 Nov;17:15.

5. Cardoso AM, Santos RV, Coimbra Jr. CEA. [Mortalidade infantil segundo raça/cor no Brasil: o que dizem os sistemas nacionais de informação?](https://doi.org/10.1590/S0102-311X2005000500035) Cadernos de Saúde Pública. 2005;21:1602–8.

6. Mangold WD, Powell-Griner E. [Race of parents and infant birthweight in the United States](https://doi.org/10.1080/19485565.1991.9988770). Social Biology. 1991;38(1-2):13–27.

7. Pollock EA, Gennuso KP, Givens ML, Kindig D. [Trends in infants born at low birthweight and disparities by maternal race and education from 2003 to 2018 in the United States](https://doi.org/10.1186/s12889-021-11185-x). BMC public health. 2021 Jun;21(1):1117.

8. Ifatunji MA, Faustin Y, Lee W, Wallace D. [Black Nativity and Health Disparities: A Research Paradigm for Understanding the Social Determinants of Health](https://doi.org/10.3390/ijerph19159166). International Journal of Environmental Research and Public Health. 2022 Jul;19(15):9166.

9. Braveman P, Dominguez TP, Burke W, Dolan SM, Stevenson DK, Jackson FM, et al. [Explaining the Black-White Disparity in Preterm Birth: A Consensus Statement From a Multi-Disciplinary Scientific Work Group Convened by the March of Dimes](https://doi.org/10.3389/frph.2021.684207). Frontiers in Reproductive Health. 2021;3:684207.

10. Clay SL, Ibe-Lamberts K, Kelly KD, Nii-Aponsah H, Woodson MJ, Tines F, et al. [US-Born Black Women and Black Immigrant Women: An Exploration of Disparities in Health Care and Sociodemographic Factors Related to Low Birth Weight](https://doi.org/10.1007/s40615-022-01477-2). Journal of Racial and Ethnic Health Disparities. 2023 Dec;10(6):3031–8.

11. McKenzie-Sampson S, Baer RJ, Blebu BE, Karasek D, Oltman SP, Pantell MS, et al. [Maternal nativity and risk of adverse perinatal outcomes among Black women residing in California, 2011-2017](https://doi.org/10.1038/s41372-021-01149-9). Journal of Perinatology: Official Journal of the California Perinatal Association. 2021 Dec;41(12):2736–41.

12. Montoya-Williams D, Barreto A, Fuentes-Afflick E, Collins JW. [Nativity and perinatal outcome disparities in the United States: Beyond the immigrant paradox](https://doi.org/10.1016/j.semperi.2022.151658). Seminars in Perinatology. 2022 Dec;46(8):151658.

13. Adamo SC. The Broken Promise: Race, Health, and Justice in Rio de Janeiro, 1890-1940 [PhD thesis]. [New Mexico]: The University of New Mexico; 1983.

14. Otovo OT. Progressive Mothers, Better Babies: Race, Public Health, and the State in Brazil, 1850-1945. Austin: University of Texas Press; 2016.

15. Roth C. A Miscarriage of Justice: Women’s Reproductive Lives and the Law in Early Twentieth-Century Brazil. Stanford, CA: Stanford University Press; 2020.

16. Telles LF da S. Teresa Benguela e Felipa Crioula estavam grávidas: maternidade e escravidão no Rio de Janeiro (1830-1888). São Paulo: Editora Unifesp; 2022.

17. Roth C. Black Nurse, White Milk: Breastfeeding, Slavery, and Abolition in 19th-Century Brazil. Journal of Human Lactation. 2018;34(4):804–9.

18. Roth C. Birthing Life and Death: Women’s Reproductive Health in Early Twentieth-Century Rio de Janeiro. História, Ciências, Saúde-Manguinhos. 2018;25(4):921–41.

19. Michelle J. The African Diaspora: Countries Outside Of Africa With Large Black Populations. Yahoo News. https://news.yahoo.com/african-diaspora-countries-largest-black-014535599.html; 2023.

20. Belandi C, Gomes I. 2022 Census: Self-reported brown population is the majority in Brazil for the first time. Instituto Brasileiro de Geografia e Estatística. https://agenciadenoticias.ibge.gov.br/en/agencia-news/2184-news-agency/news/38726-2022-census-self-reported-brown-population-is-the-majority-in-brazil-for-the-first-time; 2023.

21. Klein HS, Luna FV. Slavery in Brazil. Cambridge: Cambridge University Press; 2009.

22. Bergad LW. Slavery and the Demographic and Economic History of Minas Gerais, Brazil, 1720-1888. New York: Cambridge University Press; 1999.

23. Schwartz SB. Sugar Plantations in the Formation of Brazilian Society. New York: Cambridge University Press; 1985.

24. Carvalho JM de. Os bestializados: o Rio de Janeiro e a República que não foi. 3rd ed. São Paulo: Companhia das Letras; 2004.

25. Ball MC. Navigating Life and Work in Old Republic São Paulo. Gainesville: University of Florida Press; 2020.

26. Fischer B. A Poverty of Rights: Citizenship and Inequality in Twentieth-Century Rio de Janeiro. Stanford, CA: Stanford University Press; 2008.

27. Franken D. [Anthropometric History of Brazil, 1850-1950: Insights from Military and Passport Records](https://doi.org/10.1017/S0212610919000077). Revista de Historia Economica - Journal of Iberian and Latin American Economic History. 2019;37(2):377–408.

28. Anderson RL. Public Health and Public Healthiness, São Paulo, Brazil, 1876-1893. The Journal of the History of Medicine and Allied Sciences. 1986 Jul;41:293–307.

29. Loudon I. Death in Childbirth: An International Study of Maternal Care and Maternal Mortality, 1800-1950. Oxford: Clarendon Press; 1992.

30. Woods R. Death Before Birth: Fetal Health and Mortality in Historical Perspective. New York: Oxford University Press; 2009.

31. Barreto MRN. Dar à luz no Rio de Janeiro da *belle époque*: o nascimento das maternidades (1870-1920). In: Sanglard G, Ferreira LO, Freire MM de L, Barreto MRN, Pimenta TS, editors. Filantropos da nação: sociedade, saúde e assistência no Brasil e em Portugal. Rio de Janeiro: Editora Fundação Getúlio Vargas; 2015. p. 185–202.

32. Barreto MRN, Oliveira SSR de. Cidade, assistência e saúde: as maternidades entre o privado e o público no subúrbio do Rio de Janeiro (1889-1930). Delaware Review of Latin American Studies. 2016;17(2).

33. Brenes AC. História da parturição no Brasil, século XIX. Cadernos de Saúde Pública. 1991;7(2):135–49.

34. Martins APV. Visões do feminino: A medicina da mulher nos séculos XIX e XX. Rio de Janeiro: Editora Fiocruz; 2004.

35. Mott ML. Assistência ao parto: do domicílio ao hospital (1830-1960). Projeto História, São Paulo. 2002 Dec;25:197–219.

36. Rohden F. Uma ciência da diferença: sexo e gênero na medicina da mulher. 2nd ed. Rio de Janeiro: Editora Fiocruz; 2009.

37. Roth C, Teixeira LA. [From Embryotomy to Cesarean: Changes in Obstetric Operatory Techniques in Nineteenth- and Twentieth-Century Urban Brazil](https://www.ncbi.nlm.nih.gov/pubmed/33967103). Bulletin of the History of Medicine. 2021;95(1):24–52.

38. Besse SK. Restructuring Patriarchy: The Modernization of Gender Inequality in Brazil, 1914-1940. Chapel Hill: University of North Carolina Press; 1996.

39. Freire MM de L. Mulheres, mães e médicos: discurso maternalista no Brasil. Rio de Janeiro: Editora Fundação Getúlio Vargas; 2009.

40. Martins APV. ’Vamos criar seu filho’: os médicos puericultores e a pedagogia materna no século XX. História, Ciências, Saúde - Manguinhos. 2008;15(1):135–54.

41. Posner GD, Dy J, Black AY, Jones GD, editors. Oxorn-Foote Human Labor & Birth. 6th ed. New York: McGraw Hill Education; 2013.

42. Eyraud JL, Riethmuller D, Clainquart N, Schaal JP, Maillet R, Colette C. [Is the Mauriceau maneuver deleterious? Study of 103 cases](https://www.ncbi.nlm.nih.gov/pubmed/9265067). Journal De Gynecologie, Obstetrique Et Biologie De La Reproduction. 1997;26(4):413–7.

43. Roth C. ’Violência obstétrica’ na Maternidade de Laranjeiras: fontes para pesquisas futuras. In: Teixeira LA, Rodrgues AP, Nucci MF, Silva FL, editors. Medicalização do parto: saberes e práticas. São Paulo: Hucitec Editora; 2020. p. 211–36.

44. Organization WH. International Classification of Diseases, Eleventh Revision (ICD-11). Geneva: World Health Organization; 2022.

45. Cutland CL, Lackritz EM, Mallett-Moore T, Bardají A, Chandrasekaran R, Lahariya C, et al. [Low birth weight: Case definition & guidelines for data collection, analysis, and presentation of maternal immunization safety data](https://doi.org/10.1016/j.vaccine.2017.01.049). Vaccine. 2017 Dec;35(48Part A):6492–500.

46. Alberto PL. Terms of Inclusion: Black Intellectuals in Twentieth-Century Brazil. Chapel Hill: University of North Carolina Press; 2011.

47. Telles EE. Race in Another America: The Significance of Skin Color in Brazil. Princeton, NJ: Princeton University Press; 2006.

48. Wehby GL, López-Camelo JS. [Maternal Education Gradients in Infant Health in Four South American Countries](https://doi.org/10.1007/s10995-017-2327-7). Maternal and Child Health Journal. 2017 Nov;21(11):2122–31.

49. Ritchie H, Roser M. Gender Ratio. Our World in Data. 2024 Mar;

50. Hanlon G. [Routine Infanticide in the West 1500–1800](https://doi.org/10.1111/hic3.12361). History Compass. 2016;14(11):535–48.