**Mortality over the years between Males and Females of Black and White races in the United States**

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**Abstract**

*Objectives*

An analysis of the changes in mortality of the different sexes within the races over time aims to find if race and sex have any influence over the other and to see how accurate public health studies’ claims have been when regarding health disparities.

*Methods*

Bio-statistical analysis methods were performed in R, v. 3.3.1 (R Core Team, 2016) to test to see if there were significant differences in each group; black males, black females, white males, white males. An Analysis of Covariance (ANCOVA) linear model test was first attempted. Assumptions did not allow the test, so a Bootstrapping method was tried to test for the significance of the differences of each variable and their interaction with each other.

*Results*

Each race’s mortality and each sex’s mortality depended heavily on the time of year. There was no interaction between race and sex in determining mortality. A negative relationship between mortality over the years exists but differences still exist between the different mortality (per 100,000 people) that these specific populations face.

*Conclusions*

Though public health claims to be making great progress in decreasing the mortality of each race (black and white) and sex (female and male), it has short falls in how well it has been addressing the gaps of health equity among these groups over time. In fact, the gaps between sexes in each race are widening slowly over time. More research is encouraged to help find the reason for this phenomenon.

**Introduction**

Health disparities continue to exist in the world and in the United States. Health disparities are what the Centers for Disease Control and Prevention define as differences in burdens of disease, violence, injury, and opportunities among different social groups.1 Social groups are defined by factors of gender, race, income, and sexual orientation among others. The experiences of these different social groups are not only influenced by the factors listed, but by historical events that have determined how resources are distributed among the different populations. History also plays a great role in terms of public health and how the field has attempted to tackle the burdens faced by all groups. For example, public health achievements have improved health and prolonged life in all groups where heart disease decreased 56% from 1950-1996, stroke death rates have decreased nearly 70% from 1950-1996, control of infectious diseases, clinical medicine, social welfare, health of mothers and their children.2, 3

Studies claim gaps between the burdens different groups experience have closed or are continuing to close because of achievements in public health over time. Public health also seeks to provide health equity for all social groups. Ways in which large public health organizations, governmental departments and other programs have sought to identify vulnerable populations has been by segregating health indicators by race, income, and all other identifiable factors.4 By monitoring health equity in countries, states—and more geographically specific—communities, differences in healthcare access and other relevant needs are revealed. The differences in indicators then provide proof for interventions and policy changes.

Most programs and organizations utilize childbirth, child mortality, or maternal health as health equity indicators. In this study, age-adjusted mortality (per 100,000 standard people) was analyzed as an indicator of healthcare access and outcome inequalities between the two predominant races in America, black and white. In addition, another layer of analysis was added to find inequality gaps between the sexes female and male. Both factors were analyzed for mortality with a covariant of the years 1900-2013.5 To test all variables and their interactions null hypothesis of no difference between the adjusted population means was proposed. The alternative hypothesis would suggest a difference between all groups: black males, black females, white males, and white females. It was hypothesized the results would demonstrate to accept the alternative hypothesis, but the aim of the study was to find how health equity has changed over time, how intersectionality of identities among groups have changed and how correct public health studies’ claims have been in suggesting health disparity gaps between groups have closed.

**Methods**

The data was found on an online data catalog made available by the U.S. Department of Human and Health Services and published by the Centers for Disease Control and Prevention. The data was condensed to focus on the mortality of the races black and white and both sexes for each race, excluding the all races factor. Once concentrated, the data consisted of 465 observations with responding mortality data for the variables of race (black and white) and sex (female and male) with the covariate of years (1900-2013). Data for the black population, prior to year 1970, is unknown; all data made available for this population is based on data for the 1900-1968 non-white population. Also, data before 2010 are intercensal estimates, meaning the data are estimates of taken between official census dates, while the 2011-2013 data are postcensal, meaning the mortality rates were calculated based on an estimation method after the last census.6

Based on the variables available for the indicator of mortality in the United States, an ANCOVA linear model test was selected to test the hypothesis of the possible differences between the chosen groups. Before beginning the test, assumptions of normality of the data’s distribution and homoscedasticity were tested using a Shapiro-Wilk test and a Breusch-Pagan test, respectively. An analysis of the graphed model’s residuals was completed before performing the Shapiro-Wilk test to assess for outliers. After the data met the assumption of normality graphically, the residuals of the ANCOVA model were tested with the Shapiro-Wilk test. Normality was not met. A log transformation was chosen to see if the transformation would meet the assumption with the Shapiro-Wilk test but the assumption was not met again. Homoscedasticity was tested with and without the transformation of the data and also failed to meet the assumption of homoscedasticity, meaning there was no equal variance of within the different populations. Independence was the only assumption met, as the data was obtained through random sampling. All transformations proved ineffective, rendering an ANCOVA model test unusable.

Since, all assumptions were not met, and alternative method that does not rely on assumptions was conducted. The Bootstrapping test method was advised through Professor Todd Livdahl and his Teacher Assistant, Levi Seeley. A Boot Strap of an ANCOVA test 7 was conducted in R, v. 3.3.1 (R Core Team, 2016) 8 for a sample of 10,000 with all interactions between the race, sex, and year factors. The interaction that was non-significant, or with a p-value above 0.05, and tested for the most factors (Race: Sex: Year), was taken out of the model first. Then, all other most non-significant interactions were taken out one by one to provide only the significant interactions between the terms tested. The results were finally graphed in an ANCOVA figure to further demonstrate the differences among the groups.

**Results**

The Shapiro-Wilk test for the residuals of the ANCOVA linear model reported a significant value (W=0.98907, P-value= 0.01), violating the assumptions of normality. The ANCOVA linear model transformed with log also violated the assumption of normality with a p-value < 2.2e-16 (W=0.2639). The Breusch-Pagan test for the initial model revealed a p-value < 2.2e-16 (BP7=92.897). Meanwhile, the transformed model revealed a significant p-value, also violating the assumption of equal variance (BP7 = 92.897, p-value < 2.2e-16). Neither the assumption of normality nor equal variance was met.

The Boot Strapping of the ANCOVA model test reported all significant and non-significant interactions between race, sex, and the years (Table 1). The three-way interaction between race, sex, and year was first removed because it was non-significant (p-value=0.36). Then, all other interaction terms were removed one by one by their revealed non-significance (Table 2). As shown in Table 2, the terms with greatest significance were those of race and year. Sex was non-significant in comparison to all other factors tested (P-value=0.06). However, sex was maintained as a term of importance in the final bootstrapping analysis because of its interaction significance with year (P-value=0.03). Race and year also had a significant interaction with a p-value of 4.88e-09. Overall race and sex did not have a significant interaction with each other, while time in years seems to have had great influence in the outcomes of mortality for each group depending on race and sex alone. The significances of each identity factor with the interaction of time (years) are also observed in Figure 1. Over time mortality rates have significantly decreased but changes in the difference of mortality (per 100,000) between black and white males and females and in comparison to each other have not dramatically changed (Fig. 1).

**Discussion**

The initial and final analyses of the differences between Black and White females and males demonstrated a significant difference between mortality of each group of race, but there is a more significant relationship between mortality of each group and the year (Race and Year: F1=144.04, p-value=4.88e-09; Sex and Year: F1=19.60, p-value=0.03). Therefore, the null is rejected and the alternative supporting there are differences among populations is accepted. The findings are consistent with the literature supporting public health achievements have decreased some of the burdens, in this case mortality of each social group. In addition, there are almost no studies that have found other factors influence the disparities of deaths between different races beyond socio-economic status.9 This study also supports that conclusion seeing that sex was not significant when interacting with race. Race and sex had no significant interaction with each other in regards to mortality; meaning intersectionality of race and sex in the United States did not have much influence in the mortality of each group. What the study presents that literature fail to address and are incorrect in, is the gaps that exist between the mortality rates for males and females in each racial group. Studies suggest mortality rate gaps between the male and females have began to close because of females rising with social status in society, change in behaviors such as doctor visits, and decrease in child-bearing deaths.10 However, Figure 1, demonstrates a discrepancy between what is published and what numbers say based on calculated estimates. Gaps between male and female mortality between groups have widened since the 1900’s. More accurate research needs to be conducted to find why the gap has widened and why articles fail to recognize the gaps in the burden that each group faces with mortality.

**Public Health Implications**

Many public health experts will argue that the findings in this study are problematic. They will argue censal estimates are too abstract and may disregard the findings of the U.S. populations’ data. The findings simply urge that more research be conducted to address the possible widening of gaps in health equity among these populations.

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Table 1: Summary statistics of age-adjusted mortality in groups separated by Race and Sex with the covariate of Year. Interactions’ significance between Race, Sex, and Year are shown.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Sum of Squares | Df | F-value | SE | Lower Bound | Upper Bound | Crit F | z | Pr(>|z|) |
| Intercept | 74552150.21 | 1 | 2226.90 | 301.58 | 1673.78 | 2858.18 | 3.86 | 7.38 | 1.53e-13 |
| Race | 3515422.48 | 1 | 105.01 | 24.88 | 61.70 | 159.85 | 3.86 | 4.22 | 2.43e-05 |
| Year | 69358684.97 | 1 | 2071.77 | 278.74 | 1561.57 | 2656.50 | 3.86 | 7.43 | 1.06e-13 |
| Sex | 614429.79 | 1 | 18.35 | 11.33 | 3.14 | 45.89 | 3.86 | 1.62 | 0.105 |
| Race:Year | 3316899.32 | 1 | 99.08 | 24.00 | 57.29 | 152.02 | 3.86 | 4.13 | 3.67e-05 |
| Race: Sex | 134696.56 | 1 | 4.02 | 4.45 | 0.04 | 16.36 | 3.86 | 0.90 | 0.366 |
| Year: Sex | 701096.95 | 1 | 20.94 | 12.05 | 4.27 | 49.79 | 3.86 | 1.74 | 0.0822 |
| Race: Yr.: Sex | 137538.39 | 1 | 4.11 | 4.48 | 0.04 | 16.51 | 3.86 | 0.92 | 0.359 |
| Residuals | 14998148.34 | 448 |  |  |  |  |  |  |  |

Table 2: Summary statistics of age-adjusted mortality in groups separated by Race and Sex with the covariate of Year. Significant interactions between Race, Sex, and Year are shown.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Sum of Squares | | Df | | F-value | SE | Lower Bound | Upper Bound | Crit F | z | Pr(>|z|) |
| Intercept | | 95222567.77 | | 1 | 2821.56 | 310.84 | 2272.74 | 3494.67 | 3.86 | 9.08 | 1.11e-19 |
| Race | | 5219231.57 | | 1 | 154.65 | 25.82 | 107.19 | 208.69 | 3.86 | 5.99 | 2.1e-09 |
| Year | | 88405952.53 | | 1 | 2619.57 | 287.12 | 2112.01 | 3239.36 | 3.86 | 9.12 | 7.27e-20 |
| Sex | | 549865.41 | | 1 | 16.29 | 8.48 | 4.06 | 36.42 | 3.86 | 1.92 | 0.0548 |
| Race: Year | | 4860942.32 | | 1 | 144.04 | 24.62 | 98.72 | 195.52 | 3.86 | 5.85 | 4.88e-09 |
| Year: Sex | | 661425.98 | | 1 | 19.60 | 9.27 | 5.80 | 41.28 | 3.86 | 2.11 | 0.0345 |
| Residuals | | 15186715.35 | | 450 |  |  |  |  |  |  |  |

Figure 1: Age-adjusted mortality (per 100,000 people) differed over the years for both Black and White males and females. Over the years mortality has decreased for all groups. Confidence intervals (95%) are shown on the regression lines.

