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Analyzing the Impact of Key Factors on an Individual's Life Expectancy From 1991 to 2006 in U.S

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ANALYZING THE IMPACT OF KEY FACTORS ON AN INDIVIDUAL'S LIFE EXPECTANCY FROM 1991 TO 2006 IN U.S.

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ABSTRACT

Since the 20th century, U.S. health spending has continuously increased, but the residents' life expectancy has not reached the average level of OECD countries. In this paper, hazard duration models are built; primary demographic, geographic, socioeconomic and healthcare factors are taken into consideration. The main purpose of this paper is to study the effect of these factors on an individual's risk of mortality and life expectancy. We build a general model and two gender-specific models. Females are affected by relative deprivation, a measure of their position in the income distribution, much more than males. The effect of family income is only statistically significant for male. In terms of healthcare factors, we find, when people get older, the health spending will have more beneficial (for men) or at least less negative effects (for women) on the life span.

ACKNOWLEDGMENTS

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I will always regard myself as a Tiger girl with confidence, passions, and courage. Look forward Clemson Tigers going to all over the world. Go tigers！

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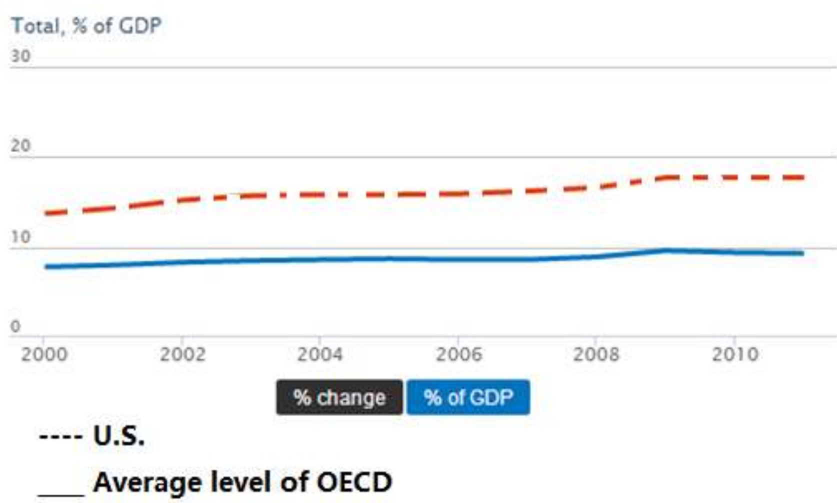
CHAPTER ONE

INTRODUCTION

The United States has had increasing health spending since the 20th century. In 2013, the total health expenditure (public and private expenditures) in the United States is 17.7% of GDP, which is much higher than the average level of OECD (The Organization for Economic Co-operation and Development) countries which is just 9.3% of GDP.[1]

Figure 1.1: The Percent of Health Spending in Nation's GDP

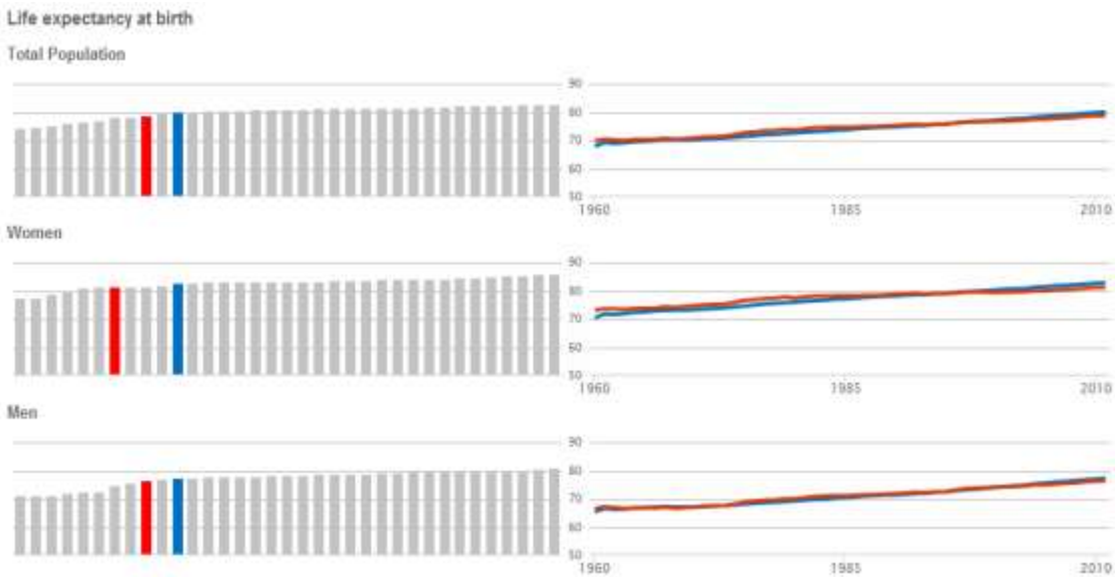


However, considering the life expectancy at birth for the total population in 2011, the United States is 78.7 years, which is lower than the average level of OECD countries at 80 years. [2] Some earlier studies build a positive association between supplies of medical

[1] The health spending figure comes from OECD Health Data http://www.compareyourcountry.org/health/health-spending-gdp?cr=oecd&lg=en
[2] The life expectancy figure comes from OECD Health Data http://www.compareyourcountry.org/health/index?cr=oecd&lg=en

care resources and health outcomes. However, one may conclude that it is a controversial issue for further study.

Figure 1.2: Life Expectancy at Birth in 2011



_____U.S.
_____Average level of OECD

In this paper, the effect of medical resources on an individual's survival is explored, when the geographical aspects are taken into consideration. One goal of this paper is to see, if the supply of the physician and hospital, and the health spending affect an individual's life expectancy. I also build the models separately for females and males, in order to see the difference between two gender groups. The most important demographic factors and socioeconomic factors are taken into consideration, which will be helpful to compare the results with other previous studies.

CHAPTER TWO

REVIEWS OF OTHER STUDIES

Impact of Marital Status

There are many studies illustrating that an individual's marital status significantly affect mortality rates. Goldman & Hu (1993) [3]construct a sequence of mortality rates for different marital status. In their study, 'divorced individuals have the highest mortality rate, followed by the widowed, the singles and the married.' In selectivity theory, individuals prefer to select healthier spouses. Unhealthy individuals are more likely to get divorced or never marry. Based on this theory, a married person has a lower mortality rate than an unmarried person.[4] However, Gove[5] (1973) indicates in his study that most causes of mortality are just genetic or biological problems, and there is no big difference between the married and unmarried groups. Social and behavioral factors related to marriage have more influence on mortality rate. In other words, marriage may be functionally protective, such as parenthood or social support, which has positive effects on reducing an individual's mortality rate. Meanwhile, Gove also suggests that men's relative death rate is higher than women after divorce.

The social integration theory is different from the selectivity theory. Commonly, people believe that marriage will let an individual care more about his/her own and

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[3] Goldman, N., & Hu, Y. "Excess Mortality among the Unmarried: A Case Study of Japan." Social Science and Medicine, 1993, Vol.36, pp.533-546

[4] Kisker, E., & Goldman, N. "Perils of Single Life and Benefits of Marriage." Social Biology, 1987, Vol.34,

[5] Gove, W, R. "Sex, Marital Status, and Mortality." American Journal of Sociology, 1973, Vol.79, pp.45-67

his/her partner's healthy status.[6] Berkman &Syme[7] (1979) demonstrates that social integration is related to well-being and survival. Umberson[8] (1987) builds a model to interpret the causal pathway from family relationships to social control and health behavior. The selectivity theory and the social integration need not be mutually exclusive. They are both potentially helpful for us to analyze the effect of marital status from different aspects.

Impact of Marital Status by Gender

The studies from Shurtleff[9](1955) and Greerken & Gove[10](1974) highlight that men take more advantages then woman in a marital relationship. It means that married men have lower mortality rate than the unmarried ones and this difference is much bigger than the difference between married woman and unmarried ones. 'Marriage may be more psychologically constraining for women: the role of a house-wife is characterized by low status and little power'. Richard G. Rogers [11] (2001) used the 1986 National Mortality Follow-Back Survey (NMFS) data set to analyze the 18,733 individuals aged 25 and over who died in 1986 and concludes that 'Married individuals generally display lower mortality than non-married ones. But these relations can be mediated by income.' That means a single person with higher income may live longer than a married one with lower

[6] Trovato, F., & Lauris, G. "Marital Status and Mortality in Canada: 1951-1981." Journal of Marriage and the Family, 1989, Vol.51, pp.907-922
[7] Berkman &Syme. "Social Networks, Host Resistance, and Mortality: A Nine-Year Follow-up Study of Alameda County Residents." American Journal of Epidemiology, 1979, Vol.109, pp.186-204
[8] Umberson, D. "Family Status and Health Behaviors: Social Control as a Dimension of Social Integration." Journal of Health and Social Behavior, 1987, Vol.28, pp.306-319
[9] Shurtleff, D. "Mortality and Marital Status.' Public Health Report, 1955, Vol.104, pp.183-188
[10] Geerken, M., & Gove,R. "Race, Sex, and Marital Status: Their effects on Mortality." Social Problems, 1974, Vol.21, pp.567-568
[11] Richard G. Rogers. " Marriage, Sex, and Mortality" Journal of Marriage and the Family, 2001, pp.524

income. Moreover, Richard disagrees with Greerken and Gove's view. He illuminates that 'both genders benefit from marriage.' And as woman's roles, social status, attitudes and so forth have changed through time, women have received more benefits from marriage than before. Some studies discover that after marriage dissolution, men are likely to have worse health conditions than woman.[12] But if we take marital quality into consideration, there is no large difference between two gender groups.[8]

Impact of Income and Relative Deprivation

Economic status and socioeconomic difference are always considered to be significant factors related to mortality rate. Zick & Smith[13] (1991) points that, ceteris paribus, a poor woman has 20% higher possibility of death than a non-poor one. Income largely affects mortality. A higher income enables an individual to have a higher quality of health care. However, the drift hypothesis[14] claims that illness affects income instead of income affects individual's longevity. Smith[15] supported that poor health prevents individuals from high-paid work and increase their medical bills at the same time. For this hypothesis, Adler[16]'s study concluded that although prolonged illness may render lower income, 'the central relation between income and mortality remains.'

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[12] Pienta, A. M., Hayward, M.D., & Jenkins, K. R. "High Consequences of Marriage and retirement years." Journal of Family Issues." San Diego, CA: Academic Press. 2000
[13] Zick, C. D., & Smith, K. R "Marital Transitions, Poverty, and Gender Differences in Mortality." Journal of Marriage and the Family, 1991, Vol.53, pp.327
14 Buck, E. M., & Morrison, S. L. "Schizophrenia and Social Class". The Challenge of Epidemiology: Issues and Selected Readings. Washington, DC: Pan American Health Organization. 1988, pp. 368–383.
[15] Smith, J.P. "Healthy Bodies and Thick Wallets: The Dual Relation between Health and Economic Status." Journal of Economic Perspectives, 1999, Vol.13, pp.145-166
[16] Adler, Boyce, Coheny, Folkman & Syme. "Socioeconomic status and health: The challenge of the gradient." American Psychologist, 1994, Vol.49, pp.15-24

Christine & William[17], (2005) obtained the data from the National Health Interview Survey Multiple Cause of Death Files. They used individual-level data on males from 1988-1991 and examined the impact of relative deprivation (RD) on the mortality rate. RD refers to dissatisfaction individuals feel when they compare their income or living condition with their reference group. After using several different approaches to define RD, they found that no matter which method they use, almost all models had the same change in mortality from a fixed change in income. Thus, they concluded that RD is a key factor for survival instead of absolute income.

Salti [18]used Deaton's Relative Deprivation Function on a South African sample. On the one hand, he found evidence to bolster the RD hypothesis. On the other hand, his results largely depend on the age used as a reference group. Yngwe, Kondo, Hagg, and Kawachi, [19]conducted a study on relative deprivation and mortality at Swedish residents from 1990-2006. They concluded that RD is one possible causal way between income and health. By using Yitzhaki index to measure the RD, they found the stronger effect of RD on mortality among men than women. Compared with the results from different income strata, the effect was weakest among the poorest.

[17] Christine Eibner & William N. Evans. "Relative Deprivation, Poor Health Habit, and Mortality." The Journal of Human Resources, 2005, Vol.3 pp.591-616
[18] Salti, N. "Relative Deprivation and Mortality in South Africa." Social Science & Medicine, 2010, vol.70, pp.720-728
[19] Aberg., Yngwe, Naoki., Kondo, & Sara., Hagg "Relative Deprivation and Mortality—A Longitudinal Study in a Swedish Population of 4,7 Million, 1990-2006." BMC Public Health, 2012, 644

Impact of Education

The positive associations between education and an individual's economic health status are well established by many studies (Ross & Mirowsky[20] 2003, 2010; Hummer & Lariscy[21] 2011). The human capital theory [20]regards education as a vital resource for healthy life, because it gives people the ability and motivation to manage their lives. Moreover, some studies show that education is associated with healthier behaviors, such as non smoking, weight control, and eating balanced diet. [22] However, the causal relationship between education and health cannot be distinguished clearly. Haas[23] pointed out in his research that "poor health during childhood or adolescence has significant, direct, and large adverse effects on an individual's educational attainment, which will cause an individual to have fewer opportunities to get a high-paying job."

Impact of Education by Gender

The resource substitution theory [20] claims that "education may be especially important to the health of people who are otherwise disadvantaged." As women have fewer alternative socioeconomic resources and restricted opportunities in labor market, their

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[20] Ross, C. E., & Mirowsky, J. "Refining the Association between Education and Health: Effects of Quantity, Credential, and Selectivity." Demography 1999, Vol. 36, pp.445-460
"Age and the Gender Gap in the Sense of Personal Control." Social Psychology Quarterly, 2002, Vol.65, pp.125-145
" Why Education is Key to Socioeconomic Differentials in Health." Handbook of Medical Sociology, 6th, 2010
[21] Hummer, R. A., & Lariscy, J. "Educational Attainment and Adult Mortality." International Handbook of Adult Mortality, 2011, pp.241-261
[22] Barbeau, E. M., Krieger, N., & Soobader, M. J. "Working Class Matters: Socioeconomic Disadvantage, Race/ Ethnicity, Gender, and Smoking in NHIS 2000." American Journal of Public Health, 2004, Vol.94, pp.269-278
Laditka, S. B., & Laditka, J. N. "Recent Perspectives on Active Life Expectancy for Older Women." Journal of Women & Aging, 2002, Vol.14, pp.163-184
[23] Hass, S. A. "Health Selection and the Process of Social Stratification: The Effect of Childhood Health on Socioeconomic Attainment." Journal of Health and Social Behavior, 2006, Vol.47, pp.339-354

well-being largely depends on their levels of education. Therefore, educational attainment may affect survival for women much more than for men.[24] However, there is less evidence to support this assumption. In contrast, some statistical results show there is no significant gender difference of educational attainment on their mortality rate.[25]

Impact of Medical Resources

The association between the physician supply and health outcomes is always a controversial issue. There are a series of studies justifying the positive association between them.[26] But, McKinlay and McKinlay[27] indicate that medical care factors matter little on the overall decline of mortality in the United States from 1900 to 1973. Young[28] points out that "growing industrial cities attract an oversupply of doctors and rural immigrants," which causes the "persistent but puzzling correlation" between physicians supply and mortality rate. Kindig, Seplaki, & Libby[29] suggest that in the long-term the weak association between medical care supply and the mortality rate does not mean that

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[24] Kilbourne, B. S., England, P., Farkas, G., Beron, K., & Weir, D. "Returns to Skill, Compensating Differentials, and Gender Bias: Effects of Occuptional Characteristics on the Wages of White Women and Men." American Journal of Sociology, 1994, Vol.100, pp.689-719

[25] Avendano, M., Kunst, A. E., Huisman, M., Van Lenthe, F., & Bopp, M. "Educational Level and Stroke Mortality: A Comparison of 10 European Populations During the 1990s." Stroke, 2004, Vol.35, pp.432-437

[26] Shi, L., J. Macinko, B. Starfield, J. Wulu, J. Regan, & R. Politzer, "The Relationship between Primary Care, Income Inequality, and Mortallity in US States, 1980-1995." Journal of the American Board of Family Practice, 2003, Vol.16(5), pp.412-422

Starfield, B., L. Shi, A. Grover, and J. Macinko, "The Effects of Specialist Supply on Populations' Health: Assessing the Evidence." Health Affairs Web Exclusive, 2005, W5:98-107

Macinko, J., B. Starfield, & L.Shi, "The Contribution of Primary Care Systems to Health outcomes within Organization for Economic Cooperation and Development (OECD) Countries, 1970-1998." Health Services Research, 2005, Vol.38(3), pp.831-865

[27] McKinlay, J. B., & S. M. McKinlay, "The Questionable Effect of Medical Measures on the Decline in Mortality in the United States in the Twentieth Century." Milbank Quarterly, 1977, Vol.55, pp.405-428

[28] Young, F. W. "An Explanation of the Persistent Doctor-Mortality Association." Journal of Epidemiology and Community Health, 2001, Vol.55(2), pp.80-84

[29] Kindig, D. A., C. L. Seplaki, & D. L. Libby. "Death Rate Variation in US Subpopulations." Bulletin of the World Health Organization, 2002, Vol.80(1), pp.9-15

physician supply is not important. It means that some other factors contribute more to the mortality decline. Moreover, negative relationships are found by Kindig, Seplaki, & Libby, and Starfield et al.[30] in their studies. In these studies, regional effects on mortality rate are generally accepted.

[30] Starfield, B., L. Shi, A. Grover, and J. Macinko, "The Effects of Specialist Supply on Populations' Health: Assessing the Evidence." Health Affairs Web Exclusive, 2005, W5:98-107

CHAPTER THREE

THE DATA AND THE MODEL

The Data[31]

In this project, data was collected from several different resources. All of an individual's information, including demography, geography, income and mortality, come from Integrated Health Interview Series (IHIS). This dataset provides harmonized data and documentation from the 1960s to the present for the U.S. National Health Interview Survey (NHIS).[32] It has over 12,000 integrated variables harmonizing the leading source of information on the health of the U.S. population[33].

For this project, an individual's all-cause mortality status is primarily studied. Since 1986, NHIS respondents have been tracked using the National Death Index. IHIS covers the individuals, interviewed from 1986 to 2004. Those ages 18 and older are eligible for the mortality follow-up from survey year through 2006. The vital status data reported here match the survey participants' NHIS records to NDI (National Death Index)[34]. In this research, base observations come from surveys in 1991 to 2004, with mortality follow-up data from 1991 to 2006. Individuals are limited within working age ranging from 21 to 64 at the date of interview.

The data about Health Care Expenditures per Capita by State of Residence ranging from 1991 to 2006 are released to the public. The resource of data is from Kaiser Family Foundation (KFF). KFF is a U.S.-based non-profit, non-partisan, private

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[31] The summary statistics are in the Data Appendix on Tables B1-3 and are on pages 48-51
[32] The U.S. National Health Interview Survey (NHIS): http://www.cdc.gov/nchs/nhis/nhis_products.htm
[33] Health Interview Series (IHIS): https://www.ihis.us/ihis/
[34] Health Interview Series (IHIS): https://www.ihis.us/ihis-action/variables/MORTDODY#description_section

operating organization, which focuses on healthcare issues and provides sources for the public. Healthcare spending here includes all funded personal health care services and products, such as hospital spending, physician services, prescription drug, etc[35].

The data of hospital and physician amount are derived from two different sources, KFF and the County and City Data book. County and City Data book provides more than 100 socioeconomic and housing data for nationwide countries and cities. For my research, only the editions of 1988, 1994, 2000 and 2007 are accessible.[36] After merging the data, the data of the number of hospitals by states in years 1991, 1998, 2000, 2004 and 2006 by, and the data of physician by state in years 1990, 1999, and 2004 are used. Meanwhile, the U.S. population by state in years 1995, 1997, 2000 and 2005, is accessible from U.S. Bureau of the Census. The explicit used data show below:

Table 3.1 Year of Used Data

Population	**Hospital**	**Year Range**	**Physician**	**Year Rang**
1995	1991	1991-1995	1990	1991-1995
1997	1998	1996-1999	1999	1996-2001
2000	2000	2000-2002		
2005	2004	2003-2004	2004	2002-2006
2005	2006	2005-2006		

The Variables and the Model

[35] Kaiser Family Foundation http://kff.org/
[36] County and City Data Book http://www2.lib.virginia.edu/ccdb/

As mentioned above, base data are collected from individual at a specific year with a longitudinal follow-up of mortality. Causes of mortality are not distinguished in this thesis.

Dependent variable

The dependent variable in this model is whether or not the individual died in each of the follow-up years. The survey year is from 1991 to 2004, and the follow-up mortality year is from 1991 to 2006. I model the annual hazard of death, so only individual-level outcomes (zero or one) up to the year of death or 2006, whichever comes first.

Independent variable: Quantitative variables

Income. Income is total combined family income, ranging from 2.5 to 90 thousand dollars/year. Income is adjusted for inflation. In this study, all annual income is converted into constant current dollars according to the Consumer Price Index (January, 2014).

Educational attainment. Educational status is coded as 0-17 years of school, including high school and college.

Relative Deprivation. The Deaton's Relative Deprivation Function[37] is applied in this study. It is defined as

$$\mathrm{DRD_i} = \frac{1}{\mu n}\sum_{j}(\mathrm{y_j} - \mathrm{y_i}) \text{ for all } \mathrm{y_j} > y_i$$

For person i, within a same reference group, DRD is defined as the accumulate difference between i's income and j's income for all people who have income greater than that for

[37] Deaton, Angus. "Relative Deprivation, Inequality, and Mortality." National Bureau of Economic Research Working Paper, 2001

person i. In this function, the measure is normalized by μ (the average income in the community), which assumes that person i cares about the proportion of total income earned by people who are at higher in the income distribution rather than the sum of the absolute incomes. In this model, an individual's reference group is defined as people from the same region and same age group. Eleven age groups are coded by five year increments, ranging from 21 to 64 years old. These data come from IHIS.

Health spending per capita. Health spending includes all privately and publicly funded personal health care services and products. Hospital spending is included also. The health spending is adjusted into constant current dollars according to the Consumer Price Index (January, 2014). In the model, the health spending per capita is measured by 1000 dollars per increment. These data come from KFF.

Number of hospitals. Hospitals are community hospitals representing 85% of all hospitals in the U.S. The data per year by state are collected and merged into region, and expressed hospitals per 100,000 resident populations. Therefore, the final hospital numbers, from 1991 to 2006, are measured by per 100,000 resident populations for each region.

Physician amount. Physicians include active allopathic physicians and osteopathic physicians from 1991 to 2006. The data is standardized by the same approach as the variable "number of hospitals", so it is measured as physician per 100,000 residents in the region.

Independent variables: Categorical variables

Region. In this study, the states are classified into four regions corresponding to the U.S. regions recognized by the Census Bureau—Northeast: New England Division (Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut) and Middle Atlantic Division (New York, New Jersey, and Pennsylvania), North Central/Midwest: North Central/Midwest: East North Central Division (Michigan, Ohio, Indiana, Illinois, Wisconsin) and West North Central Division (Minnesota, Iowa, Missouri, North Dakota, South Dakota, Kansas, and Nebraska) , South: South Atlantic Division (Delaware, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, and Florida), East South Central Division (Kentucky, Tennessee, Mississippi, and Alabama), and West South Central Division (Texas, Arkansas, Oklahoma, and Louisiana), and West: Pacific Division (Washington, Alaska, Oregon, California, and Hawaii) and Mountain Division (Montana, Idaho, Wyoming, Colorado, New Mexico, Arizona, Utah, and Nevada). As the region is a categorical variable, 'West' is treated as a baseline.

Marital Status. Considering the effects of marriage dissolution on individuals' survival status, four categories are set: 0-married, 1-widowed, 2-divorced or separated, 3-single (never married). "Married" is the reference group.

Race. Race is coded into 3 groups: white, black and others. "White" is the reference group.

Gender. 0-Female, 1-Male. "Female" is the reference group.

D_{92}-D_{06}. Year 1992 to2006 are individually set as a dummy variable and the year 1991 is the baseline.

After year. This variable refers to the number of years from survey years to each follow-up year.

A_{22}-A_{79}. They are age dummy variables from 21 to 79. Age 21 is set as the base line.

Age. Individual's age at the survey or follow-up year.

General model

$$\begin{aligned}\text{Mortality rate} = {} & \beta_0 + \beta_1 A_{22} + \beta_2 A_{23} \ldots \ldots \beta_{58} A_{79} + \beta_{59} D_{92} + \beta_{60} D_{93} \ldots \ldots + \beta_{73} D_{06} \\ & + \beta_{74}\text{REGION}_{\text{Northeast}} + \beta_{75}\text{REGION}_{\text{Midwest}} + \beta_{76}\text{REGION}_{\text{south}} \\ & + \beta_{77}\text{RACE}_{\text{black}} + \beta_{78}\text{RACE}_{\text{others}} + \beta_{79}\text{MARITAL STATUS}_{\text{widowed}} \\ & + \beta_{80}\text{MARITAL STATUS}_{\text{divorced/separated}} + \beta_{81}\text{MARITAL STATUS}_{\text{single}} \\ & + \beta_{82}\text{EDUCATION} + \beta_{83}\text{INCOME} + \beta_{84}\text{AFTERYEAR} * \text{INCOME} \\ & + \beta_{85}\text{ RELATIVE DEPRIVATION} + \beta_{86}\text{HEALTH SPENDING} + \beta_{87}\text{Age} \\ & * \text{HEALTH SPENDING} + \beta_{88}\text{HOSPITAL} + \beta_{89}\text{Age} * \text{HOSP} \\ & + \beta_{90}\text{PHYSICIAN} + \beta_{91}\text{Age} * \text{PHY} + \beta_{92}\text{GENDER}\end{aligned}$$

Gender Model: Gender-specific analysis for women and men

The data set is divided into two sub data sets according to the classification of female and male. The analysis is carried out separately for men and women in the second and third model and the further contrast is made based on the result between two models. The models are similar to the first general model. Only the variable 'Gender' is deleted.

$$
\begin{aligned}
\text{Mortality rate}(F / M) &= \beta_0 + \beta_1 A_{22} + \beta_2 A_{23} \ldots \ldots \beta_{58} A_{79} + \beta_{59} D_{92} + \beta_{60} D_{93} \ldots \ldots + \beta_{73} D_{06} \\
&+ \beta_{74}\text{REGION}_{\text{Northeast}} + \beta_{75}\text{REGION}_{\text{Midwest}} + \beta_{76}\text{REGION}_{\text{south}} \\
&+ \beta_{77}\text{RACE}_{\text{black}} + \beta_{78}\text{RACE}_{\text{others}} + \beta_{79}\text{MARITAL STATUS}_{\text{widowed}} \\
&+ \beta_{80}\text{MARITAL STATUS}_{\text{divorced/separated}} + \beta_{81}\text{MARITAL STATUS}_{\text{single}} \\
&+ \beta_{82}\text{EDUCATION} + \beta_{83}\text{INCOME} + \beta_{84}\text{AFTERYEAR} * \text{INCOME} \\
&+ \beta_{85}\text{ RELATIVE DEPRIVATION} + \beta_{86}\text{HEALTH SPENDING} + \beta_{87}\text{Age} \\
&* \text{HEALTH SPENDING} + \beta_{88}\text{HOSPITAL} + \beta_{89}\text{Age} * \text{HOSP} \\
&+ \beta_{90}\text{PHYSICIAN} + \beta_{91}\text{Age} * \text{PHY}
\end{aligned}
$$

The empirical models built in this paper are a hazard duration regression model. The impact on the individual's risk of death is studied, including various demographic and socioeconomic factors on an individual level, and the health spending per capita, hospital numbers per 100,000 residents, and physician numbers per 100,000 residents on a regional level. Region, marital status and education are assumed to be stable through time, which is a limitation of this type of data.

Because an individual's family income may change in the follow-up years, the impact of constant family income could change. An interaction term *Afteryear*income* is included to address this issue, which represents the years after the survey year interacting with the family income.

Because individuals are inclined to have more relations with health spending, hospital supply and physician supply in their region when they get older, some interaction terms, *Age*Hospital*, *Age*Health spending*, *Age*Physician*, are included as age interacting with different medical variables (health spending, hospital numbers, physician numbers).

CHAPTER FOUR

THE RESULT AND DATA ANALYSIS

The life expectancy of an individual is commonly expected to be 80 years. Therefore, a 50-year-old person is expected to have another 30 years life-span. In this paper, an individual's life expectancy, at 50 years old, is anticipated based on the effects from different factors. I evaluate effects assuming a constant hazard of mortality for age 50 and older. This provides a simple way to summarize effects and is easier to interpret on odds ratios.

General Model for all Observations

There are 6,005,056 expanded observations included in the first model. A binary logistic model is built. If a person was died in a specific year, the value of dependent variable is 1. If not, the value is 0. The total frequency of observation died in the study is 25,751. I evaluate effects assuming a constant hazard of mortality for age 50 and older. This provides a simple way to summarize effects and is easier to interpret than effects on odds va

Table 4.1: Testing Global Null Hypothesis for General Model: BETA=0

Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	34826.2818	92	<.0001
Score	47208.3287	92	<.0001
Wald	31878.5579	92	<.0001

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As Table 4.1 reveals, the model is statistically significant. P-value is smaller than 0.0001.

Table 4.2: General Model: Coefficient Results of Age Dummies

Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	1	-7.6130	0.8104	88.2411	<.0001
A22	1	-0.0357	0.4978	0.0051	0.9428
A23	1	0.4919	0.4441	1.2269	0.2680
A24	1	0.4872	0.4355	1.2517	0.2632
A25	1	0.2800	0.4359	0.4127	0.5206
A26	1	0.1606	0.4351	0.1362	0.7120
A27	1	0.4641	0.4262	1.1855	0.2762
A28	1	0.5469	0.4239	1.6642	0.1970
A29	1	0.2961	0.4272	0.4805	0.4882
A30	1	0.5606	0.4234	1.7534	0.1855
A31	1	0.6499	0.4229	2.3624	0.1243
A32	1	0.6312	0.4238	2.2188	0.1363
A33	1	0.6486	0.4246	2.3334	0.1266
A34	1	0.4943	0.4272	1.3388	0.2473
A35	1	0.8132	0.4263	3.6388	0.0564
A36	1	0.7897	0.4283	3.3999	0.0652
A37	1	1.0184	0.4290	5.6368	0.0176
A38	1	0.9607	0.4314	4.9600	0.0259
A39	1	1.0640	0.4331	6.0349	0.0140
A40	1	1.2201	0.4349	7.8713	0.0050
A41	1	1.2210	0.4375	7.7902	0.0053
A42	1	1.2127	0.4402	7.5897	0.0059
A43	1	1.3337	0.4426	9.0791	0.0026
A44	1	1.3641	0.4455	9.3753	0.0022
A45	1	1.4689	0.4483	10.7364	0.0011
A46	1	1.4281	0.4516	9.9990	0.0016
A47	1	1.6310	0.4544	12.8806	0.0003

A48	1	1.6807	0.4578	13.4790	0.0002
A49	1	1.8323	0.4610	15.7952	<.0001
A50	1	1.7615	0.4648	14.3599	0.0002
A51	1	1.9123	0.4683	16.6723	<.0001
A52	1	2.0033	0.4720	18.0111	<.0001
A53	1	2.0578	0.4759	18.6959	<.0001
A54	1	2.0949	0.4799	19.0536	<.0001
A55	1	2.1135	0.4840	19.0661	<.0001
A56	1	2.2346	0.4881	20.9582	<.0001
A57	1	2.2832	0.4924	21.5039	<.0001
A58	1	2.3767	0.4966	22.9018	<.0001
A59	1	2.4470	0.5011	23.8498	<.0001
A60	1	2.4868	0.5056	24.1938	<.0001
A61	1	2.5411	0.5102	24.8099	<.0001
A62	1	2.5978	0.5148	25.4654	<.0001
A63	1	2.6460	0.5195	25.9408	<.0001
A64	1	2.7041	0.5243	26.5996	<.0001
A65	1	2.8635	0.5293	29.2714	<.0001
A66	1	2.8788	0.5345	29.0105	<.0001
A67	1	2.9333	0.5397	29.5348	<.0001
A68	1	3.0276	0.5450	30.8571	<.0001
A69	1	3.0955	0.5504	31.6333	<.0001
A70	1	3.1442	0.5557	32.0162	<.0001
A71	1	3.2316	0.5611	33.1691	<.0001
A72	1	3.2753	0.5668	33.3972	<.0001
A73	1	3.3991	0.5724	35.2645	<.0001
A74	1	3.4402	0.5785	35.3664	<.0001
A75	1	3.5001	0.5848	35.8258	<.0001
A76	1	3.4699	0.5916	34.4026	<.0001
A77	1	3.4912	0.6000	33.8615	<.0001
A78	1	3.8852	0.6085	40.7729	<.0001
A79	1	3.8108	0.6364	35.8564	<.0001

As I mentioned above, in this model, ages are set for each person as dummy variables. A person at 21 years old is set as the base group. In Table 4.2, age factors become increasingly larger in magnitude and statistically significant (α=0.05 P-value <0.05.

Table 4.3: General Model: Coefficient Results of Year Dummies

Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
D92	1	0.5807	0.1352	18.4480	<.0001
D93	1	0.6730	0.1311	26.3364	<.0001
D94	1	0.7441	0.1305	32.4909	<.0001
D95	1	0.7329	0.1330	30.3752	<.0001
D96	1	0.7612	0.1995	14.5511	0.0001
D97	1	0.6784	0.2014	11.3498	0.0008
D98	1	0.7050	0.2037	11.9786	0.0005
D99	1	0.6151	0.2075	8.7881	0.0030
D00	1	0.6423	0.2469	6.7655	0.0093
D01	1	0.6295	0.2576	5.9712	0.0145
D02	1	0.6413	0.3077	4.3438	0.0371
D03	1	0.5455	0.3425	2.5374	0.1112
D04	1	0.4947	0.3541	1.9512	0.1625
D05	1	0.4896	0.3663	1.7866	0.1813
D06	1	0.4148	0.3798	1.1931	0.2747

From Table 4.3, year 1991 is as a referent. An individual's risk of death increases year by year at first, but declines after 1996.

Table 4.4: General Model: Coefficient Results of Demographic, Geographic, and Socioeconomic Variables

Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Northeast	1	0.0734	0.2467	0.0886	0.7660
Midwest	1	0.2809	0.2842	0.9767	0.3230
South	1	0.2681	0.1705	2.4739	0.1158
Male	1	0.5584	0.0130	1831.4207	<.0001
Black	1	0.2596	0.0173	225.8104	<.0001
Race:others	1	0.5584	0.0130	1831.4207	<.0001
Widowed	1	0.2161	0.0280	59.5084	<.0001
Divorced/ Separate	1	0.2628	0.0178	217.5674	<.0001
Single	1	0.3619	0.0215	284.5792	<.0001
Education	1	-0.0353	0.00228	239.9663	<.0001
Income	1	-0.00292	0.000709	16.9496	<.0001
After year* income	1	0.000308	0.000030	104.0177	<.0001
Relative Deprivation	1	1.0804	0.0842	164.7011	<.0001

If the annual hazard of mortality for a 50 year old individual in the following 30 years is 0.0333, there would be a life expectancy of age80 (an additional 30 years of the life).

In terms of a logistic model, the formula for going from a probability to odds ratio is:

$$\frac{e^{Arg}}{1 + e^{Arg}} = 0.0333$$

$$e^{Arg} = 0.0344$$

$$Arg = \ln(0.0344) = -3.3696$$

To evaluate the effects of covariates, I deviate this argument and solve for the “new” argument, translate it to a constant hazard rate, and solve for the implied number of additional years of life. I then compare this to the 30 years of life expectancy in the baseline.

NewArg=-3.3696+marginal log-odds ratio effect from a certain variable

Table 4.5: General Model: Transformed Marginal Effects of Demographic, Geographic, and Socioeconomic Variables Results

Parameter	**Estimate**	**NewArg**	**e^{New}**	**NewPro**	**1/NewPro**	**Dif(year)**
Northeast	0.0734	-3.30	0.04	0.04	28.01	-1.99
Midwest	0.2809	-3.09	0.05	0.04	22.95	-7.05
South	0.2681	-3.10	0.04	0.04	23.23	-6.77
Male	0.5584	-2.81	0.06	0.06	17.63	-12.4
Black	0.2596	-3.11	0.04	0.04	23.42	-6.58
Race: others	-0.1926	-3.56	0.03	0.03	36.24	6.241
Widowed	0.2161	-3.15	0.04	0.04	24.42	-5.58
Divorced/sep	0.2628	-3.11	0.04	0.04	23.35	-6.65
Single	0.3619	-3.01	0.05	0.05	21.24	-8.76
Education	-0.0353	-3.40	0.03	0.03	31.11	1.111
Income	-0.0029	-3.37	0.03	0.03	30.15	0.151
After year* income	0.00031	-3.3693	0.034	0.0333	30.05789	0.06
RD	1.0804	-3.28	0.04	0.04	27.54	-2.46

In Table 4.4 and 4.5, although the regional factors are not individually statistically significant different from the West, their economic effects are vital. Ceteris paribus, the residents in Northeast and West have the similar life expectancy. And the residents at age 50 in Midwest and South have similar life expectancy. Compared with the residents in Northeast and West, the life expectancy of a resident at age 50 in Midwest and South generally is about 6 years shorter than that in Northeast and West.

Meanwhile, the rest variables included in this model are all statistically significant (α=0.05 P-value <0.05). Ceteris paribus, at age 50, a male's life expectancy is shorter than the female's for about 12.4 years. A white's life expectancy is longer than the black's for about 6.58 years. Considering the marital status, the married have the longest life span. The sequence from high to low is the married, the widowed, the divorced/ separated, and the single. Ceteris paribus, with an additional year of education, an individual's life span will increase about 1.11 years.

Because the value of a family income just represents the economic condition at survey year, in the follow-up year, the impact could change. To accommodate this an interaction term 'after year*income' is generated. From Table 4.4, individuals with higher income at the date of the survey live longer, but the effect of that income diminished over time.

In terms of relative deprivation, the higher value means that an individual has a lower income compared the reference group. If an individual's relative deprivation is zero, it means that he or she has the highest income within the reference group. Because, relative deprivation is an index value, the value of its standard deviation is used to calculate and interpret its marginal effect. Ceteris paribus, at age of 50, if an individual's relative deprivation index increases additional 0.0843 (one standard deviation), his or her life span will decrease 2.45 years.

Table 4.6: General Model: Coefficient Results of Healthcare Factors

Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
hspending	1	0.1206	0.0918	1.7257	0.1890
HSP_AGE	1	-0.00160	0.000919	3.0241	0.0820**
hospital	1	-0.5764	0.4093	1.9830	0.1591
HOS_AGE	1	0.00495	0.00235	4.4421	0.0351***
physician	1	-0.00513	0.00266	3.7323	0.0534**
PHY_AGE	1	0.000070	0.000023	9.3124	0.0023***

Table 4.6 shows that most of the healthcare related factors are statistically insignificant. Additionally, the interaction terms *Hospital*age and Physician*age* show statistically significant (α=0.05 P-value <0.05). The results reveal that the beneficial effects of numbers of hospitals and physicians become smaller for older individuals. When individuals are 50 years old and 60 years old, the transformed effect of health spending, numbers of hospital and physician amount are listed below:

Table 4.7: General Model: Transformed Marginal Effects of Healthcare Factors

Odds Ratio	Estimate	NewArg	e^{New}	NewPro	1/NewPro	Dif(year)
50_hspending	0.0406	-3.33	0.04	0.03	28.91	-1.09
50_hospital	-0.3289	-3.70	0.02	0.02	41.39	11.39
50_physician	-0.00163	-3.37	0.03	0.03	30.11	0.11
60_hspending	0.0246	-3.35	0.04	0.03	29.36	-0.64
60_hospital	-0.2794	-3.65	0.03	0.03	39.44	9.44
60_physician	-0.00093	-3.37	0.03	0.03	30.09	0.09

In Table 4.7, the economic effect of physician is small. For example, ceteris paribus, with an additional physician per 100,000 residents in this region, life expectancy of an individual at age 50 will increase for about 0.11 year. When an individual gets older, the physician amount has a decreasing impact on individual's life expectancy. Ceteris paribus, with an additional physician per 100,000 residents in this region, life expectancy of an individual at age 60 will increase for about 0.09 year.

Although, the beneficial effect of the number of hospitals does not show statistically significant in Table 4.6, its economic effect is big. Table 4.7 shows that, ceteris paribus, for an individual at 50 years old, an additional hospital per 100,000 residents will prolong the individual's life expectancy for 11.39 years. The positive coefficient sign of the interaction term *hospital*age* shows when an individual get older, the beneficial effect of hospital on an individual decreases.

Considering the health spending and related terms, ceteris paribus, for an individual at 50 years old, with an additional 1000 dollars health spending per capita, the individual's life expectancy will decrease about 1.09 years. Although, the interaction term health spending*age is not statistically significant at $\alpha=0.05$, its economic meaning is vital. When an individual get older, ceteris paribus, the negative effect of health spending on one's life expectancy will decrease.

Model for Females

There are 3,162,316 expanded female samples in this second model. The total frequency of female died before 2006 is 10,898.

Table 4.8: Testing Global Null Hypothesis for Female: BETA=0

Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	14870.2131	91	<.0001
Score	20924.3400	91	<.0001
Wald	13362.8039	91	<.0001

As Table 4.8 shows, the female model is statistically significant. P-value is smaller than 0.0001.

Table 4.9: Female-Specific Model: Coefficient Results of Age Dummies

Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	1	-10.6445	1.4755	52.0423	<.0001
A22	1	0.3542	1.1513	0.0946	0.7584
A23	1	1.3080	1.0373	1.5901	0.2073
A24	1	1.3017	1.0275	1.6048	0.2052
A25	1	1.1396	1.0262	1.2332	0.2668
A26	1	0.9610	1.0268	0.8758	0.3493
A27	1	1.1163	1.0201	1.1976	0.2738
A28	1	1.2854	1.0155	1.6022	0.2056
A29	1	0.8738	1.0221	0.7309	0.3926
A30	1	1.4880	1.0124	2.1605	0.1416
A31	1	1.3341	1.0144	1.7296	0.1885
A32	1	1.3823	1.0145	1.8565	0.1730
A33	1	1.2529	1.0167	1.5184	0.2179
A34	1	1.2366	1.0181	1.4752	0.2245
A35	1	1.5043	1.0173	2.1866	0.1392
A36	1	1.6102	1.0184	2.5000	0.1138
A37	1	1.6645	1.0201	2.6627	0.1027
A38	1	1.6959	1.0220	2.7534	0.0970
A39	1	1.9034	1.0233	3.4599	0.0629
A40	1	1.8693	1.0259	3.3202	0.0684
A41	1	1.9718	1.0281	3.6784	0.0551
A42	1	1.9854	1.0309	3.7092	0.0541

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A43	1	2.1578	1.0332	4.3618	0.0368
A44	1	2.2499	1.0360	4.7163	0.0299
A45	1	2.3608	1.0389	5.1636	0.0231
A46	1	2.2912	1.0425	4.8304	0.0280
A47	1	2.4726	1.0455	5.5929	0.0180
A48	1	2.4270	1.0493	5.3502	0.0207
A49	1	2.5907	1.0526	6.0576	0.0138
A50	1	2.4893	1.0567	5.5488	0.0185
A51	1	2.6725	1.0604	6.3523	0.0117
A52	1	2.7716	1.0643	6.7815	0.0092
A53	1	2.9142	1.0683	7.4408	0.0064
A54	1	2.8759	1.0728	7.1866	0.0073
A55	1	2.9006	1.0772	7.2508	0.0071
A56	1	3.0855	1.0815	8.1388	0.0043
A57	1	3.0664	1.0863	7.9684	0.0048
A58	1	3.1399	1.0910	8.2828	0.0040
A59	1	3.1905	1.0959	8.4760	0.0036
A60	1	3.3204	1.1008	9.0991	0.0026
A61	1	3.3565	1.1059	9.2121	0.0024
A62	1	3.3938	1.1111	9.3304	0.0023
A63	1	3.4216	1.1164	9.3937	0.0022
A64	1	3.5001	1.1218	9.7357	0.0018
A65	1	3.6191	1.1274	10.3052	0.0013
A66	1	3.6630	1.1332	10.4483	0.0012
A67	1	3.7099	1.1392	10.6048	0.0011
A68	1	3.7932	1.1452	10.9702	0.0009
A69	1	3.9586	1.1512	11.8239	0.0006
A70	1	3.9585	1.1574	11.6975	0.0006
A71	1	4.0461	1.1637	12.0898	0.0005
A72	1	4.0771	1.1702	12.1396	0.0005
A73	1	4.2440	1.1767	13.0084	0.0003
A74	1	4.2260	1.1839	12.7423	0.0004
A75	1	4.3747	1.1910	13.4927	0.0002
A76	1	4.1557	1.1995	12.0023	0.0005
A77	1	4.3306	1.2080	12.8527	0.0003
A78	1	4.7572	1.2176	15.2647	<.0001
A79	1	4.8086	1.2424	14.9802	0.0001

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In this model, an individual at 21 years old is also set as the base group. In Table 4.9, age factors become increasingly larger in magnitude and statistically significant (α=0.05 P-value <0.05). An individual is more likely to die, as getting older. Therefore, the results of those age dummies generally make sense.

Table 4.10: Female-Specific Model: Coefficient Results of year dummies

Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
D92	1	0.7468	0.2225	11.2658	0.0008
D93	1	0.7683	0.2177	12.4571	0.0004
D94	1	0.8171	0.2168	14.2052	0.0002
D95	1	0.8938	0.2197	16.5514	<.0001
D96	1	1.5233	0.3235	22.1725	<.0001
D97	1	1.4683	0.3264	20.2360	<.0001
D98	1	1.4789	0.3302	20.0593	<.0001
D99	1	1.4316	0.3360	18.1550	<.0001
D00	1	1.6566	0.3963	17.4776	<.0001
D01	1	1.7443	0.4126	17.8733	<.0001
D02	1	1.9278	0.4929	15.2992	<.0001
D03	1	1.9873	0.5465	13.2254	0.0003
D04	1	1.9919	0.5646	12.4484	0.0004
D05	1	1.9708	0.5833	11.4147	0.0007
D06	1	1.9366	0.6041	10.2761	0.0013

In this model, year 1991 is also a referent. In Table 4.10, it shows that years are statistically significant factors for a female mortality rate. Moreover, the mortality rate tended to increase throughout the years, which is out of expectation.

Table 4.11: Female-Specific Model: Coefficient Results of Demographic, Geographic, and Socioeconomic Variables

Parameter	DF	Estimate	Standard Error	Chi-Square	Pr > ChiSq
Northeast	1	0.8980	0.3929	5.2228	0.0223
Midwest	1	-1.0810	0.4402	6.0305	0.0141
South	1	-0.5902	0.2639	5.0028	0.0253
Black	1	0.2589	0.0258	100.4074	<.0001
Race:others	1	-0.1697	0.0434	15.2498	<.0001
Widowed	1	0.1337	0.0339	15.5980	<.0001
Divorced/ Seperate	1	0.0949	0.0267	12.6268	0.0004
Single	1	0.1810	0.0357	25.6640	<.0001
Education	1	-0.0370	0.00364	102.9851	<.0001
Income	1	-0.00179	0.00113	2.4987	0.1139
After year*income	1	0.000314	0.000049	41.1471	<.0001
Relative Deprivation	1	1.3076	0.1314	99.0871	<.0001

In Table 4.11, the family income is not statistically significant for a female mortality rate. All the other variables are statistically significant (α=0.05 P-value <0.05). Especially, the regional factors, which are statistically insignificant in General Model, are quite significant here. Therefore, other three regions have different mortality rates than the West.

Table 4.12: Female-Specific Model: Transformed Marginal Effects of Demographic, Geographic, and Socioeconomic Variables Results

Parameter	Estimate	NewArg	e^{New}	NewPro	1/NewPro	Dif(year)
Northeast	0.8980	-2.4716	0.0844	0.0779	12.8414	-17.16
Midwest	-1.0810	-4.4506	0.0117	0.0115	86.6783	56.68
South	-0.5902	-3.9598	0.0191	0.0187	53.4468	23.45
Black	0.2589	-3.1107	0.0446	0.0427	23.4367	-6.56
Race:others	-0.1697	-3.5393	0.0290	0.0282	35.4428	5.44
Widowed	0.1337	-3.2359	0.0393	0.0378	26.4292	-3.57
Divorced/sep	0.0949	-3.2747	0.0378	0.0364	27.4353	-2.56
Single	0.1810	-3.1886	0.0412	0.0396	25.2544	-4.75
Education	-0.0370	-3.4066	0.0332	0.0321	31.1625	1.16
Income	-0.00179	-3.3714	0.0343	0.0332	30.1190	0.12
After year*income	0.000314	-3.3693	0.0344	0.0333	30.0578	0.0578
Relative Deprivation	1.3076	-3.1978	0.0409	0.0392	25.4782	-4.5218

In Table 4.12, a female's life expectancy is affected by regional factors. Females in Northeast have a life expectancy which is 17.16 years shorter than these in West. However, females in Midwest and South have much longer life expectancy than those in West, which are seriously different from the results in General Model.

The effects of race, income and education in this female-specific model are similar to the General Model. Considering the marital factors, ceteris paribus, married females have the longest life expectancy. The divorced and the separated are ranked the second, followed by the widowed and the single. The sequence is a little bit different from the General Model.

What should be paid attention is that although the family income does not make a great economic effect on a female's life expectancy, the relative deprivation does.

Table 4.13: Female-Specific Model: Coefficient Results of Healthcare Factors

Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
hspending	1	0.1297	0.1424	0.8296	0.3624
HSP_AGE	1	-0.00285	0.00143	3.9891	0.0458***
hospital	1	1.2470	0.6365	3.8385	0.0501**
HOS_AGE	1	0.00421	0.00366	1.3275	0.2493
physician	1	-0.0111	0.00417	7.0784	0.0078***
PHY_AGE	1	0.000088	0.000036	6.0919	0.0136***

In Table 4.13, *physician amount* and the interaction term *physician*age* are both statistically significant for female's risk of mortality. The beneficial effect of *physician amount* on individuals' life spans decrease, as individuals gets older. Also, the interaction term of *health spending*age* is statistically significant.

Table 4.14: Female-Specific Model: Transformed Marginal Effects of Healthcare Factors

Odds Ratio	Estimate	NewArg	e^{New}	NewPro	1/NewPro	Dif(year)
50_hspending	-0.0128	-3.38	0.03	0.03	30.44	0.44
50_hospital	1.4575	-1.91	0.15	0.13	7.77	-22.23
50_physician	-0.0067	-3.38	0.03	0.03	30.26	0.26
60_hspending	-0.0413	-3.41	0.03	0.03	31.29	1.29
60_hospital	1.4996	-1.87	0.15	0.13	7.49	-22.51
60_physician	-0.00582	-3.38	0.03	0.03	30.24	0.24

In Table 4.14, a female at age of 50 years old, which an additional 1000 dollars increments of health spending, her life expectancy will be about 0.44 years longer, and 1.29 years longer, when she is 60 years old. This effect is economic significant, which means when a female get older, the beneficial effect of health spending becomes larger. Different from the results in General Model, in this female-specific model, ceteris paribus, with an additional hospital per 100,000 residents, a female's life expectancy at age 50 will decrease 22.23 years. It is a critical economic effect. But it does not make sense, there might be some unanticipated factors related to number of regional hospitals affect the result.

Moreover, regional physician amount is statistically, but not economically significant to anticipate a female's life expectancy. At age 50, with an additional physician per 100,000 residents in this region, a female's life expectancy will increase 0.26 years. And the beneficial effect decreases, when a female gets older.

Model for Male

There are 2,842,740 expanded male samples in this male-specific model. The total frequency of male died before 2006 is14, 853.

Table 4.15: Testing Global Null Hypothesis for Male: BETA=0

Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	19042.4509	91	<.0001
Score	26315.6361	91	<.0001
Wald	17923.7957	91	<.0001

As Table 4.15 shows, the male-specific model is statistically significant. P-value is smaller than 0.0001.

Table 4.16: Male-Specific Model: Coefficient Results of Age Dummies

Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	1	-5.1828	1.0213	25.7546	<.0001
A22	1	-0.1214	0.5575	0.0474	0.8276
A23	1	0.2150	0.5028	0.1829	0.6689
A24	1	0.2120	0.4906	0.1867	0.6657
A25	1	-0.0253	0.4929	0.0026	0.9591
A26	1	-0.1046	0.4905	0.0455	0.8311
A27	1	0.2880	0.4753	0.3670	0.5447
A28	1	0.3241	0.4734	0.4688	0.4935
A29	1	0.1615	0.4763	0.1150	0.7345
A30	1	0.2039	0.4754	0.1840	0.6680
A31	1	0.4642	0.4719	0.9679	0.3252
A32	1	0.4065	0.4739	0.7358	0.3910
A33	1	0.5091	0.4743	1.1522	0.2831
A34	1	0.2776	0.4791	0.3358	0.5623
A35	1	0.6290	0.4776	1.7345	0.1878
A36	1	0.5218	0.4814	1.1747	0.2784
A37	1	0.8635	0.4816	3.2145	0.0730
A38	1	0.7543	0.4857	2.4117	0.1204
A39	1	0.7852	0.4889	2.5790	0.1083
A40	1	1.0678	0.4908	4.7328	0.0296
A41	1	1.0074	0.4951	4.1413	0.0419
A42	1	0.9857	0.4993	3.8976	0.0484
A43	1	1.0711	0.5031	4.5327	0.0333
A44	1	1.0539	0.5077	4.3102	0.0379
A45	1	1.1548	0.5118	5.0913	0.0240
A46	1	1.1388	0.5167	4.8574	0.0275
A47	1	1.3596	0.5208	6.8140	0.0090

A48	1	1.4779	0.5256	7.9071	0.0049
A49	1	1.6226	0.5305	9.3559	0.0022
A50	1	1.5726	0.5361	8.6058	0.0034
A51	1	1.7031	0.5413	9.8990	0.0017
A52	1	1.7898	0.5468	10.7124	0.0011
A53	1	1.7802	0.5527	10.3744	0.0013
A54	1	1.8745	0.5585	11.2663	0.0008
A55	1	1.8894	0.5645	11.2019	0.0008
A56	1	1.9635	0.5706	11.8428	0.0006
A57	1	2.0632	0.5767	12.7990	0.0003
A58	1	2.1723	0.5829	13.8868	0.0002
A59	1	2.2569	0.5894	14.6637	0.0001
A60	1	2.2315	0.5961	14.0162	0.0002
A61	1	2.3011	0.6027	14.5796	0.0001
A62	1	2.3736	0.6093	15.1742	<.0001
A63	1	2.4374	0.6161	15.6496	<.0001
A64	1	2.4813	0.6231	15.8579	<.0001
A65	1	2.6710	0.6302	17.9633	<.0001
A66	1	2.6665	0.6378	17.4818	<.0001
A67	1	2.7277	0.6453	17.8685	<.0001
A68	1	2.8317	0.6529	18.8113	<.0001
A69	1	2.8210	0.6607	18.2306	<.0001
A70	1	2.9126	0.6682	18.9987	<.0001
A71	1	3.0022	0.6760	19.7252	<.0001
A72	1	3.0566	0.6841	19.9652	<.0001
A73	1	3.1440	0.6922	20.6303	<.0001
A74	1	3.2396	0.7008	21.3722	<.0001
A75	1	3.2193	0.7100	20.5558	<.0001
A76	1	3.3506	0.7191	21.7071	<.0001
A77	1	3.2456	0.7327	19.6202	<.0001
A78	1	3.6132	0.7452	23.5061	<.0001
A79	1	3.3834	0.7988	17.9403	<.0001

From Tables 4.16, we can find that age has the similar effect on both females and males. However, although females generally have a longer life expectancy than males, ceteris paribus, ceteris paribus, compared with a female, a male has less probability of death when he gets older.

Table 4.17: Male-Specific Model: Coefficient Results of Year Dummies

Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
D92	1	0.4770	0.1706	7.8152	0.0052
D93	1	0.6174	0.1645	14.0900	0.0002
D94	1	0.7024	0.1637	18.4075	<.0001
D95	1	0.6346	0.1674	14.3712	0.0002
D96	1	0.2478	0.2541	0.9516	0.3293
D97	1	0.1455	0.2564	0.3222	0.5703
D98	1	0.1838	0.2594	0.5024	0.4784
D99	1	0.0639	0.2644	0.0585	0.8089
D00	1	-0.0512	0.3165	0.0261	0.8716
D01	1	-0.1364	0.3306	0.1703	0.6799
D02	1	-0.2352	0.3947	0.3552	0.5512
D03	1	-0.4410	0.4404	1.0031	0.3166
D04	1	-0.5320	0.4556	1.3630	0.2430
D05	1	-0.5218	0.4715	1.2249	0.2684
D06	1	-0.6254	0.4893	1.6339	0.2012

In Table 4.17, the general trend of the effect made by year dummies for males is opposite to the effect for females. Thus, males are less significantly affected by year factors, but females do.

Table 4.18: Male-Specific Model: Coefficient Results of Demographic, Geographic, and Socioeconomic Variables

Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Northeast	1	-0.4799	0.3173	2.2876	0.1304
Midwest	1	1.2647	0.3726	11.5186	0.0007
South	1	0.8884	0.2237	15.7769	<.0001
Black	1	0.2726	0.0233	136.5702	<.0001
Race:others	1	-0.2062	0.0384	28.8171	<.0001
Widowed	1	0.2971	0.0537	30.6444	<.0001
Divorced/ Separate	1	0.3961	0.0239	275.5846	<.0001
Single	1	0.4682	0.0270	301.6752	<.0001
Education	1	-0.0330	0.00293	126.4196	<.0001
Income	1	-0.00374	0.000915	16.6935	<.0001
After year* income	1	0.000312	0.000039	65.3622	<.0001
Relative Deprivation	1	0.9376	0.1105	71.9475	<.0001

Table 4.18 shows that the effect of region is statistically significant in Midwest and South (α=0.05 P-value <0.05). But it is insignificant in Northeast. And different from females, effect of family income is statistically significant for males.

Table 4.19: Male-Specific Model: Transformed Marginal Effects of Demographic, Geographic, and Socioeconomic Variables

Parameter	Estimate	NewArg	e^{New}	NewPro	1/NewPro	Dif(year)
Northeast	-0.4642	-3.8495	0.02129	0.021	47.970	17.97
Midwest	1.2349	-2.1049	0.121858	0.109	9.206	-20.79

South	0.87	-2.4812	0.083643	0.077	12.956	-17.04
Black	0.2725	-3.097	0.045185	0.043	23.131	-6.87
Race:others	-0.2064	-3.5758	0.027993	0.027	36.723	6.72
Widowed	0.2969	-3.0725	0.046305	0.044	22.596	-7.40
Divorced/sep	0.3963	-2.974	0.0511	0.049	20.560	-9.44
Single	0.4694	-2.901	0.0549	0.052	19.200	-10.80
Education	-0.0331	-3.403	0.0333	0.032	31.042	1.04
Income	-0.00375	-3.373	0.0343	0.033	30.176	0.18
After year* income	0.00031	-3.369	0.0344	0.033	30.058	0.06
RD	0.9343	-3.266	0.0382	0.037	27.206	-2.79

Table 4.19 shows that regional factors are economically significant on a male's life expectancy. Ceteris paribus, the life expectancy of a male in Northeast is 17.97 years longer than that in West. In contrast, the life expectancy of a female in Northeast is 17.16 years shorter than that in West. Ceteris paribus, the life expectancy of a male in Midwest is 20.79 years shorter than that in West. In contrast, the life expectancy of a female in Midwest is 56.68 longer than that in West. Ceteris paribus, the life expectancy of a male in South is 17.04 years shorter than that in West. In contrast, the life expectancy of a female in South is 23.45 years longer than that in West. Therefore, we can conclude that the life expectancy for an individual in a specific region is seriously different based on the gender.

Compared with a married person, a widowed, divorced/separated, and single person has much lower life expectancy. From the table, we can also find that the marital status affects a man's life span much more than that for a female. For example, ceteris paribus, at age 50, a single man's life span is 10.8 years shorter than a married. For a female, a single person has only a 4.75 years shorter expected life than a married one's.

The effect of family income and relative deprivation are both statistical and economical significant for a male. The relative deprivation does not affect a man's life expectancy as much as a female's.

Table 4.20: Male-Specific Model: Coefficient Results of Healthcare Factors

Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
hspending	1	0.1093	0.1202	0.8273	0.3630
HSP_AGE	1	-0.00071	0.00120	0.3455	0.5567
hospital	1	-1.8791	0.5352	12.3256	0.0004***
HOS_AGE	1	0.00528	0.00307	2.9535	0.0857**
physician	1	-0.00104	0.00345	0.0908	0.7632
PHY_AGE	1	0.000056	0.000030	3.4159	0.0646**

In Table 4.20, only the *number of hospitals* is statistically significant in this male-specific model (α=0.05 P-value <0.05).

Table 4.21: Male-Specific Model: Transformed Marginal Effects of Healthcare Factors

Odds Ratio	Estimate	NewArg	e^{New}	NewPro	1/NewPro	Dif(year)
50_hspending	0.0738	-3.30	0.04	0.04	28.00	-2.00
50_hospital	-1.6151	-4.98	0.01	0.01	147.16	117.16
50_physician	0.00176	-3.37	0.03	0.03	30.02	0.02
60_hspending	0.0667	-3.30	0.04	0.04	28.19	-1.81
60_hospital	-1.5623	-4.93	0.01	0.01	139.64	109.64
60_physician	0.00232	-3.37	0.03	0.03	30.00	0.00

In Table 4.21, although health spending does not statistically significant, it makes an economically significant effect on a male's life expectancy. For a male at age 50, an additional 1,000 dollars increment of health spending will cause his life expectancy to decrease 2 years. Yet, the negative effect will decrease, as a male gets older.

However, the same as the effect of number of hospitals on female, the effect on male is extremely weird. In Table 4.20, ceteris paribus, with an additional regional hospital per 100,000 residents, for a male at age 50, his life expectancy will increase about 117.16 years. Therefore, as I inferred before, there should be some unanticipated factors related regional number of hospitals significantly affect a person's life expectancy.

When a male gets older, the beneficial effect of physician amount decreases. Ceteris paribus, at age 60, with an additional physician per 100,000 residents, a male's life expectancy does not change.

CHAPTER FIVE

THE CONCLUSION

First of all, according to the analysis of these three models in this paper, we find that regional factors have important effects on an individual's life expectancy. Many of these have been ignored by most previous researches. Many former researches related to mortality rate or life expectancy, no matter what issues is focused on, use the nation-wide dataset and do not take regional factors into consideration. However, from this study, obviously, a female from different region will have different life expectancy, and the discrepancies of different regions are huge. Also, the aggregative data set, which does not consider the different life expectancy for female and male from a same region, will misinterpret the effect of regions on an individual's risk of mortality. Multiple factors, such as regional criminal rate, industrial construction, residents' life behaviors, etc, may cause an individual's life expectancy in this region to be longer or shorter. Therefore, further study can narrow the samples to one specific region or different states. The results might be more valid and convincing.

Second, considering the effect of an individual's marital status, ceteris paribus, in this paper, we find that a single person has the lowest life expectancy. This is different from the sequence made by Goldman & Hu. What is same to the point of Goldman & Hu is that a men's risk of death is much higher than a female after divorce. Generally speaking, a female is not affected by her marital status as much as a male is. In a word, for both female and male, a married person has the longest life expectancy, which is same as all the former study.

Third, in terms of income and relative deprivation, it is clear that a one thousand dollars increment of absolute family income has less effect on an individual's survival than one standard deviation change of RD does. These results strongly support Christine & William's conclusion that RD is a driven factor for an individual's survival instead of absolute income. Especially for a female, RD means much more than income does.

Finally, for these variables related to medical resources, we find "puzzling correlation" between health spending, supply of hospital, supply of physician and mortality rate. Some variables are not statistically significant, but economically important to affect an individual's life expectancy. Especially for the number of hospitals, the coefficient results are obviously strange. One phenomenon is obvious that when people get older, these health spending will have more beneficial (for men) or at least less negative effects (for women) on the life span. Although sometimes physician amount or related terms are statistically significant, but when people get older, the effect of physician amount is very tiny. Meanwhile, there might be some significant variables related to hospital or regional factors not included in the models, which need further study.

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APPENDICES

<u>Appendix A</u>

<u>Figures of the U.S. Health Spending and Number of Hospitals</u>

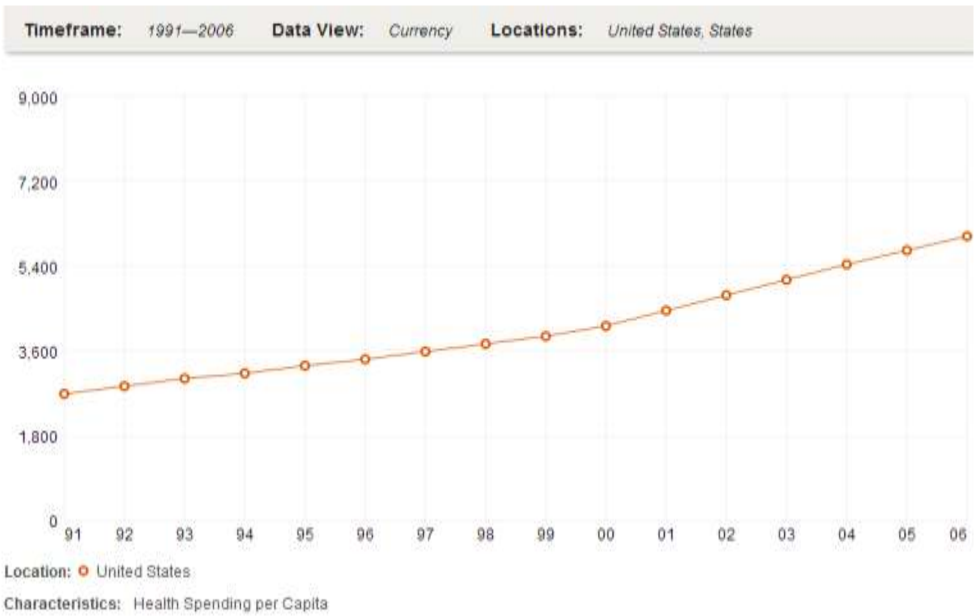

Figure A-1: The Trend of Health Spending per Capita in the US.

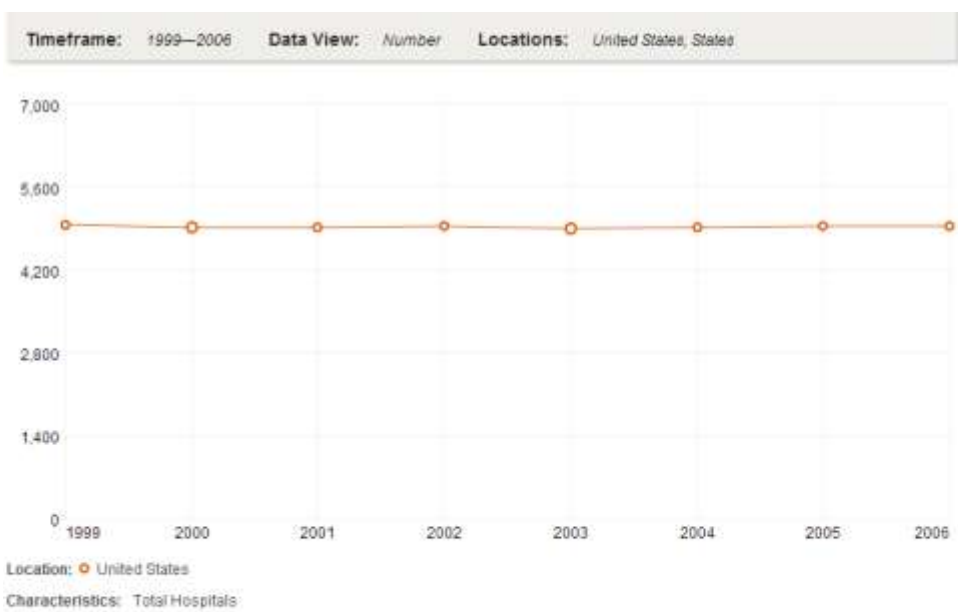

Figure A-2: The Trend of Total Hospital number in the US.

Appendix B

Table B1: Descriptive Statistics (original data)

Variable	N	Mean	Std Dev	Minimum	Maximum
SURVEY YEAR	607453	1996.92	4.085271	1991	2004
DEAD YEAR	607453	9659.96	1611.38	1991	9999
REGION	607453	2.6298578	1.0372545	1	4
AGE	607453	40.1537535	11.5664963	21	64
AGE GROUP	607453	4.4377046	2.3154316	1	9
GENDER	607453	0.4763019	0.4994385	0	1
RACE	607453	0.27881	0.5967632	0	2
INCOME (thousand)	607453	64.4989073	36.3147984	3.095765	131.1678505
EDUCATION （year)	607453	13.1517089	2.6366561	0	17
MARITIAL STATUS	607453	0.836552	1.230846	0	3
RELATIVE DEPRIVATION	607453	0.3084499	0.2760863	0	0.9607802

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Table B2: Survey Year*Year of Death

YEAR (Survey year)	MORTDODY(Year of death)																Total
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	
1991	70	190	202	218	242	226	245	257	271	290	321	357	356	377	389	390	4401
	0.27	0.74	0.78	0.85	0.94	0.88	0.95	1	1.05	1.13	1.25	1.39	1.38	1.46	1.51	1.51	17.09
	100	70.37	44.3	31.87	27.78	21.75	20.92	17.96	17.63	15.14	14.64	14.56	13.65	13.36	12.61	12.39	
1992	0	80	196	227	193	233	240	239	243	303	322	371	354	353	380	380	4114
	0	0.31	0.76	0.88	0.75	0.9	0.93	0.93	0.94	1.18	1.25	1.44	1.37	1.37	1.48	1.48	15.98
	0	29.63	42.98	33.19	22.16	22.43	20.5	16.7	15.81	15.82	14.68	15.13	13.57	12.51	12.32	12.07	
1993	0	0	58	168	192	177	210	223	230	250	254	287	282	322	314	305	3272
	0	0	0.23	0.65	0.75	0.69	0.82	0.87	0.89	0.97	0.99	1.11	1.1	1.25	1.22	1.18	12.71
	0	0	12.72	24.56	22.04	17.04	17.93	15.58	14.96	13.05	11.58	11.7	10.81	11.41	10.18	9.69	
1994	0	0	0	71	159	203	180	201	229	259	248	289	330	319	333	341	3162
	0	0	0	0.28	0.62	0.79	0.7	0.78	0.89	1.01	0.96	1.12	1.28	1.24	1.29	1.32	12.28
	0	0	0	10.38	18.25	19.54	15.37	14.05	14.9	13.52	11.31	11.79	12.65	11.31	10.79	10.83	
1995	0	0	0	0	85	159	159	174	150	222	233	220	196	246	277	284	2405
	0	0	0	0	0.33	0.62	0.62	0.68	0.58	0.86	0.9	0.85	0.76	0.96	1.08	1.1	9.34
	0	0	0	0	9.76	15.3	13.58	12.16	9.76	11.59	10.62	8.97	7.52	8.72	8.98	9.02	
1996	0	0	0	0	0	41	79	125	103	109	153	115	145	131	154	181	1336
	0	0	0	0	0	0.16	0.31	0.49	0.4	0.42	0.59	0.45	0.56	0.51	0.6	0.7	5.19
	0	0	0	0	0	3.95	6.75	8.74	6.7	5.69	6.98	4.69	5.56	4.64	4.99	5.75	
1997	0	0	0	0	0	0	58	147	142	155	160	191	180	191	206	228	1658
	0	0	0	0	0	0	0.23	0.57	0.55	0.6	0.62	0.74	0.7	0.74	0.8	0.89	6.44
	0	0	0	0	0	0	4.95	10.27	9.24	8.09	7.3	7.79	6.9	6.77	6.68	7.24	
1998	0	0	0	0	0	0	0	65	115	145	144	174	163	183	176	177	1342
	0	0	0	0	0	0	0	0.25	0.45	0.56	0.56	0.68	0.63	0.71	0.68	0.69	5.21
	0	0	0	0	0	0	0	4.54	7.48	7.57	6.57	7.1	6.25	6.49	5.71	5.62	

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1999	0	0	0	0	0	0	0	0	54	133	150	137	165	153	174	165	1131
	0	0	0	0	0	0	0	0	0.21	0.52	0.58	0.53	0.64	0.59	0.68	0.64	4.39
	0	0	0	0	0	0	0	0	3.51	6.95	6.84	5.59	6.33	5.42	5.64	5.24	
2000	0	0	0	0	0	0	0	0	0	49	153	135	160	143	168	166	974
	0	0	0	0	0	0	0	0	0	0.19	0.59	0.52	0.62	0.56	0.65	0.64	3.78
	0	0	0	0	0	0	0	0	0	2.56	6.98	5.51	6.13	5.07	5.45	5.27	
2001	0	0	0	0	0	0	0	0	0	0	55	127	130	114	147	169	742
	0	0	0	0	0	0	0	0	0	0	0.21	0.49	0.5	0.44	0.57	0.66	2.88
	0	0	0	0	0	0	0	0	0	0	2.51	5.18	4.98	4.04	4.76	5.37	
2002	0	0	0	0	0	0	0	0	0	0	0	49	97	119	146	138	549
	0	0	0	0	0	0	0	0	0	0	0	0.19	0.38	0.46	0.57	0.54	2.13
	0	0	0	0	0	0	0	0	0	0	0	2	3.72	4.22	4.73	4.38	
2003	0	0	0	0	0	0	0	0	0	0	0	0	50	123	112	125	410
	0	0	0	0	0	0	0	0	0	0	0	0	0.19	0.48	0.43	0.49	1.59
	0	0	0	0	0	0	0	0	0	0	0	0	1.92	4.36	3.63	3.97	
2004	0	0	0	0	0	0	0	0	0	0	0	0	0	47	109	99	255
	0	0	0	0	0	0	0	0	0	0	0	0	0	0.18	0.42	0.38	0.99
	0	0	0	0	0	0	0	0	0	0	0	0	0	1.67	3.53	3.14	
Total	70	270	456	684	871	1039	1171	1431	1537	1915	2193	2452	2608	2821	3085	3148	25751
	0.27	1.05	1.77	2.66	3.38	4.03	4.55	5.56	5.97	7.44	8.52	9.52	10.13	10.95	11.98	12.22	100

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Table B3: Descriptive Statistics (expanded data)

Variable	N	Mean	Std Dev	Minimum	Maximum
YEAR	6005056	1995.29	3.5788204	1991	2004
REGION	6005056	2.610752	1.0440504	1	4
AGE2 (follow-up year)	6005056	45.0545817	12.0118375	21	79
GENDER	6005056	0.4733911	0.4992915	0	1
RACE	6005056	0.2740547	0.5935402	0	2
DEAD YEAR	6005056	9737.7	1421.68	1991	9999
AGE GROUP	6005056	4.3585372	2.2977805	1	9
INCOME	6005056	63.8239114	35.6664598	3.095765	131.1678505
EDUCATION	6005056	13.1460664	2.6145897	0	17
MARITIAL STATUS	6005056	0.801203	1.21749	0	3
DIED (1) OR NOT (0)	6005056	0.0042882	0.0653439	0	1
HEALTH SPENDING (thousand)	6005056	4.5224387	1.0840999	2.541	7.237
HOSPTIAL AMOUNT/100,000	6005056	1.7781202	0.3639692	1.234471	2.498
PHYSICAN AMOUNT/100,000	6005056	268.6527078	53.1610068	177.4198	387.2014