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 or processingcode.R in the processing-code folder; 2) eda-v1.qmd or edacode.R in the eda-code 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. Please defer to all .qmd files as the master over any .R files.

## 1.2 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 or processingcode.R 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]](#footnote-22)

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.[[2]](#footnote-23)

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.

## 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 or gravidity; nationality; combined nationality; birth outcome; maternal outcome; fetal outcome; and fetal sex.

In the exploratory analysis, I included recorded spontaneous abortions and all recorded live births. For the statistical models, I excluded both spontaneous abortions and any recorded live births weighing <500 grams to avoid the inclusion of any possible stillbirths that were misrecorded as live births.[[3]](#footnote-25)

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.[[4]](#footnote-28) 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.[[5]](#footnote-30) 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.[[6]](#footnote-32)

### 1.4.1 Maternal Skin Color

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. Please see the eda-v1.qmd file for more information on the variable manipulation process.

### 1.4.2 Gestational Status

Gestational status was divided into parity and gravidity. Originally, the data had eight categories: nullipara, primipara, secundipara, multipara; and primigravida, secundigravida, trigravida, and multigravida. I combined categories into four final categories: 1) nullipara and primigravida into nullipara (or any woman who has never given birth to a viable fetus); 2) primipara into primipara (or any woman who has given birth to one viable fetus); 3) secundipara and multipara into multipara (or any woman who has given birth to more than one viable fetus); and 4) secundigravida, trigravida, and multigravida into multigravida (or any woman who has been pregnant more than one but never given birth to a viable fetus).

### 1.4.3 Maternal Nationality

For maternal nationality, I created categories based on individual country (nationality) and categories based on region (modifiednationality). Recategorization occurred as follows: Brazilian; Latin American (Argentine, Paraguayan, Uruguayan); European (Austrian, French, German, Italian, Polish, Portuguese, Romanian, Russian, Spanish, and Swiss); and Middle Eastern (Syrian).

### 1.4.4 Clinical Outcomes

The clinical notes upon which I based this dataset 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) (J. L. Eyraud et al.[[7]](#footnote-38)), coded as operatory or natural by physicians, as interventionist. I classified clinical outcomes as spontaneous abortion, natural (normal delivery), interventionist (interventionist delivery), and operative (surgical delivery).

### 1.4.5 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 (5.8) | | 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%) | | Birth Length (cms) | 2,405 | 48.3 (3.9) | | Birth Weight (grms) | 2,384 | 3,087 (567) | | 1n (%); Mean (SD) | | | |

## 1.5 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.[[8]](#footnote-43)

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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.[[9]](#footnote-48)

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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 |

Finally, Figure 4 visualizes the relationship of birth weight and length, stratified by sex since male infants are usually slightly heavier and longer than females K Maršál et al.[[10]](#footnote-58)

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

## 1.6 Models

### 1.6.1 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 | 17.6 | 181 | 3,153, 3,222 | **<0.001** | | ModifiedColor\_Afro.Descent | -97 | 22.9 | -4.25 | -142, -52 | **<0.001** | | R² | 0.009 |  |  |  |  | | Adjusted R² | 0.009 |  |  |  |  | | No. Obs. | 1,919 |  |  |  |  | | 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) | 2,933 | 51.7 | 56.8 | 2,831, 3,034 | **<0.001** | | Age | 7.8 | 2.00 | 3.92 | 3.9, 12 | **<0.001** | | R² | 0.008 |  |  |  |  | | No. Obs. | 1,919 |  |  |  |  | | 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) | 3,179 | 70.8 | 44.9 | 3,041, 3,318 | **<0.001** | | ModifiedColor |  |  |  |  |  | | Euro-Descent | — | — | — | — |  | | Afro-Descent | -83 | 26.8 | -3.11 | -136, -31 | **0.002** | | Age | 2.7 | 2.22 | 1.20 | -1.7, 7.0 | 0.2 | | ModifiedStatus |  |  |  |  |  | | Multiparous | — | — | — | — |  | | Nulliparous | -111 | 25.2 | -4.39 | -160, -61 | **<0.001** | | ModifiedNationality |  |  |  |  |  | | European | — | — | — | — |  | | Latin American | 48 | 166 | 0.290 | -278, 374 | 0.8 | | Middle Eastern | 501 | 492 | 1.02 | -463, 1,465 | 0.3 | | Brazilian | -27 | 36.4 | -0.738 | -98, 45 | 0.5 | | R² | 0.026 |  |  |  |  | | Adjusted R² | 0.023 |  |  |  |  | | No. Obs. | 1,919 |  |  |  |  | | 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.

For all three models, the r-squared is very small (0.007, 0.006, and 0.008), 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.

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) | 3,181 | 70.8 | 44.9 | 3,042, 3,320 | **<0.001** | | Color |  |  |  |  |  | | White | — | — | — | — |  | | Black | -96 | 30.7 | -3.12 | -156, -36 | **0.002** | | Mixed Race | -72 | 30.3 | -2.36 | -131, -12 | **0.018** | | Age | 2.6 | 2.22 | 1.18 | -1.7, 7.0 | 0.2 | | ModifiedStatus |  |  |  |  |  | | Multiparous | — | — | — | — |  | | Nulliparous | -111 | 25.2 | -4.42 | -161, -62 | **<0.001** | | ModifiedNationality |  |  |  |  |  | | European | — | — | — | — |  | | Latin American | 48 | 166 | 0.290 | -278, 374 | 0.8 | | Middle Eastern | 501 | 492 | 1.02 | -464, 1,465 | 0.3 | | Brazilian | -27 | 36.4 | -0.739 | -98, 45 | 0.5 | | R² | 0.027 |  |  |  |  | | Adjusted R² | 0.023 |  |  |  |  | | No. Obs. | 1,919 |  |  |  |  | | 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.[[11]](#footnote-69) 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 in this study.[[12]](#footnote-71) 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 influenced birth weight, as the lack of historical data precludes this line of inquiry. Rather, it is exploring if maternal skin color is associated with lower infant birth weight during this specific time period in Rio de Janeiro. 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.

### 1.6.2 Logistic Models

Now we will still consider Birthweight as the outcome of interest, but we will transform it into a categorical outcome of <=2500 (low birth weight, LBW) and >2500 (normal birth weight, NBW) and fit a logistic model, using the main predictor of interest, ModifiedColor.

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\_Afro.Descent | 1.19 | 1.03, 1.39 | 0.019 | | 1OR = Odds Ratio, CI = Confidence Interval | | | | |

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

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| Table 7: Model 6   | **Characteristic** | **OR**1 | **95% CI**1 | **p-value** | | --- | --- | --- | --- | | Color\_Black | 1.10 | 0.93, 1.29 | 0.3 | | Color\_Mixed.Race | 1.25 | 1.07, 1.47 | 0.004 | | 1OR = Odds Ratio, CI = Confidence Interval | | | | |

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** | | --- | --- | --- | --- | | Age | 0.99 | 0.84, 1.17 | >0.9 | | ModifiedColor\_Afro.Descent | 1.16 | 0.98, 1.38 | 0.10 | | 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 | | | | |

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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 | 0.89, 1.28 | 0.5 | | Color\_Mixed.Race | 1.21 | 1.02, 1.45 | **0.031** | | ModifiedStatus\_Nulliparous | 1.06 | 0.90, 1.24 | 0.5 | | 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 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.[[13]](#footnote-78) Thus, I will not include these logistic regressions in the final analysis.

## 1.7 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 test/train and cross-validation were applied to test performance. Model performance did not significantly improve with these additional tests. When run on testing data, most results were insignificant.

Test/train (75-25 split) and cross-validation were performed on all models. Model prediction performance did not improve greatly using these tests. Model performance resulted in insignificant results when run on the testing data 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 488. 10 14.8  2 rsq standard 0.0150 10 0.00668 |

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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 484. 10 15.0  2 rsq standard 0.0260 10 0.00377 |

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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 488. 10 14.9  2 rsq standard 0.0110 10 0.00418 |

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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 484. 10 15.1  2 rsq standard 0.0249 10 0.00382 |

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

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