Cause Specific Mortality and Income in the United States and the Mississippi River Delta Region

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Abstract

This chapter uses cause specific mortality rates to examine the health of the population in the Mississippi River Delta Region by first examining trends for five causes of death (cardiovascular disease, other noncommunicable diseases,[1] communicable diseases, injuries and diabetes) over the period 1970 to 2000; analyzing the relationship from county income to levels of cardiovascular disease and other noncommunicable diseases; and finally estimating the contribution of all five causes of death to economic growth at the county level. The Mississippi River Delta Region is defined by the United States government as 240 counties along or near the lower Mississippi River in the eight states of Alabama, Arkansas, Illinois, Kentucky, Louisiana, Mississippi, Missouri, and Tennessee. This analysis enhances the results of a separate analysis where it was shown that life expectancy in the Delta Region is lagging behind the rest of the United States and life expectancy for females in the Delta Region has decreased over the period 1990 to 2000 for 35% of Delta counties. This analysis further contributes to estimations of the effects of health on economic growth by using cause specific mortality rates, rather than life expectancy, as a proxy for health.

The trend analysis demonstrates that age-standardized death rates for all causes of death, which have remained higher in the Delta Region than the non-Delta Region since 1970, decline at a similar rate in both Regions during the period 1970 to 1990. During the period 1990 to 2000 age-standardized death rates continue on their same pattern of increase or decrease in the non-Delta Region. In contrast, over the period 1990 to 2000 age-standardized death rates fall at a

[1] As of the year 2000, 66% of other noncommunicable diseases are cancers (51%) and respiratory diseases (15%). The other causes of death classified as other noncommunicable diseases in this paper are listed in the method section and comprise the remaining 34%.

slower rate for cardiovascular disease and injuries and increase at a higher rate for other noncommunicable diseases, communicable diseases, and diabetes in the Delta Region compared to the non-Delta Region.

This paper examines, visually and with regression analysis, how income and other factors impact the two largest causes of death in the Delta and non-Delta Regions, cardiovascular deaths and other noncommunicable diseases. Visually, the results show higher levels of cardiovascular disease are associated with the lowest income levels in the non-Delta Region. In contrast, in the Delta Region the "diseases of affluence" paradigm remains until 1980 with higher income counties having higher levels of cardiovascular disease. Since 1990, the pattern in the Delta Region follows that of the non-Delta Region with the poorest counties in the Delta Region having higher levels of cardiovascular disease than the wealthier counties. For both Delta and non-Delta counties, for all years, higher levels of income are associated with lower levels of other noncommunicable diseases. A regression analysis shows that the factors, other than income, that are associated with higher levels of age-standardized cardiovascular disease death rate and age-standardized other noncommunicable disease death rate are the percent black in each merged county unit and smoking. The most important factor associated with lower levels of age-standardized cardiovascular disease death rate and age-standardized other noncommunicable disease death rate is years of schooling. In terms of infrastructure, hospitals per capita are associated with lower other noncommunicable diseases while the number of hospital beds per capita and physicians per capita (Delta Region only) are associated with higher other noncommuncable diseases. Hospital beds per capita are also associated with higher CVD mortality in the Delta Region.

Finally, this paper explores the relationship from health to economic growth. This paper uses an OLS difference in difference model to show that higher levels of injuries and diabetes may have a negative association with earnings per capita.

Introduction

Noncommunicable diseases (NCD), especially deaths from cardiovascular disease (CVD), used to be classified as "diseases of affluence" and considered a result of economic development. With access to improved modern technology and health achievements from antibiotics and vaccines after the early 1900s, death from communicable diseases declined while deaths from noncommunicable diseases rose in developed countries. Heart disease, cancer, and diabetes became known as diseases that primarily impacted the wealthy. However, more recently noncommunicable diseases have been on the rise in poorer countries as well with the burden of disease from noncommunicable diseases in developing countries increasing from 47% in 1990 to an expected 69% in 2020 (Boutayeb 2005, Jamison 2006). The fall of the paradigm of "diseases of affluence" applies within countries as well. In the United States (US), increasing health disparities for the poor has been documented. This relationship has been established at the individual level (Hummer et al. 1998; Christenson and Johnson 1995) and at the county and state levels (Kawachi and Kennedy 1997; James and Franzini et al. 2001; Cossman 2006). This paper will examine how cardiovascular disease and other noncommunicable diseases, which contribute to 39% and 45% of the burden of disease in the United States in the year 2000, interact with income in the United States, with a specific focus on the Mississippi River Delta Region.

This paper also examines the impact on economic growth from five different causes of death (cardiovascular disease, other noncommunicable diseases, communicable diseases, injuries and diabetes). Theoretically and empirically micro and macro research has provided evidence that general health levels can be inputs to economic growth (Hoddinott et al. 2008; Case Fertig and Paxon 2005; Gluckman and Hanson 2005 and 2006; Bloom, Canning and Sevilla 2004; Behrman and Rosenzweig 2004; Bhargava, Jamison, Lau, and Murray 2001; Bloom, Canning and Malaney 1999; Bloom and Malaney 1998; Bloom and Williamson 1998; Barker 1998; Sachs and Warner 1997; Barro and Sala-I-Martin 1995; Fogel 1997 and 2003). As two of the most significant and growing inputs to general health levels, it is hypothesized that certain causes of death, such as cardiovascular disease and other noncommunicable diseases, would also impact on economic growth. The relationship between cardiovascular disease and other noncommunicable diseases and subsequent economic growth has only begun to be estimated globally (Suhrcke 2009). The most recent county level analysis of cause specific health patterns in the United States analyzes trends in changes in county level life expectancy and cause specific mortality but does not look closely at the impact of income (Ezzati et al. 2008).

Cause specific mortality rates are hypothesized to impact income levels in a similar way that general health levels would impact income and economic growth. Certain causes of death may even have a larger impact on economic growth than general health levels due to the morbidity that may accompany the illnesses associated with cardiovascular disease, cancers, injuries, and diabetes before death. Such illness might affect labor supply as the population is working longer into retirement. Certain mechanisms have been suggested for how cardiovascular disease and

other noncommunicable diseases impact economic growth, such as decreased incentive for human or physical capital accumulation and higher health expenditures leading up to death (Suhrcke 2009).

This paper adds to the existing literature by examining the relationship between income and cause specific mortality as both a result and as inputs to income measured with earnings per capita. The paper examines this relationship in the Mississippi River Delta Region compared to the rest of the United States.

Data and Methods

Through a special request from the National Center for Public Health Data and the National Center for Health Statistics individual mortality data for the years 1968 through 2002 are used to calculate cause specific mortality rates for the Delta and non-Delta Regions. The data are adjusted for variation in reporting between diabetes, cardiovascular disease, communicable and other noncommunicable diseases following the methods of Murray et al. (2008). Corrected data are then used to calculate age-standardized cause specific mortality for 2,826 merged county units every ten years over the period 1970-2000 for further analysis. Cause specific mortality from cardiovascular disease and other noncommunicable diseases are used to examine the relationship between these two causes of death and income levels. Preston Curves and ordinary least squares regression are used examine the contribution of income, as well as other factors, to cardiovascular disease and other noncommunicable diseases. Ordinary least squares are used to

examine the relationship from changes in cause specific mortality to earnings per capita. Further details on the methods are given below.

Following the methods of Murray et al. (2008) multinomial logistic regression is used to estimate the probability that an individual, who had diabetes as a multiple cause of death, died of cardiovascular disease, diabetes, a communicable or a noncommunicable disease. These probabilities, along with all other deaths for which diabetes was not a multiple cause of death, are aggregated at the merged county unit in order to calculate corrected cause specific deaths rates for cardiovascular disease, diabetes, communicable and other noncommunicable diseases. The relative risk ratios used to calculate the predicted probabilities for each year of analysis are shown in Annex B. For this analysis data are summed over 5 years (the year of analysis and two years on each side) to reduce sensitivity to small numbers.

A description of all variables used in the analyses in this paper is given below.

The Mississippi River Delta Region: The Mississippi River Delta Region is defined by the United States government as 240 counties along or near the lower Mississippi River in the eight states of Alabama, Arkansas, Illinois, Kentucky, Louisiana, Mississippi, Missouri, and Tennessee. Each county in the analysis is identified being part of the Mississippi River Delta Region or as a non-Delta county. Note that Mississippi River Delta Region and Delta Region are synonymous in the text below.

Age-Standardized Death Rates: The direct method is used to calculate all age-standardized death rates with population data from the Compressed Mortality File (CMF) file and mortality data from individual death certificates after being adjusted for individual and community level factors that influence reporting between cardiovascular disease, diabetes, communicable diseases and other noncommunicable diseases (Murray et al. 2008). Deaths and population are summed over 5 years (the year of analysis and two years on each side) to reduce sensitivity to small numbers. The calculation is done using 13 different age groups and standardized according to the 2000 United States standard million population.

Net Earnings per Capita: Using the Bureau of Economic Analysis's (BEA) Regional Economic Accounts, net earnings are obtained for all merged county units from 1969-2005. Net earnings for each merged county unit is the sum of wage and salary disbursements, employer contributions for employee pension and insurance funds and proprietor's income (farm and nonfarm) plus an adjustment to convert earnings by place of work to a place of residence basis.[2] The Census Bureau's midyear population estimates are used to calculate net earnings per capita. Net earnings per capita for 1970, 1980 and 1990 are adjusted for regional inflation to the 2000 US$ based on the US Department of Labor, Bureau of Labor Statistics, Consumer Price Index, Regional Estimates (http://www.bls.gov/cpi/). Net earnings per capita are also referred to as earnings per capita throughout the text.

Cardiovascular Disease: Includes codes for rheumatic heart disease, hypertensive disease, ischemic heart disease, cerebrovascular disease (stroke), inflammatory heart diseases and other cardiac diseases. The corresponding ICD-10 codes for years 1989-2002 are I00-I99. The

[2] The adjustment for residence can be positive or negative depending on the county.

corresponding ICD-9 codes for years 1968-1988 are 390-459.

Diabetes: Diabetes Mellitus includes type 1 and 2, malnutrition related and other diabetes. The corresponding International Statistical Classification of Diseases and Related Health Problems (ICD)-10 codes are E10-E14. The corresponding ICD-9 code is 250.

Communicable Diseases: These include infectious and parasitic diseases, respiratory infections, maternal conditions, conditions arising during the perinatal period, and nutritional deficiencies. The corresponding ICD-10 codes are A00-B99, G00-G04, N70-N73, J00-J06, J10-J18, J20-J22, H65-H66, O00-O99, P00-P96, E00-E02, E40-E46, E50, and D50-D64. The corresponding ICD-9 codes are 001-139, 240-242, 260-263, 264, 280-285, 320-324, 381-382, 460-465, 466, 480-488, 614-616, 630-679 and 760-779.

Other Noncommunicable Diseases: These include malignant neoplasms, other neoplasms, endocrine disorders, neuropsychiatric conditions, sense organ diseases, respiratory diseases, digestive diseases, genitourinary diseases, skin diseases, musculoskeletal diseases, congenital anomalies and oral conditions. 66% of other noncommunicable diseases are due to cancers and respiratory diseases. The corresponding ICD-10 codes are C00-C97, D00-D48, D65-D89, E03-E07, E15-E16, E20-E34, E51-E88, F01-F99, G06-G98, H00-H61, H68-H93, J30-J98, K00-K92, N00-N64, N75-N98, L00-L98, M00-M99 and Q00-Q99. The corresponding ICD-9 codes are 140-239, 243-246, 249, 251, 265-279, 286-289, 290-319, 325-380, 383-389, 470-478, 490-519, 520-579, 580-612, 617-629, 680-709, 710-739, 740-759, 780-799, and 252-259.

Injuries: External causes of morbidity and mortality. The corresponding ICD-10 codes are V01-X85, Y09-Y89. The corresponding ICD-9 codes are 800-999.

Years of schooling: The data on county level education levels in the form of percent of persons 25 years and older who completed different levels of schooling are transformed into years of schooling completed using the conversion factors created by Jaeger (1997). Years of schooling is weighted by county population size for each decade to create a years of schooling figure for each merged county unit.

Race: Percent black and percent "other race" are used as proxies for race.[3] Percent black and percent "other race" for each merged county unit in each of the four data sets are calculated from the National Center for Health Statistic's Compressed Mortality File data or from the National Center for Health Statistic's Individual Mortality Files for the years 1970, 1980, 1990, and 2000.[4]

Age Structure: The percent of the population in each merged county unit between the ages 0-19 years, 20-44 years, 45-64 years, and 65-85+ years is created using population totals for each county in the National Center for Health Statistic's Compressed Mortality File data or from the National Center for Health Statistic's Individual Mortality Files for the years 1970, 1980, 1990, and 2000.

[3] More detailed race data were available after 1980, but in order to be consistent over time this analysis uses only percent black and percent "other race".
[4] Data by race include persons of Hispanic and non-Hispanic origin.

Consumer Price Index: Income for 1970, 1980 and 1990 are adjusted for regional inflation to the 2000 US$ based on the US Department of Labor, Bureau of Labor Statistics, Consumer Price Index, Regional Estimates (http://www.bls.gov/cpi/).

Body Mass Index (BMI): BMI is calculated from self-reported height and weight and is calculated as weight in kilograms divided by height in meters squared (m^2). Reported height and weight are taken from the Behavioral Risk Factor Surveillance Survey (BRFSS). The height and weight responses are corrected for self-report biases for men and women based on analyses conducted by Ezzati et al. (2006). Due to a number of outliers, each BMI response was capped at a reasonable answer. Any BMI less than 12 was changed to 12 and any BMI over 100 was changed to 100. BMI is calculated for the year 2000 (summed over 5 years; the year of analysis and two years on each side).

Cigarette Consumption per capita: The data for cigarette consumption include per capita packs of tobacco consumption in each state for the years 1970, 1980, 1990, and 2000 (Orzechowski and Walker 2006).

Blood Pressure: Blood pressure was determined by the answer to the question "Have you ever been told by a doctor, nurse or other health professional that you have high blood pressure?" from the Behavioral Risk Factor Surveillance Survey. Reported blood pressure is calculated for the year 2000 (summed over 5 years; the year of analysis and two years on each side).

Health Insurance Coverage: Health insurance coverage is measured by the response to the

question “Do you have any kind of health care coverage, including health insurance, prepaid plans such as HMOs, or government plans such as Medicare?” taken from the Behavioral Risk Factor Surveillance Survey. Reported health insurance coverage is calculated for the year 2000 (summed over 5 years; the year of analysis and two years on each side).

Unemployment Rate (16+): From the Area Resource File (ARF) which is extracted from the Bureau of Labor Statistics for years 1980, 1990, and 2000.

Total Active, Non-Federal Physicians per 10,000 Population: From ARF which is extracted from American Medical Association (AMA) Physician Master; 1970, 1980, 1990, 2000.

Total Non-Federal Cardiovascular Disease Physicians per 10,000 Population: From ARF which is extracted from AMA Physician Master File for 2003.

Total Number of Hospitals per 10,000 population: From ARF which is extracted from the American Hospital Association (AHA) Survey Database for the year 2000 and the County Hospital File for the year 1990.

Total Hospital Beds per 1000 population: From ARF which is extracted from the AHA Survey Database for the year 2000 and the County Hosp File for the year 1990.

Two equations are measured in the analysis below. Equation 1 examines the relationship from income to health, measured through cardiovascular disease mortality rates and other

noncommunicable disease mortality rates. X is a vector of state and county level characteristics that affect CVD and/or NCD including risk factors (BMI, blood pressure, and cigarette consumption data), health system measurements (physicians per capita, cardiologists per capita, hospitals per capita, hospital beds per capita, and health insurance coverage), as well as demographic and economic indicators (race, schooling, and unemployment).

$$Health_{j,t} = \log Earn/cap_{j,t}\pi + X_{j,t}\beta + e_{j,t}$$

The second equation examines the opposite arrow, the relationship from health, measured through five main causes of death to economic growth, measured with earnings per capita. Equation 2 is written as:

$$\Delta LogEarn/cap_{j,t-(t-1)} = \Delta \log Health_{j,t-(t-1)}\pi + \Delta X_{j,t-(t-1)}\beta + e_{j,t-(t-1)}$$

where $\Delta \log Health$ is the change in the log of age-standardized cardiovascular mortality rate, log of age-standardized other noncommunicable disease mortality rate, log of age-standardized communicable disease death rate, log of age-standardized death from injuries, and log of age-standardized death from diabetes. ΔX is a vector of differenced county level characteristics that affect earnings per capita including years of schooling, age structure, and race as well as initial levels of log net earnings per capita and initial levels of log CVD mortality, log NCD mortality, log communicable disease mortality, log death from injuries, log of death from diabetes. Age-standardized death rates for CVD mortality, NCD mortality, injuries and diabetes are calculated for persons aged 15 years and older. Age-standardized death rates for communicable diseases mortality are calculated for all ages. This equation is tested over three

decades (1970-1980, 1980-1990, 1990-2000) as well as over the long difference (1970 to 2000) at the merged county unit (in the equation above j refers to merged county unit). Each method has a full set of year dummies[5] as well as robust standard errors adjusted for intrastate correlation.[6] The above model is tested using ordinary least squares (OLS).

[5] A time dummy is included to capture natural fluctuations in income per capita.
[6] Adjusting for intrastate correlation addresses the problem that counties may be independent across states but are not necessarily independent within states.

Results

Cause-Specific Mortality Trends

The following figures show that the Delta Region had similar (and sometimes even greater) declines and/or improvements than the non-Delta Region in age-specific death rates from overall deaths, cardiovascular disease deaths, other noncommunicable disease deaths, communicable diseases deaths, injuries and diabetes for the periods 1970 to 1980 and 1980 to 1990. During the period 1990 to 2000, however, while the non-Delta Region continued on a similar pattern of improvement and/or decline as during the previous decades, age-standardized death rates in the Delta Region slowed more than the non-Delta Region for overall deaths, deaths from cardiovascular disease and injuries and increased more than the non-Delta Region for other noncommunicable diseases, communicable disease, and diabetes. Figure 1 shows age-standardized death rates for all causes, cardiovascular disease, and other noncommunicable diseases for the Delta and non-Delta Regions over four time periods: 1970, 1980, 1990 and 2000 (actual numbers for this figure are shown in Annex A). Age-standardized death rates for overall deaths decreased by similar amounts over the period 1970 to 1980 for the Delta (14%) and non-Delta Regions (16%) and even decreased more in the Delta Region (14%) than the non-Delta Region (9%) over the period 1980 to 1990. However, from 1990 to 2000, age-standardized death rates for overall deaths in the Delta Region fell by only 2% while age-standardized death rates for all deaths in the non-Delta Region continued on a similar decline as in the previous decade (7%). The percentage decline in age-standardized cardiovascular disease deaths was similar for the Delta and non-Delta Regions over the periods 1970 to 1980 and 1980 to 1990 (21%-25%). Over the period 1990 to 2000 the age-standardized death rates for the non-Delta Region declined by 17% while rates in the Delta Region declined by 12%. Other non-

communicable diseases have increased by 2% over the period 1970 to 1980, 7% over the periods 1980 to 1990, and 5% over the period 1990 to 2000 in the non-Delta Region. In the Delta Region, other non-communicable disease increased by 6% over the period 1970 to 1980, declined by 2% over the period 1980 to 1990 and increased by 8% over the period 1990 to 2000.

Figure 1. Age-standardized death rates per 100,000 population; 1970, 1980, 1990 and 2000

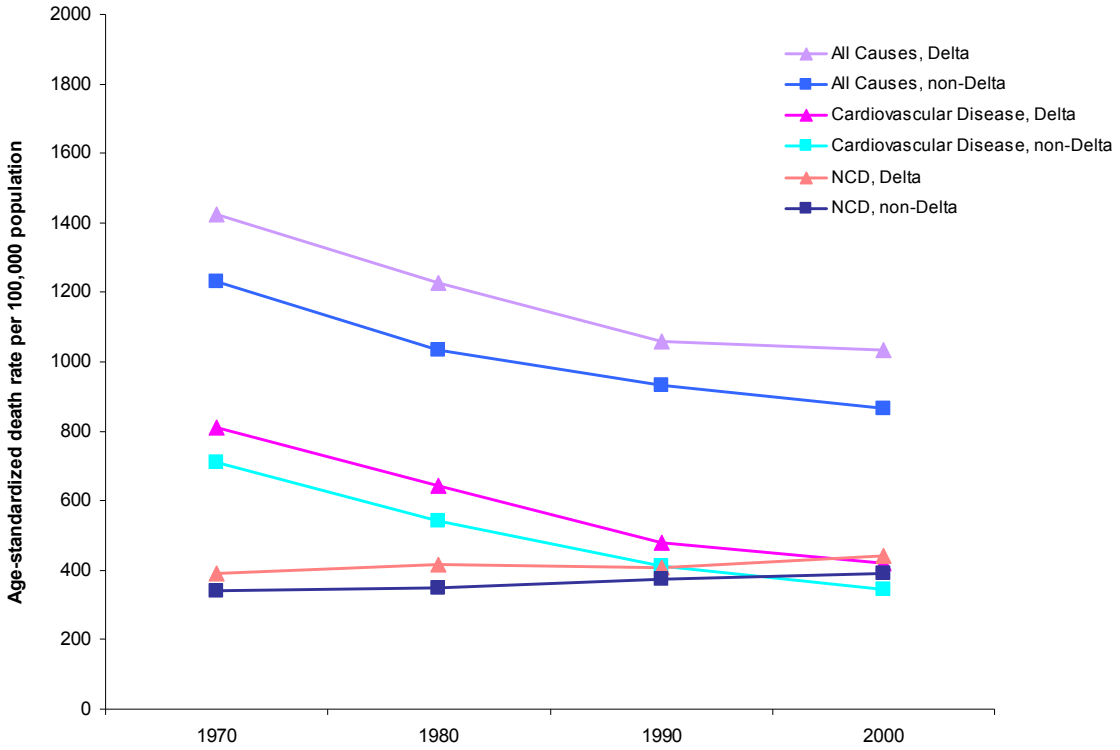
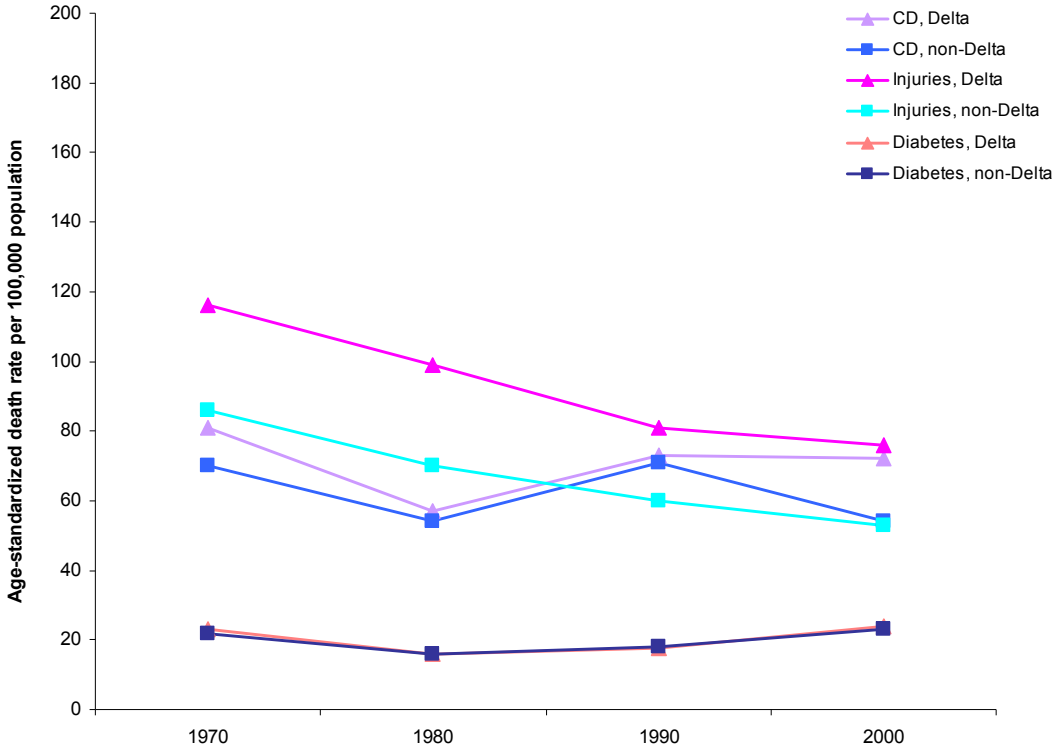


Figure 2 shows age-standardized death rates for communicable diseases (CD), injuries, and diabetes for the Delta and non-Delta Regions over four time periods: 1970, 1980, 1990 and 2000 (actual numbers for this figure are shown in Annex A). Injuries decreased between 15%-19% for the Delta and non-Delta Regions over the periods 1970 to 1980 and 1980 to 1990. Over the period 1990 to 2000 injuries decreased by 11% in the non-Delta Region and only 6% in the Delta Region. One can visually note the similar patterns of change in age-standardized death rates from communicable diseases in the Delta and non-Delta Regions over the period 1970 to 1990 followed by the continued increase in the Delta Region to the year 2000 while in the non-Delta Region age-standardized death rates from communicable diseases declined. Patterns of change in deaths from diabetes are similar in the Delta and non-Delta Regions over time after adjusting

for differences in regional reporting using the methods of Murray et al. (2008) (Refer to the discussion section for more information on this adjustment).

Figure 2. Age-standardized death rates per 100,000 population; 1970, 1980, 1990 and 2000



In order to further explain the slowing in the fall of age-standardized overall death rates for the Delta Region and more specifically the increase in age-standardized communicable disease for the Delta Region over the period 1990 to 2000, age-standardized death rates are examined for males and females. Figure 3 shows age-standardized death rates for all causes, cardiovascular disease, and other noncommunicable diseases for females in the Delta and non-Delta Regions over four time periods: 1970, 1980, 1990 and 2000 (actual numbers for this figure are shown in Annex A). Females in the Delta Region follow the same pattern for females in the non-Delta

Region in terms of cardiovascular disease death rates and other noncommunicable disease death rates. All cause age-standardized mortality has increased for females in the Delta Region over the period 1990 to 2000 by 3%. All cause age-standardized mortality decreased by 3% for females in the non-Delta Region over the period 1990 to 2000.

Figure 3. Age-standardized death rates per 100,000 population; 1970, 1980, 1990 and 2000; females

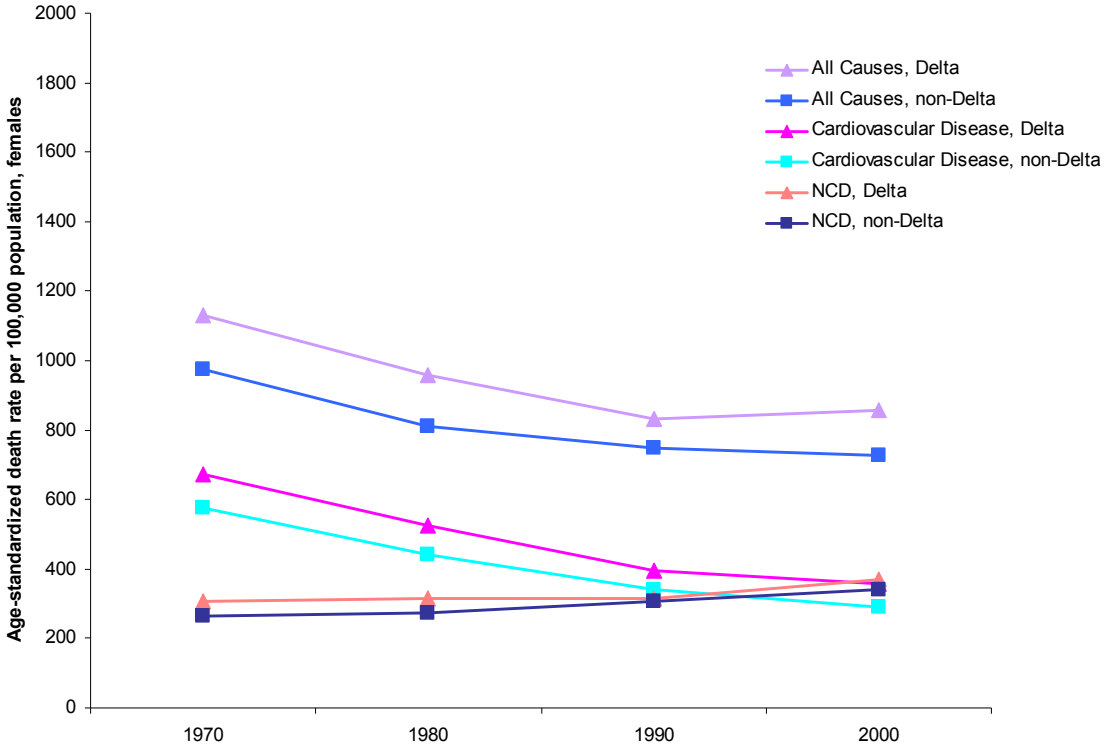


Figure 4 shows age-standardized death rates for communicable diseases, injuries, and diabetes for females in the Delta and non-Delta Regions over four time periods: 1970, 1980, 1990 and 2000 (actual numbers for this figure are shown in Annex A). While communicable diseases for non-Delta Region females decreased over the period 1990 to 2000 by 13%, communicable diseases for Delta Region females increased from 1990 to 2000 by 10%. This larger increase in

communicable disease for females in the Delta Region is mostly attributable to increases in infectious diseases including death from certain bacterial infections and HIV/AIDS and respiratory infections including influenza and pneumonia.

Figure 4. Age-standardized death rates per 100,000 population; 1970, 1980, 1990 and 2000; females

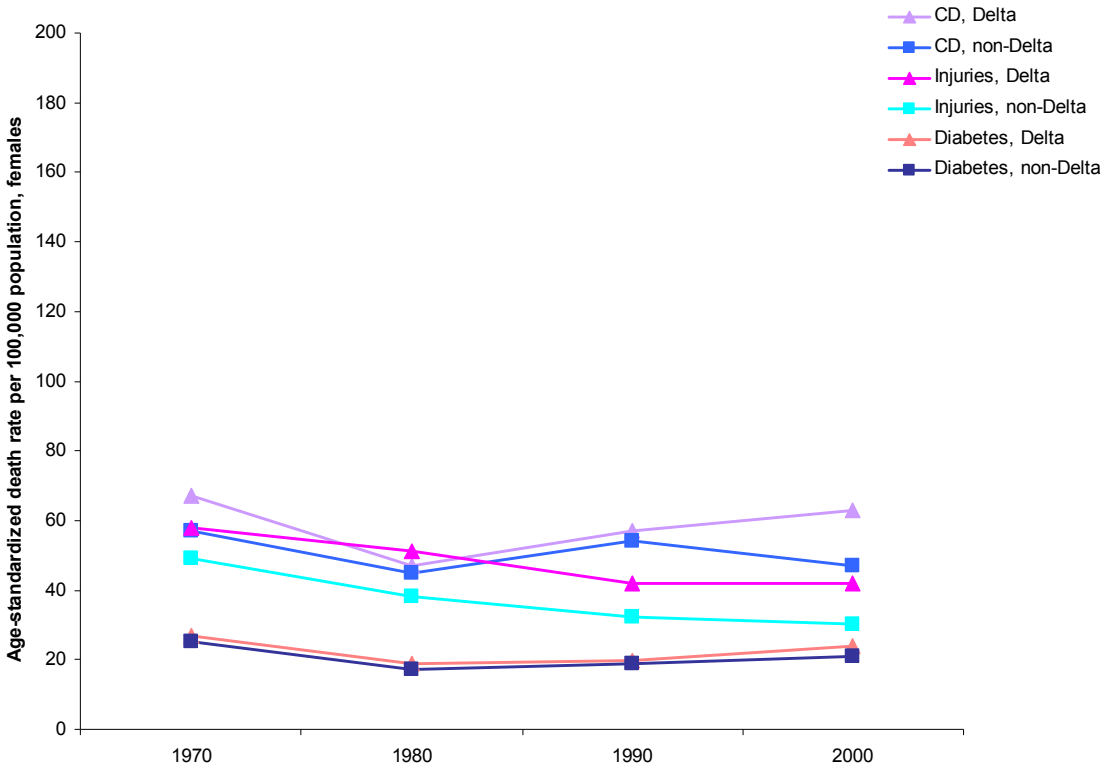


Figure 5 shows age-standardized death rates for all causes, cardiovascular disease, and noncommunicable diseases for males in the Delta and non-Delta Regions over four time periods: 1970, 1980, 1990 and 2000 (actual numbers for this figure are shown in Annex A). For males, all cause age-standardized mortality and age-standardized cardiovascular disease mortality decrease in both the Delta and non-Delta regions over the three decades shown in the figure

below. Other noncommunicable diseases decrease slightly (2%) for the non-Delta Region over the period 1990 to 2000 and increase by 2% in the Delta Region over this same period.

Figure 5. Age-standardized death rates per 100,000 population; 1970, 1980, 1990 and 2000; males

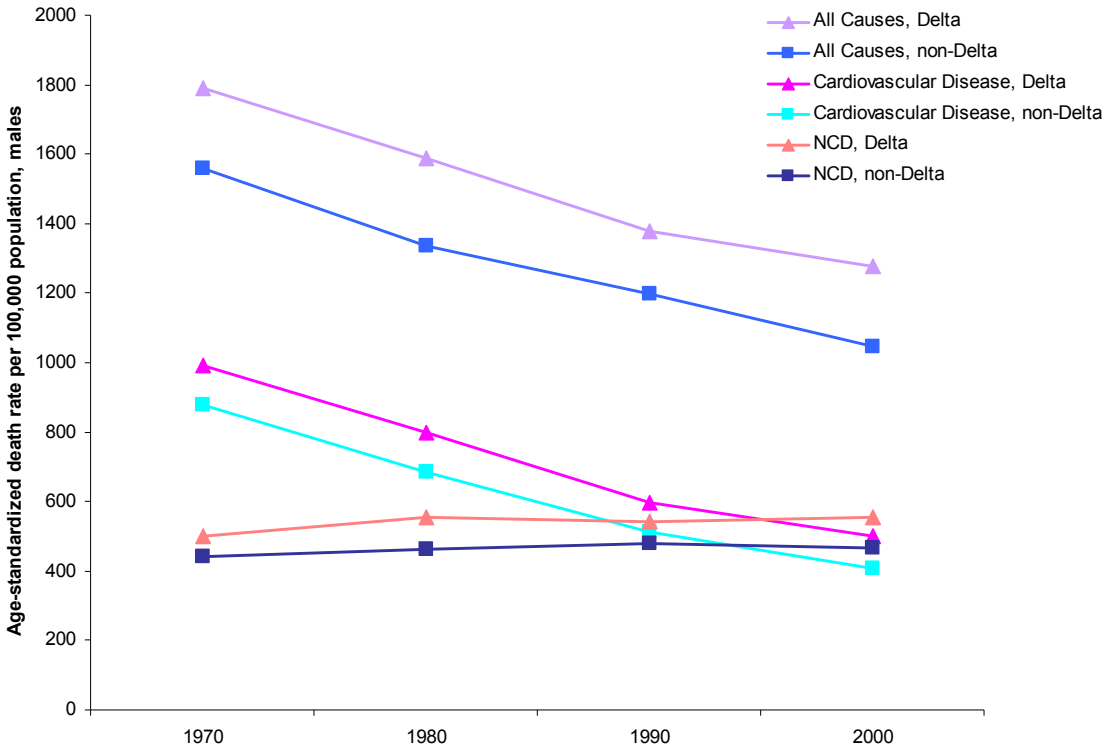
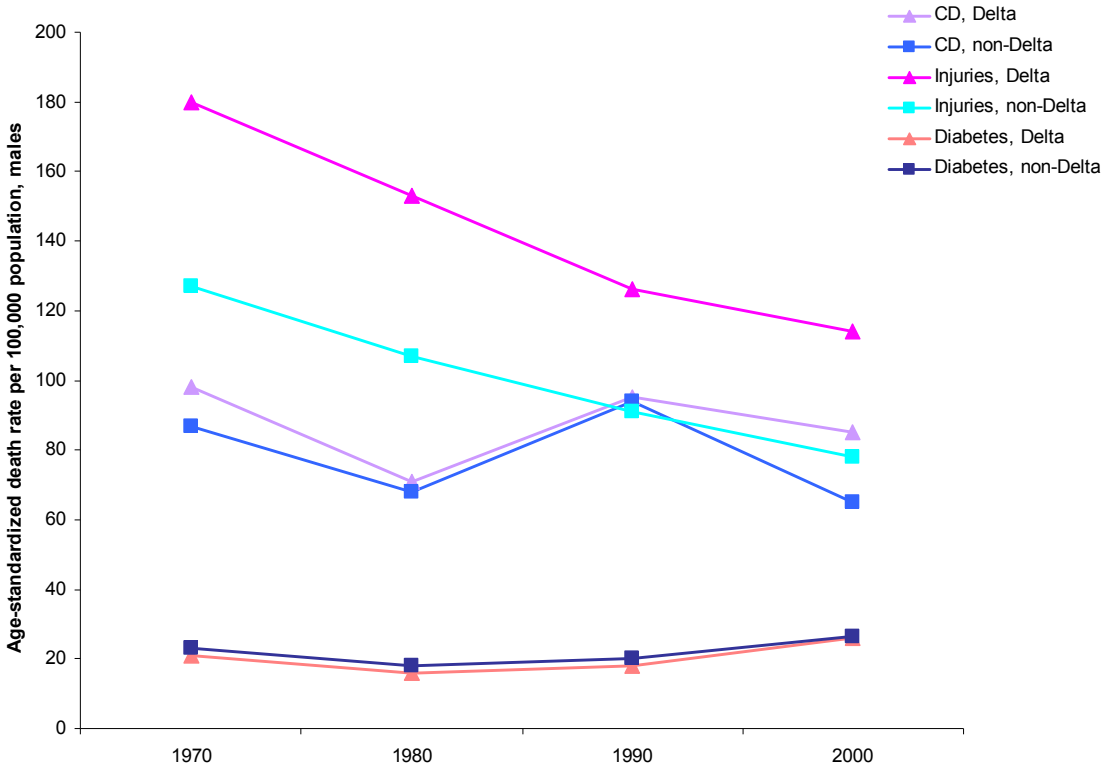


Figure 6 shows age-standardized death rates for communicable diseases (CD), injuries, and diabetes for males in the Delta and non-Delta Regions over four time periods: 1970, 1980, 1990 and 2000 (actual numbers for this figure are shown in Annex A). Both Delta (34% increase) and non-Delta Region (38% increase) males had an increase in communicable diseases during the period 1980 to 1990 which lowered again in the non-Delta Region (31% decline) but remained higher in the Delta Region (11% decline) over the period 1990 to 2000. This is mostly attributable to increases in infectious diseases including HIV/AIDS and TB in the 1980s followed by a larger decrease in these diseases as well as respiratory infections including

influenza and pneumonia in the non-Delta as compared to the Delta Region. Injuries remain higher in the Delta Region for males than in the non-Delta Region.

Figure 6. Age-standardized death rates per 100,000 population; 1970, 1980, 1990 and 2000; males

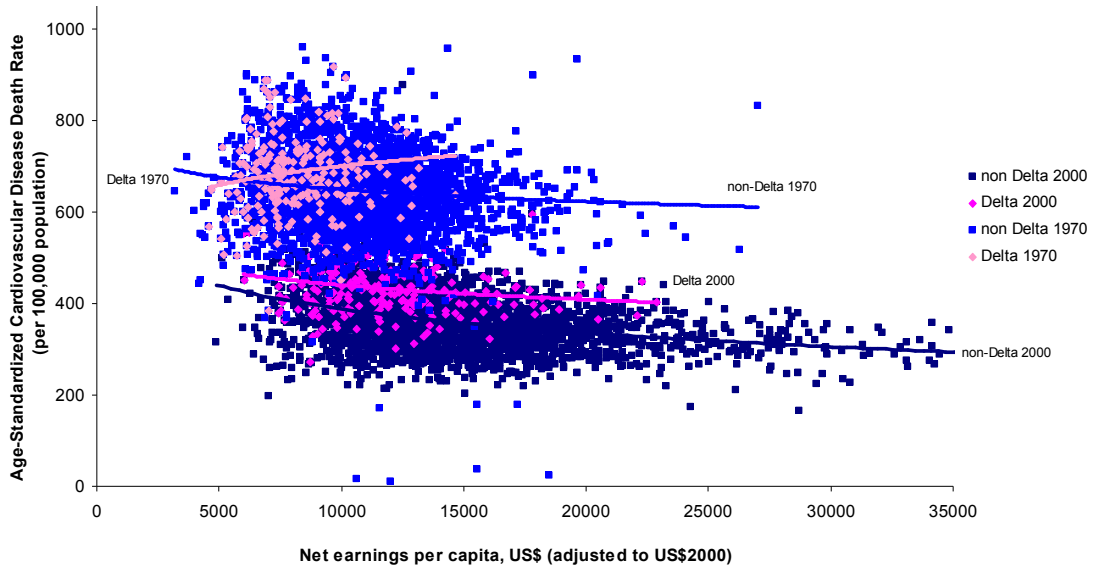


Next, the relationship between cardiovascular deaths and non-communicable diseases, the two leading causes of death in the US, and net earnings per capita is examined in more detail through the creation of Preston Curves with cause specific mortality rates on the y-axis and net income per capita on the x-axis. This analysis is done for deaths from cardiovascular disease and other noncommunicable diseases, the two largest contributors to deaths in the US in the year 2000, 39% and 45% respectively.

Earnings per Capita and Cardiovascular Disease

The age-standardized death rate from cardiovascular disease (per 100,000 population) has decreased by 52% in the non-Delta Region and by 48% in the Delta Region over the period 1970 to 2000. Figure 7 shows that while the age-standardized death rate from cardiovascular disease (per 100,000 population) is fairly similar in the Delta and non-Delta Region in 1970, by the year 2000 the age-standardized death rate from cardiovascular disease (per 100,000 population) has not decreased as rapidly in the Delta Region as in the non-Delta Region. Poorer counties have had the narrowest decrease in age-standardized death rate from cardiovascular disease (per 100,000 population.

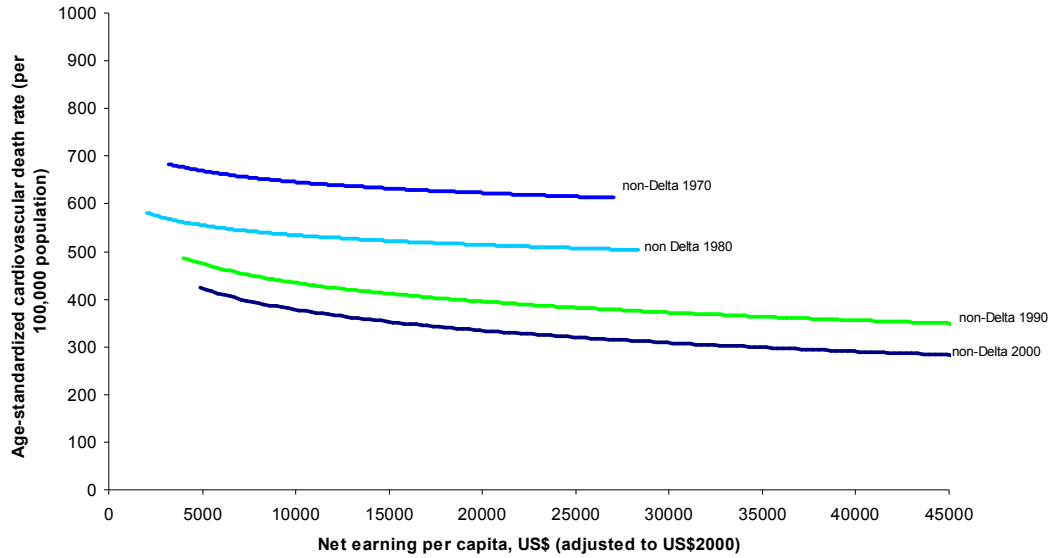
Figure 7. Y-axis: Age-standardized cardiovascular disease death rate (per 100,000 population); X-axis: Net earnings per capita (US$); Curves: Age-standardized cardiovascular disease death rate (per 100,000 population) versus log net earnings per capita; 2,826 merged county units;[7] 1970 and 2000



[7] One outlying county in Missouri and one outlying county in Nevada were eliminated from the analysis in 1970.

Figures 8 and 9 show the relationship between net earnings per capita and cardiovascular disease death rates (per 100,000 population) over four time periods (1970, 1980, 1990 and 2000) for the Delta and non-Delta Regions. As shown in Figure 8, the decline in CVD death rates in the non-Delta Region is largest from 1970 to 1990 and then slows after this period.

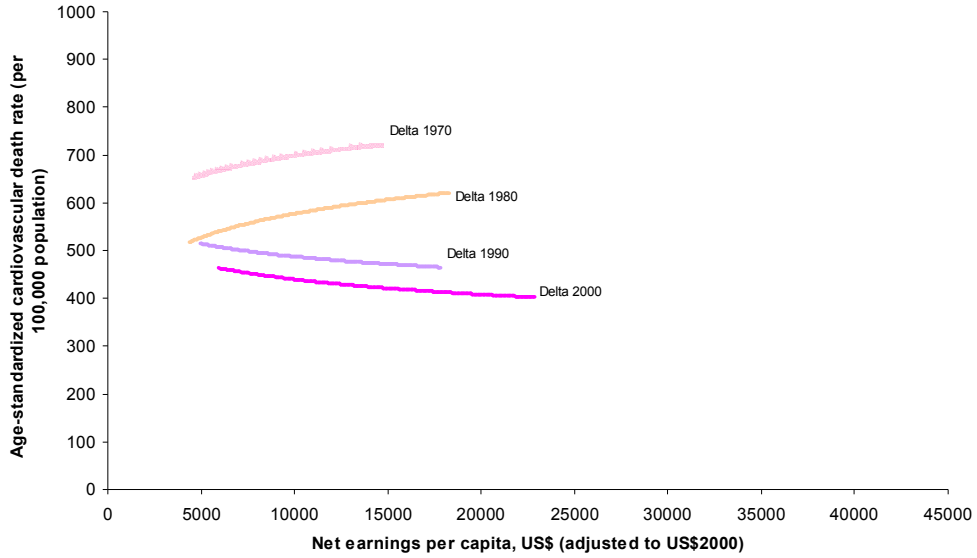
Figure 8. Y-axis: Age-standardized cardiovascular disease death rate (per 100,000 population), non-Delta Region; X-axis: Net earnings per capita (US$), non-Delta Region; Curves: Age-standardized cardiovascular disease death rate (per 100,000 population) versus log net earnings per capita; 2,589 merged non-Delta county units;[8] 1970, 1980, 1990 and 2000



[8] One outlying county in Nevada was eliminated from the analysis in 1970 and 1980.

As is shown in Figure 9, cardiovascular disease death rates in the Delta Region are higher for those counties with higher income levels in the years 1970 and 1980 providing some evidence that the "diseases of affluence" paradigm was still applicable in the Delta Region up until 1980. By 1990, the curve is downward sloping in the Delta Region with higher CVD deaths among the poorest counties.

Figure 9. Y-axis: Age-standardized cardiovascular disease death rate (per 100,000 population), Delta Region; X-axis: Net earnings per capita (US$), Delta Region; Curves: Age-standardized cardiovascular disease death rate (per 100,000 population) versus log net earnings per capita; 237 merged Delta county units;[9] 1970, 1980, 1990 and 2000

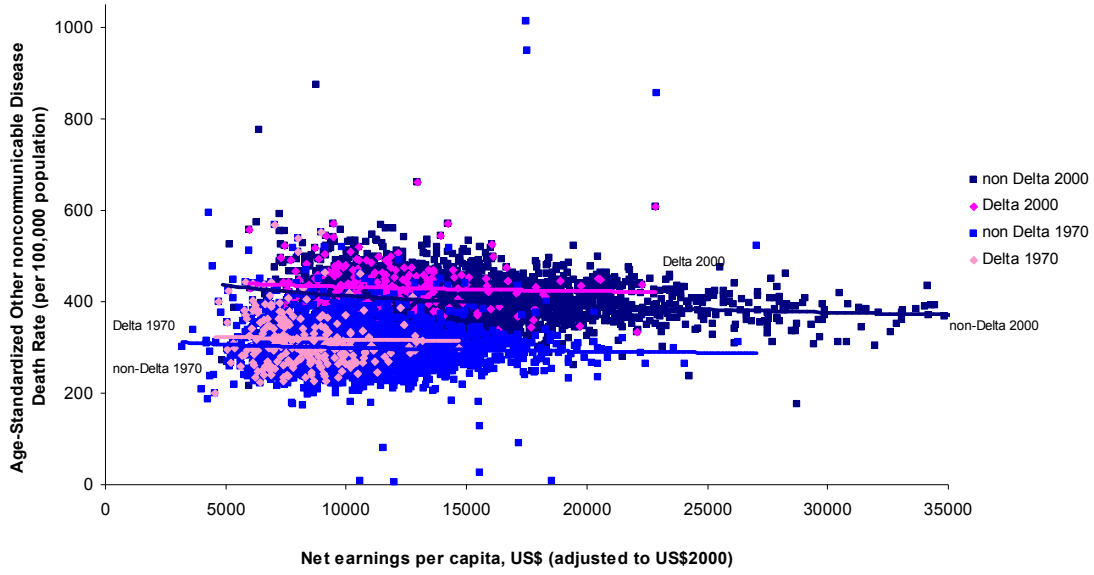


[9] One outlying county in Missouri was eliminated from the analysis in 1970 and 1980.

Earnings per Capita and Other noncommunicable diseases

The age-standardized death rate from other noncommunicable diseases (per 100,000 population)[10] has increased by 14% in the non-Delta Region and by 12% in the Delta Region over the period 1970 to 2000. Figure 10 demonstrates that age-standardized death rates from other noncommunicable diseases (per 100,000 population) are increasing over time in both the Delta and non-Delta Regions.

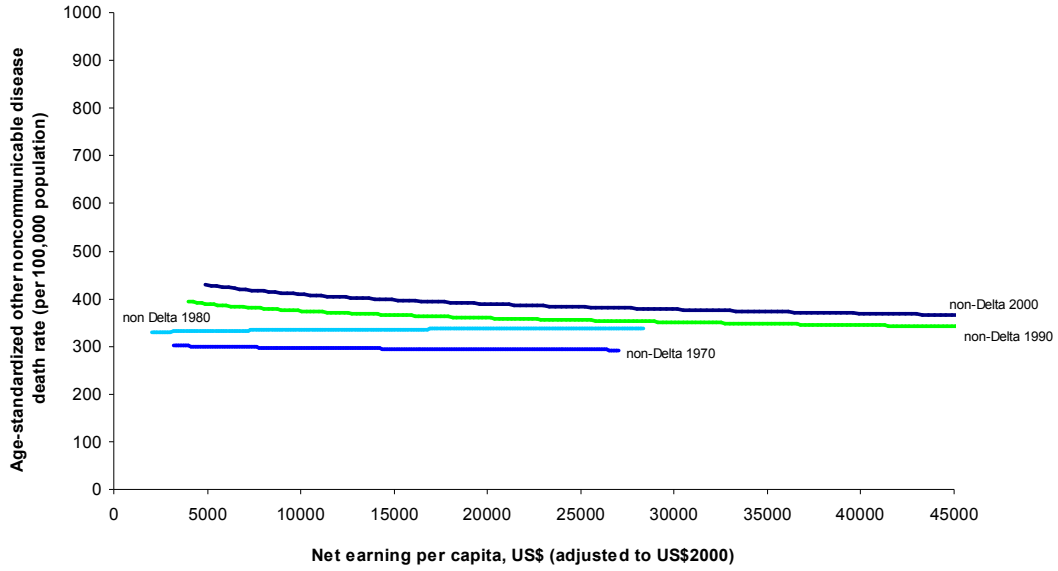
Figure 10. Y-axis: Age-standardized other noncommunicable disease death rate (per 100,000 population); X-axis: Net earnings per capita (US$); Curves: Age-standardized other non-communicable disease death rate (per 100,000 population) versus log net earnings per capita; 2,826 merged county units;[11] 1970 and 2000



[10] 66% of other NCD are cancers and respiratory disease.
[11] One outlying county in Missouri and one outlying county in Nevada were eliminated from the analysis in 1970.

Figures 11 and 12 show the relationship between net earnings per capita and other noncommunicable disease death rates (per 100,000 population) over four time periods (1970, 1980, 1990 and 2000) for the Delta and non-Delta Regions. As shown in Figure 11, the increase in other noncommunicable disease death rates in the non-Delta Region is fairly stable over time.

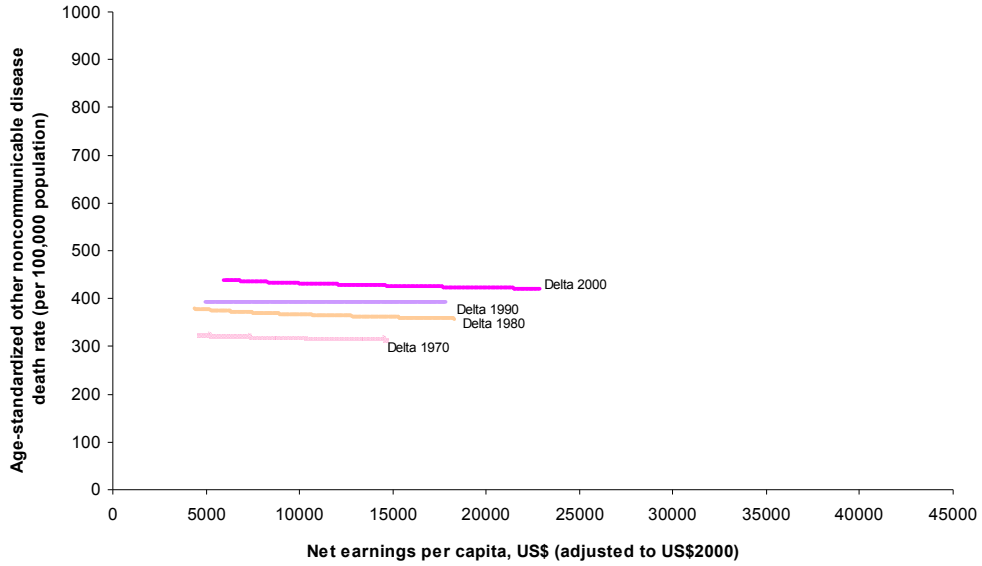
Figure 11. Y-axis: Age-standardized other noncommunicable disease death rate (per 100,000 population), non-Delta Region; X-axis: Net earnings per capita (US$), non-Delta Region; Curves: Age-standardized other noncommunicable disease death rate (per 100,000 population) versus log net earnings per capita; 2,589 merged non-Delta county units;[12] 1970, 1980, 1990 and 2000



As is shown in Figure 12, other noncommunicable disease death rate in the Delta Region increases fairly steadily over the period 1970 to 2000 with a smaller increase over the period 1980 to 1990.

[12] One outlying county in Nevada was eliminated from the analysis in 1970 and 1980.

Figure 12. Y-axis: Age-standardized other noncommunicable disease death rate (per 100,000 population), Delta Region; X-axis: Net earnings per capita (US$), Delta Region; Curves: Age-standardized other noncommunicable disease death rate (per 100,000 population) versus log net earnings per capita; 237 merged Delta county units;[13] 1970, 1980, 1990 and 2000



OLS: Earnings per Capita and CVD and other NCD

Table 1 shows that in the year 2000, the one factor associated with lower levels of age-standardized cardiovascular disease death rate (per 100,000 population) in the non-Delta Region is schooling. The factors that are associated with higher levels of age-standardized cardiovascular disease death rate (per 100,000 population) in the non-Delta Region are the percent black in each merged county unit and smoking. The Delta Region does not behave differently in terms of the association between schooling and lower levels of CVD mortality and percent black and smoking and higher levels of CVD mortality. An additional factor associated with higher CVD mortality in the Delta Region is hospital beds per capita while percent other race in each Delta county is associated with lower CVD mortality.

[13] One outlying county in Missouri was eliminated from the analysis in 1970 and 1980

Schooling and hospitals per capita are associated with lower levels of age-standardized other noncommunicable disease death rate (per 100,000 population) in the non-Delta Region. The factors that are associated with higher levels of age-standardized other noncommunicable disease death rate (per 100,000 population) in the non-Delta Region are the percent black in each merged county unit, smoking, and hospital beds per capita. The Delta Region does not behave differently in terms of any of these associations except that smoking is associated with lower levels of other noncommunicable diseases and physicians per capita are associated with higher other noncommunicable mortality.

Table 1. OLS: Dependent variable: Age-standardized cardiovascular disease (CVD) and other noncommunicable disease (NCD) death rate (per 100,000 population); 2000

	CVD	**NCD**
Log Net Earnings per capita	-2.32 (10.17)	0.51 (8.79)
Years Schooling	-27.36 (8.46)**	-12.60 (4.64)**
Percent Black	1.21 (0.24)**	0.80 (0.21)**
Percent Other	0.43 (0.42)	0.87 (0.44)
Unemployment	0.37 (1.27)	1.16 (1.17)
Percent High Blood Pressure	5.71 (11.59)	17.57 (12.35)
BMI	2.67 (1.68)	-0.66 (1.44)
Cigarette Consumption per capita	0.70 (0.13)**	0.60 (0.07)**
Percent with Health Insurance	-0.43 (0.33)	-0.43 (0.28)
Hospitals per capita	-0.54 (0.29)	-0.99 (0.42)*
Hospital Beds per capita	0.28 (0.33)	1.01 (0.28)**
Physicians per capita	-0.30 (0.20)	0.07 (0.17)
Cardiologists per capita	0.09 (0.34)	0.08 (0.29)
Delta	-56.44 (266.00)	196.18 (192.64)
Delta* Log Net Earnings per capita	19.93 (36.82)	-12.90 (24.64)
Delta*Years Schooling	-0.13 (15.78)	-5.55 (11.04)
Delta*Percent Black	-0.73 (0.31)*	-0.56 (0.28)
Delta*Percent Other	-5.31 (1.77)**	-2.43 (2.98)
Delta* Unemployment	3.43 (2.11)	-1.63 (2.02)
Delta* Percent High Blood Pressure	45.87 (24.67)	3.64 (25.68)
Delta* BMI	-3.98 (2.27)	1.78 (3.25)
Delta*Cigarette Consumption per capita	-0.35 (0.19)	-0.84 (0.11)**
Delta*Percent with Health Insurance	0.26 (0.59)	0.51 (0.51)
Delta*Hospitals per capita	-0.47 (0.99)	-1.30 (0.99)
Delta*Hospital Beds per capita	2.03 (0.84)*	-1.22 (1.05)
Delta*Physicians per capita	0.64 (0.47)	1.93 (0.81)*
Delta*Cardiologists per capita	-1.42 (0.97)	-1.79 (1.80)
Constant	593.60 (89.00)**	527.11 (65.64)**
R-square	0.50	0.26
N	2826	2826

Robust standard errors, adjusted for clustering by merged county unit, in parentheses; * significant at 5%; ** significant at 1%

OLS: Cause Specific Mortality and Economic Growth

Table 2 reports the difference in difference regressions with the change in the log of earnings per capita at the merged county unit as the dependent variable and age-standardized cause specific

mortality for five categories of death (cardiovascular disease, other noncommunicable disease, communicable disease, injuries and diabetes) in the United States as independent variables.[14] The data are differenced over the long difference (1970 to 2000) as well as differenced over four times periods (1970 to 2000) leaving three differenced time points (1970 - 1980, 1980 - 1990, and 1990 - 2000). The results suggest that injuries (in both the long run and over each decade) and diabetes (in the long run) are associated with lower earnings per capita. There is not a consistent association between cardiovascular disease, other noncommunicable diseases, or communicable diseases and earnings per capita.

[14] These five causes of death are used rather than just CVD and other NCD in order to avoid omitted variable bias from including only certain causes of death.

Table 2. OLS: Dependent variable: Difference in log net earnings per capita (Long Difference and Panel); Independent variables: Differenced (Long Difference and Panel)

	Long Difference		**Panel**	
Δ Log CVD Mortality	-0.016	-0.035	0.020	-0.024
	(0.026)	(0.039)	(0.028)	(0.035)
Δ Log NCD Mortality	0.0001	-0.058	-0.008	0.031
	(0.023)	(0.051)	(0.022)	(0.024)
Δ Log CD Mortality	0.033	0.047	-0.026	-0.009
	(0.016)	(0.021)*	(0.010)**	(0.012)
Δ Log Injury Mortality	0.008	-0.151	0.050	-0.047
	(0.020)	(0.040)**	(0.017)**	(0.021)*
Δ Log Diabetes Mortality	-0.036	-0.043	-0.015	-0.024
	(0.014)*	(0.017)*	(0.014)	(0.017)
Initial Log CVD Mortality	---	0.035	---	-0.034
		(0.053)		(0.027)
Initial Log NCD Mortality	---	-0.042	---	0.086
		(0.056)		(0.028)**
Initial Log CD mortality	---	0.045	---	0.027
		(0.026)		(0.014)
Initial Log Injury	---	-0.264	---	-0.165
Mortality		(0.041)**		(0.023)**
Initial Log Diabetes	---	-0.044	---	-0.020
Mortality		(0.019)*		(0.012)
Initial Log	---	-0.206	---	-0.195
Earnings/cap		(0.035)**		(0.035)**
Δ Years of Schooling	0.211	0.185	0.155	0.150
	(0.014)**	(0.012)**	(0.019)**	(0.020)**
Δ % 20-44 years old	0.008	0.004	0.002	0.000
	(0.004)*	(0.003)	(0.003)	(0.003)
Δ % 45-64 years old	0.022	0.022	0.001	0.004
	(0.003)**	(0.003)**	(0.003)	(0.003)
Δ % 65-85 years old	-0.019	-0.020	-0.016	-0.017
	(0.003)**	(0.003)**	(0.004)**	(0.004)**
Δ % Black	-0.002	-0.003	-0.006	-0.006
	(0.001)	(0.001)*	(0.002)**	(0.002)**
Δ % Other Race	0.001	0.004	-0.002	0.003
	(0.004)	(0.003)	(0.004)	(0.005)
Constant	-0.160	2.985	-0.080	2.160
	(0.045)**	(0.639)**	(0.023)**	(0.410)**
1980	---	---	---	---
1990	---	---	0.146	0.099
			(0.027)**	(0.023)**
2000	---	---	0.139	0.075
			(0.026)**	(0.031)*
Number of Observations	2826	2826	8476	8476

OLS regressions with year dummies. Robust standard errors, adjusted for clustering within state, in parentheses; * significant at 5%; ** significant at 1%; 2 observations are missing from the analysis because 1 counties in North Dakota had negative net earnings in 1980 causing this county to lose 2 differenced time points (1970-1980 and 1980-1990) (La Moure, ND), explain other missing.

Discussion

The above analysis shows that, levels for all causes of death are consistently higher in the Delta Region compared to the non-Delta Region and patterns of change in cause specific mortality are similar in the Delta and non-Delta Regions during the period 1970 to 1990. During the period 1990 to 2000, age-standardized death rates in the non-Delta Region continued on a similar pattern of improvement and/or decline as during the previous decades. In the Delta Region, from 1990 to 2000, age-standardized death rates slowed for overall deaths, deaths from cardiovascular disease and injuries and increased more than the non-Delta Region for other noncommunicable diseases, communicable disease and diabetes. Trends in cause specific mortality for males and females in the Delta and non-Delta Regions follow similar patterns to overall populations with some notable differences. For females, communicable diseases in the non-Delta Region decreased over the period 1990 to 2000 by 13%, while communicable diseases for Delta Region females increased from 1990 to 2000 by 10%. For males, communicable diseases increased in both the Delta (34% increases) and non-Delta Region (38% increases) over the period 1980 to 1990, then lowered once again in the non-Delta Region by 31% from 1990 to 2000, while rates of communicable diseases for males decreased by only 11% in the Delta Region from 1990 to 2000.

The Preston Curves and accompanying OLS results show that income levels (measured through net earnings per capita) are a stronger predictor for cardiovascular disease than for other noncommunicable diseases. The relationship between income and age-standardized cardiovascular disease death rates differs in the Delta and non-Delta Regions. Higher income is correlated with lower cardiovascular death rates since 1970 in the non-Delta Region. In the

Delta Region, higher income is associated with higher rates of death from cardiovascular disease up until the 1980s at which time the trend reverses.

The OLS regression results from Table 1 show that the main factors associated with higher levels of age-standardized cardiovascular disease death rate and age-standardized other noncommunicable disease death rate are the percent black in each merged county unit and smoking. The most important factor associated with lower levels of age-standardized cardiovascular disease death rate and age-standardized other noncommunicable disease death rate is years of schooling. In terms of infrastructure (health facilities), hospitals per capita are associated with lower other noncommunicable diseases while the number of hospital beds per capita and physicians per capita (Delta Region only) are associated with higher other noncommuncable diseases. Hospital beds per capita are also associated with higher CVD mortality in the Delta Region. There is numerous data and literature supporting the link between higher levels of smoking and poor health outcomes (Doll and Hill 1950; Wynder and Graham 1950; Cancer Research UK 2005; US Department of Health and Human Services 1990; Doll et al. 2004). The relationship from schooling to better health outcomes is also well researched (Lleras-Muney 2002; Currie and Moretti 2002). The results in this paper also show that health facilities have an association with health outcomes. Additionally, in the Delta Region more hospitals bed per capita and more physicians per capita are associated with higher levels of CVD and NCD respectively.

The OLS results examining the association between five causes of death (cardiovascular disease, other noncommunicable diseases, communicable diseases, diabetes and injuries) and earnings

per capita show that diabetes and injuries are most associated with lower earnings per capita. The results show that a 1% increase in mortality from injuries is associated with a 0.15% decline in earnings over the long run (1970 to 2000) and a 1% increase in initial levels of mortality from injuries is associated with a 0.264% decline in earnings per capita over the long run. Diabetes has a smaller impact on earnings per capita than injuries. In the long run, a 1% increase diabetes mortality is associated with between a 0.036% and a 0.044% decline in earnings per capita. By including levels of schooling and age structure of the population in this model suggests that the measured association of cause specific mortality on earnings per capita is through morbidity effects. The results suggest that injuries and diabetes potentially have the largest impact on earnings through a morbidity effect.

The differences in cause specific deaths between the Delta and non-Delta Regions may be slightly diminished in this analysis, especially for cardiovascular deaths and deaths from diabetes, due to an adjustment for individual and community level factors that have been shown to impact cause of death reporting on death certificates. The methods of Murray et al. (2008) are used to make this adjustment. The relative risk ratios that are estimated using multinomial logistic regression analysis and are used to predict the probability that each death would be assigned to eithercardiovascular disease, diabetes, other noncommunicable diseases or communicable diseases are shown in Annex B. The adjustments reduced the number of direct diabetes deaths by 8.8% in 1970, 9.5% in 1980, 12.6% in 1990 and 9.7% in 2000.

In conclusion, this chapter shows that, while the Delta Region has always had higher levels of deaths than the rest of the United States the pattern of increase and/or decrease in specific causes

of death (cardiovasacular disease, other noncommunicable diseases, communicable diseases, injuries and diabetes) did not differ from the rest of the United States prior to 1990. After 1990, population health in the Delta Region began to suffer due to more cardiovascular disease, other noncommunicable, communicable disease, injuries and diabetes. As of the year 2000, schooling, the percent black in each merged county unit, smoking, hospitals per capita, and hospital beds per capita are associated with death rates from cardiovascular and other noncommunicable diseases (higher and lower). The results also demonstrate using OLS that higher levels of mortality from injuries and diabetes are associated with lower earnings per capita at the county level due to their impact on morbidity.

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Annexes

Annex A. Age-standardized death rate per 100,000 population; 1970, 1980, 1990 and 2000

Table 3. Age-standardized death rates (per 100,000 population); 1970, 1980, 1990 and 2000

		1970	1980	1990	2000
All Causes	Non-Delta	1229	1032	934	864
	Delta	1425	1228	1057	1035
Cardiovascular Disease	Non-Delta	708	541	412	343
	Delta	813	641	479	422
NCD	Non-Delta	342	350	374	391
	Delta	392	414	407	440
CD	Non-Delta	70	54	71	54
	Delta	81	57	73	72
Injuries	Non-Delta	86	70	60	53
	Delta	116	99	81	76
Diabetes	Non-Delta	22	16	18	23
	Delta	23	16	18	24

*Directly adjusted to the 2000 US standard populations and adjusted for regional reporting per (Murray et al. 2000)

Table 4. Age-standardized death rates (per 100,000 population); 1970, 1980, 1990 and 2000; females

		1970	1980	1990	2000
All Causes	Non-Delta	974	813	748	728
	Delta	1132	959	830	857
Cardiovascular Disease	Non-Delta	577	440	339	289
	Delta	671	526	394	359
NCD	Non-Delta	266	273	306	341
	Delta	308	317	317	369
CD	Non-Delta	57	45	54	47
	Delta	67	47	57	63
Injuries	Non-Delta	49	38	32	30
	Delta	58	51	42	42
Diabetes	Non-Delta	25	17	19	21
	Delta	27	19	20	24

*Directly adjusted to the 2000 US standard populations and adjusted for regional reporting per (Murray et al. 2000)

Table 5. Age-standardized death rates (per 100,000 population); 1970, 1980, 1990 and 2000; males

		1970	**1980**	**1990**	**2000**
All Causes	Non-Delta	1558	1338	1196	1047
	Delta	1791	1590	1378	1277
Cardiovascular Disease	Non-Delta	878	683	513	409
	Delta	992	798	598	499
NCD	Non-Delta	442	463	479	468
	Delta	499	553	541	553
CD	Non-Delta	87	68	94	65
	Delta	98	71	95	85
Injuries	Non-Delta	127	107	91	78
	Delta	180	153	126	114
Diabetes	Non-Delta	23	18	20	26
	Delta	21	16	18	26

*Directly adjusted to the 2000 US standard populations and adjusted for regional reporting per (Murray et al. 2000)

Annex B. Results from the Multinomial Logistic Regression Analysis

Table 6. RRRs, P values, and 95% CI for multinomial logistic regression; 2000

	Cardiovascular diseases			Other noncommunicable diseases			Communicable diseases		
	RRR	P value	95% CI	RRR	P value	95% CI	RRR	P value	95% CI
Race/Sex									
WM	1.00	---	---	1.00	---	---	1.00	---	---
WF	0.82	0.00	0.81-0.84	1.09	0.00	1.06-1.11	1.05	0.02	1.01-1.09
BM	0.86	0.00	0.84-0.87	0.84	0.00	0.82-0.86	1.16	0.00	1.11-1.22
BF	0.70	0.00	0.69-0.72	0.83	0.00	0.81-0.85	0.95	0.06	0.91-1.00
OM	1.06	0.01	1.02-1.10	0.94	0.02	0.90-0.99	1.33	0.00	1.22-1.45
OF	0.81	0.00	0.78-0.85	0.96	0.14	0.91-1.01	1.21	0.00	1.11-1.33
Age (yrs)									
20-24	0.15	0.00	0.11-0.19	0.26	0.00	0.21-0.31	0.60	0.01	0.42-0.87
25-29	0.22	0.00	0.19-0.26	0.23	0.00	0.20-0.26	0.85	0.18	0.67-1.08
30-34	0.35	0.00	0.32-0.39	0.26	0.00	0.23-0.29	0.97	0.74	0.81-1.16
35-39	0.47	0.00	0.44-0.51	0.27	0.00	0.25-0.29	1.16	0.04	1.01-1.33
40-44	0.63	0.00	0.59-066	0.32	0.00	0.30-0.34	1.23	0.00	1.09-1.38
45-49	0.79	0.00	0.75-0.83	0.38	0.00	0.36-0.40	1.20	0.00	1.07-1.34
50-54	0.96	0.07	0.91-1.00	0.43	0.00	0.41-0.46	1.01	0.85	0.91-1.12
55-59	1.07	0.00	1.02-1.12	0.50	0.00	0.47-0.53	0.93	0.19	0.84-1.03
60-64	0.96	0.00	0.94-0.99	0.92	0.00	0.89-0.94	0.96	0.21	0.91-1.02
65-69	1.00	---	---	1.00	---	---	1.00	---	---
70-74	1.07	0.00	1.05-1.09	1.07	0.00	1.05-1.10	1.18	0.00	1.12-1.24
75-79	1.14	0.00	1.11-1.16	1.08	0.00	1.06-1.10	1.32	0.00	1.26-1.38
80-84	1.18	0.00	1.16-1.21	1.01	0.20	0.99-1.04	1.60	0.00	1.53-1.68
85+	1.24	0.00	1.21-1.26	0.92	0.00	0.90-0.94	2.15	0.00	2.06-2.25
Place of Death									
Hospital	1.16	0.00	1.14-1.17	0.88	0.00	0.87-0.89	2.78	0.00	2.71-2.84
Education									
< HS	0.94	0.00	0.92-0.96	0.96	0.00	0.94-0.98	0.95	0.02	0.92-0.99
< college	1.00	0.76	0.98-1.01	1.00	0.91	0.98-1.02	0.98	0.32	0.94-1.02
College +	1.00	---	---	1.00	---	---	1.00	---	---
SBP	1.01	0.00	1.01-1.01	0.97	0.00	0.97-0.98	1.00	0.04	0.99-1.00
BMI	1.00	0.57	0.99-1.01	0.99	0.39	0.98-1.01	0.99	0.24	0.96-1.01

Table 7. RRRs, P values, and 95% CI for multinomial logistic regression; 1990

	Cardiovascular diseases			Other noncommunicable diseases			Communicable diseases		
	RRR	P value	95% CI	RRR	P value	95% CI	RRR	P value	95% CI
Race/Sex									
WM	1.00	---	---	1.00	---	---	1.00	---	---
WF	0.89	0.00	0.87-0.90	0.81	0.00	0.80-0.83	0.85	0.00	0.83-0.88
BM	0.75	0.00	0.73-0.77	0.85	0.00	0.82-0.88	1.03	0.34	0.97-1.10
BF	0.69	0.00	0.67-0.70	0.65	0.00	0.63-0.67	0.75	0.00	0.71-0.79
OM	1.03	0.43	0.96-1.11	0.97	0.46	0.88-1.06	1.63	0.00	1.43-1.87
OF	0.85	0.00	0.80-0.91	0.77	0.00	0.71-0.85	1.10	0.18	0.95-1.28
Age (yrs)									
20-24	0.11	0.00	0.08-0.14	0.35	0.00	0.27-0.45	1.24	0.23	0.88-1.75
25-29	0.12	0.00	0.10-0.14	0.26	0.00	0.21-0.31	1.16	0.20	0.92-1.46
30-34	0.20	0.00	0.18-0.23	0.31	0.00	0.27-0.35	1.19	0.05	1.00-1.42
35-39	0.28	0.00	0.26-0.30	0.37	0.00	0.33-0.40	1.23	0.00	1.07-1.41
40-44	0.44	0.00	0.41-0.47	0.45	0.00	0.41-0.48	1.12	0.08	0.99-1.27
45-49	0.61	0.00	0.58-0.64	0.56	0.00	0.52-0.59	1.01	0.89	0.90-1.13
50-54	0.76	0.00	0.73-0.79	0.71	0.00	0.68-0.75	0.93	0.18	0.84-1.03
55-59	0.88	0.00	0.85-0.91	0.81	0.00	0.78-0.85	0.83	0.00	0.76-0.91
60-64	0.95	0.00	0.92-0.97	0.95	0.00	0.92-0.98	0.95	0.16	0.88-1.02
65-69	1.00	---	---	1.00	---	---	1.00		---
70-74	1.09	0.00	1.06-1.11	1.06	0.00	1.02-1.09	1.22	0.00	1.15-1.30
75-79	1.12	0.00	1.10-1.15	1.03	0.05	1.00-1.06	1.51	0.00	1.43-1.61
80-84	1.15	0.00	1.13-1.18	0.98	0.13	0.95-1.01	2.03	0.00	1.91-2.15
85+	1.16	0.00	1.13-1.18	0.82	0.00	0.79-0.84	2.86	0.00	2.70-3.03
Place of Death									
Hospital	1.16	0.00	1.14-1.17	0.92	0.00	0.91-0.94	1.88	0.00	1.82-1.94
Education									
< HS	0.93	0.00	0.91-0.95	0.91	0.00	0.88-0.94	0.94	0.03	0.89-0.99
< college	0.99	0.58	0.97-1.02	0.98	0.27	0.95-1.01	0.97	0.24	0.92-1.02
College +	1.00	---	---	1.00	---	---	1.00	---	---

Note: 1988 was estimated separately and figures can be requested from the author

Table 8. RRRs, P values, and 95% CI for multinomial logistic regression; 1980

	Cardiovascular diseases			Other noncommunicable diseases			Communicable diseases		
	RRR	P value	95% CI	RRR	P value	95% CI	RRR	P value	95% CI
Race/Sex									
WM	1.00	---	---	1.00	---	---	1.00	---	---
WF	0.89	0.00	0.87-0.90	0.74	0.00	0.73-0.76	0.78	0.00	0.75-0.80
BM	0.72	0.00	0.68-0.75	0.74	0.00	0.69-0.79	1.20	0.00	1.07-1.34
BF	0.61	0.00	0.59-0.64	0.58	0.00	0.55-0.62	0.97	0.55	0.88-1.07
OM	0.68	0.00	0.66-0.70	0.81	0.00	0.78-0.84	1.04	0.32	0.96-1.12
OF	0.62	0.00	0.61-0.64	0.58	0.00	0.57-0.60	0.80	0.00	0.75-0.85
Age (yrs)									
20-24	0.06	0.00	0.05-0.08	0.35	0.00	0.29-0.43	1.02	0.88	0.75-1.40
25-29	0.10	0.00	0.09-0.12	0.28	0.00	0.24-0.33	1.15	0.19	0.93-1.41
30-34	0.15	0.00	0.14-0.17	0.36	0.00	0.33-0.41	0.89	0.19	0.73-1.06
35-39	0.24	0.00	0.22-0.26	0.46	0.00	0.42-0.50	0.99	0.87	0.84-1.16
40-44	0.41	0.00	0.38-0.43	0.58	0.00	0.54-0.63	1.07	0.39	0.92-1.23
45-49	0.61	0.00	0.59-0.64	0.79	0.00	0.75-0.84	1.07	0.27	0.95-1.20
50-54	0.76	0.00	0.73-0.78	0.86	0.00	0.82-0.89	0.99	0.84	0.90-1.09
55-59	0.88	0.00	0.85-0.90	0.92	0.00	0.89-0.96	0.95	0.24	0.88-1.03
60-64	0.95	0.00	0.93-0.98	0.96	0.01	0.93-0.99	0.92	0.03	0.86-0.99
65-69	1.00	---	---	1.00	---	---	1.00		
70-74	1.07	0.00	1.05-1.09	0.99	0.44	0.96-1.02	1.14	0.00	1.07-1.22
75-79	1.08	0.00	1.05-1.10	0.91	0.00	0.88-0.93	1.37	0.00	1.29-1.46
80-84	1.07	0.00	1.05-1.09	0.81	0.00	0.78-0.83	1.73	0.00	1.62-1.83
85+	1.03	0.01	1.01-1.05	0.65	0.00	0.63-0.67	2.17	0.00	2.05-2.30

Table 9. RRRs, P values, and 95% CI for multinomial logistic regression; 1970

	Cardiovascular diseases			Other noncommunicable diseases			Communicable diseases		
	RRR	P value	95% CI	RRR	P value	95% CI	RRR	P value	95% CI
Race/Sex									
WM	1.00	---	---	1.00	---	---	1.00	---	---
WF	0.88	0.00	0.87-0.89	0.72	0.00	0.71-0.73	0.75	0.00	0.72-0.78
BM	0.58	0.00	0.56-0.60	0.63	0.00	0.60-0.66	1.13	0.00	1.06-1.22
BF	0.57	0.00	0.55-0.58	0.48	0.00	0.46-0.50	0.76	0.00	0.71-0.81
OM	0.69	0.00	0.63-0.76	0.95	0.43	0.84-1.08	1.70	0.00	1.42-2.04
OF	0.66	0.00	0.60-0.73	0.72	0.00	0.63-0.82	1.12	0.32	0.90-1.40
Age (yrs)									
20-24	0.05	0.00	0.04-0.06	0.34	0.00	0.28-0.42	1.16	0.25	0.90-1.51
25-29	0.07	0.00	0.06-0.08	0.31	0.00	0.27-0.37	0.81	0.08	0.64-1.02
30-34	0.11	0.00	0.10-0.13	0.34	0.00	0.30-0.39	0.83	0.08	0.68-1.02
35-39	0.20	0.00	0.18-0.21	0.50	0.00	0.45-0.55	0.87	0.11	0.74-1.03
40-44	0.38	0.00	0.36-0.40	0.64	0.00	0.59-0.69	0.93	0.27	0.81-1.06
45-49	0.54	0.00	0.52-0.56	0.83	0.00	0.78-0.87	1.11	0.06	1.00-1.23
50-54	0.69	0.00	0.67-0.71	0.93	0.00	0.89-0.98	1.03	0.51	0.94-1.13
55-59	0.83	0.00	0.80-0.85	0.99	0.78	0.96-1.03	1.00	0.97	0.92-1.08
60-64	0.91	0.00	0.89-0.93	0.99	0.65	0.96-1.03	0.97	0.36	0.90-1.04
65-69	1.00	---	---	1.00	---	---	1.00		
70-74	1.05	0.00	1.03-1.07	0.93	0.00	0.90-0.96	1.10	0.00	1.03-1.17
75-79	1.06	0.00	1.04-1.08	0.84	0.00	0.81-0.86	1.30	0.00	1.23-1.39
80-84	1.06	0.00	1.04-1.08	0.72	0.00	0.70-0.75	1.49	0.00	1.40-1.59
85+	1.07	0.00	1.05-1.10	0.60	0.00	0.58-0.63	1.89	0.00	1.78-2.02

Annex C. Age-standardized death rates not adjusted per Murray et al. (2008)

Table 10. Age-standardized death rates (per 100,000 population); 1970, 1980, 1990 and 2000; not adjusted for regional reporting per Murray et al. (2008)

		1970	**1980**	**1990**	**2000**
All Causes	Non-Delta	1229	1032	934	864
	Delta	1425	1228	1057	1035
Cardiovascular Disease	Non-Delta	708	541	411	339
	Delta	809	638	474	414
NCD	Non-Delta	341	349	373	394
	Delta	390	413	405	440
CD	Non-Delta	70	54	71	53
	Delta	81	57	72	71
Injuries	Non-Delta	86	70	60	53
	Delta	116	99	81	76
Diabetes	Non-Delta	24	18	20	25
	Delta	29	22	25	34

*Directly adjusted to the 2000 US standard population

Figure 13. Age-standardized death rate (per 100,000 population); 1970, 1980, 1990 and 2000; not adjusted for regional reporting per Murray et al. (2008)

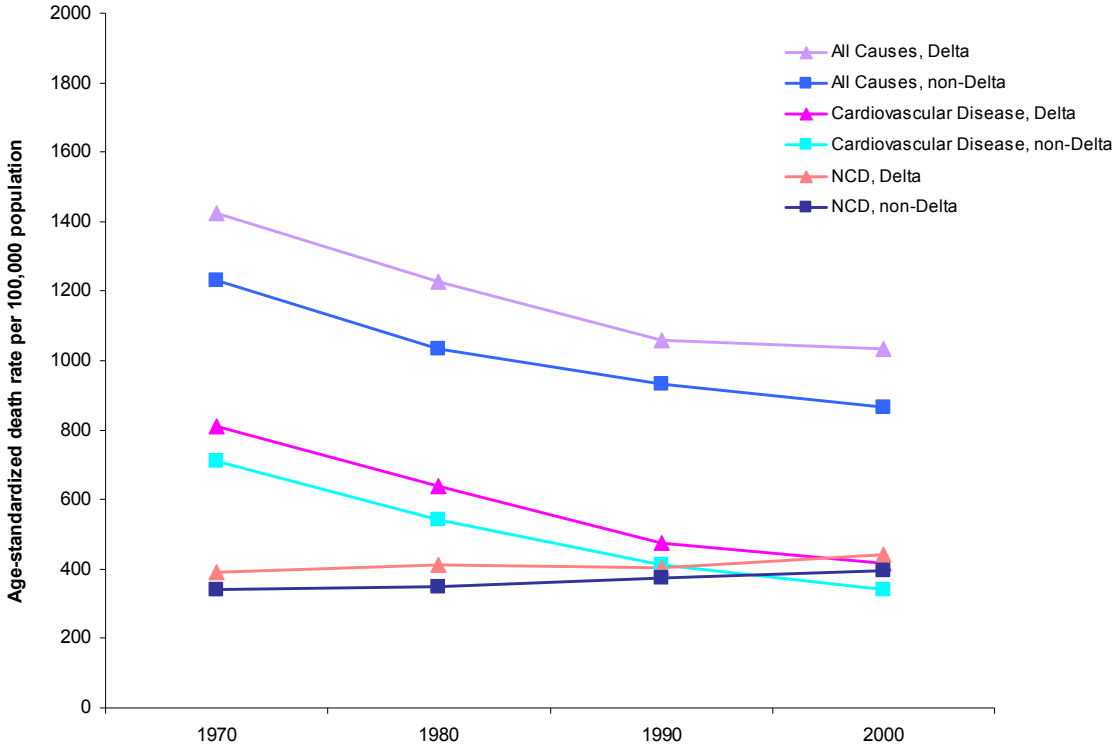

Figure 14. Age-standardized death rate per 100,000 population; 1970, 1980, 1990 and 2000; not adjusted for regional reporting per Murray et al. (2008)