Supplemental Materials

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# 1. Supplemental Materials

## 1.1 Schematic of workflow

If reproducing this analysis, please run code in the following order: 1) processingfile-v1.qmd in the processing-code folder; 2) eda-v1.qmd in the eda-code folder; 3) introanalyis-v1.qmd in the analysis-code folder; 4) fullanalysis-v1.qmd in the analysis-code folder. Older versions of code in .r are available in the old-code folder. This is not updated since 15 August 2024.

## 1.2 Data import and cleaning

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

## 1.3 Data Source

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 (1).

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. Ohter publications have more detailed information on this source (2,3). Because most clinical notes were short – only those that described surgical births such as cesarean sections included details – they do not show if racist thought affected how physicians, all male and mostly White, practiced medicine (4). 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.

The journal is held at the Biblioteca Nacional (BN), the Maternidade Escola, Rio de Janeiro (ME-UFRJ), and the Biblioteca CB/A-Biomédica A, Universidade Estadual do Rio de Janeiro (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.

## 1.4 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.

## 1.5 Introductory Information

Please note the excluded information from the manuscript draft.

Fetal programming: Warrington et al (5) argue that genetic effects and not intrauterine programming are associated with later life high blood pressure. Maruyama and Heinesen (6) have found that lower birth weight is associated with both infant mortality and other health issues in the neonatal period, but its association with long-term health issues declines over time.

Racist policy and birth weight: 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 (7).

Slave population size: Brazil imported over five million enslaved Africans during the nearly four centuries of the existence of chattel slavery (8), compared to around 300,000 for the United States (8). Mortality rates that outstripped fertility rates in Brazil, in addition to higher rates of individual manumission – the freeing of an enslaved person, can help explain Brazil reliance on the transatlantic slave trade in comparison with the United States, where endogenous growth among the enslaved population occurred by the early nineteenth century (9).

Growth rates during pregnancy: But other health problems related to maternal undernutrition during pregnancy depend on gestational period. Research on the Dutch famine during World War II has shown that the adult health problems of infants born to mothers who were pregnant during the famine depended on the gestational period during which maternal undernutrition occurred (10,11).

Rounding error: Any systematic bias in any direction for any group of infants would have been at the hospital level since multiple physicians and medical students weighed babies over the five-year period.

### 1.5.1 Full Summary Table

Here is the code for the full summary table of all variables.

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| Table 1: Supplemental Table   | **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 |  | 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%) | | Parity | 2,836 |  | | Multiparous |  | 1,681 (59%) | | Nulliparous |  | 1,155 (41%) | | 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%) | | Combined Nationality | 2,773 |  | | European |  | 416 (15%) | | Latin American |  | 12 (0.4%) | | Brazilian |  | 2,342 (84%) | | Middle Eastern |  | 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%) | | 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) | | | |

## 1.6 Basic Statistical 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 (12).

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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 (13).

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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 (15).

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

Finally, I calculated the sex ratio at birth (SRaB).

The SRaB is:

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

The sex ratio was 1.2: there were 120 male live births per 100 female live births. This is much higher than the current range of between 103 and 107 male births per 100 female births (16). 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 (17). 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.

## 1.7 Models

### 1.7.1 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 (birthweight in grams) and exposure variable maternal ancestry (Euro-descent or Afro-descent).

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| Table 2: 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\_Afro.Descent | -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.

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| Table 3: Model 2   | **Characteristic** | **Beta** | **SE**1 | **Statistic** | **95% CI**1 | **p-value** | | --- | --- | --- | --- | --- | --- | | (Intercept) | 2,927 | 51.9 | 56.4 | 2,825, 3,029 | **<0.001** | | Age | 8.0 | 2.01 | 3.99 | 4.1, 12 | **<0.001** | | R² | 0.008 |  |  |  |  | | 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, nationality, and gestational status on infant birth weight.

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| Table 4: Model 3   | **Characteristic** | **Beta** | **SE**1 | **Statistic** | **95% CI**1 | **p-value** | | --- | --- | --- | --- | --- | --- | | (Intercept) | 3,152 | 65.5 | 48.1 | 3,023, 3,280 | **<0.001** | | ModifiedColor |  |  |  |  |  | | Euro-Descent | — | — | — | — |  | | Afro-Descent | -85 | 26.9 | -3.17 | -138, -32 | **0.002** | | Age | 2.7 | 2.23 | 1.22 | -1.6, 7.1 | 0.2 | | ModifiedStatus |  |  |  |  |  | | Multiparous | — | — | — | — |  | | Nulliparous | -113 | 25.3 | -4.47 | -163, -63 | **<0.001** | | ModifiedNationality |  |  |  |  |  | | Brazilian | — | — | — | — |  | | European | 27 | 36.6 | 0.727 | -45, 98 | 0.5 | | Latin American | 75 | 166 | 0.451 | -251, 400 | 0.7 | | Middle Eastern | 526 | 494 | 1.07 | -442, 1,495 | 0.3 | | R² | 0.027 |  |  |  |  | | Adjusted R² | 0.024 |  |  |  |  | | No. Obs. | 1,920 |  |  |  |  | | 1SE = 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.

The fourth 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 5: Model 4   | **Characteristic** | **Beta** | **SE**1 | **Statistic** | **95% CI**1 | **p-value** | | --- | --- | --- | --- | --- | --- | | (Intercept) | 3,113 | 12.4 | 251 | 3,088, 3,137 | **<0.001** | | ModifiedNationality |  |  |  |  |  | | Brazilian | — | — | — | — |  | | European | 97 | 31.3 | 3.10 | 36, 159 | **0.002** | | Latin American | 137 | 166 | 0.825 | -189, 464 | 0.4 | | Middle Eastern | 647 | 498 | 1.30 | -329, 1,624 | 0.2 | | R² | 0.006 |  |  |  |  | | Adjusted R² | 0.005 |  |  |  |  | | 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 (18). 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 (19). 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 (20).

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.

### 1.7.2 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 (21–26).

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 (12).

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

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| Table 6: Model 5   | **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).

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| Table 7: Model 6   | **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.

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| Table 8: Model 7   | **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 |  |  |  | | Multiparous | — | — |  | | Nulliparous | 1.15 | 0.83, 1.58 | 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 | | | | |

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| Table 9: Model 8   | **Characteristic** | **OR**1 | **95% CI**1 | **p-value** | | --- | --- | --- | --- | | Age | 0.99 | 0.84, 1.16 | >0.9 | | Color\_Black | 1.07 | 0.90, 1.29 | 0.4 | | Color\_Mixed.Race | 1.21 | 1.02, 1.45 | **0.031** | | ModifiedStatus\_Nulliparous | 1.06 | 0.91, 1.24 | 0.4 | | ModifiedNationality\_European | 0.93 | 0.77, 1.12 | 0.5 | | ModifiedNationality\_Latin.American | 1.01 | 0.83, 1.14 | 0.9 | | ModifiedNationality\_Middle.Eastern | 0.79 |  | >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 (27). Thus, I will not include these logistic regressions in the final analysis.

## 1.8 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.

Here I include the cross-validation results for the linear models.

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| Table 10: Cross-Validation Model 1  # A tibble: 2 × 5  .metric .estimator mean n std\_err  <chr> <chr> <dbl> <int> <dbl> 1 rmse standard 490. 10 14.5  2 rsq standard 0.0169 10 0.00554 |

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| Table 11: Cross-Validation Model 2  # A tibble: 2 × 5  .metric .estimator mean n std\_err  <chr> <chr> <dbl> <int> <dbl> 1 rmse standard 486. 10 16.4  2 rsq standard 0.0369 10 0.0114 |

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| Table 12: Cross-Validation Model 3  # A tibble: 2 × 5  .metric .estimator mean n std\_err  <chr> <chr> <dbl> <int> <dbl> 1 rmse standard 490. 10 14.5  2 rsq standard 0.0161 10 0.00445 |

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| --- |
| Table 13: Cross-Validation Model 4  # A tibble: 2 × 5  .metric .estimator mean n std\_err  <chr> <chr> <dbl> <int> <dbl> 1 rmse standard 486. 10 16.4  2 rsq standard 0.0367 10 0.0107 |

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

# 2. Appendix

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