Supplemental Materials

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# 1. Supplemental Materials

## 1.1 Background

In this paper, I analyze a unique dataset of 2845 recorded clinical visits to Maternidade Laranjeiras between June 1922 and May 1926. These hospital records were a result of a public-private expansion in what was then called maternal-infant healthcare services in Brazil’s urban centers, specifically the capital city of Rio de Janeiro. 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 provide prenatal care and hospitalize labor and delivery (Barreto, 2015; Barreto & Oliveira, 2016; Mott, 2002; Roth, 2020a). Dedicated maternity hospitals such as Laranjeiras were central to this hospitalization process. There, obstetricians and gynecologists, all male and mostly White, began implementing surgical advances (Martins, 2004; Rohden, 2009; Roth & Teixeira, 2021).Although the notes show no direct evidence of racist medical practice, the hospital space was one of gender and racial hierarchy – not separate from Brazilian society but its microcosm. Underlying these structural and technological changes was the scientific motherhood movement, supported by both physicians and elite women, which relied on advances in medical knowledge and clinical infrastructure to support a technocratic model towards pregnancy and motherhood. This movement essentialized notions of gender, foregrounding physicians’ scientific authority (Besse, 1996; Freire, 2009; Martins, 2008). As the higher Maternal Mortality Ratio (MMR) and stillbirth rate (SBR) in the clinic compared to the city of Rio de Janeiro demonstrate, delivering in the presence of licensed clinicians did not necessarily improve outcomes for the mother and infant and supports other historical studies that interventionist obstetric procedures before antibiotics and blood transfusions could be detrimental to maternal-infant health (Goldin & Margo, 1989).

During the same period, centuries-old racial hierarchies forged under racial slavery morphed into new allegedly scientific ways to categorize humans based on skin color in post-abolition contexts. In Brazil, with a large Black and mixed-race population, early twentieth-century racist thinkers first embraced a theory of whitening in which they believed that racial mixture would eventually lead to a White population (Schwarcz, 1993; Skidmore, 1993). Both government- and private-run initiatives to attract European immigrants had begun as early as the 1870s, in an effort to replace the slave labor force not with freed Blacks but with White immigrants (Ball, 2020; Skidmore, 1993). In the 1920s and 1930s, scientists and policymakers turned toward preventive eugenic theories that focused on improving environmental factors rather than coercively restricting reproduction through sterilization (Stepan, 1991). Although some eugenicists called for sterilization of unfit citizens, they never couched these discussions in explicitly racial terms (Roth, 2020b; Wegner & de Souza, 2013). In the end, whiteness remained a cultural and social goal even if the state did not engage in coercive measures of reproductive control.

Census data reflects these racial currents. Brazil did not conduct censuses in 1900 or 1910, and the 1920 census excluded skin color. In 1890, Rio de Janeiro’s female population comprised 56% White, 29% mixed race, and 15% Black. In 1940, the next census to include skin color, the city’s female population in 1940 comprised 69% White women, 18% mixed-race women, and 12.5% Black women. Brazil did not record censuses in 1900 or 1910 and excluded skin color in 1920. The shift from mixed-race to white women was probably an reporting artifice rather than true change (Roth, 2020a).

## 1.2 Study Measures

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

To justify the nationality groupings, I calculated mean birth weight for different immigrant groups by nationality. Ball (2020) found that Portuguese immigrants had worse economic opportunities in São Paulo during the same time period. Although the Portuguese immigrant experience in Rio de Janeiro was likely better due to community, merchant connection, Portuguese business owners, and job availability, I needed to better justify my nationality categorization. In the eda-v1.qmd file, I calculated the mean birth weight for individual nationalities and performed a t-test between Portuguese infants and infants born to all other European nationalities and Portuguese infants and infants born to White Brazilian mothers.

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| Table 1: Mean Birthweights by Nationality   | **Nationality** | **N** | **Mean (Q1, Q3)**1 | | --- | --- | --- | | Portuguese | 272 | 3,127 (2,819, 3,500) | | German | 16 | 3,172 (3,088, 3,350) | | Italian | 12 | 3,229 (3,075, 3,663) | | Austrian | 1 | 2,250 (2,250, 2,250) | | French | 3 | 3,137 (3,055, 3,280) | | Spanish | 20 | 3,172 (2,875, 3,350) | | Polish | 2 | 3,475 (3,238, 3,713) | | Swiss | 2 | 3,050 (2,950, 3,150) | | Romanian | 4 | 2,975 (2,900, 3,100) | | Russian | 15 | 3,183 (3,000, 3,450) | | European (Exc. Portuguese) | 75 | 3,164 (2,950, 3,475) | | Argentine | 7 | 3,307 (3,000, 3,700) | | Paraguayan | 1 | 3,350 (3,350, 3,350) | | Uruguayan | 2 | 2,500 (2,375, 2,625) | | Syrian | 2 | 2,930 (2,515, 3,345) | | Brazilian White | 545 | 3,131 (2,800, 3,500) | | Brazilian Black | 642 | 3,037 (2,750, 3,250) | | Brazilian Mixed-Race | 675 | 3,064 (2,750, 3,450) | | 1Mean (IQR) | | | |

All results were not significant at the alpha 0.05 level. Thus, I will maintain the nationality categorizations of European, Brazilian, Latin American, and Middle Eastern.

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| Table 2: T-Test Results  Table 1: T-Test Results   | Comparison | t-statistic | p-value | Mean Difference | 95% CI Lower | 95% CI Upper | | --- | --- | --- | --- | --- | --- | | Portuguese vs Other European | -0.47 | 0.637 | 36.8 | -190.6 | 117.0 | | Portuguese vs Brazilian White | -0.08 | 0.938 | 3.5 | -93.7 | 86.6 | |

### 1.2.1 Full Summary Table

This summary table includes all original variables.

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| Table 3: Supplemental Table   | **Characteristic** | **N** | **N = 2,845**1 | | --- | --- | --- | | Skin color | 2,695 |  | | Black |  | 763 (28%) | | Mixed Race |  | 788 (29%) | | White |  | 1,144 (42%) | | Parity or Gravidity | 2,836 |  | | Multigravida |  | 141 (5.0%) | | Trigravida |  | 6 (0.2%) | | Secundigravida |  | 519 (18%) | | Secundiparous |  | 17 (0.6%) | | Multiparous |  | 998 (35%) | | Primigravida |  | 1,084 (38%) | | Nulliparous |  | 4 (0.1%) | | Primiparous |  | 67 (2.4%) | | Maternal Age | 2,783 | 25.3 (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%) | | 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 |  | 2,445 (92%) | | Stillbirth |  | 221 (8.3%) | | Infant Sex | 2,534 |  | | F |  | 1,153 (46%) | | M |  | 1,381 (54%) | | Birth Length (cms) | 2,405 | 48.3 (47.0, 50.0) | | Birth Weight (grms) | 2,384 | 3,087 (2,800, 3,450) | | 1n (%); Mean (IQR) | | | |

## 1.3 Exploratory Analysis

To better understand our outcome of interest, birth weight, the exploratory analysis includes the distribution of the data. Figure 1 is a histogram of the birth weight data, with the two dotted red lines marking the upper and lower limits of what the WHO now defines as normal birth weight (WHO, 2022).

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| Figure 1: Histogram of birth weight |

Because the data are missing gestational age, birth length is less important for our analysis. Nonetheless, Figure 2 shows 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), which is in line with current estimates on birth length globally (Jamshed et al., 2020).

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| Figure 2: Histogram of birth length |

Figure 3 visualizes the relationship between infant weight and length. Unsurprisingly, birth weight and length are positively correlated.

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| Figure 3: Scatterplot of birth weight by length |

Figure 4 visualizes the relationship of birth weight and length, stratified by sex since male infants are usually slightly heavier and longer than females Maršál et al. (1996).

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

Here, I also create a plot of the distribution of birth weights at Laranjeiras, following Wilcox’s discussion of the residual and predominant birth weight distributions (Wilcox, 2001).

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| Figure 5: Birth Weight Distribution for Afro- and Euro-Descended Infants, Maternidade Laranjeiras, 1922-1926 |

I also calculate (SRaB) in the hospital:

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

The sex ratio in Maternidade Laranjeiras was 1.2: there were 120 male live births per 100 female live births. The sex ratio of 120 male live births per 100 female live births is much higher than the current range of between 103 and 107 male births per 100 female births (Ritchie & Roser, 2024). 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 female. Contrary to popular belief, this practice occurred in both Asian and European countries, although no evidence of it exists for the Americas (Hanlon, 2016). However, this explanation does not hold for a maternity clinic in which women were seeking care to deliver their infants. Yet, the skewed sex ratio remains important to note even if we don’t understand the underlying cause.

## 1.4 Models

### 1.4.1 Linear Models

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, the reference, and Afro-descent). There is an association between maternal skin color and infant birth weight, with Euro-descended women having infants with higher birth weights than Afro-descended women. This initial finding serves as the impetus for the rest of the models.

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| Table 4: Model 1   | **Characteristic** | **Beta** | **SE**1 | **Statistic** | **95% CI**1 | **p-value** | | --- | --- | --- | --- | --- | --- | | (Intercept) | 3,188 | 17.7 | 180 | 3,153, 3,222 | **<0.001** | | ModifiedColor | -99 | 23.0 | -4.31 | -145, -54 | **<0.001** | | R² | 0.010 |  |  |  |  | | Adjusted R² | 0.009 |  |  |  |  | | No. Obs. | 1,920 |  |  |  |  | | 1SE = Standard Error, CI = Confidence Interval | | | | | | |

The second simple bivariate linear analysis, looks at infant birth weight as a function of maternal age on both a linear scale and age-squared with ModifiedColor as the main predictor variable. Neither age nor age-squared were significant. Including in the model did not improve the fit, and the coefficient was not significant. Despite a lack of statistical significance, the coefficients suggests that while birth weight increases with maternal age, it does so at a decreasing rate. At a certain maternal age, infant birth weight begins decreasing, presenting a reverse U-shaped curve.

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| Table 5: Model 2   | **Characteristic** | **Beta** | **SE**1 | **Statistic** | **95% CI**1 | **p-value** | | --- | --- | --- | --- | --- | --- | | (Intercept) | 2,707 | 212 | 12.8 | 2,291, 3,123 | **<0.001** | | Age | 25 | 15.9 | 1.56 | -6.3, 56 | 0.12 | | AgeSquared | -0.31 | 0.288 | -1.07 | -0.87, 0.26 | 0.3 | | R² | 0.009 |  |  |  |  | | No. Obs. | 1,920 |  |  |  |  | | 1SE = Standard Error, CI = Confidence Interval | | | | | | |

The third exploratory statistical model is a multilinear regression, looking at the relationship of maternal skin color, age, age squared, nationality, and gestational status on infant birth weight with the ModifiedColor variable as the main predictor variable.

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| Table 6: Age-Squared   | **Characteristic** | **Beta** | **SE**1 | **Statistic** | **95% CI**1 | **p-value** | | --- | --- | --- | --- | --- | --- | | (Intercept) | 2,951 | 216 | 13.6 | 2,527, 3,375 | **<0.001** | | ModifiedColor |  |  |  |  |  | | Euro-Descent | — | — | — | — |  | | Afro-Descent | -86 | 26.9 | -3.17 | -138, -33 | **0.002** | | Age | 9.5 | 16.3 | 0.583 | -22, 41 | 0.6 | | AgeSquared | -0.12 | 0.291 | -0.419 | -0.69, 0.45 | 0.7 | | ModifiedStatus |  |  |  |  |  | | Nulliparous | — | — | — | — |  | | Multiparous | 111 | 25.7 | 4.32 | 61, 161 | **<0.001** | | ModifiedNationality |  |  |  |  |  | | Brazilian | — | — | — | — |  | | European | 27 | 36.6 | 0.732 | -45, 99 | 0.5 | | Latin American | 74 | 166 | 0.447 | -251, 400 | 0.7 | | Middle Eastern | 523 | 494 | 1.06 | -445, 1,492 | 0.3 | | R² | 0.027 |  |  |  |  | | Adjusted R² | 0.024 |  |  |  |  | | No. Obs. | 1,920 |  |  |  |  | | 1SE = Standard Error, CI = Confidence Interval | | | | | | |

Peer review suggested that I control for year-specific effects given possible periodic epidemics in infectious disease such as malaria and yellow fever and changes in real wages. I do this by including year fixed effects. The fourth model looks at the relationship between maternal skin color, age, nationality, gestational status, and year fixed effects on infant birth weight with ModifiedColor as the main predictor variable. Generally, differences across years are common given changes in macroeconomic conditions such as real wages and epidemic disease. The coefficient for the main predictor variable Afro-descent is -84, compared to -86 in the full model without year fixed effects. Thus, controlling for year-specific effects, the model provides similar coefficients for birth weight, which were highest in 1922. This result is consistent with lower birth weights due to significant inflation and increased cost of living in Rio de Janeiro from 1923 to 1925 (Lobo, 2024).

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| Table 7: Model 4   | **Characteristic** | **Beta** | **SE**1 | **Statistic** | **95% CI**1 | **p-value** | | --- | --- | --- | --- | --- | --- | | (Intercept) | 3,119 | 61.9 | 50.4 | 2,997, 3,240 | **<0.001** | | ModifiedColor |  |  |  |  |  | | Euro-Descent | — | — | — | — |  | | Afro-Descent | -84 | 27.0 | -3.13 | -137, -32 | **0.002** | | Age | 2.5 | 2.23 | 1.14 | -1.8, 6.9 | 0.3 | | ModifiedStatus |  |  |  |  |  | | Nulliparous | — | — | — | — |  | | Multiparous | 115 | 25.3 | 4.57 | 66, 165 | **<0.001** | | ModifiedNationality |  |  |  |  |  | | Brazilian | — | — | — | — |  | | European | 27 | 36.6 | 0.751 | -44, 99 | 0.5 | | Latin American | 80 | 166 | 0.485 | -245, 405 | 0.6 | | Middle Eastern | 571 | 494 | 1.16 | -398, 1,540 | 0.2 | | Year |  |  |  |  |  | | 1922 | — | — | — | — |  | | 1923 | -102 | 35.1 | -2.90 | -170, -33 | **0.004** | | 1924 | -110 | 38.1 | -2.89 | -185, -35 | **0.004** | | 1925 | -70 | 33.9 | -2.06 | -136, -3.3 | **0.040** | | 1926 | -122 | 48.9 | -2.49 | -218, -26 | **0.013** | | R² | 0.033 |  |  |  |  | | Adjusted R² | 0.028 |  |  |  |  | | No. Obs. | 1,920 |  |  |  |  | | 1SE = Standard Error, CI = Confidence Interval | | | | | | |

I also tested the model five times, one for each year.

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| Table 8: Model 5   |  | **1922** | | | | **1923** | | | | **1924** | | | | **1925** | | | | **1926** | | | | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **Characteristic** | **Beta** | **SE**1 | **Statistic** | **p-value** | **Beta** | **SE**1 | **Statistic** | **p-value** | **Beta** | **SE**1 | **Statistic** | **p-value** | **Beta** | **SE**1 | **Statistic** | **p-value** | **Beta** | **SE**1 | **Statistic** | **p-value** | | (Intercept) | 3,040 | 124 | 24.6 | **<0.001** | 3,039 | 117 | 25.9 | **<0.001** | 3,159 | 138 | 23.0 | **<0.001** | 3,118 | 98.1 | 31.8 | **<0.001** | 2,586 | 205 | 12.6 | **<0.001** | | Age | 5.5 | 4.82 | 1.14 | 0.3 | 8.0 | 4.55 | 1.77 | 0.078 | -4.8 | 5.33 | -0.894 | 0.4 | -1.7 | 3.96 | -0.425 | 0.7 | 13 | 8.57 | 1.56 | 0.12 | | ModifiedColor |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | Euro-Descent | — | — | — |  | — | — | — |  | — | — | — |  | — | — | — |  | — | — | — |  | | Afro-Descent | -41 | 59.0 | -0.702 | 0.5 | -237 | 58.6 | -4.04 | **<0.001** | -28 | 66.6 | -0.419 | 0.7 | -56 | 45.7 | -1.23 | 0.2 | -24 | 95.4 | -0.251 | 0.8 | | ModifiedNationality |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | Brazilian | — | — | — |  | — | — | — |  | — | — | — |  | — | — | — |  | — | — | — |  | | European | 49 | 80.3 | 0.611 | 0.5 | -185 | 76.1 | -2.43 | **0.015** | 164 | 89.3 | 1.83 | 0.068 | 79 | 63.2 | 1.24 | 0.2 | 20 | 137 | 0.145 | 0.9 | | Latin American | 39 | 448 | 0.087 | >0.9 | 389 | 254 | 1.53 | 0.13 |  |  |  |  | -325 | 279 | -1.16 | 0.2 | -290 | 518 | -0.559 | 0.6 | | Middle Eastern |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 472 | 506 | 0.933 | 0.4 | | ModifiedStatus |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | Nulliparous | — | — | — |  | — | — | — |  | — | — | — |  | — | — | — |  | — | — | — |  | | Multiparous | 72 | 55.4 | 1.30 | 0.2 | 65 | 50.5 | 1.29 | 0.2 | 86 | 63.8 | 1.35 | 0.2 | 141 | 44.3 | 3.18 | **0.002** | 302 | 95.0 | 3.18 | **0.002** | | Adjusted R² | 0.010 |  |  |  | 0.051 |  |  |  | 0.009 |  |  |  | 0.022 |  |  |  | 0.113 |  |  |  | | No. Obs. | 325 |  |  |  | 503 |  |  |  | 343 |  |  |  | 601 |  |  |  | 148 |  |  |  | | R² | 0.025 |  |  |  | 0.061 |  |  |  | 0.020 |  |  |  | 0.030 |  |  |  | 0.149 |  |  |  | | 1SE = Standard Error | | | | | | | | | | | | | | | | | | | | | |

In every year, the coefficient for Afro-descended infants is consistently negative. However, the coefficient is statistically significant at conventional levels only for the 1923 sub-sample, in which the coefficient for infant birth weights to Afro-descended mothers was nearly 3 times the sample coefficient (-237 compared to -84). Thus, I then dropped the observations from 1923 and re-ran the model to see if the results remained robust.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table 9: Model 6: 1922, 1924, 1925, 1926   | **Characteristic** | **Beta** | **SE**1 | **Statistic** | **95% CI**1 | **p-value** | | --- | --- | --- | --- | --- | --- | | (Intercept) | 3,126 | 68.7 | 45.5 | 2,991, 3,260 | **<0.001** | | ModifiedColor |  |  |  |  |  | | Euro-Descent | — | — | — | — |  | | Afro-Descent | -43 | 30.3 | -1.41 | -102, 17 | 0.2 | | Age | 0.62 | 2.54 | 0.245 | -4.4, 5.6 | 0.8 | | ModifiedStatus |  |  |  |  |  | | Nulliparous | — | — | — | — |  | | Multiparous | 130 | 29.1 | 4.48 | 73, 187 | **<0.001** | | ModifiedNationality |  |  |  |  |  | | Brazilian | — | — | — | — |  | | European | 90 | 41.6 | 2.17 | 8.7, 172 | **0.030** | | Latin American | -232 | 220 | -1.06 | -664, 199 | 0.3 | | Middle Eastern | 605 | 490 | 1.24 | -356, 1,567 | 0.2 | | Year |  |  |  |  |  | | 1922 | — | — | — | — |  | | 1924 | -111 | 37.8 | -2.93 | -185, -36 | **0.003** | | 1925 | -69 | 33.6 | -2.05 | -135, -3.1 | **0.040** | | 1926 | -120 | 48.5 | -2.47 | -215, -25 | **0.013** | | R² | 0.035 |  |  |  |  | | Adjusted R² | 0.029 |  |  |  |  | | No. Obs. | 1,417 |  |  |  |  | | 1SE = Standard Error, CI = Confidence Interval | | | | | | |

In this sub-sample model (Model 6), the coefficient for infants born to Afro-descended mothers was both not significant and lower than in the full model (-40). However, dropping the observations from 1923 has reduced my sample size by about 25%. It appears that births from 1923 are driving the overall results. In 1922, Brazil experienced an economic crisis with a drop in coffee prices, high inflation, and a resulting fiscal emergency, which most likely affected the port city and capital of Rio de Janeiro (Fritsch, 1993). It appears that economic uncertainty affected women of African descent more than those of European descent in this year.

Additionally, these results could be due to smaller sample sizes and larger standard errors – noise in the data. This reflects the limitations of historical data and historical research given small sample sizes.

The last exploratory model again runs a multivariate linear regression, this time using skin color as it was differentiated in the original data, or with three categories (White, Black, and Mixed Race).

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table 10: Model 7   | **Characteristic** | **Beta** | **SE**1 | **Statistic** | **95% CI**1 | **p-value** | | --- | --- | --- | --- | --- | --- | | (Intercept) | 3,039 | 56.4 | 53.9 | 2,929, 3,150 | **<0.001** | | Color |  |  |  |  |  | | White | — | — | — | — |  | | Black | -100 | 30.9 | -3.23 | -160, -39 | **0.001** | | Mixed Race | -72 | 30.5 | -2.35 | -131, -12 | **0.019** | | Age | 2.7 | 2.23 | 1.20 | -1.7, 7.1 | 0.2 | | ModifiedStatus |  |  |  |  |  | | Nulliparous | — | — | — | — |  | | Multiparous | 114 | 25.3 | 4.50 | 64, 164 | **<0.001** | | ModifiedNationality |  |  |  |  |  | | Brazilian | — | — | — | — |  | | European | 27 | 36.6 | 0.728 | -45, 98 | 0.5 | | Latin American | 75 | 166 | 0.452 | -250, 400 | 0.7 | | Middle Eastern | 526 | 494 | 1.07 | -442, 1,494 | 0.3 | | R² | 0.028 |  |  |  |  | | Adjusted R² | 0.024 |  |  |  |  | | No. Obs. | 1,920 |  |  |  |  | | 1SE = Standard Error, CI = Confidence Interval | | | | | | |

For all models in this study, the is small, 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 genetic (not related to skin color), environmental, and social factors (Leimert & Olson, 2020). Yet, as Claudia Goldin and Robert A. Margo have shown for nineteenth-century Philadelphia, the inclusion of gestational age greatly improved the regression fit in their studies, demonstrating that gestational age could explain much of the variance of birth weight (Goldin & Margo, 1989). Nonetheless, other scholars have shown that even though differential rates of PTB explain some of the variance in birth weight according to maternal skin color in the United States, up to 91 percent of the Black-White gap in full-term birth weight remained unexplained (Costa, 2004).

Here, I am exploring if maternal skin color is associated with lower infant birth weight during a historical time period in Rio de Janeiro, Brazil. Given my hypothesis, that the legacies of slavery affected maternal-fetal health, then maternal skin color is also probably associated with premature birth, which is correlated to infant birth weight.

All code for these models is available in the introanalysis-v1.qmd file.

### 1.4.2 Logistic Models

In my introductory analysis, I further ran logistic models that estimated the relationship of maternal variables on infant birth weight as a categorical variable, in line with some studies on birth weight (Falcão et al., 2020; Nyarko et al., 2013; Paixao et al., 2021; Silva et al., 1998; Wehby et al., 2015; Wehby & López-Camelo, 2017).

I consider Birthweight as the outcome of interest, but I transformed it into a categorical outcome of NBW g or LBW g) and fit a logistic model, using the main predictor of interest, ModifiedColor. These cutoffs are according to the WHO (WHO, 2022).

The first model is a simple logistic regression, with modified maternal skin color as the predictor variable.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table 11: Model 8   | **Characteristic** | **OR**1 | **95% CI**1 | **p-value** | | --- | --- | --- | --- | | **ModifiedColor** |  |  |  | | Euro-Descent | — | — |  | | Afro-Descent | 1.45 | 1.07, 1.96 | **0.016** | | 1OR = Odds Ratio, CI = Confidence Interval | | | | |

Model 5 demonstrates that women of African-descent had higher odds of giving birth to infants with lower birth weight than Euro-descended women (OR 1.45 [95% CI 1.07, 1.96, p-value = 0.016).

The second model is also a simple logistic regression, this time using Color as the predictor variable (Black, mixed race, and White).

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table 12: Model 9   | **Characteristic** | **OR**1 | **95% CI**1 | **p-value** | | --- | --- | --- | --- | | **Color** |  |  |  | | White | — | — |  | | Black | 1.25 | 0.87, 1.79 | 0.2 | | Mixed Race | 1.64 | 1.17, 2.30 | **0.004** | | 1OR = Odds Ratio, CI = Confidence Interval | | | | |

When using the hospital records’ original skin color categories, mixed-race women had higher odds of giving birth to infants of lower birth weight (OR 1.64 [95% CI 1.17, 2.30], p-value = 0.004), but results for the infants of Black women were not significant at the alpha 0.05 level (OR 1.25 [95% CI 0.87, 1.79], p-value = 0.2).

Then, I ran two more logistic models, one with ModifiedColor and the other covariates Age, ModifiedStatus, ModifiedNationality, and one with Color and these same covariates. The results are below.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table 13: Model 10   | **Characteristic** | **OR**1 | **95% CI**1 | **p-value** | | --- | --- | --- | --- | | ModifiedColor |  |  |  | | Euro-Descent | — | — |  | | Afro-Descent | 1.35 | 0.96, 1.94 | 0.094 | | Age | 1.00 | 0.97, 1.03 | >0.9 | | ModifiedStatus |  |  |  | | Nulliparous | — | — |  | | Multiparous | 0.87 | 0.63, 1.20 | 0.4 | | ModifiedNationality |  |  |  | | Brazilian | — | — |  | | European | 0.83 | 0.49, 1.38 | 0.5 | | Latin American | 1.18 | 0.06, 6.63 | 0.9 | | Middle Eastern | 0.00 |  | >0.9 | | 1OR = Odds Ratio, CI = Confidence Interval | | | | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table 14: Model 11   | **Characteristic** | **OR**1 | **95% CI**1 | **p-value** | | --- | --- | --- | --- | | Color |  |  |  | | White | — | — |  | | Black | 1.17 | 0.78, 1.76 | 0.4 | | Mixed Race | 1.53 | 1.04, 2.26 | **0.031** | | Age | 1.00 | 0.97, 1.03 | >0.9 | | ModifiedStatus |  |  |  | | Nulliparous | — | — |  | | Multiparous | 0.88 | 0.64, 1.21 | 0.4 | | ModifiedNationality |  |  |  | | Brazilian | — | — |  | | European | 0.83 | 0.49, 1.38 | 0.5 | | Latin American | 1.18 | 0.06, 6.63 | 0.9 | | Middle Eastern | 0.00 |  | >0.9 | | 1OR = Odds Ratio, CI = Confidence Interval | | | | |

In these two models, the only significant finding is from the final logistic model, in which infants born to mixed-race mothers had 21% higher odds of being born with low birth weight compared to infants born to white mothers. The other models did not show significant results.

Best practice is to not categorize continuous variables, as this can include arbitrary cutoffs for variables that are best understood continuously (Senn, 2005). Thus, I will not include these logistic regressions in the final analysis.

Performing a logistic regression with stillbirth as an outcome could bring robustness to the racial disparities I highlight in the linear regression. After running a simple logistic regression with FetalOutcome as the predictor variable and ModifiedColor as the outcome, infants born to African-descended women had a 9% higher odds of having a stillbirth than Euro-descended women. However, all results were not significant [95% CI 0.82, 1.45; p-value 0.6], and thus I exclude them from the final analysis.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table 15: Model 12   | **Characteristic** | **N** | **OR**1 | **95% CI**1 | **p-value** | | --- | --- | --- | --- | --- | | ModifiedColor | 2,531 |  |  |  | | Euro-Descent |  | — | — |  | | Afro-Descent |  | 1.09 | 0.82, 1.45 | 0.6 | | 1OR = Odds Ratio, CI = Confidence Interval | | | | | |

## 1.5 Performance Measures

Given that this study is an inferential, hypothesis-supporting approach that is exploring how specific maternal predictors affect the outcome of interest, birth weight, please see the fullanalysis-v1.qmd for all predictive metrics, where I applied test/train (75-25 split) and cross-validation to test performance. Model performance did not significantly improve with these additional tests. When run on testing data, most results were insignificant, given the smaller sample size.

The performance metrics for the logistic models are available in the introanalysis-v1.qmd file.

## 1.6 Discussion

Differences in birth weight between racialized groups is the paper’s significant result and supports findings in other contexts. For example, differences in birth weight and childhood growth patterns among differently racialized groups in South Africa since the end of Apartheid also show a gap between White and Black and “colored” children that starts at birth and increases over time even as all children have gotten larger (Cameron, 2003).

Although not discussed in the main analysis, discussions of epigenetic markers associated with the lived experience of racism might also be applicable to racial differences in birth weight outcomes. Studies have connected racial disparities in pregnancy outcomes, including PTB and LBW, with the accumulation of stress over the pregnant person’s life course (and the life courses of their ancestors) understood as allostatic load measured by biomarkers such as cortisol and blood pressure, mediated through epigenetic mechanisms (Leimert & Olson, 2020). Although there is no genetic basis for race, experiences of racism can result in the accumulation of stressors that can be expressed epigenetically and lead to adverse pregnancy and health outcomes across generations through transgenerational epigenetic inheritance (Jasienska, 2009; Leimert & Olson, 2020). Yet, it is crucial to remember that these are not deterministic processes but can be counteracted by social and political interventions that address the root causes of racism and its effects on health (Meloni et al., 2022).

A more complete analysis would further explore interactions between birth weight and birth length, which can be a proxy for the nutritional and health status of the mother later in pregnancy (Santana et al., 2021). The third trimester is when most fetal weight gain occurs, and maternal malnutrition during this period can have a dramatic effect on infant birth weight (Jasienska, 2009; Ward, 1993).

# 2. AI Use

During the preparation of this work the author used the LLMs ChatGPT, CoPilot, and Claude in order to troubleshoot coding errors in R. After using this tool/service, the author reviewed and edited the content as needed and takes full responsibility for the content of the publication.

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