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ASSESSING THE CONTRIBUTION OF DIFFERENT CAUSES OF DEATH TO LIFE EXPECTANCY DISPARITIES IN THE UNITED STATES

by

Max Tyler Roberts

A dissertation submitted in partial fulfillment
of the requirements for the degree

of

DOCTOR OF PHILOSOPHY

in

Sociology

Approved:

_____	_____
Eric N. Reither, Ph.D. Major Professor	Sojung Lim, Ph.D. Committee Member
_____	_____
Erin Hofmann, Ph.D. Committee Member	Hyojun Park, Ph.D. Committee Member
_____	_____
Paul Peppard, Ph.D. Committee Member	D. Richard Cutler, Ph.D. Interim Vice Provost Of Graduate Studies

UTAH STATE UNIVERSITY
Logan, Utah

2021

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ABSTRACT

Assessing the Contribution of Different Causes of Death to

Life Expectancy Disparities in the United States

by

Max Tyler Roberts, Master of Science

Utah State University, 2021

Major Professor: Dr. Eric N. Reither
Department: Sociology, Social Work, and Anthropology

Life expectancy disparities between different socioeconomic and demographic groups persist in the U.S. across different places. While these longevity disparities are well documented, little research identifies specific contributors to ongoing longevity disparities. In this dissertation, I investigate how specific causes of death contribute to longevity gaps across sex, race, ethnic, and educational groups, how specific causes of death contribute to changing life expectancy over time for select groups, and where across the life span these causes contribute most to longevity disparities. Specifically, using national vital statistics, and employing life table and decomposition analysis, I examine longevity disparities in the U.S. at the national, regional (e.g., Great Lakes region), and municipality (e.g., Washington, D.C.) levels. In Chapter 2, I find that homicide is a leading contributor to Black-white longevity gaps in the U.S. among young, low-educated males, whereas heart disease contributes most to Black-white longevity gaps among males and females across all other levels of education. Additionally, I find that low rates of heart disease among Hispanics, relative to their white counterparts,

produces a longevity advantage for Hispanics across all levels of education. In Chapter 3, I find that homicide contributes most to longevity losses among young, low-educated Blacks in the Great Lakes region. Drug poisoning was also a major contributor to longevity losses among Black and white males and females without a 4-year college degree, but especially among the least-educated white males and females. In Chapter 4, I find that homicide is a leading contributor to the Black-white longevity gap among young males in Washington, D.C., while heart disease and cancer were leading contributors to Black-white longevity gaps among both males and females at later stages of life. Drug poisoning was also a large contributor to the increasing Black-white longevity gap in Washington, D.C. Preventable causes of death, such as homicide and drug poisoning at young- and middle ages, and heart disease at older ages, are key drivers of longevity disparities in the U.S. Policy and programs to address these risks could effectively improve ongoing longevity disparities.

(168 pages)

PUBLIC ABSTRACT

Assessing the Contribution of Different Causes of Death to
Life Expectancy Disparities in the United States
Max Tyler Roberts

Life expectancy is not the same for all people in the United States. While some enjoy life expectancies of more than 80 years, others are at risk of dying much sooner. The following studies investigate how different causes of death such as homicide, diabetes, heart disease, and drug poisoning contribute across the life span to: 1) life expectancy gaps across different sex, racial, ethnic, and education groups, and 2) life expectancy change over time for different sex, racial, ethnic, and education groups. Each study focuses on a different area of the U.S., with Chapter 2 focusing on the national-level, Chapter 3 focusing on the Great Lakes region, and Chapter 4 focusing on Washington, D.C. In Chapter 2, I find that homicide among low-educated, young males contributes to life expectancy gaps between Black and white males, and also life expectancy gaps between Hispanic and white males. Additionally, heart disease among older, higher-educated males and females contributes to life expectancy gaps between Blacks and whites. In Chapter 3, I find that drug poisoning among all Black and white males and females has contributed to reductions in life expectancy over time in the Great Lakes region, but drug poisoning has decreased life expectancy particularly for low-educated, white males and females. In Chapter 4, I find that homicide contributed most to the life expectancy gap between Black and white males at young ages in Washington,

D.C., while heart disease and cancer contributed most to Black-white life expectancy gaps among both males and females at later stages of life in Washington, D.C. The findings from these studies can inform future research on life expectancy differences and guide targeted public health interventions to help reduce life expectancy disparities in the U.S.

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Max Tyler Roberts

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CHAPTER I

INTRODUCTION

Life expectancy is an estimate of the average number of years a person can expect to live at birth and is a commonly used indicator of the health and wellbeing of a population (The World Factbook, 2020). If the average life expectancy of a population is relatively high, this suggests that the population is generally in good health. Alternatively, if the average life expectancy of a population is low, this suggests that the health of the population is relatively poor. Global life expectancy has improved substantially over time, with many developed nations enjoying life expectancies of >70 years today (The World Factbook, 2020). These improvements in life expectancy were made possible through enhanced sanitation, living conditions, and hygiene, as well as improved public health infrastructure and advances in medical science (McKeown, 2009).

The United States has a relatively high life expectancy for both males (76.1 years in 2017) and females (81.1 years in 2017) (Arias & Xu, 2019), although some other developed nations enjoy higher life expectancy than the U.S. (The World Factbook, 2020). Despite national improvement, longevity gains have not been shared equally across different populations in the U.S. While some groups have appreciated either relatively high life expectancy or improving longevity over time, other groups have experienced relatively low life expectancy or stalls or even losses in longevity.

Life expectancy disparities are consistently observed between males and females (Luy & Gast, 2014; Seifarth, McGowan, & Milne, 2012; Shrestha, 2005), across race and

ethnic groups (Arias, 2016; Harper, MacLehose, & Kaufman, 2014b; Meara, Richards, & Cutler, 2008; Riddell, Morrison, Kaufman, & Harper, 2018), and across groups with different socioeconomic status and educational attainment (Hendi, 2015; Olshansky et al., 2012; Sasson, 2016b; Singh & Siahpush, 2006). Life expectancy also varies across different parts of the U.S. While some parts of the U.S. appreciate life expectancies greater than the national average, others face life expectancies lower than the national average (Harper et al., 2014b). For example, life expectancy in New England has increased in the last two decades, while the Midwest has experienced stalls and, in some instances, even declines in recent years (Woolf & Schoomaker, 2019). Such differences in life expectancy are observed across U.S. states (Harper et al., 2014b; Riddell et al., 2018), and cities (Fenelon & Boudreaux, 2019b).

Existing research has shown how life expectancy varies in the U.S. by race and ethnicity. Non-Hispanic Black males and females overwhelmingly face shorter life expectancies than their white counterparts (Arias & Xu, 2019; Firebaugh, Acciai, Noah, Prather, & Nau, 2014a; Harper et al., 2014b). Conversely, Hispanic males and females have been found to have higher life expectancies than their Black and white counterparts (Arias & Xu, 2019; Olshansky et al., 2012). Life expectancy in the U.S. also varies by socioeconomic status. Higher educational attainment, an indicator commonly used to measure socioeconomic status, generally translates into higher incomes, healthier lifestyles, and access to quality healthcare (Hummer & Hernandez, 2013; Marmot & Wilkinson, 2005). Previous studies have illuminated the education longevity gradient in the U.S., where life expectancy increases with each higher level of education an

individual reaches (Montez, Hummer, Hayward, Woo, & Rogers, 2011; Rostron, Arias, & Boies, 2010).

As longevity disparities persist in the U.S., life expectancy gaps between advantaged and disadvantaged groups are widening. Varying life expectancy by race and ethnicity has led to large life expectancy gaps between racial and ethnic groups in the U.S., highlighting ongoing health inequities and differing longevity outcomes (Firebaugh, Acciai, Noah, Prather, & Nau, 2014c; Harper et al., 2014b; Riddell et al., 2018; Roberts, Reither, & Lim, 2019). Over time, the gap between the most- and least-educated groups in the U.S. has grown across all sex and racial and ethnic groups. For instance, in 2018, a Black male with a 4-year college degree could expect to live nearly 5 years longer than a Black male without a 4-year college degree. Meanwhile, a white female with a 4-year college degree could expect to live >2 years longer than a white female without a 4-year college degree (Case & Deaton, 2021).

There is substantial variation across states when looking at life expectancy gaps (e.g., Black-white). For example, Wisconsin has the largest Black-white longevity gap of all 50 states in the nation, with white males and females living 7.3 and 5.6 years longer than their Black counterparts, respectively (Roberts et al., 2019), while Illinois, Michigan, and Pennsylvania have Black-white longevity gaps of >6 years (Harper et al., 2014b). Meanwhile, Kentucky, Nevada, New Mexico, Oregon, and Washington all have Black-white longevity gaps of <4 years (Harper et al., 2014b). Even in states with small racial longevity gaps, white males and females consistently outlive their Black counterparts throughout the U.S. This variation highlights the need to continue to investigate, in detail, longevity disparities at sub-national levels, which likely require

unique, local interventions to reduce disparities. Additionally, the widening longevity gaps across sex, race, ethnic, and education groups in the U.S. warrant further investigation to identify solutions capable of reducing these life expectancy inequities.

For over 40 years, the Healthy People initiative has assisted in improving the health and wellbeing of people throughout the U.S. The key goal of the Healthy People initiative is to eliminate health disparities while striving for health equity for all people (Office of Disease Prevention and Health Promotion, 2020). The U.S. has room to improve when it comes to life expectancy disparities throughout the country and across different demographic and socioeconomic groups. In order to address persistent longevity disparities in the U.S., more research is needed to identify factors contributing to wide life expectancy gaps, as well as factors contributing to life expectancy decline among certain groups.

While existing research has begun to analyze the cause-specific contributors to large life expectancy gaps (Riddell et al., 2018; Roberts et al., 2019; Sasson, 2016a; Sasson & Hayward, 2019), there is still limited evidence to determine how specific causes of death are contributing across the life course to longevity disparities (Roberts et al., 2019). Even less evidence is available to determine cause-specific contributors to changes in life expectancy (Sasson, 2016a) – an important concern in light of a recent decline in U.S. life expectancy from 2015 to 2017 (Harper, Kaufman, & Cooper, 2017). Lastly, only a handful of studies have measured the age-specific contribution of different causes of death to longevity disparities (Roberts, Reither, & Lim, 2020; Roberts et al., 2019), which can help policymakers target specific stages of life to maximize potential improvements in longevity disparities.

The investigations that follow build on existing research by utilizing U.S. vital statistics to quantify the contribution of specific causes of death over the life course to longevity gaps and changing life expectancy across different socioeconomic and demographic groups. The following analyses will focus on longevity disparities at the national, regional, and municipality levels. Within-group change in life expectancy will also be analyzed among groups and places that have experienced notable longevity losses in recent years. Findings from these investigations will provide detailed evidence that can be used to inform future research, guide targeted health interventions to effectively reduce ongoing longevity disparities, and improve current longevity trends observed in the U.S.

CHAPTER II

ASSESSING AGE- AND CAUSE-SPECIFIC CONTRIBUTORS TO EDUCATION LONGEVITY GAPS IN THE UNITED STATES

Introduction

Life expectancy in the United States has improved over time, with the exception of recent declines from 2015 to 2017 (Kochanek, Murphy, Xu, & Arias, 2017; Woolf & Schoomaker, 2019; Xu, Murphy, Kochanek, & Arias, 2016). However, these longevity improvements have not been uniform across the population as less-educated groups have faced stalling or declining life expectancy. For example, life expectancy decreased by more than a year among Black and white males, and white females with a high school education between 2010 and 2017. By contrast, white males and females with a college degree appreciated an increase of more than half a year. Whereas, life expectancy among Black females with a college degree increased by more than 1.5 years (Woolf & Schoomaker, 2019). Consequently, there has been a pattern of diverging longevity between advantaged and disadvantaged groups in the U.S. It is thus important to identify contributing factors to education longevity disparities and recognize the most vulnerable populations as we work toward life expectancy parity in the U.S. This investigation seeks to measure the contribution of specific causes of death to education longevity gaps across sex, race, and ethnicity in the U.S., and determine where in the life course causes of death are contributing most to education longevity gaps.

Longevity disparities in the U.S. are well documented (Firebaugh et al., 2014a; Harper et al., 2014b; Hummer & Hernandez, 2013; Kochanek, Arias, & Anderson, 2015; Meara et al., 2008; Sasson, 2016b), and the COVID-19 pandemic is accentuating these disparities across race, ethnicity, and socioeconomic status as it continues to unfold (Golestaneh et al., 2020; Kirby, 2020; Quan et al., 2021; Rollston & Galea, 2020; Tai, Shah, Doubeni, Sia, & Wieland, 2021). Longevity disparities are particularly evident across different levels of educational attainment. Those with some college education or a 4-year college degree consistently experience longer life expectancy than their lower-educated counterparts (Meara et al., 2008; Olshansky et al., 2012; Sasson, 2016b). From 1990 to 2010, education longevity gaps increased among all race and sex groups. The longevity gap between the least- and most-educated white females grew from 2.5 to 9.3 years and, among Black females, from 1.9 to 4.7 years (Sasson, 2016b). This diverging pattern was also apparent among Black males (from 6.9 years to 8.6 years) and white males (from 6.1 years to 11.9 years). These patterns are consistent among Hispanics as well. In 2008, the gap between the least- and most-educated Hispanic females was 2.9 years, and 5.5 years among Hispanic males (Olshansky et al., 2012).

White males and females consistently appreciate longer life expectancy than Black males and females (Riddell et al., 2018), and this longevity advantage persists across all levels of educational attainment (Olshansky et al., 2012). In 2017, white males and females with a 4-year college degree outlived their Black counterparts by 2.4 years (Sasson & Hayward, 2019). At the same time, white females with some college education and white males with a high school education outlived their Black counterparts by 2.2 years (Sasson & Hayward, 2019). Conversely, Hispanic males and females outlived their

white counterparts at every level of education (Olshansky et al., 2012). In 2008, Hispanic males with less than a high school education outlived their white counterparts by nearly 10 years (Olshansky et al., 2012). Currently, there is limited research to show what is contributing to wide and growing education longevity gaps between Blacks and whites, but also between whites and Hispanics.

A recent study assessed age-and cause-specific contributors to change in longevity across race and education groups from 1990 to 2010 (Sasson, 2016a). They found that midlife mortality increased among white females and males with 12 years of education or less, which caused stalls in life expectancy (Sasson, 2016a). The study focused only on nine causes of death, which concealed the contribution of important causes of death like homicide and drug poisoning—a key contributor to education longevity gaps (Ho, 2017). Additionally, the same study found that increased rates of cardiovascular disease, smoking-related, and 'external' cause of death mortality contributed most to education longevity gaps (Sasson, 2016a). These findings are consistent with research showing that those with low levels of education are at higher risk of preventable and behavioral mortality such as homicide, accidents, respiratory disease, and lung cancer (Hummer & Hernandez, 2013). However, it remains unclear how specific causes of death, including homicide and drug poisoning, are contributing to education longevity gaps across sex, race, and ethnic groups in the U.S.

The current study seeks to identify key contributors to education longevity gaps in the U.S. Knowing which causes of death are contributing most to differently-educated groups will help public health stakeholders implement policies and programs that can reduce longevity disparities between advantaged and disadvantaged groups. Additionally,

this investigation seeks to identify specific age groups where different causes of death contribute most to longevity disparities. The detailed results of this study will provide precise cause of death, demographic, and age group targets for public health stakeholders who seek to improve education longevity disparities in the U.S.

Building on existing research, this investigation pursues three aims: First, this study will trace life expectancy at age 25 of non-Hispanic Black, non-Hispanic white, and Hispanic males and females in the U.S. from 2009 to 2016 across three levels of educational attainment (e.g., ≤12, 13-15, and 16+ years of education) so as to determine the size and variation of education longevity disparities over time; second, the investigation will decompose education longevity gaps into specific causes of death at two time periods (e.g., 2009 and 2016) so as to identify causes of death that have made the largest contributions to education longevity disparities; third, this investigation will assess the contribution of specific causes of death across 13 different age groups at the most recent period of time (e.g., 2016) so as to determine where in the life course each cause of death has contributed most to education longevity gaps.

Methods

Data

This study used restricted-access multiple cause of death all-county micro data files from 2008 to 2017, provided by the National Center for Health Statistics (NCHS)

(National Center for Health Statistics, 2018). The restricted nature of these data files differs from public-use mortality data, as deaths with <10 counts are not censored. I used NCHS death counts (D_{ij}) and American Community Survey population estimates (N_{ij}) to calculate death rates ($M_{ij} = D_{ij}/N_{ij}$) for selected subgroups (i) and periods of observation (j) in the United States. The NCHS mortality data files provide complete death counts by period of observation, age, sex, race, ethnicity, and educational attainment. Following previous work (Olshansky et al., 2012), I used 1-year, person-weighted population estimates from the American Community Survey as denominators as they are available by the same demographic characteristics as the death counts – most importantly by educational attainment (U.S. Census Bureau, 2019).

Measures

This study was restricted to non-Hispanic Blacks, non-Hispanics whites, and Hispanics, as these are the three largest race/ethnic groups in the U.S. Together, they make up 92% of the U.S. population, with non-Hispanics Blacks making up 12% of the population, non-Hispanic whites making up 62% of the population, and Hispanics making up 18% of the population (United States Census Bureau, 2016). Other race groups were excluded due to relatively small population sizes which would provide insufficient data for the precise analyses performed in this study (e.g., the number of deaths from liver disease in 2016 among Asian males ages 40-44 with ≤12 years of education). I differentiated Hispanics from non-Hispanics as Hispanics are distinct in terms of socioeconomic characteristics, health outcomes, and longevity (Morales, Lara, Kington, Valdez, & Escarce, 2002; Olshansky et al., 2012).

I stratified the population by sex as males and females differ in their mortality risks and life expectancy (Luy & Gast, 2014; Seifarth et al., 2012). This investigation focused on six sex-race-ethnic groups: non-Hispanic Black males, non-Hispanic Black females, non-Hispanic white males, non-Hispanic white females, Hispanic males, and Hispanic females (hereafter, Black males, Black females, white males, white females, Hispanic males, and Hispanic females). I categorized age into 13 different age groups which included a sequence of five-year age groups from ages 25-29 to 80-84, along with an open-ended age group for 85 and older.

I created three categories for educational attainment: ≤12 years, 13-15 years, and 16+ years, following previous work (Sasson & Hayward, 2019). Having ≤12 years of education reflected having a high school diploma, GED, or less education; having 13-15 years of education reflected having one, two, or three years of college education, or an Associate degree but no 4-year degree; having 16+ years of education reflected having 4 or more years of college education, or a Bachelor's, Master's, or Doctorate degree.

All causes of death were categorized according to the International Classification of Diseases, Tenth Revision (ICD-10) (World Health Organization, 2016), and coded using the Department of Vital Statistics Underlying Cause of Death 358 Recode (Centers for Disease Control and Prevention, 2017b). I included 25 sex-specific causes of death in my analysis that were either, i) leading causes of death in the U.S. for race-ethnic groups in this study (Murphy, Xu J., Kochanek, & Arias E., 2018), or ii) known or suspected causes of death that contribute to racial longevity disparities (Kochanek et al., 2015). These causes of death included: Alzheimer's disease, breast cancer, colorectal cancer, esophageal cancer, liver cancer, lung cancer, pancreatic cancer, prostate cancer (males

only), stomach cancer, all other cancer, cerebrovascular disease, diabetes, heart disease, HIV, homicide, hypertension, influenza and pneumonia, liver disease, nephritis, respiratory disease, septicemia, suicide, drug poisoning, motor vehicle accidents, all other unintentional injuries, and a residual category for all remaining causes. I disaggregated cancer into eight specific types of cancer as they differ in their etiology, prevention, and treatment. Additionally, I disaggregated unintentional injuries into motor vehicle accidents and drug poisoning, as these are the two leading causes of unintentional death (Centers for Disease Control and Prevention, 2021a). A complete coding scheme of all causes of death is included in the appendix (see Appendix A).

Analysis

All analysis for this study was conducted using Microsoft Excel 2016 (Microsoft, 2016). I aggregated death counts (D_{ij}) and population estimates (N_{ij}) into three-year cross-sections of time spanning 2009 (e.g., 2008 to 2010) to 2016 (e.g., 2015 to 2017), in order to account for any random fluctuations in mortality rates (M_{ij}) among each subgroup. When calculating mortality rates, I used death counts and population at-risk estimates for each subgroup. For example, when estimating mortality rates for Black males with 13-15 years of education, I used death counts for Black males with 13-15 years of education in the numerator, and population estimates for Black males with 13-15 years of education in the denominator.

To address the first aim of the investigation (i.e., tracing education longevity gaps from 2009 to 2016), I employed standard demographic methods to generate period life

tables for each sex-race-ethnic-education group (e.g., non-Hispanic Black females with 13-15 years of education) where I derived life expectancy at age 25 from 2009 to 2016 (Preston, Heuveline, & Guillot, 2001). Following existing research on education and longevity, I used life expectancy at age 25 for this study as 25 is generally the age at which adults have completed their education (Meara et al., 2008; Sasson & Hayward, 2019). I utilized graduation techniques to estimate the average person-years lived from ages x to $x+n$ ($_na_x$) in the life tables (Preston et al., 2001). The resulting life expectancies (e_{25}) from the life tables helped display longevity gaps across different levels of educational attainment from 2009 to 2016.

I employed Arriaga's decomposition methods to address the second and third aims of the investigation (Arriaga, 1984), as used in previous studies (Jung-Choi, Khang, Cho, & Yun, 2014; Roberts et al., 2019). This approach allowed me to break down the total life expectancy gap into smaller portions attributable to different causes of death. In addition, this approach allowed me to measure the age-specific contribution of each cause across different age groups. To address the second aim of the investigation (i.e., identify the largest contributors to education longevity gaps), I decomposed life expectancy gaps into portions attributable to 25 sex-specific causes of death, as well as a residual category for all remaining causes of death at two periods of time (e.g., 2009 and 2016). Lastly, to address the third aim of the investigation (i.e., identify where in the life course specific causes of death are contributing most to education longevity gaps), I calculated the total contribution, in years, of each cause of death at each age group from 25-85+ at the most recent period of observation (e.g., 2016).

Results

Table 1 shows unstandardized mortality rates and education prevalence among Black, white, and Hispanic males and females ages 25 and older. Those with ≤12 years of education faced the highest mortality rates. In 2016, males with ≤12 years of education faced a mortality rate of about 1,916 deaths per 100,000 people. Meanwhile, females with ≤12 years of education faced a mortality rate of about 2,085 deaths per 100,000 people. A large portion of Black (50.8%) and Hispanic (63.5%) males had ≤12 years of education, which was greater than their white counterparts (36%). Similar to males, a large share of Black (41.7%) and Hispanic (58%) females had ≤12 years of education, which was again greater than their white counterparts (34%). Among white males and females, 35% each had 16 or more years of education, compared to only 13.8% and 18.3% among Hispanic and Black males, and 16.6% and 23.3% among Hispanic and Black females, respectively.

Aim 1: Determine the size and variation of education longevity gaps over time

White males outlived Black males at every level of education across the study period (see Figure 1). The Black-white longevity gap shrank most among those with ≤12 years of education, from 2.2 years in 2009 to 1.6 years in 2016, while the gap among those with 13-15 years of education shrank by half a year from 2.0 years in 2009 to 1.5 years in 2016 (see Table 2). The Black-white longevity gap was largest among those with 16+ years of education, and shrank just 0.2 years from 2.4 years in 2009 to 2.2 years in 2016.

In contrast, Hispanic males experienced greater longevity than white males at every level of education across the study (see Figure 1). The Hispanic-white longevity

gap was largest among those with ≤12 years of education, where Hispanic males outlived their white counterparts by 7.4 years in 2009, and by 8 years in 2016 (see Table 2). Hispanic males with 13-15 years of education lived about 4 years longer than their white counterparts in both 2009 and 2016. Hispanic males with 16+ years of education outlived their white counterparts by 3 years in 2009 and 1.6 years in 2016.

White females outlived their Black counterparts throughout the study period (see Figure 2). The Black-white longevity gap among females with ≤12 years of education decreased the most by 1.2 years, from 1.6 in 2009 to 0.4 in 2016 (see Table 2). In contrast, the longevity gap increased over time among those with 13-15 years of education (from 2.5 years in 2009 to 2.8 years in 2016) and 16+ years of education (2.3 years in 2009 and 2.7 years in 2016). White females with 13-15 and 16+ years of education had a notable longevity advantage over their Black counterparts.

Similar to males, Hispanic females outlived white females at every level of education throughout the study period (see Figure 2). Hispanic females with ≤12 years of education outlived their white counterparts by 6.9 years in 2009 and 8.3 years in 2016 – a 1.4-year increase in the gap (see Table 2). Among those with 13-15 years of education, Hispanic females outlived white females by approximately 4.5 years in both 2009 and 2016. The Hispanic-white longevity gap among those with 16+ years of education shrank by 1.2 years, from 3.5 years in 2009 to 2.3 years in 2016.

One interesting discovery was that while Black and white males and females with ≤12 and 13-15 years of education experienced declining longevity during the study period, Black and white males and females with 16+ years of education appreciated

steady gains in life expectancy over time, suggesting that highly-educated Black and white males and females in the U.S. may have been impervious to recent national life expectancy declines. This pattern illuminates diverging longevity over time between Black and white males and females with 13-15 and 16+ years of education.

Aim 2: Identify the largest contributors to education longevity gaps in 2009 and 2016

Homicide contributed most to the Black-white longevity gap among males with ≤12 years of education, contributing about 0.8 years to the 2.2-year gap in 2009, and increasing to a 1-year contribution to the 1.6-year gap in 2016 (see Table 3). Heart disease was the leading contributor among males with 13-15 years of education, where it contributed about 0.6 years to both the 2-year gap in 2009, and the 1.5-year gap in 2016. Heart disease was also the leading contributor among males with 16+ years of education, contributing 0.8 years to both the 2.4-year gap in 2009 and the 2.2-year gap in 2016.

Among Black and white females, heart disease was the single largest contributor to longevity gaps across all levels of education (see Table 4). Among females with ≤12 years of education, heart disease contributed 0.8 years to the 1.5-year Black-white longevity gap in 2009, and 0.6 years to the 0.4-year gap in 2016 (other causes of death made negative contributions to the gap, which offset the contribution of heart disease to the total gap). Among females with 13-15 years of education, heart disease contributed about 1 year to both the 2.5-year gap in 2009 and the 2.8-year gap in 2016. Among females with 16+ years of education, heart disease contributed about 0.8 years to both the 2.2-year gap in 2009, and the 2.7-year gap in 2016.

One important finding was the contribution of suicide among white males with ≤12 years of education, respiratory disease among white females with ≤12 years of education, and drug poisoning among both white males and females with ≤12 years of education in 2016, each accounting for a *negative* contribution of half-a-year to the Black-white longevity gap. This negative contribution to the gap reflects higher rates of suicide and drug poisoning among white males and females relative to their Black counterparts, resulting in a Black longevity advantage. This finding highlights the impact of mental health issues and behavioral risks on life expectancy among white males and females with low levels of education.

Because Hispanic males outlived their white counterparts at every level of education, it is important to determine which causes of death contributed to the Hispanic longevity advantage. Heart disease, all cancer, and all unintentional injures made large, *negative* contributions to the Hispanic-white longevity gap among males (see Table 5). This negative contribution indicates that white males experienced mortality from these causes of death at a higher rate than Hispanic males. Among males with ≤12 years of education, heart disease made the largest contribution to the Hispanic-white longevity gap in 2016, -1.9-years to the -7.92-year gap. Among males with 13-15 years of education, all cancer was the largest contributor in 2016, contributing -0.9 years to the -4.0-year longevity gap. Heart disease was the largest contributor to the Hispanic-white longevity gap among males with 16+ years of education, contributing -0.4 years to the -1.6-year gap.

Among Hispanic and white females, all cancer made the largest *negative* contribution to the Hispanic-white longevity gap across all levels of educational

attainment in 2016 (see Table 6), followed by heart disease, and all unintentional injuries. That is to say, all cancer, heart disease, and all unintentional injury mortality was greater among white females than Hispanic females, which resulted in a Hispanic longevity advantage. In 2016, all cancer among females with ≤12 years of education contributed -1.68 years to the -8.31-year longevity gap. All cancer contributed nearly -1 year to the -4.6-year longevity gap among females with 13-15 years of education. Among females with 16+ years of education, all cancer contributed -0.5 years to the -2.27-year longevity gap.

Aim 3: Identify where in the life course causes of death contribute most to longevity gaps

For the sake simplicity, I included three causes of death that contributed most to longevity disparities in Figures 3-6. Complete age- and cause-decomposition tables presenting the contribution of each cause of death at each age group are available in the appendix (see Appendix B – Appendix M). The leading contributors to longevity gaps across groups varied by educational attainment.

Cerebrovascular disease, heart disease, and homicide were leading contributors to the Black-white longevity gap among males with ≤12 years of education in 2016 (see Figure 3). Among males with 13-15 years of education, heart disease, homicide, and diabetes were leading contributors to the longevity gap. Meanwhile, all cancer, diabetes, and heart disease were leading contributors to the longevity gap among males with 16+ years of education. Heart disease contributed most from ages 55-79 across all levels of education, but most notably among those with 16+ years of education. In this age range,

heart disease contributed 0.37, 0.52, and 0.70 years to the longevity gap among males with ≤12 years, 13-15 years, and 16+ years of education, respectively. Black males across all education levels had a longevity advantage from heart disease after age 85 – an indication that heart disease mortality was greater among white males than Black males at the oldest ages. Among males with ≤12 and 13-15 years of education, homicide contributed most at ages <40, where it contributed 0.78 and 0.26 years, respectively.

Among Black and white females with ≤12 years of education, cerebrovascular disease, diabetes, and heart disease were leading contributors to the Black-white longevity gap in 2016 (see Figure 4). Meanwhile, all cancer, diabetes, and heart disease were leading contributors among females with 13-15 and 16+ years of education. Heart disease made the largest contribution at all education levels from ages 55-84. Between these ages, heart disease contributed 0.47, 0.80, and 0.75 years among those with ≤12, 13-15, and 16+ years of education, respectively. After age 85, heart disease made a *negative* contribution of about -0.14 years to the Black-white longevity gap for females with ≤12 and 16+ years of education, but not for females with 13-15 years of education. This negative contribution at the oldest ages reflects higher rates of heart disease mortality among white females relative to Black females, resulting in a Black longevity advantage.

Among Hispanic and white males, all cancer, all unintentional injuries, and heart disease were leading contributors to Hispanic-white longevity gaps across all levels of education in 2016 (see Figure 5). Among males with ≤12 years of education, heart disease made large *negative* contributions to the Hispanic-white longevity gap after age 40, where it contributed -1.81 years. Heart disease made large negative contributions to

the longevity gap after age 80 among males with 13-15 and 16+ years of education, where it contributed -0.62 and -0.32 years, respectively. All cancer also made large negative contributions to the Hispanic-white longevity gap between ages 55 and 74, where it contributed -0.96 and -0.47 years among males with ≤12 and 13-15 years of education, respectively. These negative contributions to the longevity gap reflect higher mortality rates among whites compared to Hispanics, lending to the Hispanic longevity advantage.

Among Hispanic and white females, all cancer, all unintentional injuries, and heart disease were leading contributors to Hispanic-white longevity gaps among those with ≤12 and 13-15 years of education in 2016 (see Figure 6). Among females with 16+ years of education, all cancer, heart disease, and respiratory disease were leading contributors to the Hispanic-white longevity gap. Heart disease made large *negative* contributions after age 85, contributing -0.58, -0.69, and -0.40 years among females with ≤12, 13-15, and 16+ years of education, respectively. The negative contribution of heart disease, all cancer, and all unintentional injuries to the Hispanic-white longevity gap among females lends to the Hispanic longevity advantage we observe.

Discussion

This investigation found that preventable causes of death, including homicide, suicide, drug poisoning, and respiratory disease, contributed most to longevity disparities among the lowest-educated groups in the U.S., particularly at young- and middle-ages. These findings are consistent with existing research showing that individuals with low

levels of education are at greater risk of highly preventable causes of death than those with a college education (Hummer & Hernandez, 2013). Meanwhile, chronic conditions such as heart disease, cancer, and diabetes contributed to longevity disparities among those with a college education at later stages of life. Homicide among young Black and Hispanic males was a leading contributor to longevity disparities, whereas suicide impacted longevity among white males. Drug poisoning was a key contributor to longevity disparities among Black and white males and females, but drug poisoning especially affected low-educated white groups. Hispanic males and females experienced lower rates of heart disease and cancer than their white counterparts, which resulted in a life expectancy advantage across all levels of education.

Homicide was the largest contributor to the Black-white longevity gap among those with ≤12 years of education, contributing most at ages <40. Homicide consistently ranks as a leading cause of death among Black males in the U.S., and is the leading cause of death of young Black males ages 15 to 44 (Centers for Disease Control and Prevention, 2019b). From 2015 to 2017, the homicide rate among all Black males in the U.S. was 40.9 deaths per 100,000 people – 11 times greater than the homicide rate among all white males in the U.S. (Centers for Disease Control and Prevention, 2018a). The risk of homicide is even greater for Black males in Washington, D.C., Illinois, and Missouri, where the homicide rate from 2015 to 2017 was 70.7, 74.2, and 91.1 deaths per 100,000 people, respectively (Centers for Disease Control and Prevention, 2018a). Despite making up <10% of the U.S. population, homicide among Black males accounted for nearly 40% of all homicide mortality in the country from 2015 to 2017 (Centers for Disease Control and Prevention, 2021b). Reducing homicide mortality among Black

males across the U.S., and especially in states and cities experiencing high homicide mortality rates, is an urgent public health issue. Implementing programs and policy to reduce violence, engage at-risk individuals, and promote safe communities could aid in reducing homicide mortality among Black males in the U.S.

Suicide among white males, respiratory disease among white females, and drug poisoning among both white males and females with ≤12 years of education contributed to a Black longevity advantage. The negative contribution of suicide, respiratory disease, and drug poisoning reflects higher rates of these causes among white males and females relative to Black males and females. Accidental drug poisoning, fueled by the opioid pandemic, has become an increasingly important contributor to increased midlife mortality among white males and females and subsequent life expectancy declines in recent years (Acciai & Firebaugh, 2017). Drug overdose rates have more than doubled among all groups in the past 10 years. Drug overdose rates among white males increased from 6.9 deaths per 100,000 people in 2008, to 14.6 deaths in 2018. Drug overdose doubled among white females, from 2.7 to 5.3 deaths per 100,000 people. Among Black males, drug overdose rates more than tripled from 6.6 to 20.1 deaths per 100,000 people from 2008 to 2018. Among Black females, drug overdose increased from 2.6 to 6.4 deaths per 100,000 people (Centers for Disease Control and Prevention, 2018a). Drug poisoning accounted for 25% to 100% of widening educational longevity gaps in the U.S. from 1992 to 2011, particularly among non-Hispanic whites (Ho & Hendi, 2018). Between 1994 and 2010, drug poisoning rates more than tripled among white males and females with a high school education or less (Richardson, Charters, King, & Harper, 2015). Drug poisoning is contributing to widening education longevity disparities in the

U.S. and requires urgent policy and program implementation to quell its effects. One solution is to implement more robust drug monitoring programs to limit misuse and abuse of pharmaceutical opioids, which has been shown to be successful in reducing up to 20% of drug poisoning deaths (Phillips, Ford, & Bonnie, 2017). Reducing behavioral and mental health risk factors including addiction, depression, smoking, and violence, among those with low levels of education could considerably improve education longevity disparities in the U.S.

Heart disease proved to be the leading contributor to Black-white longevity gaps among those with 13-15 and 16+ years of education before age 80. After age 80, Black males and females experienced a considerable longevity advantage as white males and females experienced higher rates of heart disease mortality relative to their Black counterparts at the oldest ages. This health advantage at the oldest ages is well documented (Johnson, 2000; Lariscy, 2017; Yao & Robert, 2011). Black males and females over the age of 80 experience selective survival, as they are healthier and face lower mortality rates than their white counterparts (Yao & Robert, 2011). Individuals with a college education experienced greater longevity than those with less education, resulting from a myriad of socioeconomic benefits which produce favorable health outcomes (Ma, Pender, & Welch, 2016; Perna, 2005; Ross & Mirowsky, 2010). Thus, chronic conditions such as heart disease, cancer and diabetes, as opposed to behavioral and preventable mortality like homicide and drug poisoning, are most likely to affect longevity disparities among well-educated groups, as was found in this study.

While homicide among males, and diabetes among males and females made small contributions to Hispanic-white longevity gaps, heart disease and cancer were responsible

for substantial decreases in the gap, reflecting low rates of heart disease and cancer mortality among Hispanic compared to whites. From 2015 to 2017, all non-Hispanic whites in the U.S. experienced heart disease mortality at a rate of 232 deaths per 100,000 – nearly four times greater than the mortality rate among all Hispanics in the U.S. (Centers for Disease Control and Prevention, 2018a). This is an epidemiological phenomena known as the Hispanic health paradox (Markides & Eschbach, 2005), which postulates that Hispanics have health advantages over non-Hispanic whites, despite having socioeconomic characteristics that we would expect to result in poor health. More research is needed on the topic as existing findings explaining this pattern remain mixed (Balfour Jr, Ruiz, Talavera, Allison, & Rodriguez, 2016). Determining what is contributing to Hispanic longevity advantages could optimistically serve other populations and improve longevity for all groups.

While I did not have access to unfolding COVID-19 mortality data, future research would benefit from employing the methods of this study to measure the total contribution of COVID-19 to life expectancy gaps across age, sex, race, ethnicity, and educational attainment. Just seven months into the pandemic, COVID-19 became the third leading cause of death among adults aged 45 to 84, and the second leading cause of death among adults 85 and older (Woolf, Chapman, & Lee, 2021). In January 2021, a sharp spike in COVID-19 deaths led it to become the number one cause of death in the U.S., costing 3,000 lives, on average, per day (Amin, Cox, Rice, & Dingel, 2021). Early estimates suggest that total U.S. life expectancy will suffer a 1.4-year decline as a result of the COVID-19 pandemic (Andrasfay & Goldman, 2021). Black and Hispanic populations have been disproportionately affected by the COVID-19 pandemic

(Golestaneh et al., 2020; Kirby, 2020; Tai et al., 2021), and are estimated to face longevity declines of 2.7 and 3.7 years, respectively, which are considerably larger than the estimated longevity loss among whites of 0.8 years (Andrasfay & Goldman, 2021). COVID-19 has undoubtedly contributed significantly to widening longevity disparities across sex, race, ethnic, and education groups in the U.S.

This investigation had some notable limitations. I analyzed complete mortality data as was provided to me by the NCHS, which included missing data on educational attainment. On average, about 2% of all U.S. death certificates were missing education, with about 5% of all U.S. death certificates missing education in 2008 and 2009, and about 4% missing education in 2015. Among Black males and females, about 9% of death certificates were missing education in 2008 and 2009, and less than 4% was missing on average throughout the rest of the study period. Missing data due to absent education on death certificates was noticeably higher in 2008 and 2009 than more recent years among all groups, and especially among Black males and females. There was an unexplained spike in missing data in 2015 among all groups due to absent education on death certificates (see Appendix N), a finding that was not identified or noted in previous studies. Education is more often missing or underreported among low-educated Black and Hispanic persons than other race and ethnic groups (Rostron et al., 2010). If, for example, education was most often unreported among the lowest-educated individuals, this may inaccurately produce greater life expectancy of the group as all other individuals have higher levels of education and subsequent life expectancy. Despite some missing education data, the percent missing did not exceed 5%, on average, and thus should not alter the conclusions of this study in a significant way. Future research could elect to

employ imputation techniques to account for missing educational attainment (Sasson, 2016b).

There are also concerns for the validity of educational attainment reported on death certificates. When calculating mortality rates, death certificate data is used as the numerator and population estimate data is used as the denominator. Education is often reported on the death certificate by the next of kin on behalf of the deceased. Thus, death certificates risk education misreporting by next of kin who may be uncertain of the deceased's level of education. Indeed, it is common for those who have not completed high school to have high school graduate falsely reported on their death certificate (Makuc, Feldman, & Mussolino, 1997; Rostron et al., 2010; Sorlie & Johnson, 1996). The misclassification due to misreporting of education on death certificates would be non-differential to the causes of death or age. If bias were to be introduced because of education misreporting, it would be toward the null hypothesis, making the results of this investigation conservative. Future research could address concerns of education misreporting by adjusting for differential education reporting, following previous work (Rostron et al., 2010), which could produce more accurate mortality estimates across different levels of educational attainment.

While there are have been concerns over the accuracy of Hispanic origin reported on death certificates, research has found Hispanic identification to be as accurate as Black and white racial reporting on U.S. death certificates (Arias, Eschbach, Schauman, Backlund, & Sorlie, 2010; Arias, Heron, & Hakes, 2016). By the early 1990's, missing Hispanic origin was <1% across all U.S. (Arias et al., 2010), and Hispanic reporting has

continued to improve over time. By using recent data, there should be few concerns over misclassification of Hispanic populations in the analysis of this study.

Lastly, this study did not account for the effects of migration on life expectancy outcomes. Some immigrant groups experience longer life expectancy than their U.S.-born counterparts. For example, Black immigrants have been found to live about 8 years longer than U.S.-born Black males and females (Singh & Miller, 2004). U.S.-born Black life expectancy may in fact be shorter if I were to exclude Black immigrants from the current analysis, meaning that the current Black life expectancy estimates could be conservative, and that longevity disparities between native-born Blacks and whites may be larger than observed in my investigation. Future research would benefit from stratifying longevity gap analysis by immigrant status, which could describe disparities between U.S.-born Blacks, Hispanics, and whites and immigrant populations.

Despite limitations, this investigation had several strengths. The restricted nature of the death counts used in this study meant that death counts of <10 were not censored, and death counts were complete. Thus, there was no need to use imputation methods to estimate censored death counts from public-use data as other studies have done (Harper et al., 2014b; Riddell et al., 2018). This investigation provided new evidence for the contribution of specific causes of death to longevity disparities, such as lung cancer, homicide, and drug poisoning, whose contributions have been previously concealed in broad cause of death categories (Riddell et al., 2018; Sasson, 2016a; Sasson & Hayward, 2019). Additionally, this investigation identified specific age groups where each cause of death contributed most to longevity disparities, offering target ages where public health policy and programs can be implemented to aid in reducing longevity disparities. Lastly,

by stratifying the analysis by education, I identified how several specific causes of death have varying effects on longevity gaps across educational attainment in the U.S.

Longevity continues to vary by educational attainment and in many cases education longevity gaps are widening over time. The findings of this study provide new evidence which identifies not only specific causes of death and their contribution to longevity disparities, but also different demographic and age groups which are most affected by those specific causes of death. The level of precision these findings offer can inform public health stakeholders to target specific causes of death, among specific demographic groups, at specific stages of life to effectively reduce ongoing longevity disparities. This investigation found homicide to be a key contributor to longevity gaps among young Black and Hispanic males with low levels of education. Conversely, chronic conditions such as heart disease, cancer, and diabetes contributed most to longevity gaps among college-educated Black and white males and females at mid- and later-life. Additionally, respiratory disease, suicide, and most importantly, drug poisoning, led to longevity losses among white males and females without a college education at young- and middle-ages. Public health stakeholders could effectively shrink education longevity disparities in the U.S. by implementing policies aimed at reducing preventable causes of death such as homicide, drug poisoning, and respiratory disease among young, poorly-educated groups, and reducing the risk of chronic diseases among college-educated groups at mid- and later-life.

Tables and Figures

Table 1

Mortality rates and education prevalence among non-Hispanic Black, non-Hispanic white, and Hispanics ages 25 and older by sex, race, ethnicity, and educational attainment in the U.S. in 2016

	Males	Females
Mortality rate*		
Race/ethnicity		
non-Hispanic Black	1290.3	1069.6
non-Hispanic white	1469.4	1379.6
Hispanic	583.8	493.5
Education		
<=12	1915.9	2084.5
13-15	871.7	747.4
16+	846.1	545.2
Education prevalence		
<=12		
Non-Hispanic Black	50.8%	41.7%
Non-Hispanic white	35.9%	34.0%
Hispanic	63.5%	58.0%
13-15		
Non-Hispanic Black	30.9%	35.0%
Non-Hispanic white	29.1%	31.0%
Hispanic	22.8%	25.4%
16+		
Non-Hispanic Black	18.3%	23.3%
Non-Hispanic white	35.0%	35.0%
Hispanic	13.8%	16.6%

*unstandardized mortality rates, per 100,000 persons

Figure 1

Life expectancy at age 25 over time among non-Hispanic Black, non-Hispanic white, and Hispanic males in the United States by educational attainment

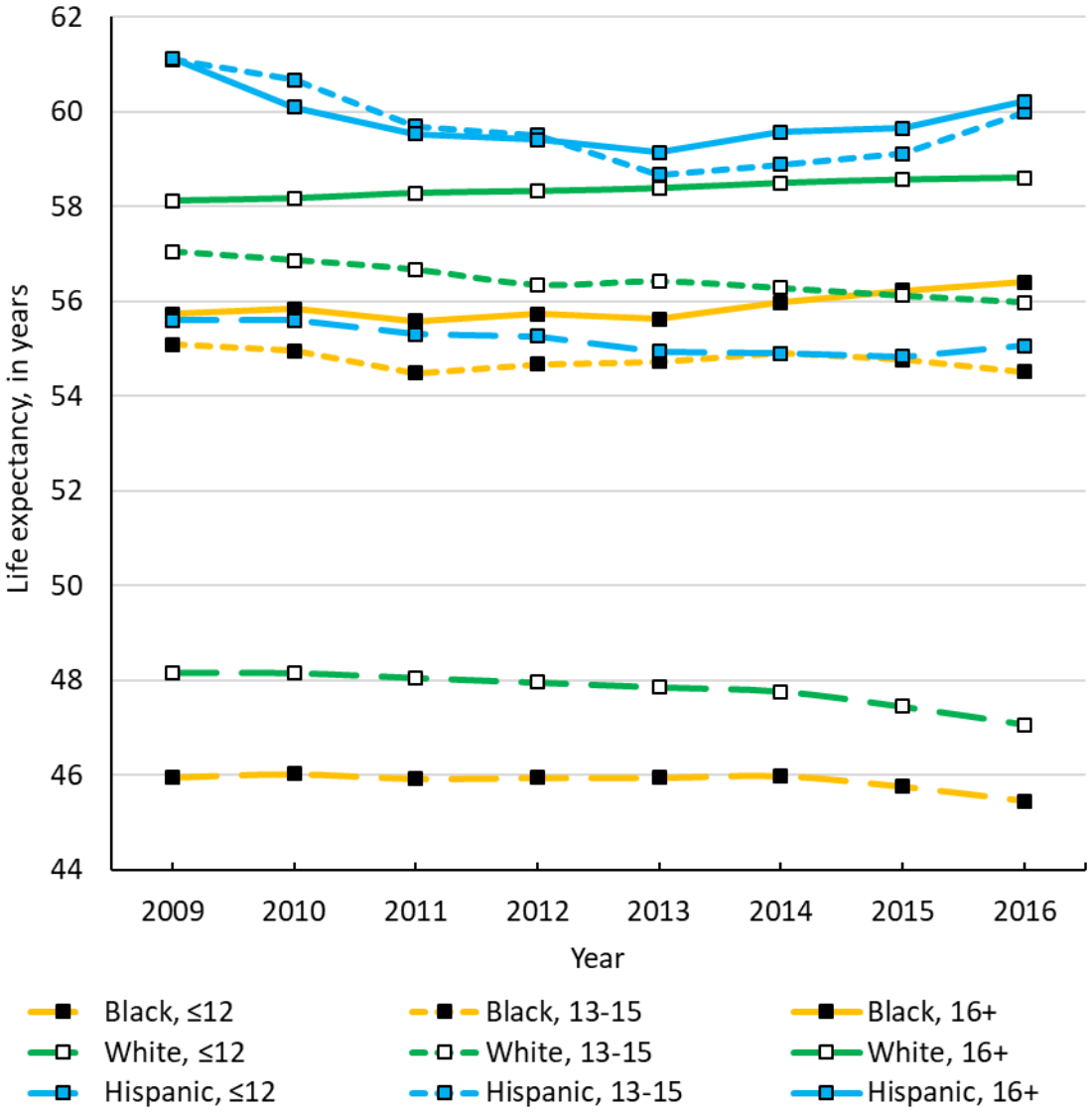


Figure 2

Life expectancy at age 25 over time among non-Hispanic Black, non-Hispanic white, and Hispanic females in the United States by educational attainment

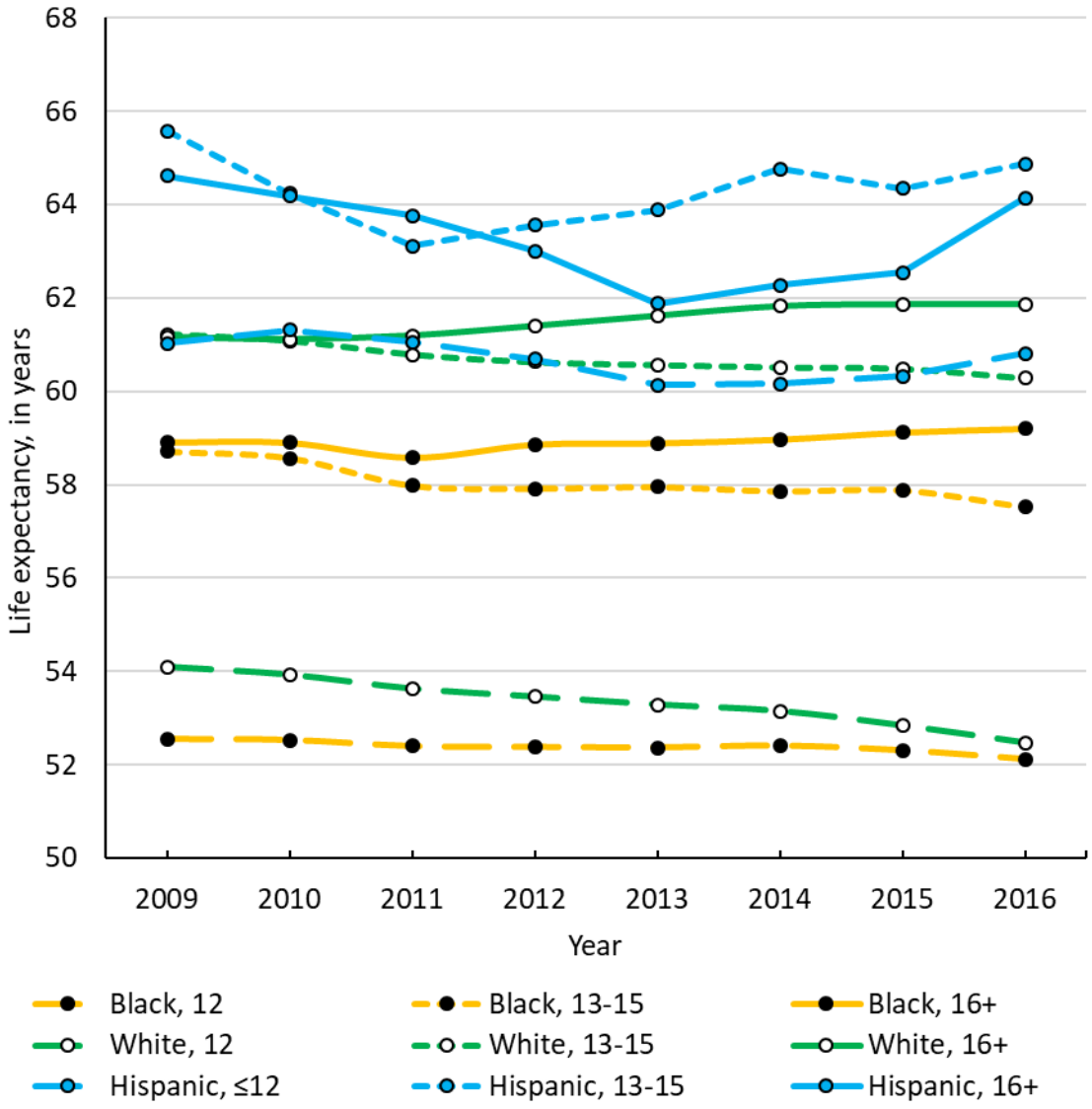


Table 2

Life expectancy gaps in the U.S. by year, sex, race, ethnicity, and educational attainment

	Black-white longevity gap		Hispanic-white longevity gap	
	Males	**Females**	**Males**	**Females**
≤12 years				
2009	2.2	1.6	-7.4	-6.9
2016	1.6	0.4	-8.0	-8.3
Total change	-0.6	-1.2	-0.6	-1.4
13-15 years				
2009	2.0	2.5	-4.1	-4.4
2016	1.5	2.8	-4.0	-4.6
Total change	-0.5	0.3	0.1	-0.2
16+ years				
2009	2.4	2.3	-3.0	-3.5
2016	2.2	2.7	-1.6	-2.3
Total change	-0.2	0.4	1.4	1.2

Table 3

Contribution of 26 causes of death to the longevity gap between non-Hispanic Black and non-Hispanic white males by educational attainment

	2009			2016		
Cause of death	**≤12**	**13-15**	**16+**	**≤12**	**13-15**	**16+**
Alzheimer's disease	-0.03	-0.08	-0.06	-0.02	-0.06	-0.04
All cancer	0.38	0.49	0.54	0.18	0.24	0.40
Breast cancer	0.00	0.00	0.01	0.00	0.00	0.01
Colorectal cancer	0.08	0.13	0.15	0.08	0.08	0.11
Esophageal cancer	-0.01	-0.05	-0.04	-0.05	-0.06	-0.05
Liver cancer	0.07	0.07	0.05	0.07	0.06	0.05
Lung cancer	0.00	0.04	0.09	-0.05	0.00	0.04
Pancreatic cancer	0.03	0.04	0.04	0.02	0.04	0.03
Prostate cancer	0.23	0.34	0.32	0.20	0.27	0.29
Stomach cancer	0.07	0.07	0.07	0.06	0.05	0.06
All other cancer	-0.10	-0.17	-0.15	-0.15	-0.20	-0.14
Cerebrovascular disease	0.29	0.23	0.19	0.30	0.23	0.24
Diabetes	0.22	0.28	0.33	0.23	0.30	0.36
Heart disease	0.61	0.63	0.77	0.58	0.57	0.82
HIV	0.41	0.20	0.18	0.22	0.13	0.10
Homicide	0.76	0.27	0.10	0.99	0.35	0.10
Hypertension	0.14	0.13	0.12	0.14	0.14	0.13
Influenza / pneumonia	0.03	0.03	0.02	0.02	0.02	0.04
Liver disease	-0.10	-0.05	-0.03	-0.16	-0.11	-0.06
Nephritis	0.20	0.21	0.20	0.20	0.21	0.20
Respiratory disease	-0.24	-0.19	-0.07	-0.27	-0.18	-0.04
Septicemia	0.13	0.12	0.13	0.10	0.09	0.10
Suicide	-0.40	-0.24	-0.14	-0.47	-0.30	-0.17
All unintentional injuries	-0.44	-0.20	-0.07	-0.59	-0.27	-0.10
Drug Poisoning	-0.30	-0.10	-0.02	-0.52	-0.21	-0.07
Motor vehicle accidents	-0.06	-0.01	0.05	0.01	0.05	0.06
All other unintentional injuries	-0.07	-0.10	-0.09	-0.08	-0.11	-0.09
All remaining causes	0.20	0.13	0.20	0.16	0.10	0.14
Total e_{25} difference	**2.18**	**1.95**	**2.40**	**1.60**	**1.46**	**2.19**

Note: Values represent the contribution, in years, to the overall life expectancy gap. Some values are negative, reflecting causes that are contributing to a Black advantage over whites.

Table 4

Contribution of 26 causes of death to the longevity gap between non-Hispanic Black and non-Hispanic white females by educational attainment

	2009			2016		
Cause of death	**≤12**	**13-15**	**16+**	**≤12**	**13-15**	**16+**
Alzheimer's disease	-0.12	-0.12	-0.10	-0.10	-0.02	-0.01
All cancer	0.10	0.68	0.58	0.04	0.68	0.73
Breast cancer	0.15	0.24	0.24	0.14	0.25	0.26
Colorectal cancer	0.07	0.13	0.12	0.05	0.10	0.10
Esophageal cancer	0.01	0.01	-0.01	0.01	0.00	-0.01
Liver cancer	0.03	0.03	0.02	0.03	0.03	0.03
Lung cancer	-0.24	0.00	0.04	-0.25	-0.01	0.05
Pancreatic cancer	0.04	0.07	0.07	0.03	0.08	0.08
Prostate cancer	--	--	--	--	--	--
Stomach cancer	0.05	0.06	0.05	0.03	0.05	0.04
All other cancer	-0.01	0.15	0.05	-0.01	0.18	0.17
Cerebrovascular disease	0.25	0.22	0.20	0.22	0.29	0.24
Diabetes	0.37	0.40	0.33	0.32	0.37	0.33
Heart disease	0.78	1.01	0.75	0.59	1.04	0.80
HIV	0.36	0.09	0.05	0.19	0.06	0.03
Homicide	0.09	0.05	0.03	0.09	0.05	0.04
Hypertension	0.17	0.17	0.14	0.14	0.18	0.14
Influenza / pneumonia	0.00	0.03	0.00	-0.02	0.03	0.03
Liver disease	-0.07	-0.03	-0.02	-0.14	-0.07	-0.04
Nephritis	0.29	0.25	0.22	0.23	0.27	0.21
Respiratory disease	-0.44	-0.28	-0.19	-0.48	-0.21	-0.11
Septicemia	0.16	0.18	0.16	0.10	0.14	0.14
Suicide	-0.16	-0.10	-0.06	-0.20	-0.14	-0.08
All unintentional injuries	-0.38	-0.21	-0.11	-0.63	-0.28	-0.13
Drug Poisoning	-0.24	-0.09	-0.02	-0.46	-0.17	-0.03
Motor vehicle accidents	-0.06	-0.01	0.00	-0.06	-0.01	0.01
All other unintentional injuries	-0.08	-0.10	-0.09	-0.11	-0.10	-0.11
All remaining causes	0.16	0.17	0.27	0.00	0.39	0.35
Total e_{25} difference	**1.55**	**2.50**	**2.25**	**0.36**	**2.76**	**2.67**

Note: Values represent the contribution, in years, to the overall life expectancy gap. Some values are negative, reflecting causes that are contributing to a Black advantage over whites.

Table 5

Contribution of 26 causes of death to the longevity gap between Hispanic and non-Hispanic white males by educational attainment

	2009			2016		
Cause of death	**≤12**	**13-15**	**16+**	**≤12**	**13-15**	**16+**
Alzheimer's disease	-0.12	-0.11	-0.12	-0.08	-0.16	-0.07
All cancer	-1.95	-1.05	-0.85	-1.70	-0.90	-0.32
Breast cancer	0.00	0.00	0.00	0.00	0.00	0.00
Colorectal cancer	-0.13	0.01	-0.02	-0.10	-0.04	0.00
Esophageal cancer	-0.10	-0.06	-0.06	-0.11	-0.10	-0.05
Liver cancer	0.05	0.10	0.05	0.04	-0.01	0.06
Lung cancer	-0.96	-0.55	-0.22	-0.79	-0.26	-0.11
Pancreatic cancer	-0.08	-0.04	-0.02	-0.09	-0.05	-0.02
Prostate cancer	-0.07	-0.05	-0.07	-0.05	0.18	0.01
Stomach cancer	0.05	0.06	0.05	0.04	0.03	0.06
All other cancer	-0.71	-0.53	-0.55	-0.65	-0.65	-0.28
Cerebrovascular disease	-0.14	-0.13	-0.14	-0.09	0.00	0.05
Diabetes	0.02	0.13	0.08	-0.02	0.10	0.13
Heart disease	-1.98	-1.16	-0.76	-1.90	-0.85	-0.42
HIV	0.05	0.05	0.05	0.02	0.06	0.03
Homicide	0.07	0.03	0.02	0.05	0.15	0.01
Hypertension	-0.01	0.00	-0.01	-0.01	0.08	0.00
Influenza / pneumonia	-0.08	-0.06	-0.06	-0.10	-0.06	-0.04
Liver disease	0.05	0.06	0.04	0.01	-0.22	0.05
Nephritis	-0.06	-0.02	0.00	-0.06	0.10	0.00
Respiratory disease	-0.73	-0.41	-0.23	-0.76	-0.39	-0.14
Septicemia	-0.07	-0.04	-0.02	-0.09	0.01	-0.01
Suicide	-0.47	-0.23	-0.15	-0.56	-0.42	-0.17
All unintentional injuries	-0.80	-0.33	-0.20	-1.28	-0.74	-0.21
Drug Poisoning	-0.40	-0.12	-0.04	-0.87	-0.36	-0.09
Motor vehicle accidents	-0.20	-0.08	-0.01	-0.20	-0.11	0.01
All other unintentional injuries	-0.19	-0.13	-0.14	-0.21	-0.26	-0.13
All remaining causes	-1.17	-0.76	-0.66	-1.36	-0.78	-0.52
Total e_{25} difference	**-7.38**	**-4.04**	**-2.98**	**-7.92**	**-4.00**	**-1.61**

Note: Values represent the contribution, in years, to the overall life expectancy gap. Some values are negative, reflecting causes that are contributing to a Hispanic advantage over whites.

Table 6

Contribution of 26 causes of death to the longevity gap between Hispanic and non-Hispanic white females by educational attainment

	2009			2016		
Cause of death	**≤12**	**13-15**	**16+**	**≤12**	**13-15**	**16+**
Alzheimer's disease	-0.27	-0.22	-0.28	-0.22	-0.40	-0.13
All cancer	-1.78	-0.98	-0.93	-1.68	-0.96	-0.45
Breast cancer	-0.22	-0.14	-0.17	-0.20	-0.06	-0.07
Colorectal cancer	-0.13	-0.07	-0.03	-0.13	-0.05	0.00
Esophageal cancer	-0.02	-0.01	-0.01	-0.03	-0.02	-0.01
Liver cancer	0.05	0.05	0.02	0.04	-0.02	0.03
Lung cancer	-0.90	-0.51	-0.35	-0.81	-0.32	-0.22
Pancreatic cancer	-0.07	-0.01	-0.05	-0.07	-0.04	-0.01
Prostate cancer	--	--	--	--	--	--
Stomach cancer	0.05	0.06	0.04	0.05	0.02	0.03
All other cancer	-0.53	-0.34	-0.38	-0.54	-0.47	-0.20
Cerebrovascular disease	-0.28	-0.18	-0.24	-0.25	-0.18	0.02
Diabetes	0.13	0.12	0.11	0.04	0.14	0.12
Heart disease	-1.45	-1.00	-0.70	-1.58	-0.65	-0.41
HIV	0.02	0.01	0.01	0.00	0.03	0.00
Homicide	-0.02	0.00	0.00	-0.03	0.00	0.00
Hypertension	-0.01	0.00	-0.03	-0.02	0.08	-0.01
Influenza / pneumonia	-0.09	-0.11	-0.11	-0.14	-0.12	-0.02
Liver disease	0.00	0.04	0.06	-0.10	-0.17	0.02
Nephritis	-0.04	-0.01	-0.03	-0.05	0.12	0.01
Respiratory disease	-0.82	-0.59	-0.31	-0.97	-0.57	-0.26
Septicemia	-0.09	-0.03	0.00	-0.13	0.03	-0.04
Suicide	-0.17	-0.09	-0.06	-0.22	-0.18	-0.07
All unintentional injuries	-0.62	-0.32	-0.16	-1.08	-0.60	-0.19
Drug Poisoning	-0.35	-0.11	-0.03	-0.72	-0.26	-0.05
Motor vehicle accidents	-0.10	-0.04	0.00	-0.13	-0.08	0.00
All other unintentional injuries	-0.17	-0.17	-0.13	-0.23	-0.26	-0.14
All remaining causes	-1.43	-1.01	-0.79	-1.88	-1.16	-0.86
Total e_{25} difference	**-6.91**	**-4.36**	**-3.45**	**-8.31**	**-4.58**	**-2.27**

Note: Values represent the contribution, in years, to the overall life expectancy gap. Some values are negative, reflecting causes that are contributing to a Hispanic advantage over whites.

Figure 3

Age-specific contributions of select causes of death to Black-white male longevity gaps by educational attainment in 2016

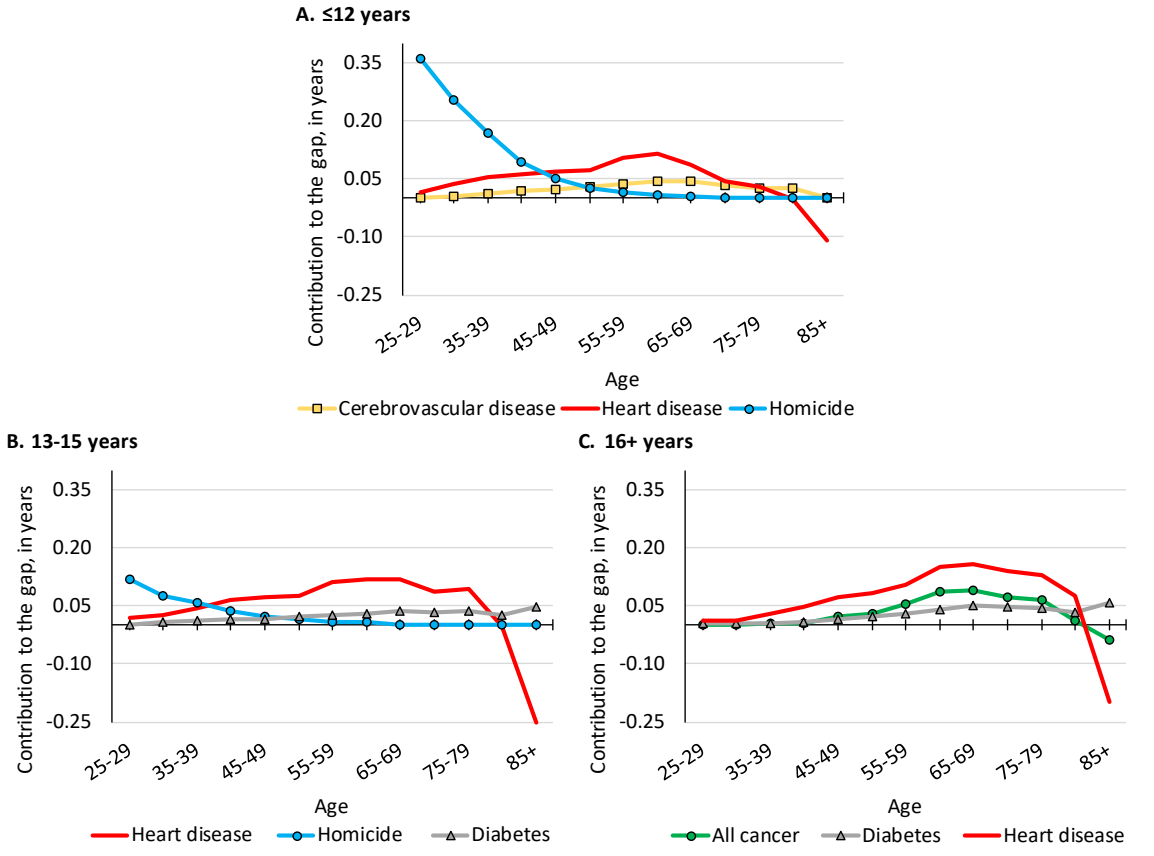


Figure 4

Age-specific contributions of select causes of death to Black-white female longevity gaps by educational attainment in 2016

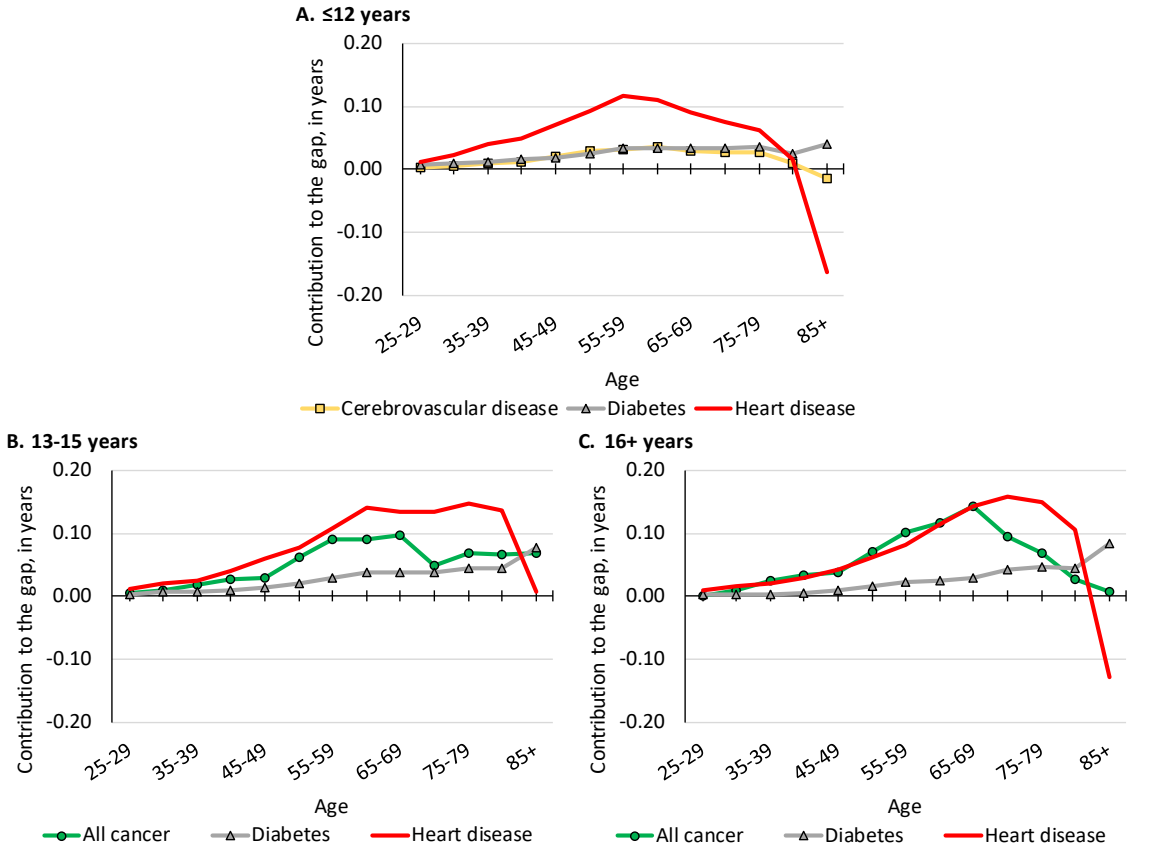


Figure 5

Age-specific contributions of select causes of death to Hispanic-white male longevity gaps by educational attainment in 2016

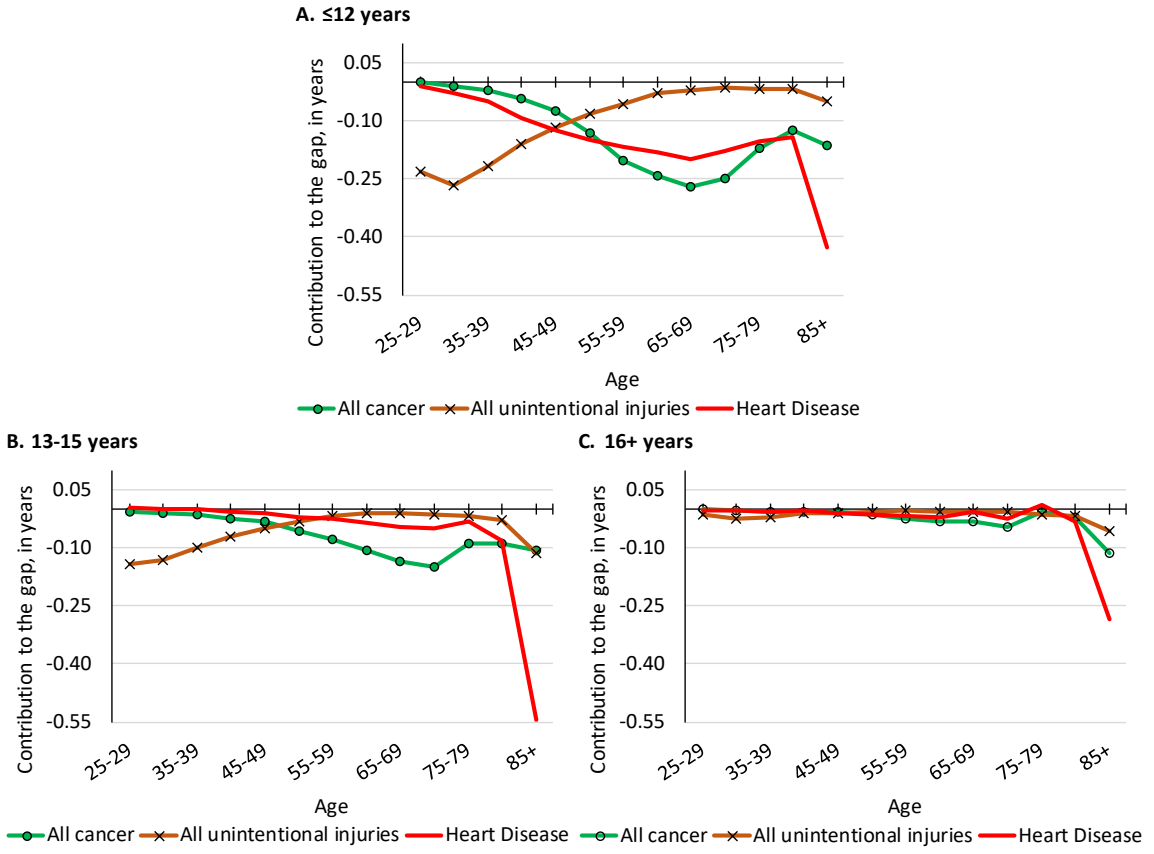
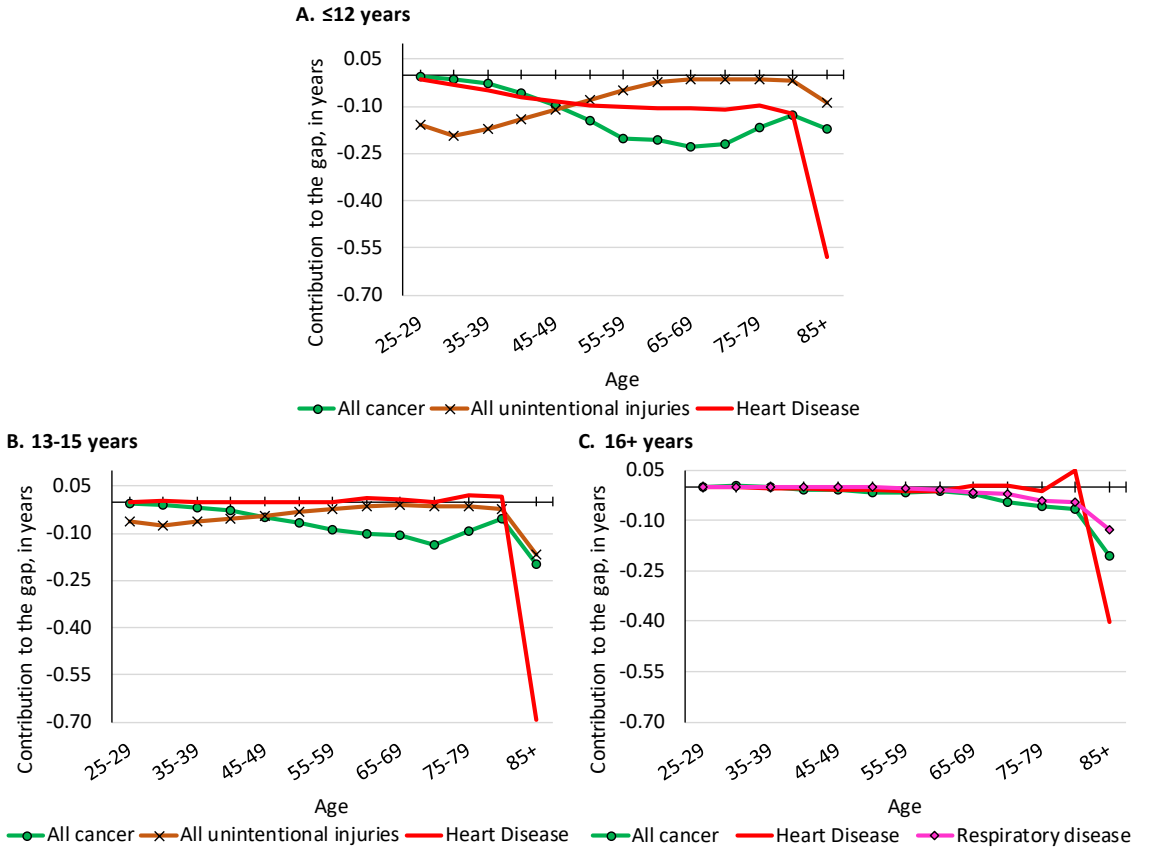


Figure 6

Age-specific contributions of select causes of death to Hispanic-white female longevity gaps by educational attainment in 2016



CHAPTER III

DECLINING LIFE EXPECTANCY IN THE GREAT LAKES REGION: CONTRIBUTORS TO BLACK AND WHITE LONGEVITY CHANGE ACROSS EDUCATIONAL ATTAINMENT

Introduction

Life expectancy in the United States recently declined for the first time since 1993, with losses occurring in three consecutive years from 2014 to 2016 (Acciai & Firebaugh, 2017; Harper et al., 2017; Kochanek et al., 2017; Murphy, Xu J., et al., 2018; Woolf & Schoomaker, 2019; Xu et al., 2016). These longevity losses were not uniform across the country. With the exception of the West South Central Census division, all Census divisions experienced longevity losses from 2014 to 2016. Of special interest in this study, the East North Central Census division (hereafter, the Great Lakes region) experienced a 0.3-year longevity decline – one of the largest life expectancy losses across the nine Census divisions of the U.S. (New England, and the East South Central divisions also experienced a 0.3-year loss) (Woolf & Schoomaker, 2019). The states that make up the Great Lakes region include Illinois, Indiana, Michigan, Ohio and Wisconsin. In both Indiana and Wisconsin, life expectancy declined by 0.3 years, from 77.4 and 79.7 years in 2014, to 77.1 and 79.4 years in 2016, respectively. Ohio experienced an even more dramatic longevity decline of 0.6 years, from 77.6 years in 2014 to 77.0 years in 2016 (Woolf & Schoomaker, 2019). Increased mid-life mortality and excess deaths have driven longevity declines in the U.S. (Acciai & Firebaugh, 2017); from 2010 to 2017, the Great Lakes region accounted for 28% of all excess deaths in the U.S. The longevity

outcomes observed for the total Great Lakes region may be considerably worse among disadvantaged groups, such as Black males and females, and individuals with low levels of education, who typically experience below average life expectancy (Olshansky et al., 2012). This investigation seeks to determine what causes of death contributed most to the large life expectancy losses observed in the Great Lakes region, and where along the life course causes of death contributed most, with particular consideration paid for differences across race and educational attainment.

Life expectancy differences in educational attainment are well documented in the U.S. (Hendi, 2015; Hummer & Hernandez, 2013; Meara et al., 2008; Sasson, 2016a, 2016b; Sasson & Hayward, 2019). There is a clear education gradient in life expectancy, one in which those with the most education live the longest, and those with the least education live relatively shorter lives (Hendi, 2015; Ho, 2017; Meara et al., 2008; Montez et al., 2011). Between 1990 and 2000, those with any college education could expect to live nearly four years longer than those with a high school diploma or less (Meara et al., 2008). More recently, in 2017, highly-educated individuals could expect to live nearly 10 years longer than those with the least amount of education (Sasson & Hayward, 2019). Education differences in life expectancy have grown substantially over time, with highly-educated groups diverging sharply from those with low levels of education.

The education longevity disparity in the U.S. is a function of considerably greater mortality among those with a high school education or less, relative to those with some college, or a college degree (Hummer & Hernandez, 2013). This pattern is also seen among racial groups as well, as white males and females consistently outlive their Black counterparts (Harper et al., 2014b; Riddell et al., 2018). For example, in Wisconsin, white

males and females outlive their Black counterparts by 7 and 5 years (Roberts et al., 2019), respectively, and in Washington, D.C., by 17 and 12 years, respectively (Roberts et al., 2020). Ongoing longevity disparities between advantaged and disadvantaged groups merit further investigation, particularly in places where the average life expectancy of all people is declining.

Individuals with low levels of educational attainment are at particular risk of preventable causes of death that are influenced by behavior, such as homicide, accidents, and smoking-related illnesses (Case & Deaton, 2015; Hummer & Hernandez, 2013). A 2015 study found that the mortality rate for preventative mortality was 90% greater among U.S. adults between the ages of 45 and 64 with less than a high school diploma, compared to those with a college degree (Case & Deaton, 2015). There is evidence to suggest that increased rates of drug use (i.e., drug poisoning, drug overdose) mortality has been a key driver of recent declines in life expectancy from 2014 to 2016 in the U.S. (Acciai & Firebaugh, 2017; Case & Deaton, 2015; Ho, 2017; Sasson & Hayward, 2019). However, additional research indicates that a stagnating decline in cardiovascular disease mortality has affected long-term patterns of stagnating longevity in the U.S. since 2010 (Mehta, Abrams, & Myrskylä, 2020).

Drug poisoning has struck non-Hispanic whites particularly hard in recent years, as well as those with a high school education, for whom drug poisoning accounted for 20% of all deaths in 2011 (Ho, 2017). Other causes of death including heart disease, cancer, and chronic obstructive pulmonary disease (COPD) have been found to be key contributors to increasing educational mortality differences (Meara et al., 2008), with COPD and lung cancer being particularly salient among white females without a college

education. It is important to continue to dissect the impact of specific causes of death in order to identify key contributors to longevity disparities so that targeted interventions can be successful in addressing ongoing longevity disparities.

A recent study estimated life expectancy change in the U.S. by age, cause of death, and educational attainment from 1990 to 2010 (Sasson, 2016a). It found that increased mortality at mid-life was responsible for longevity stalls and declines among white males and females with 12 years of education or less. Conversely, mortality declined among Black males and females over time at every age and education group. The study provides valuable insight into longevity disparities across age and socioeconomic status at the turn of the century, but it is important to renew this investigation at a time when the U.S. is facing longevity declines, especially in a region of the U.S. that has faced considerable reductions in life expectancy. Additionally, the study focused on nine broad cause of death categories such as 'smoking-related diseases', and 'external causes', which conceal the precise contribution of important causes of death such as lung cancer, homicide, and especially drug poisoning, which is purportedly a key driver of recent longevity declines in the U.S.

Recent life expectancy declines in the Great Lakes region warrant further investigation to determine what causes of death are contributing to life expectancy change, and how this change varies by race and educational attainment. This study seeks to determine what causes of death are most culpable for declining life expectancy in the Great Lakes region. Additionally, this study will determine at what ages specific causes of death have contributed most to longevity losses. Measuring these differences across race and education groups will highlight important disparities, which likely require

unique public health interventions for each group. These findings will identify not only specific causes of death, but the demographic and age groups most impacted by them. This information can be used by public health stakeholders to create policies and programs that could help improve unfavorable longevity outcomes among disadvantaged groups in the Great Lakes region.

Building on existing research, this investigation will address longevity change in the Great Lakes region by pursuing three aims. First, this investigation will trace life expectancy at age 25 of non-Hispanic Black and white males and females in the Great Lakes region (e.g., Illinois, Indiana, Michigan, Ohio, Wisconsin) by educational attainment from 2009 to 2016, in order to determine how life expectancy has changed over time. Second, this investigation will decompose within-group change in life expectancy at age 25 from 2009 to 2016 into specific causes of death and across three different levels of educational attainment (e.g., ≤12, 13-15, 16+ years of education) to determine which causes contributed most to change in life expectancy among Black and white males and females. Third, this investigation will assess the contribution of specific causes of death across 13 age categories to identify where across the life course each cause contributed most to within-group change in life expectancy.

Methods

Data

Data for this study were acquired from the National Center for Health Statistics (NCHS) and include 2008-2017 restricted-access multiple cause of death all-county

micro data files (National Center for Health Statistics, 2018). The restricted nature of these files provided uncensored death counts by period of observation, age, sex, race, ethnicity, educational attainment, and cause of death. I used NCHS death counts (D_{ij}) and American Community Survey population estimates (N_{ij}) to calculate death rates ($M_{ij} = D_{ij}/N_{ij}$) for each subgroup (i) and period of observation (j) in the Great Lakes region. The Current Population Survey (CPS) and the American Community Survey (ACS) are two primary sources of educational data in the U.S. Having a larger sample size than the CPS, and inclusion of institutionalized (i.e., group quarters) populations, the ACS is the primary source of education data in the U.S. (Crissey, 2009). Following previous work (Olshansky et al., 2012), I used American Community Survey 1-year, person-weighted population estimates as denominators, which were available by the same demographic characteristics as NCHS data (U.S. Census Bureau, 2019).

Measures

This investigation focused on non-Hispanic whites and non-Hispanic Blacks as they are the two largest race groups in the Great Lakes region, making up 80% and 12% of the total population, respectively (United States Census Bureau, 2016). Due to the precision of the analyses in this study (i.e., the number of deaths from hypertension in 2016 among non-Hispanic Black females ages 45-49 with 13-15 years of education), other race groups were excluded as there would be insufficient data to produce meaningful results. I stratified my analysis by sex, as males and females tend to experience differing mortality regimes (Luy & Gast, 2014; Seifarth et al., 2012). The

investigation thus focused on four race-sex groups: non-Hispanic Black females, non-Hispanic Black males, non-Hispanic white females, and non-Hispanic white males (hereafter, Black females, Black males, white females, and white males).

I categorized age into 13 different groups which included a series of five-year age intervals from 25-29 to 80-84, and an open-ended category for ages 85 and older. Following previous work, I categorized educational attainment into three groups: ≤12 years, 13-15 years, and 16+ years of education (Sasson & Hayward, 2019). Those with ≤12 years of education included anyone with a high school diploma, GED, or less education. Those with 13-15 years of education included anyone who has completed one, two, or three years of college education, or has an Associate degree but does not have a 4-year college degree. Lastly, those with 16+ years of education included anyone that has 4 years of college education or more, or has a Bachelor's, Master's, or Doctorate degree.

I included 24 sex-specific causes of death in my analysis that are leading causes of death among Blacks and whites, as well as causes of death that contribute to education-related mortality disparities (Hummer & Hernandez, 2013; Meara et al., 2008; Murphy, Xu, Kochanek, & Arias, 2018). These causes of death include: Alzheimer's disease, breast cancer, colorectal cancer, esophageal cancer, liver cancer, lung cancer, pancreatic cancer, prostate cancer (males only), all other cancers, chronic lower respiratory disease, cerebrovascular disease, diabetes, heart disease, HIV, homicide, hypertension, influenza and pneumonia, liver disease, nephritis, septicemia, suicide, drug poisoning, motor vehicle accidents, all other unintentional injuries, and a residual category for all remaining causes of death. I disaggregated all cancer into seven specific types of cancer, as cancers differ in their etiology, prevention, and treatment. Stomach

cancer was excluded as mortality rates were relatively low, and thus unlikely to have a notable contribution to life expectancy change in the region. Additionally, I disaggregated unintentional injuries into drug poisoning and motor vehicle accidents, as these are the two leading forms of accidental death which require different public health interventions to reduce their risks (Centers for Disease Control and Prevention, 2021a). All causes of death were categorized in accordance with the International Classification of Disease, Tenth Revision (ICD-10) (World Health Organization, 2016), and were coded using the Department of Vital Statistics 358-recode (Centers for Disease Control and Prevention, 2017b). A complete coding scheme of all causes of death for the study can be found in the appendix (see Appendix O).

Analysis

Analyses for this study were conducted using Microsoft Excel 2016 (Microsoft, 2016). Using data from 2008 to 2017, I aggregated three years of death counts (D_{ij}) and population estimates (N_{ij}) into single cross-sectional periods of observation spanning from 2009 (i.e., 2008 to 2010) to 2016 (i.e., 2015 to 2017), in order to reduce random year-to-year fluctuations in mortality rates (M_{ij}).

To address the first aim of the investigation (i.e., determine how life expectancy has changed over time in the Great Lakes region), I employed period life table analysis to calculate life expectancy at age 25 for each race-sex-education group (e.g., Black females with 16+ years of education). Following previous work, I analyzed life expectancy at age 25 (e_{25}) as this is the age at which most adults have completed their education (Meara et

al., 2008; Sasson & Hayward, 2019). I employed iterative graduation techniques to the life tables to estimate the average person years lived (${}_{n}a_{x}$) for persons living from age x to $x+n$. The results from this analysis (e.g., e_{25}) helped to generate visualization of changing life expectancy at age 25 from 2009 to 2016 in the Great Lakes region across different sex-race-education groups.

I employed Arriaga's decomposition methods in order to address the second and third aims of the investigation, following previous work (Hendi, 2015; Jung-Choi et al., 2014; Roberts et al., 2019). This approach allowed me to break down the total change in life expectancy from 2009 to 2016 into smaller portions attributable to several different causes of death. To address the second aim of the investigation (i.e., determine which causes of death contributed most to life expectancy change), I decomposed the change in life expectancy from 2009 to 2016 into portions attributable to 24 causes of death for each subgroup. To address the third aim of the investigation (i.e., identify where across the life course each cause of death contributed most to change in life expectancy), I calculated the total contribution, in years, of each cause of death across 13 age categories for each subgroup.

Results

Table 7 shows unstandardized mortality rates and education prevalence among Black and white males and females ages 25 and older. Black males in the Great Lakes region had higher overall mortality rate than white males, while white females had higher overall mortality rate than Black females. Black and white males and females with ≤12

years of education had the highest overall mortality rates of all three education groups. In 2016, Black and white males with ≤12 years of education faced a mortality rate of 2,412 deaths per 100,000 people, which was three times greater than the mortality rates among Black and white males with 13-15 or 16+ years of education. Black and white females with ≤12 years of education faced a mortality rate of 2,627 deaths per 100,000 people, which was more than three times greater than the mortality rate of Black and white females with 13-15 years of education (747 deaths per 100,000 people), and nearly five times greater than the mortality rate of Black and white females with 16+ years of education (554 deaths per 100,000 people). More than half of Black males in the Great Lakes region had ≤12 years of education, while only 15% had 16+ years of education. Meanwhile, about 40% of white males had ≤12 years of education, and 31% had 16+ years of education. Among Black females, 41% had ≤12 years of education, and 20% had 16+ years of education. About 38% of white females had ≤12 years of education, while 31% had 16+ years of education.

Aim 1: Determine how life expectancy at age 25 has changed over time in the Great Lakes region

Although life expectancy decline in both the Great Lakes region and the United States as a whole began only in 2015, some groups in the Great Lakes region experienced this decline much earlier. Longevity decline among white males with ≤12 years of education started in 2011, while declines began in 2012 among white males with 13-15 years of education (see Figure 7). White females with ≤12 years of education began to see their life expectancy decline in 2010, while white females with 13-15 years of education began seeing declines in 2011 (see Figure 8). Black males and females with

≤12 years of education saw their life expectancy begin to decline in 2013 and 2012, respectively, while Black females with 13-15 years of education experienced longevity declines in 2011. The highest-educated white males, white females, and Black females, all experienced life expectancy gains over the study period.

From 2009 to 2016, white males with ≤12 and 13-15 years of education experienced the largest longevity declines among all males: 1.3- and 1.1-year reductions, respectively (see Table 8). White males with 16+ years of education, however, experienced a gain of half a year from 2009 to 2016. All Black males experienced longevity declines over time. Life expectancy among Black males with 13-15 years of education shrank by nearly 1 year, whereas Black males with ≤12 years of education had their life expectancy shrink by just over half a year. Black males with 16+ years of education experienced a 0.4-year decrease in their life expectancy.

Similar to males, white females with ≤12 years of education experienced a large decrease in life expectancy of 1.7 years, while white females with 13-15 years of education had their life expectancy decrease by 0.8 years (see Table 8). White females with 16+ years of education appreciated a 0.7-year increase in life expectancy between 2009 and 2016. Black females with 13-15 years of education experienced the greatest loss of life expectancy, losing 2.2 years from 2009 to 2016. Black females with 16+ years of education experienced a 0.1-year increase over time.

Aim 2: Determine which causes of death contributed most to change in life expectancy across educational attainment over time

Homicide was responsible for a 0.34-year loss of life expectancy from 2009 to 2016 among Black males with ≤12 years of education, followed by drug poisoning, which contributed a 0.25-year longevity loss (see Table 9). Drug poisoning contributed a 0.30-year longevity loss among Black males with 13-15 years of education, followed by homicide, which contributed a 0.13-year loss. Heart disease among Black males with 16+ years of education contributed to a longevity loss of 0.12 years. Among white males, drug poisoning contributed most to longevity declines across all education levels, but especially among those with ≤12 years of education, where it contributed a 0.92-year loss of life expectancy. Among white males with 13-15 years of education, drug poisoning contributed a 0.35-year longevity loss, while it contributed a 0.07-year loss among those with 16+ years of education. Suicide was another notable contributor to longevity loss among white males, particularly among those with ≤12 and 13-15 years of education, where it contributed 0.10- and 0.13-year losses, respectively.

Among Black females with ≤12 years of education, drug poisoning contributed most to longevity losses over time, contributing a 0.31-year loss (see Table 10). Heart disease contributed a 0.50-year longevity loss among Black females with 13-15 years of education. Alzheimer's disease contributed a 0.34-year longevity loss among Black females with 16+ years of education, and a 0.31-year loss among those with 13-15 years of education. Similar to white males, drug poisoning was the main culprit for decreasing longevity among white females, but especially among those with ≤12 and 13-15 years of education. Drug poisoning contributed a 0.65-year loss of life expectancy among white females with ≤12 years of education, and a 0.21-year loss for those with 13-15 years of

education. Alzheimer's disease was responsible for longevity losses among white females with ≤12 (0.12 years), 13-15 (0.16 years), and 16+ (0.08) years of education.

Aim 3: Identify where in the life course each cause of death contributed most to life expectancy change

For ease of interpretation, I only included three leading contributors to life expectancy change by educational attainment in Figures 9 through 12. Complete age- and cause-decomposition tables presenting the contribution of each cause of death for each age group are available in the appendix (see Appendix P – Appendix AA).

Homicide among Black males with ≤12 years of education made the largest contribution to longevity decline at ages 25-39, where it contributed a 0.31-year loss (see Figure 9, panel A). Among Black males with 13-15 years of education, drug poisoning contributed a 0.15-year longevity loss from ages 45-64 (see Figure 9, panel B). Heart disease among Black males with 13-15 years of education made a notable contribution of 0.11 years at ages 75-79. Black males with 16+ years of education gained >0.10 years of life expectancy due to improvements in heart disease at ages 55-59, and ages 75-79, but lost 0.41 years from heart disease after age 80 (see Figure 9, panel C). Among Black females with ≤12 years of education, drug poisoning contributed a 0.15-year decrease from ages 25-39, and another 0.12-year decrease from ages 45-59 (see Figure 10, panel A). Black females with 13-15 years of education saw their life expectancy decline most from heart disease and Alzheimer's disease at age 85, where they contributed a 0.36-year, and 0.28-year longevity decrease, respectively (see Figure 10, panel B). Alzheimer's

disease also made a notable 0.30-year contribution at age 85+ among Black females with 16+ years of education (see Figure 10, panel C).

Drug poisoning among white males with ≤12 years of education made a considerable 0.80-year contribution to longevity decline before the age of 50 (see Figure 11, panel A). The contribution of drug poisoning was also evident among white males with 13-15 years of education, where it contributed a 0.31-year decrease before age 50 (see Figure 11, panel B). Similar to males, drug poisoning among females was responsible for longevity losses at relatively young ages, contributing a 0.57-year longevity decline before age 50 (see Figure 12, panel A). Among white females with 13-15 years of education, drug poisoning made smaller, yet notable contributions to longevity declines before age 40. Alzheimer's disease among those with 13-15 years of education contributed a 0.12-year decrease at the oldest stage of life (see Figure 12, panel B). Among white females with 16+ years of education, Alzheimer's disease contributed a small 0.08-year longevity decline after age 80 (see Figure 12, panel C).

Discussion

This study found that all groups in the Great Lakes region with some college education or less experienced declining life expectancy over the study period. Large losses were experienced by the lowest-educated white males and females. Black males and females with some college education experienced large longevity losses over the study period, followed by Black males and females with a high school education or less. Homicide was the leading contributor to longevity declines among Black males with a

high school education or less, particularly at younger ages. Drug poisoning was the leading contributor to declining life expectancy among the lowest-educated groups, but especially among low-educated white males and females. Drug poisoning was also a major contributor to longevity declines among Black and white males with some college education, and white females with some college education. Lastly, Alzheimer's disease was a major contributor to longevity declines among older, highly-educated Black and white females. These findings are consistent with existing research showing that key drivers of national life expectancy declines are drug poisoning among males and mental illnesses for women (Acciai & Firebaugh, 2017).

Drug poisoning was a leading contributor to life expectancy declines in the Great Lakes region among all sex and race groups. However, the contribution of drug poisoning to longevity declines was substantially greater among those with ≤12 and 13-15 years of education, and especially among white males and females. Rising drug poisoning mortality has been driven by the opioid epidemic in the U.S. (Lyden & Binswanger, 2019; Manchikanti et al., 2012). Between 2015 and 2017, there were more than 9,700 drug poisoning deaths among white males in the Great Lakes region, resulting in a mortality rate of 18.8 deaths per 100,000 people (six deaths greater than white males in the rest of the U.S.), while the drug poisoning mortality rate was 7.2 death per 100,000 among white females (nearly three deaths more than white females in the rest of the U.S.) (Centers for Disease Control and Prevention, 2021b). Among Black males in the Great Lakes region, the mortality rate from drug poisoning was nearly 30 deaths per 100,000, which was 17 deaths greater than the drug poisoning mortality rate faced by Black males in the rest of the U.S. Black females in the Great Lakes region faced a drug poisoning

mortality rate of nearly 10 deaths per 100,000 people (six deaths more than Black females in the rest of the U.S.) (Centers for Disease Control and Prevention, 2021b). These mortality rates highlight not only the severity of recent drug poisoning deaths in the Great Lakes region, but also the disproportionate impact drug poisoning has on Black communities. While the opioid epidemic in the U.S. has been framed as a serious issue among poorly-educated whites, its impact on Black communities has largely been overlooked. Drug overdose deaths among Black males and females has risen at a much faster rate than white males and females in recent years (James & Jordan, 2018), and in several states drug overdose rates among Black people are greater than the national average (Jordan et al., 2021).

Research shows that a robust state-level prescription drug monitoring program could be effective in reducing nearly 20% of opioid overdose deaths (Pardo, 2017). More robust programs could monitor opioid prescriptions for patients and help prevent abuse and misuse that is commonly leading to overdose mortality. Other strategies to the hinder impact of the opioid epidemic include education of the risks of opioids for patients, making overdose-preventing medication like Naloxone more widely accessible, and limiting supply on the market through regulation and restriction of pharmaceutical products (Phillips et al., 2017).

Homicide was a major contributor to life expectancy decline among low-educated Black males at ages <40. The risk of homicide is much greater for Black males residing in the Great Lakes region than the rest of the U.S. From 2015 to 2017, Black males in the Great Lakes region faced a homicide rate of 61 deaths per 100,000 people, compared to 37.6 deaths per 100,000 people among Black males in the rest of the U.S. (Centers for

Disease Control and Prevention, 2018a). Homicide mortality is greatest among Black males in Illinois, where there were 74 deaths per 100,000 people from 2015 to 2017. The large contribution of homicide to declining longevity among young, low-educated Black males in the Great Lakes region underscores the public health need to reduce violence among young Black males. Efforts to deter violent behavior should be made at young ages as to avoid risky lifestyles in adulthood. The CDC offers recommendations to curb youth violence including programs to strengthen parenting skills and family relationships, providing quality education, mentorship and after-school programs, and community-based outreach programs (Centers for Disease Control and Prevention, 2020).

In addition to drug poisoning, heart disease among Black females, and Alzheimer's disease among both Black and white females proved to be key contributors to longevity declines. The contribution of Alzheimer's disease was particularly noticeable among Black females with 13-15 and 16+ years of education. Conditions such as high blood pressure, diabetes, and high cholesterol increase the risk of developing heart disease, and these same conditions can also increase the risk of developing Alzheimer's disease. There is evidence to suggest that up to 80% of people dying from Alzheimer's disease also suffer from heart disease (Alzheimer's Association, 2021). Regular exercise to increase blood and oxygen to the brain, maintaining a healthy diet, and keeping intellectually active at middle- and late-stages of help can help reduce the risk of developing Alzheimer's disease (Alzheimer's Association, 2021).

There were some notable limitations in this investigation. There are concerns over the accuracy of educational attainment reported on death certificates, as they are completed by next of kin who may inaccurately report the education of the deceased.

Previous studies have found that it is common to misclassify an individual that did not complete 4 years of high school as having completed 4 years of high school (Makuc et al., 1997; Rostron et al., 2010). However, Black and Hispanic individuals with a high school education are more likely to have their education underreported as having less than 12 years of education, compared to other racial and ethnic groups (Rostron et al., 2010). Additionally, those with some college, but no Bachelor's degree have been reported as having 4 years of high school completed on their death certificate (Makuc et al., 1997; Rostron et al., 2010; Sorlie & Johnson, 1996). This is problematic as widespread inaccuracies in education reporting on death certificates could suggest larger educational longevity disparities.

Given the large regional scope of this study, education misreporting is unlikely to have influenced longevity outcomes in a significant way. Despite the risk of education misreporting, death certificates remain a valuable source of vital statistics and the most complete source for mortality data in the U.S., providing detailed mortality data by age-at-death, cause of death, race, ethnicity, sex, and educational attainment. Thus, we should continue to rely on death certificates to measure mortality trends and inform public health policy, programs, and initiatives. Nevertheless, it is important to acknowledge the risks of misreporting and account for these limitations whenever possible. Future research could benefit by adjusting for differential education reporting, which could improve mortality estimates across educational attainment (Rostron et al., 2010).

Lastly, future research could benefit by accounting for immigrant populations when estimating life expectancy. The current analysis neither excluded nor stratified the population by immigrant status. Thus, immigrant groups are included among Black and

white males and females. Black immigrants have been found to live nearly 8 years longer than their U.S.-born counterparts (Singh & Miller, 2004). However, Black immigrants make up only 3.5% of all Blacks residing in the Great Lakes region (United States Census Bureau, 2016). Thus, the current findings are unlikely to change substantially if Black immigrants were to be excluded.

Despite these limitations, this investigation had several strengths. Using restricted, uncensored death counts eliminated the need to employ imputation techniques to estimate life expectancy, as other studies have done (Harper et al., 2014b; Riddell et al., 2018). Measuring the contribution of specific causes of death, such as Alzheimer's disease, drug poisoning, and homicide, revealed important contributors to longevity decline that have previously been concealed in broad cause of death categories used in other studies (Sasson, 2016a). Additionally, measuring contributors across different age groups produced new evidence as to where along the life course causes of death are contributing most to longevity declines, providing public health stakeholders with target demographic and age groups to implement interventions to reduce declining life expectancy and longevity disparities.

This investigation provides new evidence to explain longevity change in the Great Lakes region by sex, race, and educational attainment that until now was unavailable. Findings for the Great Lakes region may have implications for other parts of the U.S. as well, where life expectancy has stalled or declined, and where longevity disparities persist across groups. This study has quantified the exact contribution of specific causes of death to longevity changes, and pinpointed where in the life course each cause of death has contributed most to those changes. This study identified drug poisoning as a major

contributor to declining life expectancy in the Great Lakes region across all sex and race groups, but especially among the lowest-educated Black and white males and females. Homicide among young Black males without a 4-year college degree was another key driver of longevity losses. Additionally, Alzheimer's among Black and white females was culpable for longevity losses at older ages, especially among Black females with 13-15 and 16+ years of education, and white females with 13-15 years of education. The findings from this study identify key at-risk demographic and age groups that public health stakeholders can target with policies to improve longevity outcomes in the Great Lakes region. Public health stakeholders could address declining life expectancy in the Great Lakes region by implementing programs aimed at reducing drug poisoning mortality among all groups, but especially those without a college degree, reducing violence and homicide among young, low-educated Black males, and promoting healthy lifestyles at older ages to prevent the onset of Alzheimer's disease among females.

Tables and Figures

Table 7

Mortality rates and education prevalence among non-Hispanic Blacks, and non-Hispanic whites ages 25 and older by sex, race, ethnicity, and educational attainment in the Great Lakes region in 2016

	Males	Females
Mortality rate*		
Race/ethnicity		
non-Hispanic Black	1504.1	1228.8
non-Hispanic white	1491.0	1433.1
Education		
<=12	2412.2	2627.3
13-15	875.3	747.1
16+	827.5	553.9
Education prevalence		
<=12		
Non-Hispanic Black	51.4%	41.3%
Non-Hispanic white	39.7%	37.7%
13-15		
Non-Hispanic Black	33.3%	38.2%
Non-Hispanic white	29.6%	31.0%
16+		
Non-Hispanic Black	15.3%	20.5%
Non-Hispanic white	30.7%	31.3%

*unstandardized mortality rates, per 100,000 persons

Figure 7

Life expectancy at age 25 over time of non-Hispanic Black and non-Hispanic white males in the Great Lakes region by educational attainment

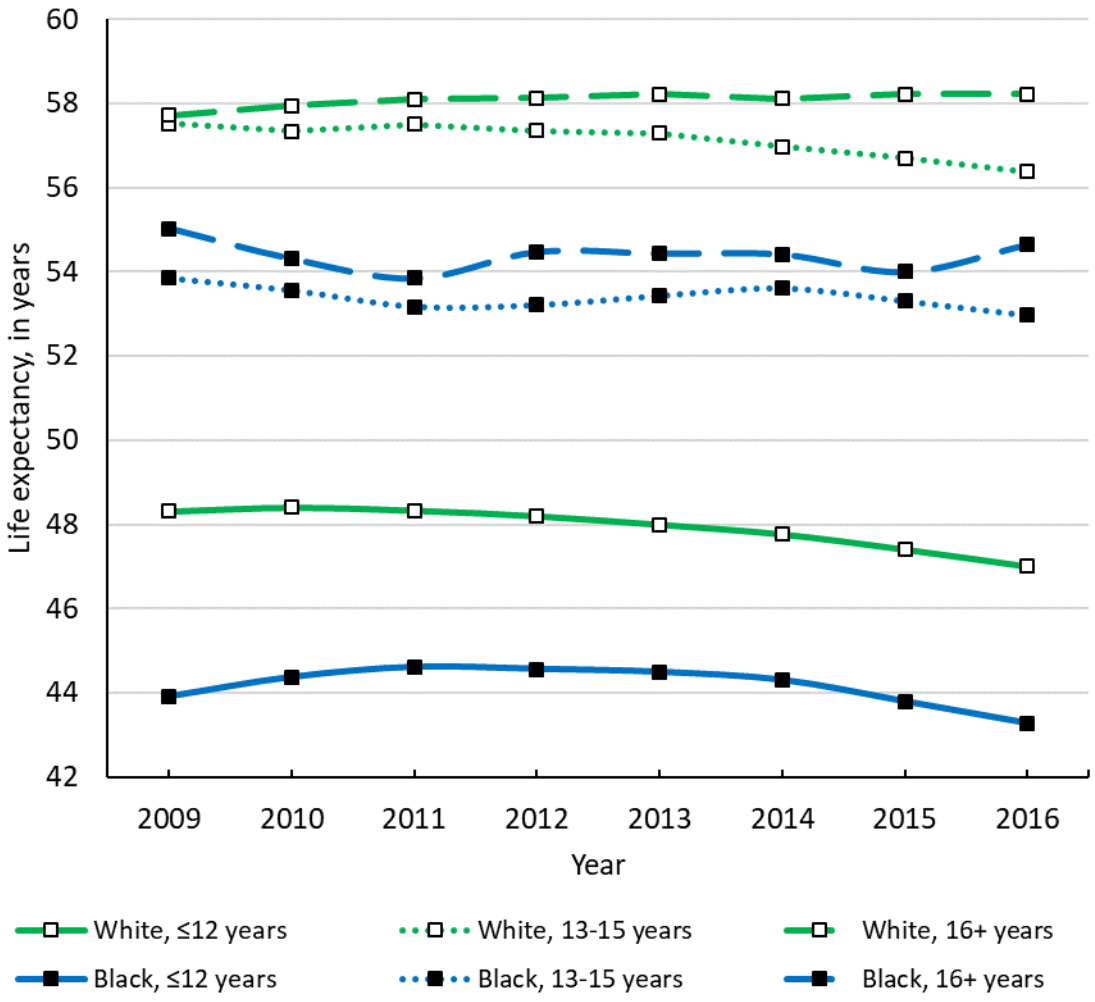


Figure 8

Life expectancy at age 25 over time of non-Hispanic Black and non-Hispanic white females in the Great Lakes region by educational attainment

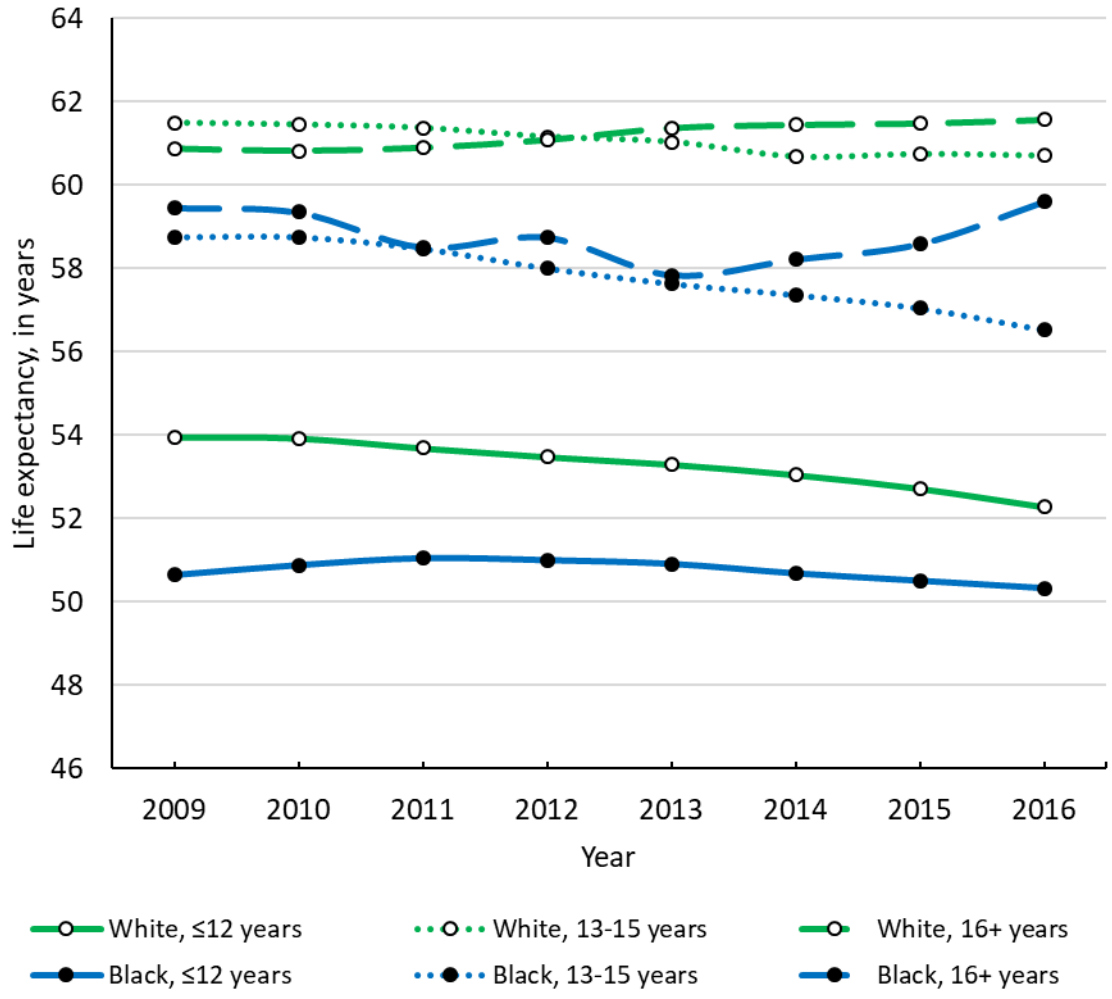


Table 8

Life expectancy at age 25 in the Great Lakes region by year, sex, race, ethnicity, and educational attainment

	Black life expectancy		White life expectancy	
	Males	**Females**	**Males**	**Females**
≤12 years				
2009	43.9	50.7	48.3	54.0
2016	43.3	50.3	47.0	52.3
Total change	-0.6	-0.3	-1.3	-1.7
13-15 years				
2009	53.9	58.8	57.5	61.5
2016	53.0	56.5	56.4	60.7
Total change	-0.9	-2.2	-1.1	-0.8
16+ years				
2009	55.0	59.5	57.7	60.9
2016	54.6	59.6	58.2	61.6
Total change	-0.4	0.1	0.5	0.7

Table 9

Contribution, in years, of specific causes of death to change in life expectancy from 2009 to 2016 among non-Hispanic Black and non-Hispanic white males in the Great Lakes region by educational attainment

	Black			White		
Cause of death	**≤12**	**13-15**	**16+**	**≤12**	**13-15**	**16+**
Alzheimer's disease	-0.01	-0.05	-0.02	0.00	-0.06	-0.06
All cancer (malignant neoplasms)	0.13	0.15	0.28	-0.02	0.13	0.52
Breast	0.00	0.00	0.00	0.00	0.00	0.00
Colorectal	0.01	0.04	0.04	-0.02	0.02	0.05
Esophageal	0.01	-0.01	0.02	0.01	0.00	0.02
Liver	0.00	-0.01	-0.03	0.00	-0.02	0.00
Lung	0.07	0.11	0.17	0.02	0.11	0.20
Pancreatic	0.00	-0.02	0.07	0.00	-0.02	0.01
Prostate	0.03	0.04	-0.01	-0.02	0.02	0.05
All other cancers	0.01	0.00	0.02	-0.01	0.01	0.19
Chronic lower respiratory disease	0.01	-0.01	-0.03	-0.03	-0.04	0.05
Cerebrovascular disease	0.01	0.01	0.00	-0.03	-0.02	0.05
Diabetes	-0.01	-0.01	-0.06	-0.01	-0.05	0.01
Heart disease	0.03	-0.10	-0.12	-0.02	-0.09	0.20
HIV	0.04	0.08	0.10	0.01	0.00	0.01
Homicide	-0.34	-0.13	0.01	-0.02	-0.01	0.00
Hypertension	-0.01	-0.04	-0.02	0.00	-0.02	-0.02
Influenza and pneumonia	0.00	0.03	0.01	-0.02	0.02	0.03
Liver disease	0.01	-0.02	0.00	-0.04	-0.07	0.00
Nephritis	0.01	-0.07	-0.04	-0.02	0.00	0.04
Septicemia	0.00	0.07	0.02	-0.01	-0.04	-0.01
Suicide	-0.04	-0.05	-0.01	-0.10	-0.13	0.00
All unintentional injuries	-0.36	-0.48	-0.10	-0.96	-0.45	-0.07
Drug poisoning	-0.25	-0.30	-0.08	-0.92	-0.35	-0.07
Motor vehicle accidents	-0.07	-0.07	0.04	-0.03	-0.03	0.02
All other unintentional injuries	-0.04	-0.11	-0.06	-0.01	-0.07	-0.02
All remaining causes of death	-0.10	-0.28	-0.33	-0.04	-0.30	-0.15
Total e_{25} change from 2009 to 2016	**-0.63**	**-0.89**	**-0.31**	**-1.29**	**-1.13**	**0.61**

Note: Values represent the contribution, in years, to change in life expectancy from 2009 to 2016. Negative values reflect life expectancy losses over time. Conversely, positive values reflect life expectancy gains over time.

Table 10

Contribution, in years, of specific causes of death to change in life expectancy from 2009 to 2016 among non-Hispanic Black and non-Hispanic white females in the Great Lakes region by educational attainment

	Black			White		
Cause of death	**≤12**	**13-15**	**16+**	**≤12**	**13-15**	**16+**
Alzheimer's disease	-0.11	-0.31	-0.34	-0.12	-0.16	-0.08
All cancer (malignant neoplasms)	0.27	-0.06	0.24	0.09	0.08	0.39
Breast	0.05	-0.03	0.11	0.04	0.03	0.08
Colorectal	0.02	0.01	0.01	0.01	0.02	0.03
Esophageal	0.00	0.01	0.00	0.00	0.00	0.00
Liver	-0.02	-0.03	-0.03	-0.02	-0.02	-0.01
Lung	0.12	0.05	0.18	0.06	0.04	0.14
Pancreatic	-0.01	-0.05	-0.01	-0.01	-0.02	0.00
Prostate	--	--	--	--	--	--
All other cancers	0.10	-0.02	-0.02	0.02	0.03	0.15
Chronic lower respiratory disease	-0.06	-0.10	-0.01	-0.11	-0.02	0.09
Cerebrovascular disease	0.00	-0.14	-0.01	-0.01	0.02	0.06
Diabetes	-0.02	-0.11	0.04	-0.01	-0.02	0.04
Heart disease	0.19	-0.50	0.11	-0.07	0.01	0.30
HIV	0.08	0.00	0.01	0.01	0.00	0.00
Homicide	-0.06	-0.02	0.01	-0.01	-0.01	0.00
Hypertension	-0.03	-0.09	-0.03	-0.02	-0.01	-0.01
Influenza and pneumonia	0.00	-0.04	0.05	-0.01	0.02	0.05
Liver disease	-0.04	-0.05	0.02	-0.08	-0.07	-0.02
Nephritis	-0.01	-0.09	0.03	-0.01	0.02	0.04
Septicemia	0.04	0.03	0.05	-0.06	-0.03	-0.02
Suicide	-0.01	0.00	0.01	-0.05	-0.05	0.00
All unintentional injuries	-0.35	-0.17	-0.03	-0.75	-0.31	-0.06
Drug poisoning	-0.31	-0.11	-0.02	-0.65	-0.21	-0.04
Motor vehicle accidents	-0.03	0.01	0.01	-0.04	-0.02	0.00
All other unintentional injuries	-0.01	-0.07	-0.03	-0.07	-0.08	-0.03
All remaining causes of death	-0.20	-0.59	0.06	-0.45	-0.26	0.01
Total e_{25} change from 2009 to 2016	**-0.31**	**-2.22**	**0.22**	**-1.67**	**-0.78**	**0.80**

Note: Values represent the contribution, in years, to change in life expectancy from 2009 to 2016. Negative values reflect life expectancy losses over time. Conversely, positive values reflect life expectancy gains over time.

Figure 9

Age-specific contributions of select causes of death to change in life expectancy among non-Hispanic Black males from 2009 to 2016 in the Great Lakes region by educational attainment

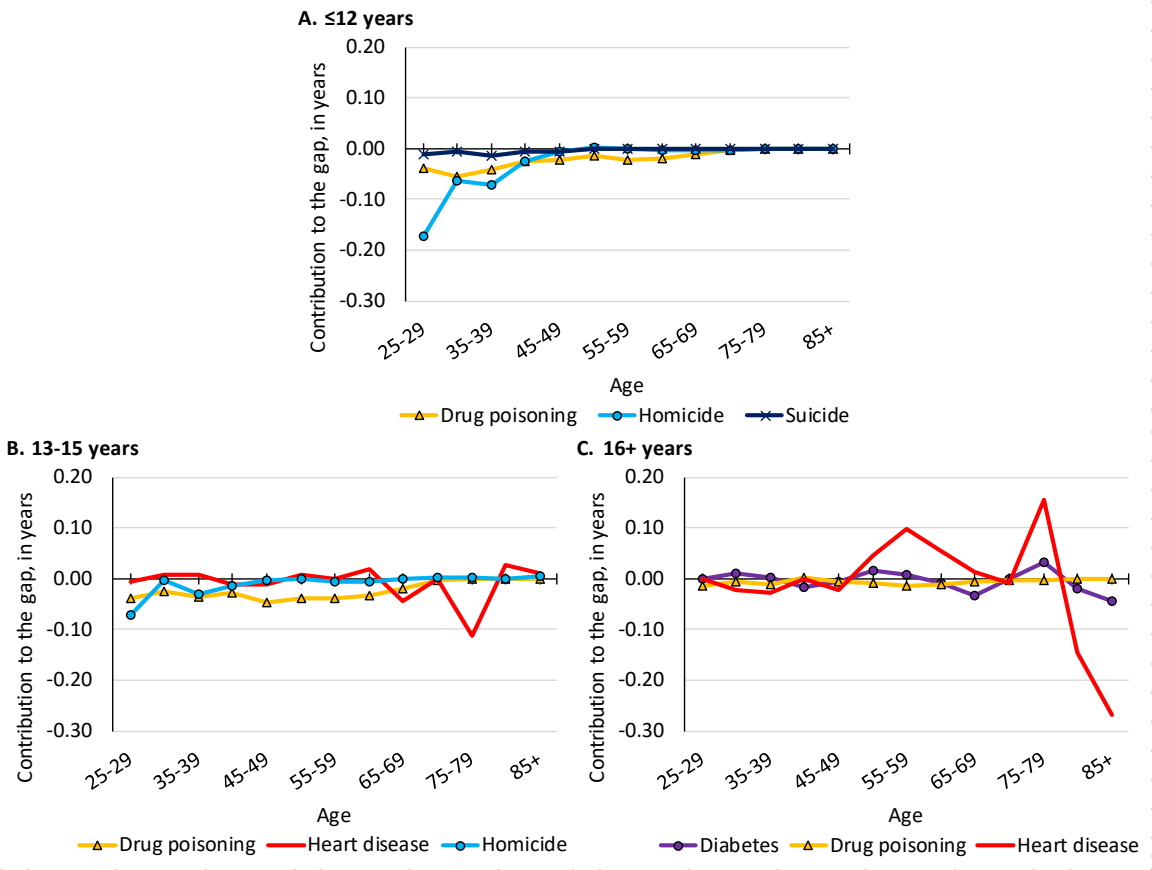


Figure 10

Age-specific contributions of select causes of death to change in life expectancy among non-Hispanic Black females from 2009 to 2016 in the Great Lakes region by educational attainment

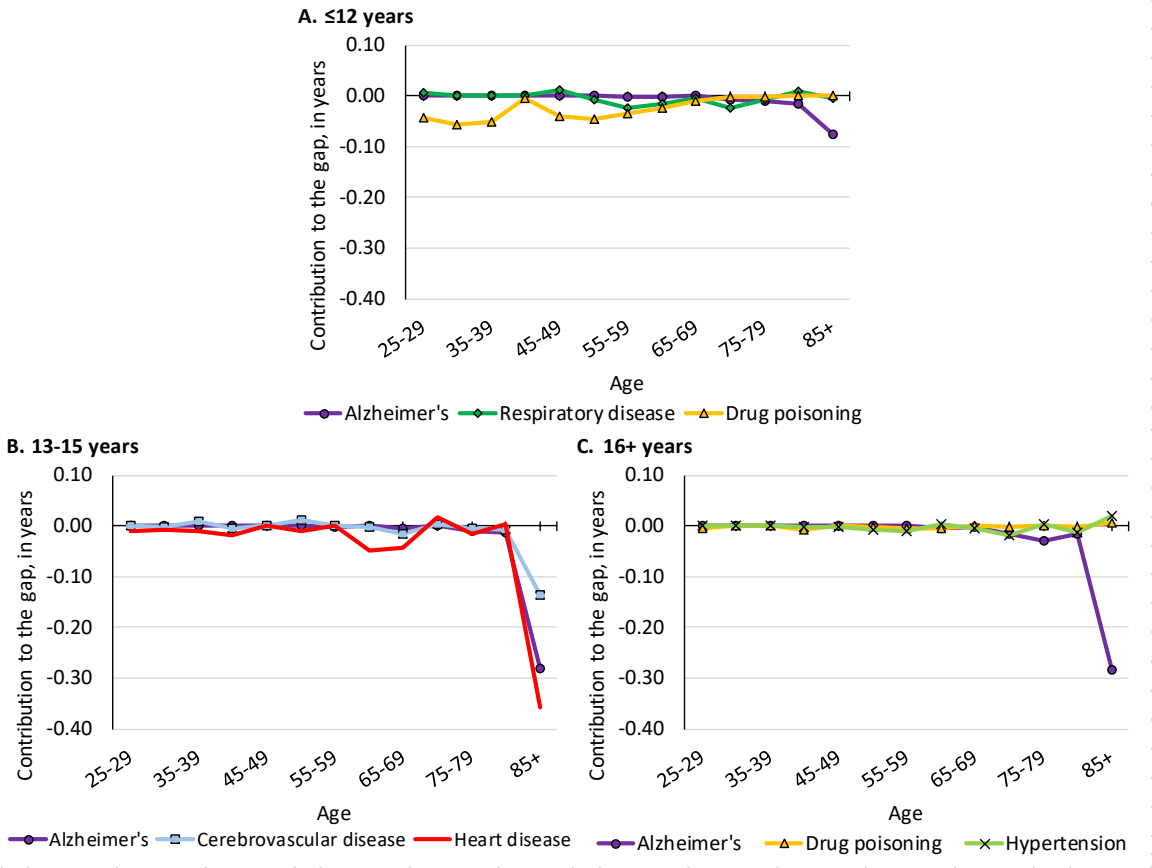


Figure 11

Age-specific contributions of select causes of death to change in life expectancy among non-Hispanic white males from 2009 to 2016 in the Great Lakes region by educational attainment

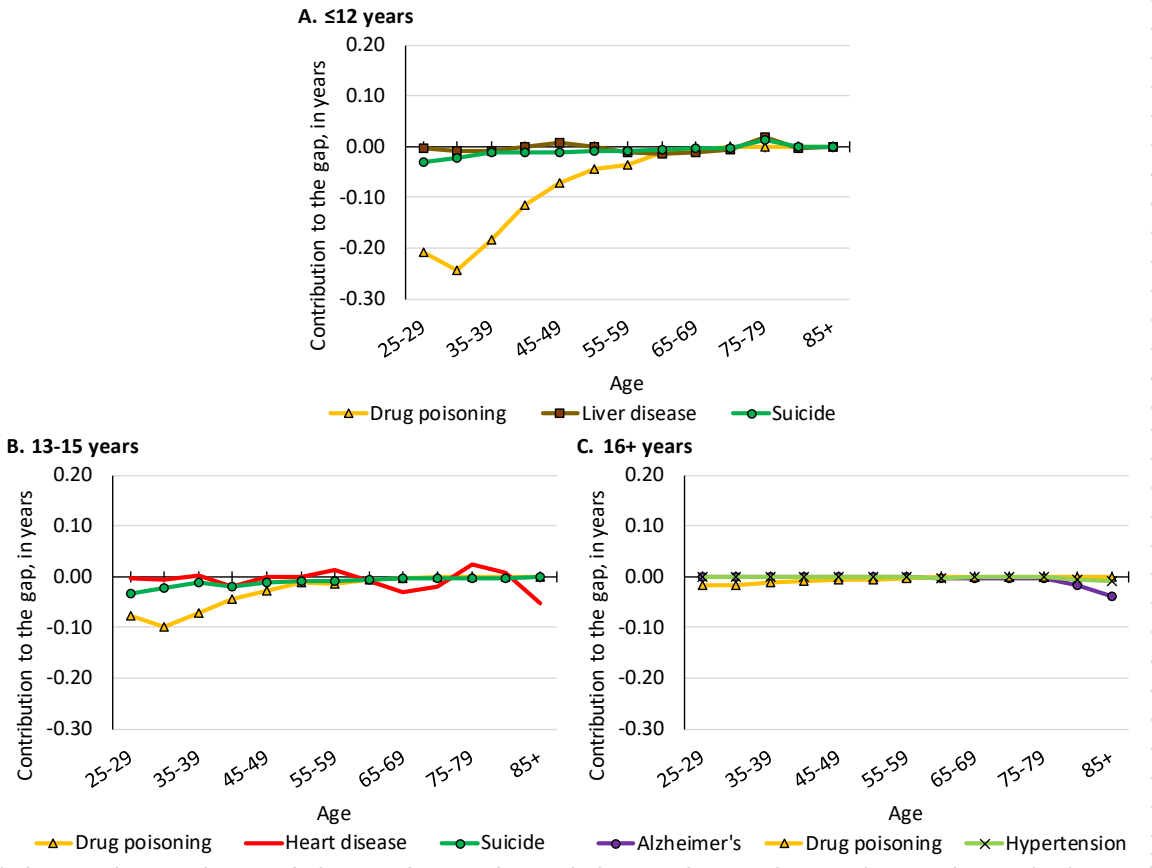
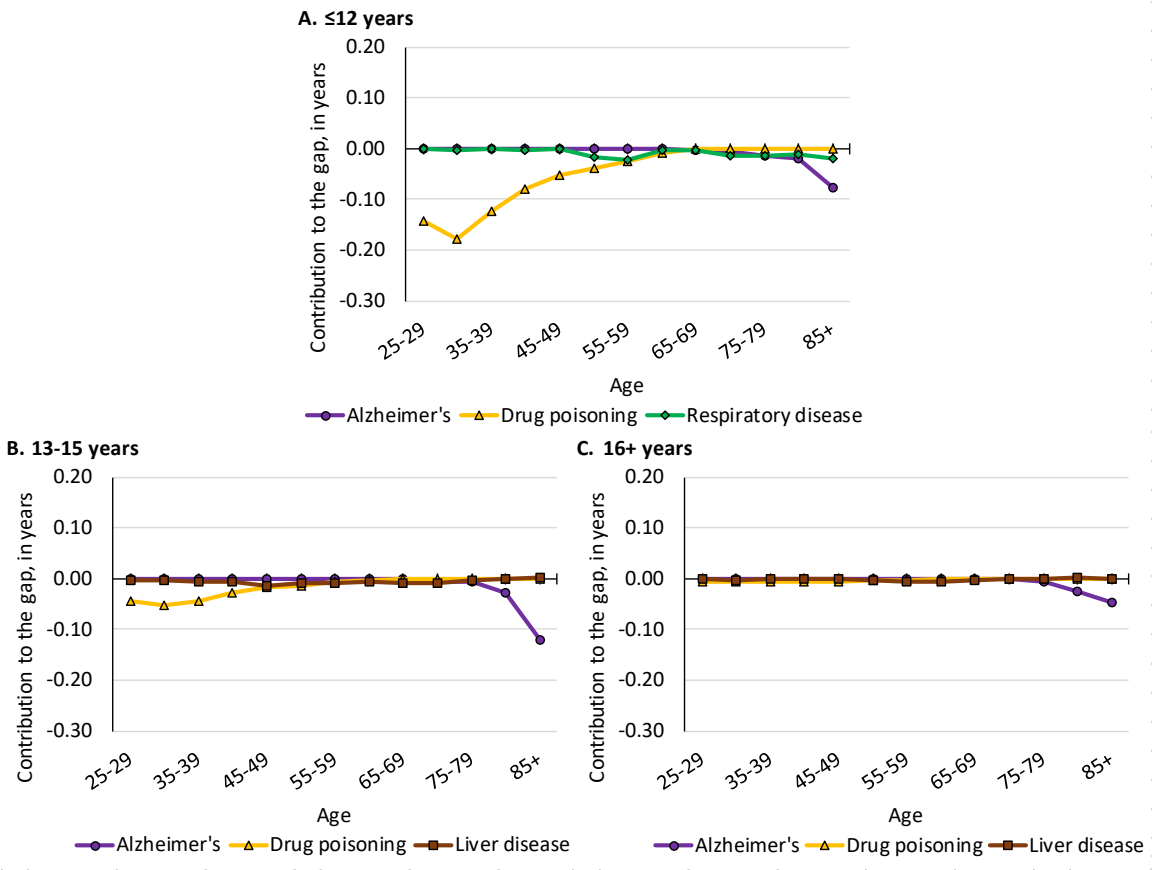


Figure 12

Age-specific contributions of select causes of death to change in life expectancy among non-Hispanic white females from 2009 to 2016 in the Great Lakes region by educational attainment



CHAPTER IV

CONTRIBUTORS TO THE BLACK-WHITE LIFE EXPECTANCY GAP IN WASHINGTON, D.C.

Introduction

The Black-white gap in life expectancy in the United States is currently about 3.6 years, which is a 50% reduction from 1970 (Arias, Xu, & Kochanek, 2019; Centers for Disease Control and Prevention, 2017c). This promising national trend conceals disparities across U.S. states and municipalities that are less encouraging (Firebaugh, Acciai, Noah, Prather, & Nau, 2014b; Harper, MacLehose, & Kaufman, 2014a). For example, Harper et al. (Harper et al., 2014a) found that Black-white life expectancy gaps increased among males in Alaska, Hawaii, Maine, New Hampshire, Wisconsin, and the District of Columbia (a.k.a., Washington, D.C.) between 1990 and 2009. They also found increasing Black-white gaps among females in Nebraska, Wisconsin, and Washington, D.C. One particularly notable finding from this study was the large Black-white life expectancy gap in Washington, D.C.—14.70 years among males and 10.60 years among females in 2009 (Harper et al., 2014a). In fact, the Black-white life expectancy gap in Washington, D.C. was larger than any other state or territory in the nation, and nearly twice the size of the second largest gap in Wisconsin. In addition to all 50 states, the Black-white longevity gap in D.C. exceeds those of peer cities. For example, in 2015 Black-white longevity gaps among males were 1.03 years in New York City, 5.57 years in San Francisco, and 9.52 years in Philadelphia (Fenelon & Boudreaux, 2019a). As we

will show, the Black-white life expectancy gap in Washington, D.C. has unfortunately continued to grow in recent years, warranting further investigation.

Washington, D.C. has a total population of just over 702,000 and is composed of 46.4% Black residents. The percentage of Black residents is greater in Washington, D.C. than any U.S. state, including Mississippi (37.8%) and Louisiana (32.7%) (United States Census Bureau, 2018). For comparative purposes, the Black population of about 325,000 in Washington, D.C. is larger than the *entire* populations of major U.S. cities like St. Paul in Minnesota, Pittsburgh in Pennsylvania, and Cincinnati in Ohio. Given the large size of the Black population and the small geographic area that places all Washington, D.C. residents in relatively close proximity, it is imperative to understand why Black residents face vastly different longevity prospects than white residents.

Although the Black-white longevity gap in Washington, D.C. is an urgent public health concern, there is limited evidence that policymakers can draw upon to combat this stark disparity. One recent study assessed how five broadly-defined causes of death (cardiovascular disease, cancer, non-communicable disease, communicable disease, and injury) contributed to the Black-white life expectancy gap across all U.S. states from 1969-2013 (Riddell et al., 2018). This study found that cardiovascular disease and cancer made the greatest contributions to the Black-white life expectancy gap in Washington, D.C. in 2013, with injuries also making a large contribution among males. This study successfully identified key contributors, but large portions of the gap were not attributed to particular causes. Moreover, it is important to disentangle some broad categories (e.g., injuries) used in this study into more specific causes (e.g., homicide, vehicle accidents, and drug overdoses) to help stakeholders identify potential solutions.

By following the approach used in a recent study of Wisconsin (Roberts et al., 2019), we will show how various causes of death contribute to the Black-white longevity gap in Washington, D.C. Because non-Hispanics are distinct from Hispanics in terms of socioeconomic factors and related health outcomes, (Ruiz, Sbarra, & Steffen, 2018) we focus on mortality disparities between non-Hispanic Black (hereafter, Black) and non-Hispanic white (hereafter, white) males and females. The aims of our investigation are threefold: first, we calculate life expectancies for males and females in Washington, D.C. and the U.S. from 2000 to 2016, revealing how Black-white gaps in Washington, D.C. have diverged from national trends; second, we decompose longevity gaps into 23 specific causes of death at three different periods of time (2000, 2008, and 2016); third, we assess each cause of death across 19 different age categories, showing how each cause of death contributes to Black-white disparities over the life course. The overarching motivation for our investigation is to provide new, detailed evidence about contributors to the Black-white longevity gap in Washington, D.C., which can be used to create targeted interventions and public health policies.

Methods

Data

Our investigation utilized restricted-use multiple cause of death-all county micro data files for 1999-2017 (National Center for Health Statistics, 2018), granted to us by National Center for Health Statistics (NCHS). We used data on death counts (D_{ij}) and population estimates (N_{ij}) to calculate death rates ($M_{ij} = D_{ij}/N_{ij}$) for selected subgroups

(*i*) and periods of observation (*j*) in Washington, D.C. Restricted-use NCHS data provide complete, uncensored mortality counts for total and specific causes of death by period of observation, sex, age, ethnicity, and race. Following prior work (Harper et al., 2014a), we used U.S. Census Bureau population estimates with bridged race categories as denominators (Centers for Disease Control and Prevention, 2018b). The population estimates cover the same time periods and demographic characteristics as the complete mortality counts.

Measures

As noted, we restricted our analyses to non-Hispanics, as they differ from Hispanics with respect to socioeconomic characteristics and health outcomes(Ruiz et al., 2018). We stratified our analyses by sex as cause-specific death rates vary between males and females (Rogers, Hummer, & Nam, 1999). Our study focused on four race-sex groups: non-Hispanic Black males; non-Hispanic Black females; non-Hispanic white males; and non-Hispanic white females. For each of these race-sex groups, we conducted a series of life table analyses. We categorized age in each life table as follows: (1) less than one year of age, (2) 1-4 years of age, (3) a series of five-year age groups ranging from 5-9 to 80-84, and (4) an open-ended category for ages 85 and older.

We selected 23 causes of death previously identified as leading causes of death nationwide (Melonie, 2019), or as suspected contributors to the Black-white life expectancy gap (Kochanek et al., 2015). These causes of death include breast cancer (among females), colorectal cancer, esophageal cancer, liver cancer, lung cancer, pancreatic cancer, prostate cancer (among males), stomach cancer, all other cancers,

cerebrovascular disease, diabetes, heart disease, HIV, assault (homicide), hypertension, influenza and pneumonia, liver disease, nephritis, perinatal conditions, respiratory disease, drug poisoning, motor vehicle accidents, all other unintentional injuries, and a residual category for all remaining causes of death. We disaggregated malignant neoplasms into different types of cancer, as they are heterogeneous in their etiology, prevention, and treatment. Additionally, we disaggregated unintentional injuries into drug poisoning and motor vehicle accidents, which are the two leading causes of unintentional death (Centers for Disease Control and Prevention, 2017a). Causes of death were categorized in accordance with the International Classification of Diseases (ICD), 10th revision (World Health Organization, 2016), and coded using the Department of Vital Statistics Underlying Cause of Death 358 Recode (Centers for Disease Control and Prevention, 2017b) (see Appendix AB for cause of death coding scheme).

Analysis

We used Microsoft Excel 2013 for our analyses, which aggregated three years of death (D_{ij}) and population (N_{ij}) data into individual cross-sections of time to minimize random fluctuations in mortality rates (M_{ij}) for each age-race-sex subgroup (e.g., 2000 represents 1999-2001). To address study aim 1 (tracing Black-white disparities since 2000), we converted age-race-sex mortality rates into probability estimates and generated period life tables for each group (i.e., Black and white males and females) in Washington, D.C. as well as the entire U.S. In the process of converting rates to probabilities, we employed graduation techniques to estimate the average person-years lived among individuals who died between the ages of x to $x+n$ ($_na_x$)(Preston et al., 2001). Next, we

ordered life expectancies (e_0) derived from these life tables into three-year moving averages, spanning the time period 2000 (i.e., 1999-01) to 2016 (i.e., 2015-17). These analyses facilitated visualization of trends in Washington, D.C.'s Black-white life expectancy gap, relative to the rest of the nation.

To address aim 2 (identifying causes of death that contributed most to Black-white disparities), we decomposed the overall Black-white e_0 gap into portions attributable to 23 causes of death, as well as a residual category for all other causes of death. We employed the age and cause decomposition method with discrete data following prior work (Arriaga, 1989; Arriaga, 1984; Riddell et al., 2018). Addressing our final aim (identifying life stages where specific causes of death made the greatest contributions), we calculated the number of years that each cause of death contributed to the overall Black-white e_0 gap for each age group. We assessed aims 2 and 3 at three different time points spanning our entire period of observation: 2000 (1999-01), 2008 (2007-09), and 2016 (2015-17).

Results

Aim 1: Tracing Black-white disparities since 2000 in Washington, D.C. and the U.S.

Figure 13 presents life expectancy trends for Black and white males in the U.S. and Washington, D.C. from 2000 to 2016. In 2000, the national Black-white gap for males was 6.60 years. At 14.68 years, the corresponding gap in Washington, D.C. was more than twice as large. Over the past two decades, the national Black-white longevity gap has steadily declined among males, reaching 4.32 years in 2016. Conversely, the gap in Washington, D.C. was fairly stable in the early 2000s but diverged sharply after 2012,

reaching 17.23 years in 2016. The Black-white gap of 17.23 years among males in Washington D.C. was 399% larger than the Black-white gap among U.S. males.

Figure 14 presents life expectancy trends for Black and white females in the U.S. and Washington, D.C. As we observed among males, the Black-white gap for U.S. females has converged over time, reaching an all-time low of 2.50 years in 2016. During our study period, both Black and white females in Washington, D.C. experienced substantial gains in life expectancy. However, gains among white females outpaced Black females and, by 2016, the gap between them had grown to 12.06 years. This gap of 12.06 years was 482% larger than the corresponding Black-white gap among U.S. females.

Shortly after the Great Recession of 2008, life expectancy stagnated for U.S. males and females from both race groups. Conversely, white males and females in Washington, D.C. continued to experience substantial gains in life expectancy after 2009. Similarly, life expectancy continued to rise after the Great Recession among Black males and females in Washington, D.C. However, progress among Blacks halted around 2013 for males and 2014 for females. Since that time, Black life expectancy in Washington, D.C. has declined. Continuing gains in life expectancy among white males in Washington, D.C., coupled with recent declines in life expectancy among Black males, have led to rapid growth in the Black-white gap. From 2013 to 2016, the gap grew from 14.64 years to 17.23 years, an increase of 2.59 years over a span of just three years. Similar trends among females in Washington, D.C. have also resulted in widening of the Black-white longevity gap—from 9.86 years in 2014 to 12.06 years in 2016, an increase of 2.20 years.

Aim 2: Contribution of 23 causes of death to Black-white longevity gaps

Table 11 presents the contribution of 22 selected causes of death and a residual "all other causes" of death category to the Black-white life expectancy gap for males at three different time periods. We found that heart disease (4.14 years), homicide (2.43 years), malignant neoplasms (2.30 years), and unintentional injuries (2.23 years) contributed most to the 17.23-year gap in 2016. We disaggregated malignant neoplasms into eight types of cancer, revealing that lung cancer (0.52 years) made the largest contribution to the gap, followed by colorectal cancer (0.31 years), liver cancer (0.30 years), and prostate cancer (0.29 years). Disaggregating the unintentional injuries category indicated a large contribution from drug poisoning (1.56 years), followed by motor vehicle accidents (0.36 years). Diabetes, perinatal conditions, and HIV were other notable causes of death among males, each contributing over half a year to the Black-white gap in 2016. Perhaps our most notable finding was the large contribution of homicide to the Black-white gap, which exceeded the total contribution of cancer in each study period. Another interesting finding was the change in key contributors over time among males. Between 2000 and 2016, the contribution of heart disease, unintentional injuries, and cancer to the Black-white gap increased by a combined total of 3.81 years. In addition, the contribution of diabetes more than doubled from 2000 (0.29 years) to 2016 (0.69 years), becoming a fifth largest contributor to the Black-white gap. Conversely, the combined contribution of HIV and homicide decreased by 1.80 years over our study period.

Table 12 presents the contribution of selected causes of death to the Black-white life expectancy gap for females in 2000, 2008, and 2016. Our analyses indicate that heart disease (3.24 years), cancer (2.36 years), unintentional injuries (0.85 years), perinatal conditions (0.57), and diabetes (0.55 years) contributed most to the 12.06-year gap in 2016. We found that breast cancer (0.43 years) was the largest cancer contributor, followed by lung cancer (0.38 years) and colorectal cancer (0.28 years). In the unintentional injuries category, drug poisoning (0.65 years) again contributed more to the gap than motor vehicle accidents (0.12 years). Cerebrovascular disease and HIV were also important contributors among females, accounting for 0.40 and 0.35 years of the gap in 2016, respectively. Altogether, heart disease and cancer accounted for 81.9% of the 2.77-year increase in the Black-white gap among females between 2000 and 2016. Whereas the contribution of drug poisoning increased by almost half a year over this timeframe, the contribution of HIV declined by just over half a year.

To characterize within-race changes in life expectancy from 2000 to 2016, we conducted a supplemental series of decomposition analyses. During this period, life expectancy increased by 5.91 years among Black males and 3.64 years among Black females (see Appendix AC). Reductions in HIV, all cancer, and homicide mortality accounted for 61.3% of the 5.91-year gain among Black males. This gain was partly offset by drug poisoning deaths, which reduced life expectancy gains by 0.72 years. Among Black females, improvements in heart disease contributed most (1.29 years) to the 3.64-year gain in life expectancy, followed by HIV (0.61 years), all cancer (0.48 years), and diabetes (0.46 years). Drug poisoning prevented the gain among Black females from being larger, accounting for a 0.45-year loss.

Between 2000 and 2016, life expectancy increased by 8.44 years among white males and 6.41 years among white females (see Appendix AD). Improvements in heart disease (2.74 years) and all cancer (2.36 years) made the largest contributions to life expectancy gains among white males, followed by HIV (0.50 years) and respiratory disease (0.32 years). White females experienced notable improvements in heart disease (2.83 years), all cancer (1.76 years), and respiratory disease (0.39 years). Although increases in drug poisoning were less dramatic among whites, life expectancy gains in all four race-sex groups were suppressed by drug poisoning between 2000 and 2016.

Aim 3: Life stages that contribute most to the Black-white gap in life expectancy

Figure 15 illustrates how each age group contributed to the Black-white life expectancy gap for males and females in 2016. For both males and females, the earliest life stage (<1 year of age) contributed nearly a year to the Black-white gap in life expectancy. Ages 1 to 14 contributed relatively little to the Black-white gap for both sexes. Beginning with the age group 15-19, Black-white disparities rose sharply among males, increasing to approximately one year at age 35-39. After a temporary decrease at age 40-44, the male Black-white gap grew again, peaking at nearly two years at age 60-64. For females, the Black-white gap in life expectancy increased steadily after age 15, reaching a maximum of almost 1.5 years at age 55-59. Contributions to the gap quickly tapered off among males and females after age 65. However, in the oldest age group (85+), the Black-white gap among females surged again to nearly a year. To summarize, among males the largest contributions to the Black-white gap occurred before age 1, from

age 15 to 39, and from age 45 to 74. Among females, the largest contributions occurred before age 1 and from age 40 to 74.

Figure 16 shows age-specific distributions for the four leading contributors to the Black-white longevity gap among males in 2016. We elected to focus on these causes of death, as age-specific contributions to the Black-white gap were relatively small for other causes. A complete table of age- and cause-specific contributors to the Black-white longevity gap among males can be viewed in the appendix (see Appendix AE). As shown in panels A and C of Figure 16, heart disease and cancer made large contributions to the Black-white gap at older life stages. Heart disease made the greatest contribution to the gap at ages 55-59 (0.53 years), 60-64 (0.55 years), and 65-69 (0.60 years). Similarly, cancer made the greatest contribution at ages 60-64 (0.38 years), 65-69 (0.49 years), and 70-74 (0.32 years). The contribution of homicide to the Black-white longevity gap (Figure 16, panel B) was heavily concentrated among adolescent and young adult males. The spike at age 20-24 indicates that homicide made a 0.65-year contribution to the gap in this age group alone. Homicide also made large contributions to the gap among males at ages 15-19 (0.29 years), 25-29 (0.53 years), and 30-34 (0.31 years). Panel D of Figure 16 indicates that unintentional injuries made moderate contributions to the gap between age 30 and 65.

For females, we illustrate age- and cause-specific contributions to the Black-white life expectancy gap in Figure 17. Note that we omit perinatal conditions (the fourth leading contributor) and include diabetes instead (the fifth leading contributor), as perinatal conditions occur entirely in the first year of life. A complete table of age- and cause-specific contributors to the Black-white longevity gap among females can be

viewed in the appendix (see Appendix AF). As we found among males, heart disease (Figure 17, panel A) and cancer (Figure 17, panel B) contributed most to the female Black-white gap at later stages of life. Heart disease contributed most after age 55; the two largest contributions occurred at ages 65-69 and 85+ (0.43 years in each age group). Cancer's peak contribution occurred at age 55-59 (0.43 years) among females, with a fairly steep drop-off before and after that age. As shown in panel C of Figure 17, unintentional injuries made notable contributions at ages 45-49 (0.14 years), 50-54 (0.18 years), and 60-64 (0.12 years). Diabetes (Figure 17, panel D) contributed most at ages 65-69 (0.07 years) and 85+ (0.11 years).

Discussion

Our investigation revealed disconcerting trends in the Black-white life expectancy gap in Washington, D.C. In the most recent period of observation (2016), Black males could expect to live 17.23 years less than white males, and Black females could expect to live 12.06 years less than white females. The longevity gap in Washington, D.C. has widened considerably in recent years, as white life expectancy has continued to increase and Black life expectancy has begun to decrease. If recent trends continue, Black and white life expectancies will diverge to an even greater extent in the future.

Heart disease was the leading contributor to the Black-white longevity gap in 2016. Moreover, racial disparities in heart disease mortality widened between 2000 and 2016 among both males and females. The rising contribution of heart disease could be related to obesity, physical activity, and smoking disparities in Washington, D.C. Although overweight and obesity increased among all race-sex groups, the rising

prevalence in obesity (i.e., BMI≥30) and morbid obesity (i.e., BMI≥40) among Black D.C. residents is of special concern, given health risks associated with this condition. Data from the Behavioral Risk Factor Surveillance System (BRFSS) (Centers for Disease Control and Prevention, 2019a) show that the prevalence of obesity was >2 times higher among Black males than white males in both 2000 and 2016. Additionally, morbid obesity rose sharply among Black males, from 2.3% in 2000 to 4.2% in 2016. By comparison, morbid obesity was low among white males—0.6% in 2000 and 0.7% in 2016. Among Black females, the prevalence of obesity increased markedly, from 29.6% in 2000 to 37.4% in 2016. Over this period, obesity among white females increased only slightly, from 6.2% in 2000 to 7.2% in 2016. The prevalence of morbid obesity was >10 times higher among Black females in both time periods. It is well established that obesity increases the risk of developing various diseases of the heart. Public health interventions such as education about healthful eating, food labeling, advertisement restrictions, and incentivizing SNAP recipients to purchase healthy foods could help reduce Black-white obesity disparities in Washington, D.C. (Nestle & Jacobson, 2000).

In 2016, 26% of Black D.C. residents reported that they did not engage in physical activity in the past month, compared to 6.1% of white residents (Washington D.C. Department of Health, 2016). Disadvantaged individuals may face barriers to exercise such as insufficient time and feelings of exhaustion (Brownson, Baker, Housemann, Brennan, & Bacak, 2001). In addition, many people rely on safe sidewalks and public parks for exercise, but these amenities are often lacking in predominantly Black neighborhoods (Robert & Reither, 2004). Additional funds and strategic zoning in disadvantaged neighborhoods could create new resources, such as walking and biking

trails. Additionally, requiring physical education in schools may improve regular physical activity among Black males and females in Washington, D.C. at early ages (Brownson et al., 2001).

Smoking is a major risk factor for ischemic heart disease, which leads to atherosclerosis and increased risk of heart failure and heart attack (National Heart Lung and Blood Institute, 2020). Although the prevalence of smoking among Black males in Washington, D.C. decreased from 25.8% in 2000 to 21.6% in 2016, it was much higher than white males (15.6% in 2000 and 10.0% in 2016) (Washington D.C. Department of Health, 2016). Black females also experienced a modest decline in smoking prevalence, from 21.7% in 2000 to 17.4% in 2016. Although smoking prevalence among white females was only slightly lower than Black females in 2000 (17.7%), it declined sharply to 7% in 2016 (Washington D.C. Department of Health, 2016).

Tobacco advertising heavily targets neighborhoods with large Black populations (Pucci, Joseph Jr, & Siegel, 1998). Reducing smoking prevalence in Black neighborhoods could be achieved through tobacco price increases, mass-media anti-smoking campaigns, smoke-free policies, restricting tobacco marketing, and educating youths about smoking risks in school (Pierce, White, & Emery, 2012). Because this is not a prospective cohort study, we cannot definitively link disparities in smoking, physical activity, and obesity to the mortality disparities that we observed. However, extant research on these risk factors is sufficiently strong to warrant public health interventions designed to reduce racial disparities in these health behaviors (National Heart Lung and Blood Institute, 2020).

In addition to heart disease, cancer was an increasingly large contributor to Black-white longevity gaps in Washington, D.C. between 2000 and 2016. Increasing contributions of breast cancer among females, prostate cancer among males, and colorectal cancer among both sexes point to shortcomings in screening and early detection. Because Black residents of Washington, D.C. often lack access to early detection screening, they are generally diagnosed with cancer at later stages of the disease (Washington D.C. Cancer Consortium, 2018). Insufficient knowledge about preventive healthcare among Black and other minority populations is another driver for underutilization of breast, colorectal, and prostate cancer screening (McAlearney et al., 2008). Educational initiatives to disseminate health information, such as the use of lay health advisors (Paskett et al., 2006), could improve knowledge of breast, colorectal, and prostate cancer risks and early-detection screening among Black males and females in Washington, D.C.

Lung cancer, another major contributor to the Black-white longevity gap, is strongly associated with tobacco use. As noted, smoking prevalence is substantially higher among Black males and females in Washington, D.C. Public health campaigns to reduce smoking prevalence among Black males and females could reduce the incidence of lung cancer, thereby shrinking its contribution to the Black-white longevity gap. As discussed, these interventions could include restrictions on tobacco advertising, increased tax on tobacco products, smoking risk education in schools, and smoke-free policies.

By examining a wider array of causes than previous research, we discovered that homicide was the second largest contributor to the Black-white longevity gap among males, accounting for more of the gap than cancer. Adolescent and young adult Black

males between age 15 and 34 were particularly vulnerable to homicide. In 2017, Black males in Washington, D.C. faced a homicide rate of 61.5 per 100,000, which was the fourth highest homicide rate among Black males in the nation, behind only Missouri, Illinois, and Indiana (Centers for Disease Control and Prevention, 2018a). The high risk of homicide for young Black males is an important contributor to reduced life expectancy, as premature deaths during adolescence and young adulthood reduce the potential person-years lived in the Black male population.

A silver lining in our findings is that homicide's contribution to the Black-white longevity gap has declined substantially among males in Washington, D.C. over the past two decades. Another promising finding among males was the sharp decline in HIV, which contributed a year less to the Black-white gap in 2016 than in 2000. Among females, the contribution of homicide remained relatively small and stable across our period of study, and the contribution of HIV decreased by over half a year. Despite the high rate of homicide in Washington, D.C., it has trended downward in recent years (Washington D.C. Metropolitan Police Department, 2019). We can see these improvements clearly in Appendix AC, as reductions in homicide among males and HIV among both sexes has led to life expectancy gains between 2000 and 2016.

Reduced homicide in Washington, D.C. is attributable in part to community outreach and police initiatives such as the Gun Recovery Unit and the Summer Crime Initiative, which focuses all resources in the summer months to districts that experience high rates of violent crime (Washington D.C. Metropolitan Police Department, 2019). Other effective homicide interventions include individual behavior change through improving educational success or enhancing knowledge and skills to avoid expressive

violence (Mercy & Hammond, 1999). Engaging at-risk individuals, such as youths arrested during violent incidents or gunshot wound survivors, and providing them with appropriate resources could further reduce the risk of homicide mortality (O'Malley et al., 2018).

Reductions in HIV are also attributable in part to successful public health policies. In particular, the 90-90-90-50 plan was implemented in 2005, which aimed to end the HIV epidemic in Washington, D.C. by 2020. Since its implementation, Washington, D.C. has seen a 72% drop in new HIV infections, from a high of 1,343 incident cases in 2007 to just 371 in 2015 (Washington D.C. Department of Health, 2019a). This is a promising decline, particularly for Black males and females who make up nearly 70% of incident cases of all people living with HIV in Washington, D.C. (Washington D.C. Department of Health, 2019a).

Unintentional injuries were the third largest contributor to the Black-white longevity gap among females, and the fourth leading contributor among males. Since 2000, the contribution of unintentional injuries has increased substantially, especially among males. This increase is largely attributable to the opioid epidemic and accidental drug poisoning. In 2017, Washington, D.C. had 244 overdose deaths involving opioids, which translates into a rate of 34.7 deaths per 100,000 persons (National Institute on Drug Abuse, 2019). This rate ranked as third highest in the U.S. and more than twice the national average of 14.6 deaths per 100,000 (National Institute on Drug Abuse, 2019). Black males and females in Washington, D.C. have been especially burdened by the opioid epidemic, as they experienced 216 deaths in 2017—a rate of 60 deaths per 100,000—which was a higher rate of opioid overdose mortality than any other group of

whites, Blacks, or Hispanics in the entire U.S. (The Henry J Kaiser Family Foundation, 2017). Opioid overdose mortality among Black males and females in Washington, D.C. is a public health priority; addressing this issue would result in immediate reductions to the Black-white longevity gap.

Diabetes and perinatal conditions were other notable contributors, each accounting for more than half a year of Black-white gaps in life expectancy among males and females. BRFSS data show that diabetes prevalence increased among Black males in Washington, D.C. from 8.2% in 2000 to 12.5% in 2016. Similarly, diabetes prevalence among Black females increased from 12.3% in 2000 to 16.6% in 2016 (Centers for Disease Control and Prevention, 2019a). Although diabetes prevalence also increased among white males and females in Washington, D.C., reflecting the general rise in overweight and obesity, racial disparities in diabetes are nevertheless stark. As of 2016, fewer than 3% of white males or females in Washington, D.C. reported diabetes. Reducing diabetes prevalence among Black D.C. residents and improving access to diabetes treatments will reduce racial disparities in longevity.

High rates of Black infant mortality are another concern in Washington, D.C. In 2016, the Black infant mortality rate in Washington, D.C. was 11.4 per 1,000 live births, which was nearly nine deaths greater than whites in Washington, D.C. (2.5 per 1,000) (The Henry J Kaiser Family Foundation, 2016). Disparities in infant mortality rates likely reflect underlying socioeconomic inequalities, as well as differential access to quality healthcare (Georgetown University School of Nursing & Health Studies, 2016). For example, during 2015-16, 86% of white D.C. mothers received prenatal care in their first trimester, but nearly 40% of Black D.C. mothers did not receive prenatal care until their

second or third trimester; over 4% of Black females received no prenatal care at all (Washington D.C. Department of Health, 2018). Differences in smoking prevalence may also play a role in Black-white disparities in infant mortality. Recent data from Washington, D.C. indicate that nearly 5% of Black mothers smoked during pregnancy, compared to fewer than 1% of white mothers (Washington D.C. Department of Health, 2018).

Black mothers in Washington, D.C. are also at high risk of maternal mortality. Although we omitted maternal mortality from our final analyses because it contributed a relatively small amount to the Black-white longevity gap (0.05 years in 2016), we note that maternal mortality among Black females in Washington, D.C. is the worst in the nation (59.7 death per 100,000 live births) (Hawkins, 2020). Meanwhile, white females in Washington, D.C. have the lowest maternal mortality ratio in the U.S., suggesting that while excellent maternal care is available in Washington, D.C., it is not accessible to all residents (Moaddab et al., 2016).

In 2018, Washington, D.C. boasted the second lowest percentage of uninsured residents at 3.2%, behind only Massachusetts (Conway, 2018). Although the percentage of uninsured non-elderly Blacks (4%) and whites (3%) was similar (The Henry J Kaiser Family Foundation, 2018), 54% of Black residents in Washington, D.C. received public health insurance, which was the second highest public insurance rate for Blacks in the nation (State Health Access Data Assistance Center, 2017). Conversely, only 13% of whites in Washington, D.C were covered by public insurance (State Health Access Data Assistance Center, 2017). Different sources of healthcare coverage reflect unequal

socioeconomic conditions for Black and white D.C. residents, and they are likely indicative of differential access to the highest standards of care.

Black-white disparities in health care and health outcomes in Washington, D.C. may be largely attributable to fundamental social and economic causes (Link & Phelan, 1995). Washington, D.C. is highly segregated, with Black residents representing just 5-10% of the population in western parts of the city and more than 90% in communities east of the Anacostia River (Georgetown University School of Nursing & Health Studies, 2016). Racial segregation is associated with environmental hazards (e.g., air and noise pollution, lead paint, and asbestos), high crime rates, poor quality schools, and food deserts. Consistent with those markers of segregation, the Washington, D.C. Department of Health has highlighted nine key drivers of public health equity, including education, employment, income, housing, transportation, food environment, medical care, outdoor environment, and community safety (Washington D.C. Department of Health, 2019b). While careful study of these factors is beyond the scope of this investigation, it is important to recognize that they may underlie Black-white longevity disparities. Equitable access to effective education, rewarding employment opportunities, safe neighborhoods and housing, and high-quality health care would likely reduce Black-white health disparities in Washington, D.C.

Another factor that may have increased Black-white longevity disparities in Washington, D.C. is the in-migration of select whites. From 2000 to 2017, the white population increased from 30% to 41% (United States Census Bureau, 2019). Over this timeframe, the magnitude of the socioeconomic gap between Black and white residents is evident in median household incomes. In 2007, Black and white D.C. residents had

median household incomes of about $42,000 and $116,000, respectively (Lazere, 2018). By 2017, median income among white households in Washington, D.C. increased to over $160,000, compared to just $48,000 among Black households (Washington D.C. Economic Strategy, 2019). Whites in Washington, D.C. also have more education than their Black counterparts. In 2000, over 80% of whites had a bachelor's degree, compared to 17% of Blacks (McNally, 2003). By 2017, over 88% of white males and females had a bachelor's degree or higher, compared to 26.7% of Black males and females (United States Census Bureau, 2017).

A notable limitation of our investigation is that our mortality data are not paired with socioeconomic indicators. Consequently, although we discuss social and economic disadvantages faced by Black D.C. residents, we are unable to quantify how much these factors contribute to the Black-white longevity gap. Our study also does not examine the impact that gentrification and mobility have on the Black-white longevity gap. Since 2000, the white population in Washington, D.C. has become more select (as noted), but the Black population has declined by 16% (Jackson, 2015). Between 1990 and 2010, Black-majority tracts decreased from 67% to 57%, and white-majority tracts increased from 26% to 30%. Gentrification is a serious social problem in Washington, D.C. as it leads to widespread displacement of Black residents (Jackson, 2015), potentially exacerbating longstanding socioeconomic and health disparities. Future research would benefit from evaluating the effect of gentrification and migration on widening Black-white longevity disparities.

Despite these limitations, a notable strength of our study is the use of restricted-access data, which provide complete uncensored mortality counts, thus eliminating the

need for sophisticated imputation estimates, as have been used previously with public-use data (Harper et al., 2014a; Riddell et al., 2018). Additionally, our investigation used the latest data available and expanded the focus to 23 different causes of death, leading to several new discoveries. Another strength is our assessment of multiple age groups, highlighting stages in the life course where each cause of death contributed most to Black-white gaps in life expectancy.

The growing Black-white life expectancy gap in Washington, D.C. is an urgent public health priority. Our findings affirmed that heart disease and cancer are major contributors to the gap in mid-to-late life. Among males, we found that homicide contributes more to the gap than cancer, afflicting adolescents and young adults most. Unintentional injuries also made a considerable contribution to the gap among males in mid-to-late life, and among females in later life. Growing contributions of heart disease, cancer, and unintentional injuries (particularly drug overdoses) have driven recent increases in the Black-white gap. Reducing homicide among young Black males and drug poisoning among Black males and females—and easing the burden of chronic conditions such as heart disease and cancer among older Black males and females—will help Washington, D.C. achieve its stated public health goal of health equity.

Tables and Figures

Figure 13

Life expectancy trends in the U.S. and Washington, D.C. for non-Hispanic Black and non-Hispanic white males

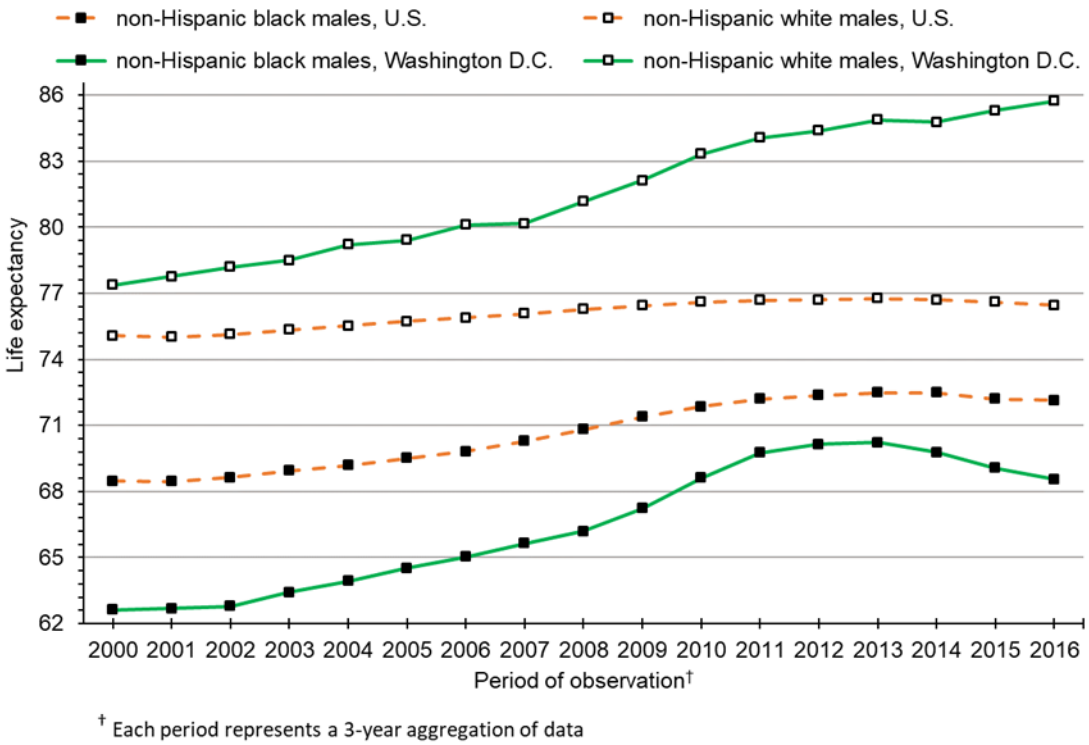


Figure 14

Life expectancy trends in the U.S. and Washington, D.C. for non-Hispanic Black and non-Hispanic white females

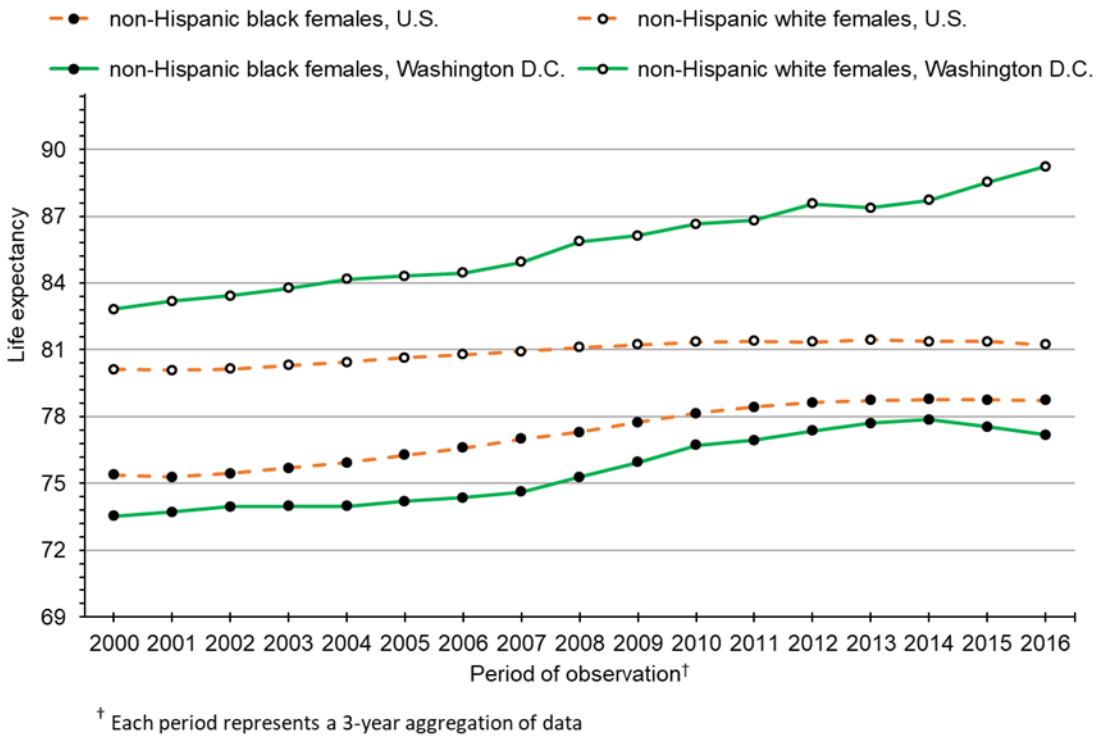


Table 11

Contribution of 23 causes of death (in years) to life expectancy (e_0) differences between non-Hispanic Black and non-Hispanic white males in Washington, D.C.

Cause of Death	2000	2008	2016	Change between 2000 & 2016	Percent of e_0 gap, 2016
All Cancer (Malignant Neoplasms)	1.70	1.94	2.30	0.60	13.3%
Colorectal	0.09	0.20	0.31	0.22	1.8%
Esophageal	0.18	0.11	0.03	-0.15	0.2%
Liver	0.06	0.24	0.30	0.24	1.7%
Lung	0.63	0.52	0.52	-0.11	3.0%
Pancreatic	0.02	0.16	0.13	0.11	0.7%
Prostate	0.23	0.31	0.29	0.05	1.7%
Stomach	0.08	0.12	0.07	-0.01	0.4%
All Other Cancers	0.41	0.29	0.66	0.25	3.8%
Cerebrovascular Disease	0.27	0.35	0.42	0.15	2.5%
Diabetes	0.29	0.38	0.69	0.40	4.0%
Heart Disease	2.14	2.84	4.14	2.00	24.0%
HIV	1.67	1.38	0.59	-1.08	3.4%
Homicide	3.15	3.00	2.43	-0.72	14.1%
Hypertension	0.13	0.15	0.28	0.15	1.6%
Influenza and Pneumonia	0.14	0.11	0.21	0.07	1.2%
Liver Disease	0.23	0.16	0.19	-0.04	1.1%
Nephritis	0.19	0.16	0.23	0.04	1.3%
Perinatal Conditions	0.65	0.43	0.51	-0.14	3.0%
Respiratory Disease	0.18	0.13	0.34	0.16	2.0%
All Unintentional Injuries	1.02	0.84	2.23	1.21	13.0%
Drug Poisoning	0.35	0.21	1.56	1.21	9.0%
Motor Vehicle Accidents	0.35	0.36	0.36	0.01	2.1%
All Other Unintentional Injuries	0.31	0.27	0.32	0.01	1.9%
All Other Causes	2.95	3.12	2.67	-0.28	15.5%
Total e_0 Difference	**14.70**	**15.01**	**17.23**		

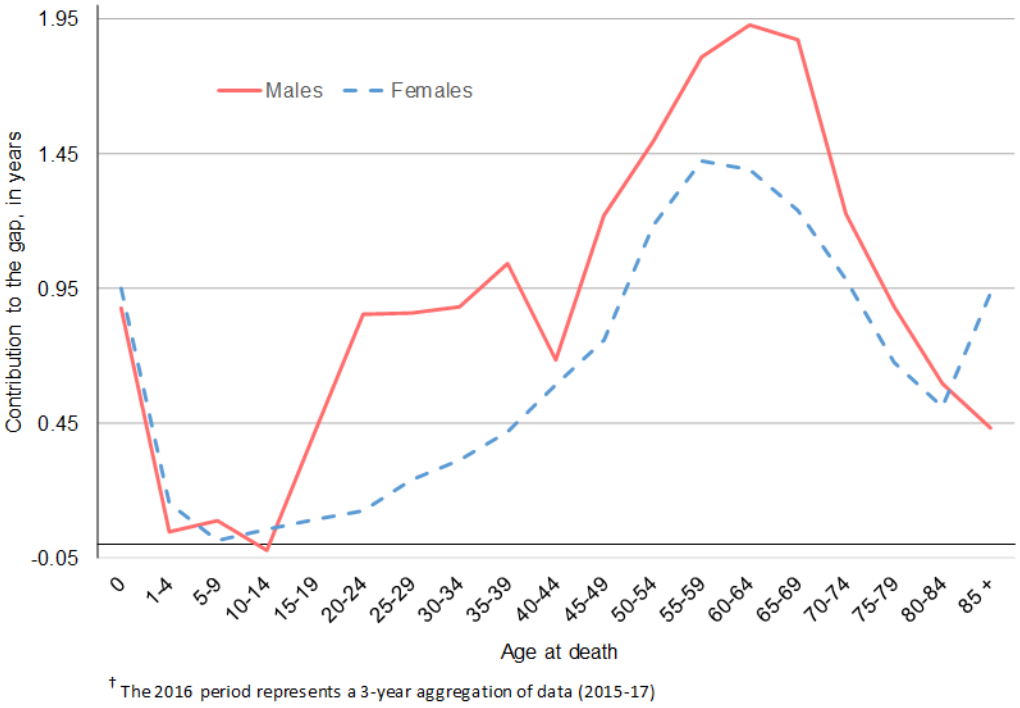
Table 12

Contribution of 23 causes of death (in years) to life expectancy (e_0) differences between non-Hispanic Black and non-Hispanic white females in Washington, D.C.

Cause of Death	2000	2008	2016	Change between 2000 & 2016	Percent of e_0 gap, 2016
All Cancer (Malignant Neoplasms)	1.22	1.95	2.36	1.14	19.6%
Breast	0.16	0.30	0.43	0.27	3.6%
Colorectal	0.25	0.25	0.28	0.03	2.3%
Esophageal	0.06	0.04	0.01	-0.05	0.1%
Liver	0.05	0.09	0.13	0.08	1.1%
Lung	0.21	0.45	0.38	0.17	3.2%
Pancreatic	0.09	0.15	0.19	0.10	1.6%
Stomach	0.07	0.07	0.05	-0.02	0.4%
All Other Cancers	0.34	0.60	0.89	0.55	7.4%
Cerebrovascular Disease	0.35	0.36	0.40	0.05	3.3%
Diabetes	0.75	0.53	0.55	-0.20	4.6%
Heart Disease	2.11	2.41	3.24	1.13	26.9%
HIV	0.88	1.01	0.35	-0.53	2.9%
Homicide	0.30	0.30	0.26	-0.04	2.1%
Hypertension	0.11	0.12	0.20	0.09	1.7%
Influenza and Pneumonia	0.07	0.06	0.14	0.07	1.1%
Liver Disease	0.09	0.19	0.13	0.04	1.1%
Nephritis	0.20	0.17	0.24	0.04	2.0%
Perinatal Conditions	0.82	0.62	0.57	-0.25	4.7%
Respiratory Disease	-0.04	0.06	0.32	0.36	2.7%
All unintentional Injuries	0.27	0.36	0.85	0.58	7.1%
Drug Poisoning	0.19	0.10	0.65	0.46	5.4%
Motor Vehicle Accidents	-0.01	0.13	0.12	0.13	1.0%
All Other Unintentional Injuries	0.09	0.13	0.08	-0.01	0.7%
All Other Causes	2.16	2.41	2.44	0.28	20.2%
Total e_0 Difference	**9.29**	**10.55**	**12.06**		

Figure 15

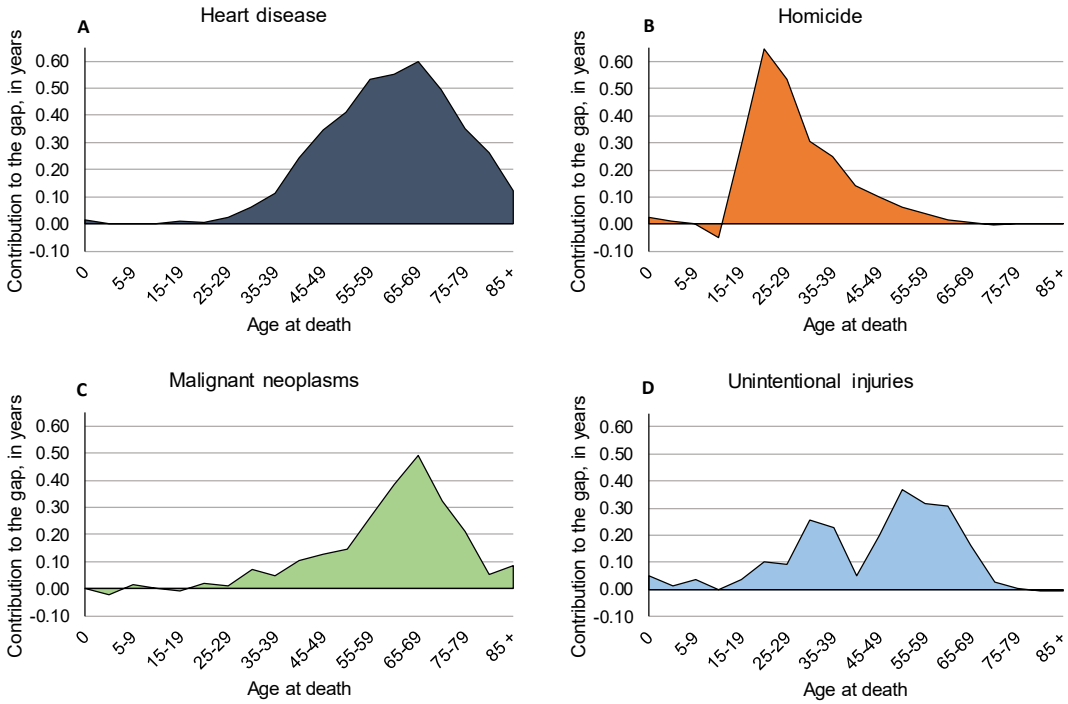
Age-specific contributions to Black-white gaps in life expectancy among non-Hispanic males and females, 2016[†]



[†] The 2016 period represents a 3-year aggregation of data (2015-17)

Figure 16

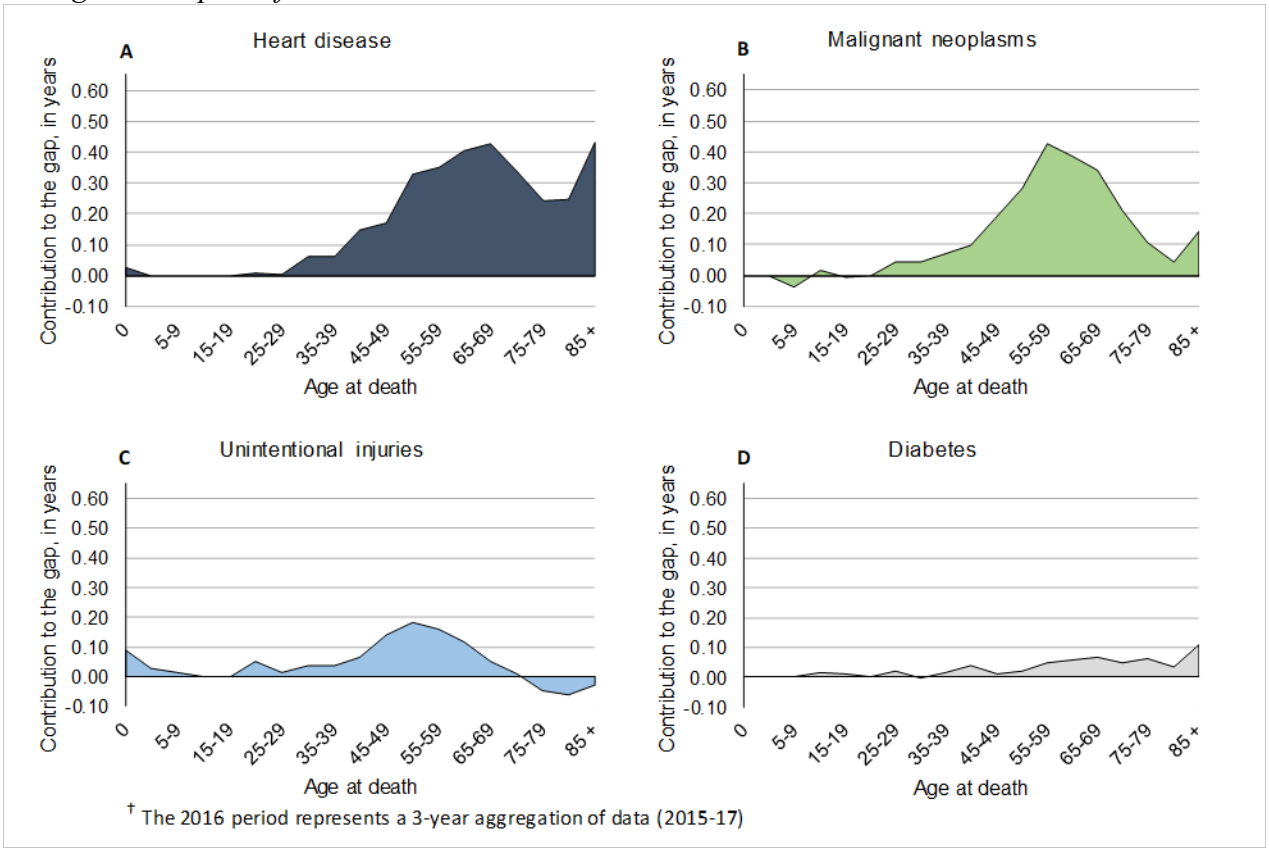
Age and cause decomposition of Washington, D.C.'s Black-white gap in life expectancy among non-Hispanic males, 2016[†]



[†] The 2016 period represents a 3-year aggregation of data (2015-17)

Figure 17

Age and cause decomposition of Washington, D.C.'s Black-white gap in life expectancy among non-Hispanic females, 2016[†]



CHAPTER V

CONCLUSION

Life expectancy disparities continue to persist in the U.S. and remain a cause for concern as disadvantaged groups face shorter life expectancies than their advantaged counterparts. These ongoing longevity disparities are producing wider gaps between the most- and least-advantaged groups. For example, the education longevity gap between the most- and least-educated groups has more than doubled in the last three decades (Meara et al., 2008). Meanwhile, Black males and females consistently face shorter life expectancies than their white counterparts across the U.S. (Harper et al., 2014b). This dissertation set out to measure how specific causes of death have contributed to longevity disparities in the U.S. across place, sex, race, ethnicity, and educational attainment, while also identifying the age-specific contribution of these causes of death.

In Chapter 2, I found that heart disease was the leading contributor to Black-white longevity gaps at middle and older ages among males with a college education, and among females at all levels of education. Public health campaigns would be most effective in targeting these particular groups to encourage healthy dieting and regular exercise to combat the risk of heart disease. Meanwhile, homicide was a key contributor to the Black-white longevity gap among males without a college degree, contributing most at ages under 40. Additionally, high rates of drug poisoning mortality among white males and females without a college degree led to shrinkage of Black-white longevity gaps. These findings were consistent with existing research showing that low-educated groups are at a disproportionate risk of preventable causes of death (Hummer &

Hernandez, 2013). This implies that public health policy and programs focusing on reducing preventable deaths should be aimed primarily at groups without a college degree. Lastly, I found that relatively lower rates of heart disease among Hispanic males and females contributed to a health advantage over their white counterparts across all levels of educational attainment. More research is needed to explain why Hispanic males and females face markedly lower rates of heart disease than their white counterparts, and subsequently appreciate greater longevity.

In Chapter 3, I found that homicide contributed to longevity losses among young, Black males without a college degree in the Great Lakes region. Drug poisoning was a leading contributor to longevity decline among Black and white males and females with ≤12 years of education, Black males and white males and females with 13-15 years of education, and Black males with 16+ years of education. Drug poisoning made a large contribution to longevity decline among poorly-educated white males and females from ages 25 to 49. Public health campaigns aimed at reducing violence among young Black males without a college degree, and limiting the risk the drug overdose among those with ≤12 years of education (and to a lesser extent, those with 13-15 years of education) could help to improve the decreasing life expectancy seen among low-educated and minority groups in the Great Lakes region. Heart disease was responsible for a large loss in life expectancy among Black females with 13-15 years of education, indicating that this is a key demographic that would benefit from campaigns to reduce the risk of heart disease. In addition, I found that Alzheimer's disease was a notable contributor to longevity losses among Black and white females at ages 80+. Public health campaigns should promote regular exercise, a healthy diet, and being intellectually active in older age. High blood

pressure, diabetes, and high cholesterol can all increase the risk of developing Alzheimer's disease.

In Chapter 4, I found that Black males lived 17 years less than white males in Washington, D.C., while Black females lived 12 years less than white females. Homicide contributed more than all cancer to the Black-white life expectancy gap among young males. Meanwhile, heart disease and cancer were found to be major contributors at middle and older ages to Black-white longevity gaps in Washington, D.C. for both males and females. Drug poisoning also made large contributions to Black-white longevity gaps among females, and especially males. Public health policy aimed at reducing violence among young Black males and chronic conditions among older adults could prove successful in shrinking the Black-white longevity gap in Washington, D.C.

These studies found mounting evidence that preventable and behavioral causes of death are contributing most to life expectancy gaps and declining longevity in the U.S. Causes of death like homicide, drug poisoning, lung cancer, respiratory disease, and suicide, can be reduced with proper policy and public health efforts. Focusing public health efforts on these particular preventable causes of death, and among the specific demographic and age groups most at risk of them, could in time make notable improvements to longevity disparities across different parts of the U.S. Among highly-educated groups, chronic conditions, such as heart disease, cancer, and diabetes, are key contributors to longevity disparities at middle and older ages. Public health policy and programs aimed at reducing obesity, promoting regular cancer screenings, and promoting healthful diets and lifestyles can effectively work to improved longevity disparities at middle and older ages.

There is much more work to be done to improve longevity disparities in the U.S. It would be valuable to measure how socioeconomic characteristics such as income, place of residence, and employment, influence the risk of specific causes of death. These fundamental social causes likely affect mortality outcomes which subsequently impact the longevity disparities we observe today (Phelan et al., 2004). Additionally, while I uncovered the contribution of several specific causes of death to longevity disparities, future research may benefit by including additional causes of death that remained hidden in my residual 'all other causes' categories. There may be new discoveries left to be made of other notable causes of death contributing to life expectancy disparities in the U.S.

Building on existing research (Harper et al., 2014b; Riddell et al., 2018; Roberts et al., 2019; Sasson, 2016b), this dissertation has provided new and insightful evidence as to how different causes of death are contributing to longevity disparities across the U.S. By disaggregating broad cause of death categories into specific causes of death, I made important discoveries of key contributors whose contributions have been concealed in previous research, which likely require unique and specific public health interventions. Additionally, this dissertation offers new evidence as to where along the life course each cause of death is contributing most to longevity disparities, providing target age groups for public health policies and programs to intervene.

In a time of increasing calls for social justice for Black Americans, and equality for all people, it is more important than ever to continue to work to address persistent and ongoing longevity disparities in the U.S. The findings presented here contribute to the growing body of research that highlights the magnitude of longevity disparities in the U.S., and that offer solutions to improve life expectancy across different socioeconomic

and demographic groups. This dissertation has provided detailed evidence of the contribution of specific causes of death to longevity gaps and declining life expectancy in the U.S., and the ages where causes of death contribute most. While analysis focused in on specific regions and municipalities of the U.S., results likely have implications for other parts of the U.S., as well. It is clear from the findings of these studies that more needs to be done to reduce the impact of preventable causes of death, particularly homicide among Black males and drug poisoning among all groups, at young and middle ages. Additionally, reducing the risk of heart disease among older Blacks adults, and chronic conditions among all older adults, could also effectively improve longevity disparities across the U.S. Public health policy and programs implemented at the national-, state- and/or local-levels aimed at reducing preventable mortality and chronic conditions could prove effective in improving persistent longevity disparities in the U.S.

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APPENDICES

Appendix A

Cause of death coding scheme

Cause of death	358 Recode values
Alzheimer's disease	189
All cancer (malignant neoplasms)	
Breast cancer	104
Colorectal cancer	081-083
Esophageal cancer	77
Liver cancer	085-086
Lung cancer	93
Pancreatic cancer	88
Prostate cancer	113
Stomach cancer	78
All Other Cancers	072-075; 079; 087; 089; 091-092; 094-096; 098-099; 101-103; 106-111; 114-115; 117-120; 122-124; 125; 127; 129-132; 134-137; 139-140; 142-146
Cerebrovascular Disease	235-239
Diabetes	159
Heart Disease	199; 201-204; 207; 209; 211-215; 218-219; 221-222; 224-228; 230-233
HIV	049-053
Homicide	433-441
Hypertension	206; 208
Influenza and pneumonia	253; 255-257
Liver disease	298-302
Nephritis	323-325; 327; 329
Respiratory disease	264-269
Septicemia	23
Suicide	425-431
All unintentional injuries	
Drug poisoning	420
Motor vehicle accidents	386-388; 390-398
All other unintentional injuries	384; 399-402; 404-418; 421-423
All other causes	All else

Appendix B

Age- and cause-specific contributors to the Black-white life expectancy gap among males with ≤12 years in the U.S. (2016)

Age	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+	Total
Alzheimer's disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.02	-0.02
Breast Cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Colorectal cancer	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.01	0.01	0.00	0.01	0.00	0.08
Esophageal cancer	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	-0.05
Liver cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.02	0.01	0.00	0.00	0.00	0.07
Lung cancer	0.00	0.00	0.00	0.00	-0.01	-0.01	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.05
Pancreatic cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.02
Prostate cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.03	0.03	0.03	0.04	0.03	0.20
Stomach cancer	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.06
All other cancer	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	-0.01	-0.02	-0.02	-0.04	-0.03	-0.15
Cerebrovascular disease	0.00	0.00	0.01	0.02	0.02	0.03	0.04	0.04	0.04	0.03	0.03	0.03	0.00	0.30
Diabetes	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.03	0.02	0.02	0.02	0.01	0.23
Heart disease	0.02	0.04	0.05	0.06	0.07	0.07	0.11	0.11	0.09	0.04	0.03	0.00	-0.11	0.58
HIV	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.02	0.01	0.01	0.00	0.00	0.00	0.22
Homicide	0.36	0.25	0.17	0.09	0.05	0.03	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.99
Hypertension	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.02	0.01	0.14
Influenza / pneumonia	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	-0.01	0.02
Liver disease	0.00	-0.01	-0.02	-0.02	-0.03	-0.03	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	-0.16
Nephritis	0.00	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.03	0.02	0.02	0.02	0.01	0.20
Respiratory	0.01	0.01	0.00	0.00	0.00	-0.01	-0.02	-0.03	-0.04	-0.05	-0.04	-0.05	-0.04	-0.27
Septicemia	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.10
Suicide	-0.06	-0.07	-0.07	-0.07	-0.05	-0.04	-0.03	-0.02	-0.01	-0.01	-0.01	-0.01	0.00	-0.47
Drug poisoning	-0.17	-0.18	-0.12	-0.07	-0.03	-0.01	0.01	0.02	0.01	0.00	0.00	0.00	0.00	-0.52
Motor vehicle accidents	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
All other unintentional	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.02	-0.08
All remaining causes	0.00	0.01	0.02	0.02	0.03	0.02	0.03	0.04	0.03	0.01	0.01	-0.01	-0.05	0.16

Appendix C

Age- and cause-specific contributors to the Black-white life expectancy gap among females with ≤12 years in the U.S. (2016)

Age	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+	Total
Alzheimer's disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.02	-0.06	-0.10
Breast Cancer	0.00	0.01	0.01	0.02	0.02	0.03	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.14
Colorectal cancer	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.05
Esophageal cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Liver cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.03
Lung cancer	0.00	0.00	0.00	-0.01	-0.02	-0.02	-0.02	-0.03	-0.05	-0.05	-0.03	-0.02	-0.01	-0.25
Pancreatic cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.03
Prostate cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Stomach cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03
All other cancer	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	-0.01	-0.01	-0.03	-0.01
Cerebrovascular disease	0.00	0.00	0.01	0.01	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.01	-0.02	0.22
Diabetes	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.04	0.02	0.04	0.32
Heart disease	0.01	0.02	0.04	0.05	0.07	0.09	0.12	0.11	0.09	0.08	0.06	0.02	-0.16	0.59
HIV	0.01	0.02	0.03	0.03	0.03	0.03	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.19
Homicide	0.03	0.03	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09
Hypertension	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.02	0.14
Influenza / pneumonia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.02	-0.02
Liver disease	0.00	-0.01	-0.02	-0.01	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	-0.14
Nephritis	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.02	0.02	0.02	0.03	0.23
Respiratory	0.00	0.00	0.00	0.00	-0.01	-0.02	-0.03	-0.04	-0.07	-0.09	-0.08	-0.06	-0.09	-0.48
Septicemia	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.10
Suicide	-0.03	-0.03	-0.03	-0.03	-0.03	-0.02	-0.02	-0.01	0.00	0.00	0.00	0.00	0.00	-0.20
Drug poisoning	-0.10	-0.12	-0.10	-0.07	-0.04	-0.02	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	-0.46
Motor vehicle accidents	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.06
All other unintentional	0.00	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.05	-0.11
All remaining causes	0.01	0.01	0.01	0.01	0.02	0.03	0.03	0.03	0.02	0.00	-0.01	-0.03	-0.15	0.00

Appendix D

Age- and cause-specific contributors to the Black-white life expectancy gap among males with 13-15 years in the U.S. (2016)

Age	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+	Total
Alzheimer's disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.04	-0.06
Breast Cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Colorectal cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.08
Esophageal cancer	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	0.00	0.00	-0.01	-0.06
Liver cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.02	0.01	0.00	0.00	0.00	0.06
Lung cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	-0.01	0.00	-0.01	-0.01	0.00
Pancreatic cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.01	0.00	0.01	0.04
Prostate cancer	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.02	0.03	0.03	0.05	0.03	0.08	0.27
Stomach cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.01	0.05
All other cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.02	-0.03	-0.02	-0.03	-0.09	-0.20
Cerebrovascular disease	0.00	0.00	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.03	0.03	0.01	0.00	0.23
Diabetes	0.00	0.01	0.01	0.01	0.01	0.02	0.03	0.03	0.04	0.03	0.04	0.02	0.05	0.30
Heart disease	0.02	0.03	0.04	0.06	0.07	0.07	0.11	0.12	0.12	0.09	0.09	0.00	-0.25	0.57
HIV	0.01	0.01	0.01	0.02	0.01	0.01	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.13
Homicide	0.12	0.08	0.06	0.04	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.35
Hypertension	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.03	0.14
Influenza / pneumonia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	-0.02	0.02
Liver disease	0.00	-0.01	-0.01	-0.01	-0.02	-0.02	-0.01	-0.01	0.00	-0.01	-0.01	-0.01	0.00	-0.11
Nephritis	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.03	0.02	0.03	0.02	0.03	0.21
Respiratory	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.02	-0.03	-0.04	-0.07	-0.18
Septicemia	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.01	0.02	0.00	0.00	0.09
Suicide	-0.03	-0.03	-0.04	-0.04	-0.04	-0.03	-0.03	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.30
Drug poisoning	-0.09	-0.09	-0.06	-0.02	-0.01	0.01	0.02	0.02	0.01	0.00	0.00	0.00	0.00	-0.21
Motor vehicle accidents	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
All other unintentional	0.00	0.00	0.00	-0.01	-0.01	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.06	-0.11
All remaining causes	0.01	0.01	0.02	0.03	0.02	0.02	0.04	0.04	0.04	0.02	0.01	-0.01	-0.14	0.10

Appendix E

Age- and cause-specific contributors to the Black-white life expectancy gap among females with 13-15 years in the U.S. (2016)

Age	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+	Total
Alzheimer's disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	-0.03	-0.02
Breast Cancer	0.00	0.01	0.01	0.02	0.03	0.03	0.03	0.02	0.02	0.01	0.02	0.01	0.03	0.25
Colorectal cancer	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.10
Esophageal cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Liver cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.03
Lung cancer	0.00	0.00	0.00	0.00	-0.01	-0.01	0.01	0.00	0.00	0.00	-0.01	0.00	0.00	-0.01
Pancreatic cancer	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.08
Prostate cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Stomach cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.05
All other cancer	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.03	0.04	0.02	0.02	0.02	0.00	0.18
Cerebrovascular disease	0.00	0.00	0.01	0.01	0.02	0.02	0.02	0.03	0.04	0.04	0.04	0.04	0.01	0.29
Diabetes	0.00	0.01	0.01	0.01	0.01	0.02	0.03	0.04	0.04	0.04	0.05	0.04	0.08	0.37
Heart disease	0.01	0.02	0.02	0.04	0.06	0.08	0.11	0.14	0.13	0.13	0.15	0.14	0.01	1.04
HIV	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.06
Homicide	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
Hypertension	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.06	0.18
Influenza / pneumonia	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.01	0.01	-0.02	0.03
Liver disease	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	-0.01	0.00	0.00	-0.07
Nephritis	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.03	0.04	0.06	0.27
Respiratory	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.02	-0.03	-0.03	-0.04	-0.10	-0.21
Septicemia	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.01	0.01	0.02	0.01	0.03	0.14
Suicide	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	-0.14
Drug poisoning	-0.04	-0.04	-0.03	-0.03	-0.02	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.17
Motor vehicle accidents	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
All other unintentional	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.07	-0.10
All remaining causes	0.02	0.02	0.03	0.03	0.04	0.05	0.05	0.06	0.05	0.03	0.05	0.05	-0.09	0.39

Appendix F

Age- and cause-specific contributors to the Black-white life expectancy gap among males with 16+ years in the U.S. (2016)

Age	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+	Total
Alzheimer's disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.05	-0.04
Breast Cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Colorectal cancer	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.00	0.01	0.11
Esophageal cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.05
Liver cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.05
Lung cancer	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.01	0.00	-0.01	-0.02	0.04
Pancreatic cancer	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.01	0.00	-0.01	0.03
Prostate cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.04	0.04	0.05	0.05	0.06	0.29
Stomach cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.06
All other cancer	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.00	-0.01	-0.02	-0.03	-0.09	-0.14
Cerebrovascular disease	0.00	0.00	0.00	0.01	0.01	0.02	0.03	0.04	0.04	0.03	0.05	0.03	-0.02	0.24
Diabetes	0.00	0.00	0.00	0.01	0.02	0.02	0.03	0.04	0.05	0.05	0.04	0.03	0.06	0.36
Heart disease	0.01	0.01	0.03	0.05	0.07	0.08	0.10	0.15	0.16	0.14	0.13	0.07	-0.20	0.82
HIV	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.10
Homicide	0.02	0.03	0.02	0.01	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.10
Hypertension	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.03	0.13
Influenza / pneumonia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	-0.01	0.04
Liver disease	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	-0.01	-0.06
Nephritis	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.02	0.03	0.03	0.03	0.02	0.03	0.20
Respiratory	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	-0.01	-0.02	-0.03	-0.04
Septicemia	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.02	0.01	0.01	0.10
Suicide	-0.01	-0.01	-0.01	-0.02	-0.02	-0.03	-0.02	-0.01	-0.01	-0.01	-0.01	0.00	-0.01	-0.17
Drug poisoning	-0.02	-0.03	-0.02	-0.01	-0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	-0.07
Motor vehicle accidents	0.01	0.01	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06
All other unintentional	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.05	-0.09
All remaining causes	0.01	0.02	0.01	0.02	0.03	0.03	0.03	0.05	0.05	0.03	0.01	0.00	-0.17	0.14

Appendix G

Age- and cause-specific contributors to the Black-white life expectancy gap among females with 16+ years in the U.S. (2016)

Age	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+	Total
Alzheimer's disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	-0.02	-0.01
Breast Cancer	0.00	0.01	0.01	0.02	0.02	0.04	0.04	0.03	0.03	0.02	0.02	0.01	0.01	0.26
Colorectal cancer	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.02	0.02	0.01	0.00	0.01	0.10
Esophageal cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
Liver cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.03
Lung cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.05
Pancreatic cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.08
Prostate cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Stomach cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.04
All other cancer	0.00	0.00	0.01	0.01	0.01	0.01	0.03	0.04	0.05	0.04	0.02	-0.01	-0.03	0.17
Cerebrovascular disease	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.02	0.03	0.04	0.05	0.04	-0.01	0.24
Diabetes	0.00	0.00	0.00	0.00	0.01	0.02	0.02	0.03	0.03	0.04	0.05	0.04	0.08	0.33
Heart disease	0.01	0.02	0.02	0.03	0.04	0.06	0.08	0.11	0.14	0.16	0.15	0.10	-0.13	0.80
HIV	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
Homicide	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04
Hypertension	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.04	0.14
Influenza / pneumonia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	-0.02	0.03
Liver disease	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	-0.01	-0.04
Nephritis	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.03	0.03	0.03	0.03	0.05	0.21
Respiratory	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	-0.01	-0.02	-0.11	-0.11
Septicemia	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.03	0.14
Suicide	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	-0.08
Drug poisoning	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.03
Motor vehicle accidents	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
All other unintentional	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.08	-0.11
All remaining causes	0.02	0.02	0.03	0.03	0.04	0.04	0.05	0.06	0.07	0.07	0.05	0.03	-0.17	0.35

Appendix H

Age- and cause-specific contributors to the Hispanic-white life expectancy gap among males with ≤12 years in the U.S. (2016)

Age	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+	Total
Alzheimer's disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.02	-0.03	-0.08
Breast Cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Colorectal cancer	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.10
Esophageal cancer	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02	-0.01	-0.01	-0.01	-0.11
Liver cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.04
Lung cancer	0.00	0.00	0.00	-0.01	-0.03	-0.06	-0.10	-0.12	-0.14	-0.13	-0.09	-0.05	-0.05	-0.79
Pancreatic cancer	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.02	-0.01	-0.01	-0.01	0.00	-0.09
Prostate cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	0.00	-0.01	-0.01	-0.05
Stomach cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.04
All other cancer	0.00	-0.01	-0.01	-0.02	-0.03	-0.05	-0.07	-0.08	-0.09	-0.08	-0.07	-0.06	-0.09	-0.65
Cerebrovascular disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.03	-0.09
Diabetes	0.00	0.00	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.02	-0.02
Heart disease	-0.01	-0.03	-0.05	-0.09	-0.12	-0.15	-0.17	-0.18	-0.20	-0.18	-0.15	-0.14	-0.43	-1.90
HIV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
Homicide	0.03	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
Hypertension	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
Influenza / pneumonia	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.03	-0.10
Liver disease	0.00	0.00	0.00	-0.01	-0.01	-0.01	0.00	0.01	0.01	0.01	0.01	0.00	0.01	0.01
Nephritis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.03	-0.06
Respiratory	0.00	0.00	0.00	-0.01	-0.01	-0.03	-0.06	-0.09	-0.12	-0.13	-0.12	-0.08	-0.10	-0.76
Septicemia	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.09
Suicide	-0.08	-0.09	-0.08	-0.08	-0.06	-0.05	-0.04	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01	-0.56
Drug poisoning	-0.19	-0.22	-0.17	-0.12	-0.08	-0.05	-0.03	-0.01	0.00	0.00	0.00	0.00	0.00	-0.87
Motor vehicle accidents	-0.03	-0.03	-0.03	-0.03	-0.02	-0.02	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	-0.20
All other unintentional	-0.01	-0.01	-0.01	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02	-0.02	-0.05	-0.21
All remaining causes	-0.05	-0.07	-0.07	-0.07	-0.08	-0.09	-0.09	-0.10	-0.10	-0.11	-0.11	-0.11	-0.30	-1.36

Appendix I

Age- and cause-specific contributors to the Hispanic-white life expectancy gap among females with ≤12 years in the U.S. (2016)

Age	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+	Total
Alzheimer's disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.02	-0.03	-0.04	-0.13	-0.22
Breast Cancer	0.00	0.00	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.03	-0.20
Colorectal cancer	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02	-0.13
Esophageal cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.03
Liver cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.04
Lung cancer	0.00	0.00	0.00	-0.01	-0.03	-0.07	-0.11	-0.11	-0.13	-0.13	-0.10	-0.06	-0.05	-0.81
Pancreatic cancer	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	-0.01	-0.07
Prostate cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Stomach cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.05
All other cancer	-0.01	-0.01	-0.02	-0.03	-0.03	-0.04	-0.05	-0.05	-0.06	-0.06	-0.05	-0.05	-0.09	-0.54
Cerebrovascular disease	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02	-0.02	-0.03	-0.11	-0.25
Diabetes	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.01	0.01	0.02	0.02	0.04	0.04
Heart disease	-0.02	-0.03	-0.05	-0.07	-0.09	-0.10	-0.10	-0.11	-0.10	-0.11	-0.10	-0.13	-0.58	-1.58
HIV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Homicide	-0.01	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.03
Hypertension	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.02
Influenza / pneumonia	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.05	-0.14
Liver disease	-0.01	-0.01	-0.02	-0.03	-0.03	-0.03	-0.02	-0.01	0.01	0.01	0.01	0.01	0.01	-0.10
Nephritis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.03	-0.05
Respiratory	0.00	0.00	-0.01	-0.01	-0.03	-0.05	-0.08	-0.10	-0.13	-0.16	-0.14	-0.11	-0.15	-0.97
Septicemia	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02	-0.13
Suicide	-0.03	-0.03	-0.04	-0.03	-0.03	-0.02	-0.02	-0.01	0.00	0.00	0.00	0.00	0.00	-0.22
Drug poisoning	-0.12	-0.15	-0.13	-0.11	-0.08	-0.06	-0.04	-0.01	0.00	0.00	0.00	0.00	0.00	-0.72
Motor vehicle accidents	-0.03	-0.03	-0.02	-0.02	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.13
All other unintentional	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02	-0.08	-0.23
All remaining causes	-0.06	-0.08	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10	-0.09	-0.11	-0.12	-0.16	-0.65	-1.88

Appendix J

Age- and cause-specific contributors to the Hispanic-white life expectancy gap among males with 13-15 years in the U.S. (2016)

Age	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+	Total
Alzheimer's disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.03	-0.10	-0.16
Breast Cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Colorectal cancer	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	0.00	-0.01	0.00	0.00	0.00	-0.01	-0.04
Esophageal cancer	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.02	-0.02	-0.01	-0.01	-0.01	-0.10
Liver cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
Lung cancer	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.02	-0.03	-0.04	-0.05	-0.04	-0.03	-0.03	-0.26
Pancreatic cancer	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	0.00	-0.01	0.00	-0.05
Prostate cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.02	0.03	0.09	0.18
Stomach cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.03
All other cancer	-0.01	-0.01	-0.01	-0.01	-0.02	-0.03	-0.04	-0.06	-0.07	-0.08	-0.07	-0.07	-0.17	-0.65
Cerebrovascular disease	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.00	-0.04	0.00
Diabetes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.05	0.10
Heart disease	0.00	0.00	0.00	-0.01	-0.01	-0.02	-0.02	-0.03	-0.05	-0.05	-0.03	-0.08	-0.54	-0.85
HIV	0.01	0.01	0.00	0.01	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.06
Homicide	0.05	0.04	0.03	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15
Hypertension	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.03	0.08
Influenza / pneumonia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.05	-0.06
Liver disease	0.00	-0.01	-0.01	-0.02	-0.03	-0.03	-0.03	-0.02	-0.02	-0.02	-0.01	-0.01	-0.01	-0.22
Nephritis	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.03	0.10
Respiratory	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.02	-0.04	-0.05	-0.06	-0.07	-0.14	-0.39
Septicemia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01
Suicide	-0.06	-0.05	-0.05	-0.05	-0.05	-0.04	-0.03	-0.02	-0.02	-0.01	-0.01	-0.01	-0.02	-0.42
Drug poisoning	-0.11	-0.10	-0.08	-0.05	-0.03	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.36
Motor vehicle accidents	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	-0.01	-0.11
All other unintentional	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02	-0.11	-0.26
All remaining causes	-0.01	-0.02	-0.02	-0.02	-0.02	-0.03	-0.03	-0.04	-0.05	-0.06	-0.07	-0.07	-0.34	-0.78

Appendix K

Age- and cause-specific contributors to the Hispanic-white life expectancy gap among females with 13-15 years in the U.S. (2016)

Age	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+	Total
Alzheimer's disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.02	-0.03	-0.33	-0.40
Breast Cancer	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	-0.06
Colorectal cancer	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	0.00	0.00	-0.01	0.00	0.00	-0.01	-0.05
Esophageal cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.02
Liver cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.02
Lung cancer	0.00	0.00	0.00	-0.01	-0.01	-0.02	-0.03	-0.04	-0.04	-0.05	-0.04	-0.03	-0.05	-0.32
Pancreatic cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	0.00	0.00	0.00	-0.04
Prostate cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Stomach cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02
All other cancer	-0.01	-0.01	-0.01	-0.02	-0.03	-0.03	-0.04	-0.04	-0.04	-0.05	-0.04	-0.03	-0.13	-0.47
Cerebrovascular disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.20	-0.18
Diabetes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.03	0.07	0.14
Heart disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.02	0.01	-0.69	-0.65
HIV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
Homicide	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hypertension	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.04	0.08
Influenza / pneumonia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.09	-0.12
Liver disease	0.00	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.17
Nephritis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.05	0.12
Respiratory	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.02	-0.03	-0.04	-0.06	-0.07	-0.07	-0.27	-0.57
Septicemia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.02	0.03
Suicide	-0.02	-0.02	-0.02	-0.03	-0.02	-0.02	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	-0.18
Drug poisoning	-0.05	-0.05	-0.05	-0.04	-0.03	-0.02	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	-0.26
Motor vehicle accidents	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.08
All other unintentional	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02	-0.16	-0.26
All remaining causes	-0.01	-0.01	-0.01	-0.01	-0.02	-0.02	-0.03	-0.03	-0.04	-0.07	-0.06	-0.06	-0.78	-1.16

Appendix L

Age- and cause-specific contributors to the Hispanic-white life expectancy gap among males with 16+ years in the U.S. (2016)

Age	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+	Total
Alzheimer's disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.04	-0.07
Breast Cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Colorectal cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
Esophageal cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	0.00	-0.05
Liver cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.06
Lung cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.02	-0.02	-0.02	-0.01	-0.01	-0.02	-0.11
Pancreatic cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	-0.01	0.00	0.00	0.00	-0.02
Prostate cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	-0.01	0.01
Stomach cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.06
All other cancer	0.00	-0.01	0.00	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02	-0.04	-0.02	-0.04	-0.09	-0.28
Cerebrovascular disease	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.05
Diabetes	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.03	0.02	0.02	0.13
Heart disease	0.00	0.00	-0.01	0.00	-0.01	-0.02	-0.02	-0.02	-0.01	-0.02	0.01	-0.03	-0.28	-0.42
HIV	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.03
Homicide	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Hypertension	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Influenza / pneumonia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.04	-0.04
Liver disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.01	0.01	0.01	0.05
Nephritis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00
Respiratory	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.02	-0.01	-0.02	-0.06	-0.14
Septicemia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01
Suicide	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01	0.00	0.00	-0.17
Drug poisoning	-0.02	-0.02	-0.02	-0.01	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.09
Motor vehicle accidents	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
All other unintentional	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.02	-0.05	-0.13
All remaining causes	0.00	-0.01	-0.01	-0.01	-0.02	-0.01	-0.02	-0.02	-0.02	-0.03	-0.03	-0.08	-0.27	-0.52

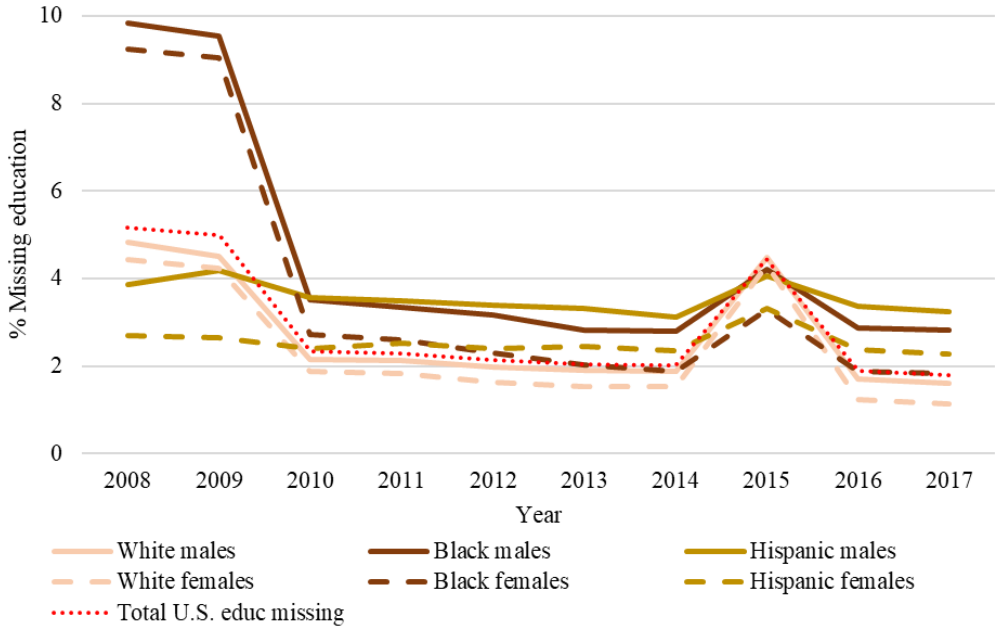
Appendix M

Age- and cause-specific contributors to the Hispanic-white life expectancy gap among females with 16+ years in the U.S. (2016)

Age	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+	Total
Alzheimer's disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.10	-0.13
Breast Cancer	0.00	0.00	0.00	0.00	-0.01	0.00	-0.01	0.00	0.00	-0.01	-0.02	-0.01	-0.01	-0.07
Colorectal cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Esophageal cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01
Liver cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.01	0.03
Lung cancer	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.02	-0.03	-0.04	-0.03	-0.08	-0.22
Pancreatic cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	-0.01	-0.01
Prostate cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Stomach cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
All other cancer	0.00	0.00	0.00	-0.01	-0.01	-0.01	0.00	0.00	0.00	-0.02	-0.01	-0.03	-0.11	-0.20
Cerebrovascular disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	-0.01	0.02
Diabetes	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.03	0.05	0.12
Heart disease	0.00	0.00	-0.01	0.00	-0.01	-0.01	-0.01	-0.01	0.00	0.00	-0.01	0.05	-0.40	-0.41
HIV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Homicide	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hypertension	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	-0.02	-0.01
Influenza / pneumonia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	-0.03	-0.02
Liver disease	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.02
Nephritis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	-0.01	0.01
Respiratory	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.02	-0.02	-0.04	-0.05	-0.13	-0.26
Septicemia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.02	-0.04
Suicide	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	-0.07
Drug poisoning	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	-0.05
Motor vehicle accidents	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
All other unintentional	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.08	-0.14
All remaining causes	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.02	-0.01	-0.02	-0.03	-0.02	-0.04	-0.68	-0.86

Appendix N

Percent mortality missing due to unknown or missing education on death certificate by sex, race, ethnicity, and year



Appendix O

Cause of death coding scheme

Cause of death	358 Recode values
Alzheimer's disease	189
All cancer (malignant neoplasms)	
Breast cancer	104
Colorectal cancer	081-083
Esophageal cancer	77
Liver cancer	085-086
Lung cancer	93
Pancreatic cancer	88
Prostate cancer	113
All Other Cancers	072-075; 079; 087; 089; 091-092; 094-096; 098-099; 101-103; 106-111; 114-115; 117-120; 122-124; 125; 127; 129-132; 134-137; 139-140; 142-146
Cerebrovascular Disease	235-239
Diabetes	159
Heart Disease	199; 201-204; 207; 209; 211-215; 218-219; 221-222; 224-228; 230-233
HIV	049-053
Homicide	433-441
Hypertension	206; 208
Influenza and pneumonia	253; 255-257
Liver disease	298-302
Nephritis	323-325; 327; 329
Respiratory disease	264-269
Septicemia	23
Suicide	425-431
All unintentional injuries	
Drug poisoning	420
Motor vehicle accidents	386-388; 390-398
All other unintentional injuries	384; 399-402; 404-418; 421-423
All other causes	All else

Appendix P

Age- and cause-specific contributors to change in life expectancy from 2009 to 2016 among Black males with ≤12 years in the Great Lakes region

Age	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+	Total
Alzheimer's disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01
Breast Cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Colorectal cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Esophageal cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Liver cancer	0.00	0.00	0.00	0.00	0.00	0.01	0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00
Lung cancer	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.02	0.00	-0.01	0.00	0.01	0.01	0.07
Pancreatic cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Prostate cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.01	0.01	0.03
All other cancer	-0.01	-0.01	-0.01	0.00	0.00	0.01	0.03	0.00	-0.01	-0.01	-0.01	0.01	0.00	0.01
Cerebrovascular disease	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	-0.01	0.00	0.00	0.01	0.01	0.01
Diabetes	0.00	0.00	-0.01	-0.01	0.00	0.01	0.02	0.00	0.00	0.00	-0.01	0.01	0.00	0.01
Heart disease	0.00	0.00	-0.01	0.00	-0.01	0.01	0.01	0.00	-0.01	0.00	0.00	0.00	0.00	-0.01
HIV	-0.01	-0.01	-0.02	-0.01	-0.01	0.03	0.05	0.01	-0.03	-0.03	0.02	0.02	0.01	0.03
Homicide	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.04
Hypertension	-0.17	-0.06	-0.07	-0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.34
Influenza / pneumonia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
Liver disease	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nephritis	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	-0.01	0.00	0.00	0.00	0.00	0.01
Respiratory	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	-0.01	0.00	0.00	0.01
Septicemia	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
Suicide	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.04
Drug poisoning	-0.04	-0.06	-0.04	-0.02	-0.02	-0.01	-0.02	-0.02	-0.01	0.00	0.00	0.00	0.00	-0.25
Motor vehicle accidents	-0.02	-0.02	-0.02	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.07
All other unintentional	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.04
All remaining causes	-0.03	-0.02	-0.03	0.00	0.00	0.03	0.02	-0.02	-0.04	-0.02	-0.01	0.00	-0.01	-0.10

Appendix Q

Age- and cause-specific contributors to change in life expectancy from 2009 to 2016 among Black females with ≤12 years in the Great Lakes region

Age	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+	Total
Alzheimer's disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.07	-0.11
Breast Cancer	0.00	0.00	0.01	0.01	0.02	0.01	0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.05
Colorectal cancer	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.02
Esophageal cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Liver cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	0.00	0.00	0.00	-0.02
Lung cancer	0.00	0.00	0.00	0.00	0.05	0.04	-0.01	0.01	0.01	0.01	0.00	0.01	-0.01	0.12
Pancreatic cancer	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	-0.01	0.01	0.01	0.00	0.00	-0.01
Prostate cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
All other cancer	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.03	0.00	0.02	0.01	0.00	0.01	0.10
Cerebrovascular disease	0.01	0.00	0.00	0.00	0.01	-0.01	-0.02	-0.02	0.00	-0.02	-0.01	0.01	-0.01	-0.06
Diabetes	0.01	0.00	-0.01	0.00	0.02	0.01	0.00	-0.01	0.00	-0.02	0.00	0.01	-0.03	0.00
Heart disease	0.00	0.00	0.00	0.00	-0.02	-0.01	0.00	0.00	0.01	0.00	0.00	0.01	0.01	-0.02
HIV	0.01	0.00	0.02	0.02	0.03	0.06	-0.03	-0.01	-0.04	0.00	0.03	0.07	0.04	0.19
Homicide	0.00	0.01	0.02	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Hypertension	-0.02	-0.02	-0.01	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	-0.06
Influenza / pneumonia	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	0.00	-0.01	-0.01	0.00	0.00	0.00	-0.03
Liver disease	0.00	0.00	0.01	0.00	0.00	0.00	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00
Nephritis	0.00	0.00	0.00	-0.01	0.00	0.01	-0.02	-0.01	-0.01	0.00	0.00	0.00	0.00	-0.04
Respiratory	0.00	-0.01	-0.01	0.00	0.00	0.01	0.01	-0.01	0.01	0.00	0.00	0.00	0.00	-0.01
Septicemia	0.00	0.00	0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.04
Suicide	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
Drug poisoning	-0.04	-0.06	-0.05	-0.01	-0.04	-0.04	-0.04	-0.02	-0.01	0.00	0.00	0.00	0.00	-0.31
Motor vehicle accidents	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.03
All other unintentional	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
All remaining causes	-0.03	0.00	0.01	-0.01	-0.02	0.03	-0.02	-0.04	-0.04	-0.03	-0.01	0.01	-0.06	-0.20

Appendix R

Age- and cause-specific contributors to change in life expectancy from 2009 to 2016 among Black males with 13-15 years in the Great Lakes region

Age	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+	Total
Alzheimer's disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	-0.01	0.04	-0.08	-0.05
Breast Cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Colorectal cancer	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.01	0.02	0.02	0.00	0.04
Esophageal cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01
Liver cancer	0.00	0.00	0.00	0.00	0.00	0.01	0.02	-0.01	-0.02	-0.01	0.00	0.00	0.00	-0.01
Lung cancer	0.00	0.00	0.00	0.00	0.01	0.03	0.03	0.00	0.00	0.01	-0.03	0.06	0.00	0.11
Pancreatic cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.01	-0.02
Prostate cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.01	-0.01	-0.03	0.04	0.03	0.04
All other cancer	0.00	0.01	0.00	0.00	0.00	0.00	0.00	-0.01	0.01	0.01	-0.04	0.01	0.02	0.00
Cerebrovascular disease	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	-0.02	-0.01	0.01	0.01	0.01	-0.01
Diabetes	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	-0.01	-0.03	0.01	0.04	0.01
Heart disease	0.00	-0.01	0.00	0.00	0.00	-0.01	-0.02	-0.01	-0.01	0.01	-0.02	0.01	0.06	-0.01
HIV	0.00	0.01	0.01	-0.01	-0.01	0.01	0.00	0.02	-0.04	0.00	-0.11	0.03	0.01	-0.10
Homicide	0.00	0.01	0.01	0.02	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Hypertension	-0.07	0.00	-0.03	-0.01	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	-0.13
Influenza / pneumonia	0.00	0.00	0.00	0.00	-0.01	-0.01	0.00	-0.01	-0.01	0.00	0.00	0.01	0.01	-0.04
Liver disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	-0.01	0.00	-0.01	0.04	0.03
Nephritis	0.00	-0.01	0.01	0.00	0.00	0.02	0.00	-0.01	-0.01	0.00	0.00	-0.01	-0.01	-0.02
Respiratory	0.00	0.00	0.00	0.00	-0.01	0.00	-0.01	0.00	0.01	0.01	-0.03	0.01	-0.05	-0.07
Septicemia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.01	0.06	0.07
Suicide	-0.01	-0.01	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	-0.05
Drug poisoning	-0.04	-0.02	-0.04	-0.03	-0.05	-0.04	-0.04	-0.03	-0.02	0.00	0.00	0.00	0.00	-0.30
Motor vehicle accidents	-0.02	-0.01	0.00	-0.02	0.00	-0.01	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	-0.07
All other unintentional	-0.01	0.00	-0.01	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	-0.01	-0.02	-0.11
All remaining causes	0.00	-0.01	0.00	-0.01	0.00	-0.01	0.02	-0.03	-0.04	-0.01	-0.10	0.01	-0.10	-0.28

Appendix S

Age- and cause-specific contributors to change in life expectancy from 2009 to 2016 among Black females with 13-15 years in the Great Lakes region

Age	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+	Total
Alzheimer's disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.28	-0.31
Breast Cancer	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	-0.01	0.01	-0.01	0.00	-0.07	-0.03
Colorectal cancer	0.00	0.00	0.00	0.01	-0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	-0.01	0.01
Esophageal cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Liver cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	0.00	0.00	0.00	-0.01	-0.03
Lung cancer	0.00	0.00	0.00	0.01	0.01	0.02	0.00	0.01	0.00	0.00	0.04	-0.01	-0.03	0.05
Pancreatic cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.01	-0.01	-0.01	-0.02	-0.05
Prostate cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
All other cancer	-0.01	-0.01	0.01	0.01	0.01	0.00	0.00	0.01	-0.01	-0.01	-0.02	0.01	-0.01	-0.02
Cerebrovascular disease	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	0.00	-0.03	0.00	-0.02	-0.10
Diabetes	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	-0.01	0.00	0.00	-0.01	-0.14	-0.14
Heart disease	0.00	0.00	-0.01	-0.01	-0.02	-0.02	0.00	-0.01	-0.01	0.00	0.00	-0.01	-0.03	-0.11
HIV	-0.01	-0.01	-0.01	-0.02	0.00	-0.01	0.00	-0.05	-0.04	0.02	-0.02	0.00	-0.36	-0.50
Homicide	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hypertension	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.02
Influenza / pneumonia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	-0.01	0.00	-0.08	-0.09
Liver disease	0.00	-0.01	0.01	0.00	0.00	0.00	0.00	-0.01	-0.01	0.01	0.00	0.00	-0.03	-0.04
Nephritis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.02	-0.05
Respiratory	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	0.00	-0.01	-0.03	-0.09
Septicemia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.01	0.03
Suicide	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Drug poisoning	-0.02	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01	-0.02	0.00	0.00	0.00	0.00	0.00	-0.11
Motor vehicle accidents	0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
All other unintentional	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	-0.01	0.00	-0.01	0.00	0.00	-0.02	-0.07
All remaining causes	0.01	-0.02	-0.01	0.00	0.00	-0.02	0.00	-0.04	-0.03	0.00	-0.01	-0.08	-0.38	-0.59

Appendix T

Age- and cause-specific contributors to change in life expectancy from 2009 to 2016 among Black males with 16+ years in the Great Lakes region

Age	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+	Total
Alzheimer's disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	0.03	-0.02	0.00	-0.02
Breast Cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Colorectal cancer	0.00	-0.01	0.00	0.00	-0.01	-0.02	0.02	0.02	0.01	0.01	0.01	0.00	0.01	0.04
Esophageal cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.02	0.02
Liver cancer	0.00	0.00	0.00	0.01	0.00	0.00	0.01	-0.02	-0.01	-0.01	0.00	0.00	-0.03	-0.03
Lung cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.04	0.01	0.01	0.05	0.00	0.04	0.17
Pancreatic cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.04	0.00	0.01	0.07
Prostate cancer	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.02	-0.02	-0.01	0.05	-0.01	0.01	-0.01
All other cancer	0.01	-0.01	0.00	0.01	-0.01	-0.01	0.03	-0.02	0.00	0.04	0.04	-0.06	-0.01	0.02
Cerebrovascular disease	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.02	0.00	-0.02	-0.02	-0.01	-0.03
Diabetes	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.02	-0.04	-0.01	0.00
Heart disease	0.00	0.01	0.00	-0.02	-0.01	0.01	0.01	-0.01	-0.03	0.00	0.03	-0.02	-0.04	-0.06
HIV	0.00	-0.02	-0.03	0.00	-0.02	0.05	0.10	0.05	0.01	-0.01	0.16	-0.15	-0.27	-0.12
Homicide	0.00	0.02	0.01	0.01	0.03	0.02	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.10
Hypertension	0.00	-0.03	0.01	0.02	0.01	-0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Influenza / pneumonia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	-0.02	0.01	-0.01	0.00	-0.02
Liver disease	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	-0.02	0.02	-0.02	0.01	0.01
Nephritis	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	-0.02	0.00	-0.01	0.01	0.00
Respiratory	0.00	0.01	0.00	0.00	0.00	0.01	0.01	0.00	-0.01	-0.03	0.03	-0.01	-0.03	-0.04
Septicemia	0.00	0.00	0.01	-0.01	-0.01	0.01	0.01	0.02	0.00	-0.01	0.00	-0.02	0.01	0.02
Suicide	0.01	-0.01	0.01	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01
Drug poisoning	-0.01	-0.01	-0.01	0.00	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	-0.08
Motor vehicle accidents	0.00	0.01	0.01	0.00	-0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.00	-0.01	0.04
All other unintentional	-0.02	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	-0.01	0.00	-0.06
All remaining causes	-0.01	-0.02	0.00	0.00	0.01	0.02	0.05	0.00	-0.06	-0.06	0.05	-0.12	-0.20	-0.33

Appendix U

Age- and cause-specific contributors to change in life expectancy from 2009 to 2016 among Black females with 16+ years in the Great Lakes region

Age	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+	Total
Alzheimer's disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.03	-0.01	-0.28	-0.34
Breast Cancer	0.00	0.00	0.01	0.01	0.02	-0.01	0.02	0.01	0.01	0.00	0.02	-0.02	0.04	0.11
Colorectal cancer	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.02	-0.02	0.00	0.04	0.02	-0.04	0.01
Esophageal cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Liver cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	0.00	0.01	-0.01	-0.01	-0.03
Lung cancer	0.00	0.00	-0.01	0.00	0.01	0.02	0.01	0.03	0.04	0.04	0.02	0.03	0.00	0.18
Pancreatic cancer	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.01	-0.01	-0.01	0.01	-0.01	0.00	-0.01
Prostate cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
All other cancer	0.00	0.00	0.00	-0.02	-0.01	0.00	0.00	-0.02	-0.02	-0.05	0.06	-0.02	0.06	-0.02
Cerebrovascular disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	-0.03	-0.02	-0.01
Diabetes	0.00	0.00	0.01	0.00	0.00	0.00	0.02	-0.01	-0.01	0.01	0.05	-0.01	-0.05	-0.01
Heart disease	0.00	0.00	0.01	0.00	0.00	0.00	0.01	-0.02	0.03	-0.02	0.01	-0.02	0.04	0.04
HIV	0.01	-0.01	0.00	-0.02	0.01	0.02	0.01	0.02	-0.01	-0.03	0.03	0.08	-0.03	0.11
Homicide	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Hypertension	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Influenza / pneumonia	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	0.00	-0.01	-0.02	0.00	-0.01	0.02	-0.03
Liver disease	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	-0.01	0.01	0.03	0.00	0.01	0.05
Nephritis	-0.01	0.00	0.00	0.00	-0.01	0.01	0.01	0.00	-0.01	0.02	0.01	0.01	0.00	0.02
Respiratory	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	-0.01	0.03	0.02	-0.04	0.03
Septicemia	0.00	0.00	0.00	0.00	0.00	0.00	0.01	-0.01	0.00	-0.01	0.00	0.01	0.05	0.05
Suicide	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Drug poisoning	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	-0.02
Motor vehicle accidents	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.01	0.01
All other unintentional	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	-0.01	-0.01	-0.01	-0.02	-0.03
All remaining causes	-0.01	-0.02	-0.03	0.01	-0.01	0.02	-0.01	0.00	0.00	-0.03	0.03	0.00	0.10	0.06

Appendix V

Age- and cause-specific contributors to change in life expectancy from 2009 to 2016 among white males with ≤12 years in the Great Lakes region

Age	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+	Total
Alzheimer's disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	-0.01	0.00
Breast Cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Colorectal cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.04	0.00	0.00	-0.02
Esophageal cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.01	0.00	0.00	0.01
Liver cancer	0.00	0.00	0.00	0.00	0.00	0.01	0.00	-0.01	-0.01	0.00	0.02	0.00	0.00	0.00
Lung cancer	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.03	0.04	0.02	-0.14	0.01	0.00	0.02
Pancreatic cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
Prostate cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.03	0.00	0.01	-0.02
All other cancer	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	-0.04	0.00	0.00	-0.01
Cerebrovascular disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	0.01	0.00	-0.03
Diabetes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.04	0.00	0.01	-0.03
Heart disease	0.00	0.00	0.00	-0.01	-0.01	0.00	0.00	0.00	0.00	-0.01	0.02	0.00	0.00	-0.01
HIV	0.00	-0.01	0.00	0.00	0.00	0.00	0.02	0.01	-0.03	-0.02	-0.02	0.02	0.02	-0.02
Homicide	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Hypertension	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.02
Influenza / pneumonia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
Liver disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.01	-0.02
Nephritis	0.00	-0.01	-0.01	0.00	0.01	0.00	-0.01	-0.01	-0.01	-0.01	0.02	0.00	0.00	-0.04
Respiratory	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.02	0.00	0.01	-0.02
Septicemia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	-0.01
Suicide	-0.03	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.01	0.00	0.00	-0.10
Drug poisoning	-0.21	-0.24	-0.18	-0.11	-0.07	-0.04	-0.03	-0.01	-0.01	0.00	0.00	0.00	0.00	-0.92
Motor vehicle accidents	-0.01	0.00	-0.01	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	-0.03
All other unintentional	0.00	-0.01	0.00	0.00	0.01	0.00	-0.01	0.00	0.00	0.00	0.03	0.00	-0.01	-0.01
All remaining causes	-0.02	-0.02	-0.01	0.00	-0.01	-0.01	0.00	-0.03	-0.04	-0.03	0.17	-0.01	-0.02	-0.04

Appendix W

Age- and cause-specific contributors to change in life expectancy from 2009 to 2016 among white females with ≤12 years in the Great Lakes region

Age	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+	Total
Alzheimer's disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.02	-0.08	-0.12
Breast Cancer	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.04
Colorectal cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Esophageal cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Liver cancer	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	-0.02
Lung cancer	0.00	0.00	0.00	0.01	0.02	0.00	-0.01	0.01	0.02	0.01	0.00	0.00	0.00	0.06
Pancreatic cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
Prostate cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
All other cancer	-0.01	0.00	0.00	-0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	-0.01	0.02
Cerebrovascular disease	0.00	0.00	0.00	0.00	0.00	-0.02	-0.02	0.00	0.00	-0.01	-0.01	-0.01	-0.02	-0.11
Diabetes	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	-0.01	-0.01
Heart disease	0.00	0.00	0.00	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
HIV	0.00	-0.01	-0.02	-0.02	-0.02	-0.02	-0.02	0.00	0.00	0.00	0.01	0.02	0.01	-0.07
Homicide	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Hypertension	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
Influenza / pneumonia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.02
Liver disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	-0.01
Nephritis	0.00	-0.01	-0.01	-0.01	0.00	-0.02	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	-0.08
Respiratory	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
Septicemia	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	-0.01	-0.01	0.00	-0.01	-0.06
Suicide	-0.01	-0.01	-0.01	-0.01	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	-0.05
Drug poisoning	-0.14	-0.18	-0.12	-0.08	-0.05	-0.04	-0.03	-0.01	0.00	0.00	0.00	0.00	0.00	-0.65
Motor vehicle accidents	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.04
All other unintentional	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.02	-0.07
All remaining causes	-0.02	-0.04	-0.02	-0.04	-0.03	-0.03	-0.02	-0.02	-0.03	-0.04	-0.03	-0.03	-0.09	-0.45

Appendix X

Age- and cause-specific contributors to change in life expectancy from 2009 to 2016 among white males with 13-15 years in the Great Lakes region

Age	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+	Total
Alzheimer's disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.04	-0.06
Breast Cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Colorectal cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.02
Esophageal cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Liver cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	0.00	0.00	0.00	-0.02
Lung cancer	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.01	0.01	0.02	0.00	0.02	0.11
Pancreatic cancer	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	-0.01	-0.01	0.00	0.00	0.00	-0.02
Prostate cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02
All other cancer	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.01	-0.02	0.01
Cerebrovascular disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.02	0.01	0.01	-0.02	-0.04
Diabetes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.01	-0.01	-0.02
Heart disease	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	-0.01	-0.01	-0.01	0.00	0.00	0.00	-0.05
HIV	0.00	-0.01	0.00	-0.02	0.00	0.00	0.01	-0.01	-0.03	-0.02	0.02	0.01	-0.05	-0.09
Homicide	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hypertension	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
Influenza / pneumonia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.02
Liver disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02
Nephritis	0.00	-0.01	-0.01	0.00	-0.01	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	-0.07
Respiratory	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Septicemia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.04
Suicide	-0.03	-0.02	-0.01	-0.02	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	-0.13
Drug poisoning	-0.08	-0.10	-0.07	-0.04	-0.03	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	-0.35
Motor vehicle accidents	-0.01	-0.01	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.03
All other unintentional	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.03	-0.07
All remaining causes	-0.01	-0.01	-0.02	-0.01	-0.01	-0.01	-0.01	-0.02	-0.03	-0.03	-0.05	-0.02	-0.08	-0.30

Appendix Y

Age- and cause-specific contributors to change in life expectancy from 2009 to 2016 among white females with 13-15 years in the Great Lakes region

Age	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+	Total
Alzheimer's disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.03	-0.12	-0.16
Breast Cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.03
Colorectal cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02
Esophageal cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Liver cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.02
Lung cancer	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.01	0.00	0.02	0.00	0.01	0.04
Pancreatic cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.02
Prostate cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
All other cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	-0.02	0.01	0.03	0.03
Cerebrovascular disease	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	-0.01	0.01	0.00	-0.01	-0.02
Diabetes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.02
Heart disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	0.00	0.00	0.00	-0.02
HIV	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02	-0.03	0.02	0.03	0.08	0.01
Homicide	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hypertension	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
Influenza / pneumonia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	-0.01
Liver disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.02
Nephritis	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	-0.07
Respiratory	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02
Septicemia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	0.00	-0.01	-0.01	-0.03
Suicide	0.00	-0.01	0.00	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.05
Drug poisoning	-0.04	-0.05	-0.04	-0.03	-0.02	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	-0.21
Motor vehicle accidents	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.02
All other unintentional	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.04	-0.08
All remaining causes	-0.01	-0.01	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02	-0.04	-0.01	-0.03	-0.08	-0.26

Appendix Z

Age- and cause-specific contributors to change in life expectancy from 2009 to 2016 among white males with 16+ years in the Great Lakes region

Age	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+	Total
Alzheimer's disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.02	-0.04	-0.06
Breast Cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Colorectal cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.05
Esophageal cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.02
Liver cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lung cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.03	0.04	0.04	0.04	0.01	0.20
Pancreatic cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	-0.01	0.01
Prostate cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.05
All other cancer	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.03	0.05	0.06	-0.01	0.19
Cerebrovascular disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.02	0.01	0.05
Diabetes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.05
Heart disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01
HIV	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.01	0.03	0.07	0.02	0.04	0.20
Homicide	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Hypertension	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Influenza / pneumonia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.02
Liver disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03
Nephritis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00
Respiratory	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.04
Septicemia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01
Suicide	-0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Drug poisoning	-0.02	-0.02	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.07
Motor vehicle accidents	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
All other unintentional	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	-0.02	-0.02
All remaining causes	0.00	-0.01	0.00	0.00	0.01	0.01	0.00	-0.02	-0.03	-0.02	-0.01	-0.02	-0.06	-0.15

Appendix AA

Age- and cause-specific contributors to change in life expectancy from 2009 to 2016 among white females with 16+ years in the Great Lakes region

Age	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+	Total
Alzheimer's disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.03	-0.05	-0.08
Breast Cancer	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.00	0.08
Colorectal cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.03
Esophageal cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Liver cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
Lung cancer	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.03	0.03	0.04	0.02	-0.01	0.14
Pancreatic cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	-0.01	-0.01	0.00
Prostate cancer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
All other cancer	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.00	0.02	0.03	0.04	0.00	0.01	0.15
Cerebrovascular disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.02	0.02	0.02	0.09
Diabetes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.01	0.01	0.06
Heart disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.01	0.01	0.01	0.02	0.04
HIV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.05	0.02	0.19	0.30
Homicide	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hypertension	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Influenza / pneumonia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
Liver disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.03	0.05
Nephritis	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	-0.02
Respiratory	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.04
Septicemia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.02
Suicide	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Drug poisoning	-0.01	0.00	0.00	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.04
Motor vehicle accidents	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
All other unintentional	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.02	-0.03
All remaining causes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	-0.01	-0.01	0.01

Appendix AB

Cause of death coding scheme

Cause of Death	358 Recode Values
All cancer (Malignant Neoplasms)	
Breast	104
Colorectal	081-083
Esophageal	77
Liver	085-086
Lung	93
Pancreatic	88
Prostate	113
Stomach	78
All Other Cancers	072-075; 079; 087; 089; 091-092; 094-096; 098-099; 101-103; 106-111; 114-115; 117-120; 122-124; 125; 127; 129-132; 134-137; 139-140; 142-146
Cerebrovascular Disease	235-239
Diabetes	159
Heart Disease	199; 201-204; 207; 209; 211-215; 218-219; 221-222; 224-228; 230-233
HIV	049-053
Homicide	433-441
Hypertension	206; 208
Influenza and Pneumonia	253; 255-257
Liver Disease	298-302
Nephritis	323-325; 327; 329
Perinatal Conditions	357-364
Respiratory Disease	264-269
All Unintentional Injuries	
Drug Poisoning	420
Motor Vehicle Accidents	386-388; 390-398
All Other Unintentional Injuries	384; 399-402; 404-418; 421-423
All Other Causes	All else

Appendix AC

Contribution of 23 causes of death (in years) to life expectancy (e_0) change among non-Hispanic black males and females from 2000 to 2016 in Washington D.C.

Cause of death	Males	Females
All cancer (malignant neoplasms)	1.20	0.48
Breast	--	0.11
Colorectal	0.04	0.11
Esophageal	0.16	0.02
Liver	-0.10	-0.05
Lung	0.49	0.23
Pancreatic	-0.02	-0.05
Prostate	0.18	--
Stomach	0.06	0.06
All other cancers	0.38	0.06
Cerebrovascular disease	0.10	0.16
Diabetes	-0.03	0.46
Heart disease	0.51	1.29
HIV	1.34	0.61
Homicide	1.08	0.12
Hypertension	-0.05	-0.04
Influenza and pneumonia	0.04	0.04
Liver disease	0.13	0.01
Nephritis	0.07	0.07
Perinatal conditions	0.34	0.32
Respiratory disease	0.06	-0.10
All unintentional injuries	-0.52	-0.55
Drug poisoning	-0.72	-0.45
Motor vehicle accidents	0.17	-0.02
All other unintentional injuries	0.03	-0.09
All other causes	1.64	0.77
Total e_0 change	**5.91**	**3.64**

Note: Table entries represent the contribution, in years, to the total change in life expectancy. Some of these values may be negative, reflecting suppression of life expectancy gains between 2000 and 2016.

Appendix AD

Contribution of 23 causes of death (in years) to life expectancy (e_0) change among non-Hispanic white males and females from 2000 to 2016 in Washington D.C.

Cause of death	Males	Females
All cancer (malignant neoplasms)	2.36	1.76
Breast	--	0.44
Colorectal	0.36	0.16
Esophageal	0.06	-0.05
Liver	0.06	0.02
Lung	0.59	0.53
Pancreatic	0.09	0.00
Prostate	0.25	--
Stomach	0.06	0.01
All other cancers	0.90	0.65
Cerebrovascular disease	0.29	0.29
Diabetes	0.26	0.12
Heart disease	2.74	2.83
HIV	0.50	0.09
Homicide	0.16	0.05
Hypertension	-0.03	-0.03
Influenza and pneumonia	0.11	0.18
Liver disease	0.11	0.06
Nephritis	0.07	0.03
Perinatal conditions	0.20	0.06
Respiratory disease	0.32	0.39
All unintentional injuries	-0.04	-0.15
Drug poisoning	-0.13	-0.12
Motor vehicle accidents	0.15	0.12
All other unintentional injuries	-0.06	-0.15
All other causes	1.39	0.72
Total e_0 change	**8.44**	**6.41**

Note: Table entries represent the contribution, in years, to the total change in life expectancy. Some of these values may be negative, reflecting suppression of life expectancy gains between 2000 and 2016.

Appendix AE

Age- and cause-specific contributors to the Black-white longevity gap among males in Washington, D.C. in 2016

	0	1-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+
Breast	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Colorectal	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.02	0.04	0.03	0.03	0.03	0.04	0.03	0.03	0.01	0.01
Esophageal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.00	-0.01	0.00
Liver	0.00	-0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.00	0.05	0.06	0.13	0.02	0.03	0.00	0.00
Lung	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.06	0.06	0.07	0.15	0.11	0.06	0.00	-0.01
Pancreatic	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	-0.01	0.01	0.00	0.03	0.03	0.04	0.03	-0.01	0.00	0.00
Prostate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.03	0.05	0.04	0.03	0.05	0.06
Stomach	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.03	0.00	0.00	0.01
All other cancers	0.00	0.00	0.01	0.00	-0.01	0.02	0.00	0.05	0.03	0.06	0.06	0.05	0.07	0.13	0.08	0.06	0.05	-0.02	0.02
Cerebrovascular Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.02	0.04	0.06	0.07	0.06	0.05	0.04	0.03	0.03	0.02
Diabetes	0.00	0.00	0.00	0.01	0.01	0.01	0.03	0.02	0.02	0.01	0.07	0.06	0.10	0.08	0.10	0.06	0.04	0.04	0.03
Heart Disease	0.01	0.00	0.00	0.00	0.01	0.01	0.02	0.06	0.11	0.24	0.35	0.41	0.53	0.55	0.60	0.49	0.35	0.26	0.12
HIV	0.00	0.00	0.00	0.00	0.00	0.03	0.05	0.06	0.03	0.05	0.10	0.08	0.06	0.07	0.05	0.01	0.00	0.01	0.00
Homicide	0.02	0.01	0.00	0.00	0.29	0.65	0.53	0.31	0.25	0.14	0.10	0.06	0.04	0.02	0.01	0.00	0.00	0.00	0.00
Hypertension	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.03	0.04	0.03	0.02	0.03	0.03	0.04	0.04
Influenza and Pneumonia	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.01	0.03	0.04	0.03	0.02	0.03	0.02	0.02	0.00
Liver Disease	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	-0.01	-0.02	0.04	0.03	0.06	0.04	0.03	0.00	-0.01	0.00
Nephritis	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.02	0.03	0.02	0.03	0.02	0.03	0.02	0.02	0.02
Perinatal conditions	0.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Respiratory Disease	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.02	0.02	0.00	0.01	0.02	0.03	0.06	0.07	0.03	0.03	0.03	0.01
Drug poisoning	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.13	0.15	0.05	0.17	0.33	0.28	0.24	0.12	0.02	0.01	0.00	0.00
Motor vehicle accidents	0.00	0.00	0.03	0.00	0.03	0.06	0.04	0.09	0.06	0.01	0.02	0.01	-0.01	0.01	0.02	0.00	-0.01	0.00	0.00
All other unintentional injuries	0.05	0.01	0.01	0.00	0.00	0.02	0.01	0.04	0.02	0.00	0.01	0.03	0.04	0.06	0.02	0.01	0.00	-0.01	0.00
All Other Causes	0.27	0.04	0.04	0.01	0.07	0.04	0.11	0.07	0.32	0.05	0.19	0.16	0.27	0.25	0.24	0.16	0.14	0.12	0.11

Appendix AF

Age- and cause-specific contributors to the Black-white longevity gap among females in Washington, D.C. in 2016

	0	1-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+
Breast	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.01	0.01	0.05	0.02	0.06	0.05	0.03	0.04	0.03	0.02	0.08
Colorectal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.01	0.03	0.03	0.02	0.05	0.03	0.03	0.03	0.01	0.05
Esophageal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.00	0.00	0.00	-0.03	0.00
Liver	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.03	0.01	0.02	0.02	0.01	0.01
Lung	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.11	0.07	0.07	0.04	0.07	-0.04	0.01
Pancreatic	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.07	0.05	0.04	0.01	0.00	0.01	0.01
Prostate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Stomach	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	-0.01	0.00	0.00	0.01	0.01	0.00	0.01	0.02
All other cancers	0.00	0.00	-0.04	0.01	-0.01	0.00	0.03	0.01	0.06	0.07	0.10	0.17	0.15	0.13	0.16	0.06	-0.05	0.06	-0.02
Cerebrovascular Disease	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.03	0.04	0.03	0.02	0.07	0.08	0.05	0.05	0.05	0.05	-0.09
Diabetes	0.00	0.00	0.00	0.01	0.01	0.00	0.02	0.00	0.01	0.04	0.01	0.02	0.05	0.06	0.07	0.05	0.06	0.03	0.11
Heart Disease	0.03	0.00	0.00	0.00	0.00	0.01	0.00	0.06	0.06	0.15	0.17	0.33	0.35	0.40	0.43	0.34	0.24	0.25	0.43
HIV	0.00	0.00	0.00	0.00	0.01	0.00	0.02	0.04	0.04	0.06	0.05	0.06	0.03	0.02	0.02	0.01	0.00	0.00	0.00
Homicide	0.03	0.03	0.00	0.00	0.06	0.02	0.03	0.03	0.03	0.03	-0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Hypertension	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.03	0.01	0.02	0.02	0.03	0.05
Influenza and Pneumonia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	-0.01	0.01	0.01	0.01	0.03	0.03	0.01	0.02	0.03	-0.02	0.01
Liver Disease	-0.02	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.00	0.02	0.00	0.04	0.00	0.03	0.00	-0.01	0.00
Nephritis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.01	0.01	0.03	0.06	0.02	0.03	0.07
Perinatal conditions	0.56	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Respiratory Disease	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.02	0.05	0.07	0.05	0.05	0.04	0.02	-0.02	0.00
Drug poisoning	0.00	0.00	0.00	0.00	0.00	-0.01	0.01	0.01	0.02	0.05	0.11	0.17	0.15	0.09	0.03	0.01	0.00	0.00	0.00
Motor vehicle accidents	0.00	0.01	0.01	0.00	0.00	0.06	0.01	0.01	0.01	0.01	0.00	0.01	-0.01	0.01	0.01	-0.01	-0.02	-0.01	0.00
All other unintentional injuries		0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.03	0.00	0.02	0.02	0.01	0.01	-0.03	-0.05	-0.03
All Other Causes	0.09	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.03	0.00	0.02	0.02	0.01	0.01	0.00	0.00	0.00
	0.26	0.08	0.03	0.03	0.02	0.04	0.09	0.06	0.13	0.09	0.12	0.19	0.22	0.18	0.17	0.15	0.18	0.17	0.23

CURRICULUM VITAE

MAX TYLER ROBERTS

EDUCATION

Ph.D. in Sociology (Demography), *Utah State University* **August 2021**
Committee: Eric Reither (chair), Sojung Lim, Hyojun Park, Erin Hofmann, Paul Peppard

M.S. in Sociology, *Utah State University* **August 2017**
Committee: Eric Reither (co-chair), Sojung Lim (co-chair), Julie Gast

B.A. in Sociology, *California State University Channel Islands* **May 2015**

A.A. in Sociology, *Ventura College* **May 2013**

A.A. in Natural Sciences or Mathematics, *Ventura College* **May 2011**

RESEARCH EXPERIENCE

Graduate Research Assistant **January 2017 – July 2021**
Department of Sociology, Social Work, and Anthropology, *Utah State University*

Graduate Research Assistant **May 2017 – June 2017**
Department of Sociology, Social Work, and Anthropology, *Utah State University*

Graduate Research Assistant **June 2016 – August 2016**
Department of Sociology, Social Work, and Anthropology, *Utah State University*

Graduate Research Assistant **August 2015 – May 2017**
Department of Sociology, Social Work, and Anthropology, *Utah State University*

PUBLICATIONS IN PEER-REVIEWED JOURNALS

Roberts, Max T., Reither, Eric N., Lim, Sojung, "Contributors to the Black-White Life Expectancy Gap in Washington, D.C." *Scientific Reports* **2020**

Roberts, Max T., Reither, Eric N., Lim, Sojung, "Contributors to Wisconsin's Persistent Black-White Gap in Life Expectancy." *BMC Public Health* **2019**

Freeman, Jacob, Keith, Jonathan, **Roberts, Max T.**, Owens, Andrew, "The Effects of Revenue and Social Capital on Collective Governance: Implications for Political Complexity." *Cross-Cultural Research* **2018**

MANUSCRIPTS UNDER REVIEW

Omisakin, Olusola, Park, Hyojun, **Roberts, Max T.**, Reither, Eric N., "Contributors to reduced life expectancy among native Americans in the Four Corners States", *PLOS One*

Liu, Yin, Palta, Mari, Barnet, Jodi H., **Roberts, Max T.**, Hagen, Erika W., Peppard, Paul E., Reither, Eric N., "Habitual Sleep, Sleep Duration Differential, and Weight Change among Adults: Findings from the Wisconsin Sleep Cohort Study", *Sleep health*

MANUSCRIPTS IN PREPARATION

Roberts, Max T., Lim, Sojung, Park, Hyojun, Reither, Eric N., "Assessing age- and cause-specific contributors to longevity gaps across educational attainment in the United States"

Roberts, Max T., Hofmann, Erin, Park, Hyojun, Reither, Eric N., "Declining Life Expectancy in the Great Lakes region: contributors to longevity change across sex, race, and educational attainment"

TEACHING EXPERIENCE

Instructor, Sociology 1020, Social Problems, *Utah State University* **Fall 2017**

Teaching Assistant, Sociology 3420, Criminology, Dr. Stephen VanGeem, *Utah State University* **Spring 2017**

Teaching Assistant, Sociology 3430, Social Deviance, Dr. Stephen VanGeem, *Utah State University* **Spring 2017**

Teaching Assistant, Sociology 3120, Social Statistics I, Dr. Stephen VanGeem, *Utah State University* **Fall 2016**

PRESENTATIONS

Omisakin, Olusola, Park, Hyojun, **Roberts, Max T.**, Reither, Eric N., "Contributors to reduced life expectancy among native Americans in the Four Corners States", *poster presentation*, Population Association of America, Virtual conference **2021**

Roberts, Max T., Reither, Eric N., Lim, Sojung, "Contributors to the Black-White Life Expectancy Gap in Washington, D.C.", *poster presentation,* American Public Health Association Conference, Philadelphia, PA **2019**

Roberts, Max T., Reither, Eric N., Lim, Sojung, "Contributors to the Black-White Life Expectancy Gap in Washington, D.C.", *poster presentation,* Utah Demography Summit, Provo, UT **2019**

Roberts, Max T., Reither, Eric N., Lim, Sojung, "Contributors to Wisconsin's Persistent Black-White Gap in Life Expectancy", *poster presentation*, Yun Kim Pop Lab 50th Anniversary, Utah State University, Logan, UT **2018**

Roberts, Max T., Reither, Eric N., Lim, Sojung, "Contributors to Wisconsin's Persistent Black-White Gap in Life Expectancy", *poster presentation*, Population Association of America Conference, Denver, CO **2018**

Roberts, Max T., "Asian Immigrants in California: A comparison of…", *poster presentation*, SAGE Student Research Conference, CSU Channel Islands, Camarillo, CA **2015**

Roberts, Max T., "Asian Immigrants in California: A comparison of…", *round table discussion*, Pacific Sociological Association Conference, Long Beach, CA **2015**

Roberts, Max T., "Asian Immigrants in California: A comparison of…", *oral presentation*, Southern California Conference for Undergraduate Research, CSU Fullerton, Fullerton, CA **2014**

AWARDS AND RECOGNITION

Doctoral Student Researcher of the Year, College of Humanities and Social Sciences, *Utah State University* **March 2021**

Doctoral Student Researcher of the Year, Department of Sociology, Social Work, and Anthropology *Utah State University* **October 2020**

National Institutes of Health, Policy Communication Fellow **June 2020**

Travel Award, Department of Sociology, *Utah State University,* ($500) **February 2020**

Travel Award, Department of Sociology, *Utah State University,* ($1,000) **June 2019**

Travel Award, Department of Sociology, *Utah State University,* ($1,200) **February 2018**

X-STEM Assistantship, *Utah State University*, ($15K/year; 3 years) **August 2017**

- 2 assistantships awarded each year to a non-STEM graduate student

Travel Award, Department of Sociology, *Utah State University,* ($750) **January 2016**

Semester Honors, *CSU Channel Islands* **May 2014**

Semester Honors, *CSU Channel Islands* **November 2014**

Inductee, Alpha Kappa Delta: Sociology Honors Society **April 2014**

SERVICE

President, Sociology Graduate Student Association, *Utah State University*
August 2018 – July 2020

Vice President, Sociology Graduate Student Association, *Utah State University*
August 2017 – July 2018

TECHNICAL SKILLS

Proficient: STATA, SAS, Excel, PowerPoint, Word, EndNote, Qualtrics

Developing: R, SPSS

Beginning: Mplus, GIS, Nvivo, Tableau

PROFESSIONAL DEVELOPMENT / WORKSHOPS

U.S. Policy Communication Training Program, Washington, D.C., Population Reference Bureau **June 2020**

Bayesian Methods in Formal Demography, University of California, Berkeley, CA, Berkeley Population Center **June 2020**

Structural Equation Modeling using Mplus, Utrecht University, Netherlands, Faculty of Social and Behavioral Sciences **July 2018**

Grant Proposal Writing Workshop, Utah State University, Logan, UT, Grant Writers' Seminars and Workshops **November 2017**

PROFESSIONAL MEMBERSHIPS

Pacific Sociological Association **2020 – 2021**
American Public Health Association **2019 - 2020**
Population Association of America **2018 - 2019**