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ABSTRACT

Recent studies indicate that the economic value of a single year of life is about $70,000, and increases in life expectancy in the U.S. since 1950 are worth $12,000 or more per person per year. Hence, understanding the determinants of life expectancy have looked at relatively small cohorts of people over time, or have looked at mortality or life expectancy have looked at mortality or life expectancy at the national or state level. Recently, the authors completed a study of the determinants of life expectancies for males and females in Mountain States counties for 1990. The current study updates the earlier work by identifying the determinants of female and male life expectancies by county for 2000 and by examining changes in the impacts of various determinants between 1990 and 2000. By looking at county-level life expectancies, we can take into account the large variability in life expectancies within states that is largely obscured by looking only at differences in life expectancy between states. In this study, we develop and test a model of the impact of demographic, economic, educational, social, and geographic factors on mean life expectancy by county for males and females born in 2000. We find that the percentage of population on rural farms, the percentage of married households, the level of education, the percentage speaking a language other than English in the home, the percentage foreign-born, and county elevation have significant positive effects on life expectancy for both males and females; while the percentage of population below the poverty level, violent crime rate, population density, unemployment rate, and latitude have significant negative effects. Income has a nonlinear effect on life expectancy, whereas household size has a positive impact on average male life expectancy, but a negative impact on average female life expectancy.
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I. INTRODUCTION

Recent studies indicate that the economic value of a single year of life is about $70,000, and that increases in life expectancy in the U.S. since 1950 are worth $12,000 or more per person per year. Hence, understanding the determinants of life expectancy has important policy implications. Previous studies of mortality or life expectancy have looked at relatively small cohorts of people over time, or have looked at mortality or life expectancy at the national or state level. Recently, the authors completed a study of the determinants of life expectancies for males and females in Mountain States counties for 1990. The current study updates the earlier work by identifying the determinants of life expectancies for males and females in Mountain States counties for 2000. In addition, we look at changes in those life expectancies between 1990 and 2000. By using county-level life expectancy data, we can take into account the large variability in life expectancies within states that is largely obscured by looking only at differences in life expectancy between states. In this study, we develop and test a model of the impact of demographic, economic, educational, social, and geographic factors on mean life expectancy by county for males and females born in 2000. We find that the insolation rate, the percentage foreign-born, and degrees of north latitude have significant positive effects on life expectancy for both males and females; while the percentage of population below the poverty level and annual precipitation have significant negative effects. Living in Nevada has a significant negative effect on life expectancy for both males and females, and living in Colorado or New Mexico has a significant positive effect on male life expectancy. Finally, educational attainment has a significant positive effect on female life expectancy, and the percentage of females married has a significant negative effect.

II. DATA

The dependent variables in the current study are life expectancy by Mountain States county for males/females born in 1999. The life expectancy data are taken from life tables created by the Harvard Center for Population and Development Studies. These life tables are derived from mortality data found in the National Center for Health Statistics detailed cause of death file. County life expectancy data are obtained for both males (LIFEXPM) and females (LIFEXPF) born in 1999 (county-level 2000 data was not available). To preserve 95 percent confidence levels the HCPDS created geographic units with at least 10,000 males and 10,000 females, merging contiguous counties into county clusters. After county mergers, life expectancy was determined for both males and females in 2,077 counties and county clusters, encompassing the entire population of the United States. In our study, we examine the determinants of life expectancy for males and females in the 135 counties and county clusters in the Mountain States.

In our data, county life expectancies for males born in 1999 range from 69.6 years in Big Horn, Rosebud, and Treasure counties, Montana to 80.3 years in Clear Creek, Eagle, Gilpin, Grand,
Jackson, Park, and Summit counties, Colorado, with an average county life expectancy of 74.8 years. County life expectancies for females born in 1999 range from 76.5 years in Big Horn, Rosebud, and Treasure counties, Montana, to 83.9 years in La Paz and Yuma counties, Arizona, with an average county life expectancy of 80.3 years. For men born in 1990, average county life expectancy was 72.8 years, and for females born in 1990, average county life expectancy was 79.4 years. Table 1 shows the top five highest and lowest counties by life expectancy for men and women in the Mountain States in 1990 and 1999. The purpose of this study is to identify the factors that lead to these variations in life expectancy.

Table 1. Life expectancy by county, Mountain States, 1990 and 1999

**FEMALE LIFE EXPECTANCY**

1999 Maximum
1. La Paz, Yuma, AZ 83.9
2. Archuleta, Gunnison, Hinsdale, Mineral, Ouray, San Miguel, CO 83.4
3. Blaine, Boise, Camas, Custer, ID 83.2
4. Washington, UT 83.1
5. Santa Cruz, AZ 82.9

1999 Minimum
1. Big Horn, Rosebud, Treasure, MT 76.5
2. Fremont, WY 76.8
3. Benewah, Shoshone, ID 77.4
4. Churchill, Esmerelda, Lyon, Mineral, NV 77.5
5. Dolores, Montezuma, San Juan, CO 77.6

1990 Maximum
1. Cache, Rich, UT 81.8
2. Clear Creek, Eagle, Gilpin, Grand, Jackson, Park, Summit, CO 81.8
3. Gallatin, MT 81.6
4. Boulder, CO 81.5
5. Washington, UT 81.5

1990 Minimum
1. Big Horn, Rosebud, Treasure, MT 75.5
2. Benewah, Shoshone, ID 76.8
3. McKinley, NM 76.8
4. Navajo, AZ 77.2
5. Daniels, Garfield, McCone, Petroleum, Roosevelt, Sheridan, MT 77.2
MALE LIFE EXPECTANCY

1999 Maximum
1. Clear Creek, Eagle, Gilpin, Grand, Jackson, Park, Summit, CO 80.3
2. Morgan, Summit, UT 79.4
3. Douglas, Elbert, CO 79.1
4. Cache, Rich, UT 78.6
5. Blaine, Boise, Camas, Custer, ID 78.6

1999 Minimum
1. Big Horn, Rosebud, Treasure, MT 69.6
2. Apache, AZ 70.2
3. Rio Arriba, NM 70.2
4. McKinley, NM 70.5
5. Glacier, Pondera, Teton, MT 71.0

1990 Maximum
1. Cache, Rich, UT 77.4
2. Douglas, Elbert, CO 77.1
3. Davis, UT 76.5
4. Gallatin, MT 76.3
5. Boulder, CO 76.0

1990 Minimum
1. Big Horn, Rosebud, Treasure, MT 67.6
2. Apache, AZ 68.2
3. Rio Arriba, NM 68.4
4. Navajo, AZ 69.0
5. Mohave, AZ 69.1

Appendix 1 contains maps showing county-level life expectancies for males and females in Mountain States counties for 1990 and 1999, along with changes in life expectancies between 1990 and 1999.

Independent variables in the model include the percent of the county population living in an urban area (URBAN), percent of the county population living on a rural farm (RURFARM), percentage of the county population living on Indian reservations (RES), mean household size (HHSIZE), percent of county households in which a married couple resides (MARRIED), per capita income in thousands of dollars (INCOME), per capita income in thousands of dollars squared (INCOME2), percent of the county population below the poverty level (POVERTY), violent crimes per 1000 people (VIOLCRIM), persons per square mile (POPDENS), percent of persons 25 years or older who have completed at least 12 years of education (EDUCATN), civilian labor force unemployment rate (UNEMP), percent of persons 5 years and older speaking a language other than English at home (LANGUAGE), percent of the county population born in a foreign country (FORNBRN), latitude of the county seat (LATITUDE), the log of the elevation of the county seat...
(LNELEVAT), insolation rate (INSOLATION), the average amount of sunlight striking the earth in a location, annual precipitation (PRECIP), mean annual temperature (TEMP), 23 ancestry variables, 8 race variables, 3 Hispanic origin variables, and 7 state dummy variables. The data on ancestry, race, and origin represent self-classification by people according to the group with which they most closely identify. Both ancestry and origin refer to a person's ethnic origin, lineage, or place of birth of the person or the person's parents before their arrival in the United States.

Other than the dummy variables, all of the data are expressed in per capita terms with the exception of VIOLCRIM (violent crimes/1000 persons), POPDENS (population per square mile), HHSIZE (population per household), MARRIED, LATITUDE, and LNELEVAT, INSOLATION, PRECIP, and TEMP. In order to combine the data into county clusters when necessary, weighted averages using population weights were calculated for geographic and environmental variables. Because of the relatively large variation in elevation among counties, the elevation data has been logged.

Data for population, urban population, rural farm population, households, land area, poverty, educational attainment, language, foreign born, ancestry, race and origin are taken from the U.S. Bureau of the Census. Income data are taken from the U.S. Bureau of Economic Analysis. Unemployment data are taken from the U.S. Bureau of Labor Statistics. Crime data are taken from the U.S. Federal Bureau of Investigation. Latitude and elevation data are taken from the U.S. Geological Survey. Independent variable data is for the year 2000.

**Expected effects of included variables.** We had no reason to expect that the effect of independent variables in the model on life expectancies would be different for 2000 than it was for 1990. Hence, the discussion that follows mirrors that in our 2002 paper. Three independent variables in the current study—insolation, annual precipitation, and average annual temperature—were not used in the earlier study. We expected that the degree of urbanization would have both positive and negative consequences for life expectancies. Easier access to health care and other amenities would be expected to increase average life expectancy, whereas higher levels of pollution and stress associated with urban environments would be expected to decrease average life expectancy. We thought that the negative impacts of urbanization would outweigh the positive impacts; hence, we expected the URBAN coefficient to be negative.

We believed that the percentage of the county population living on rural farms would positively affect average life expectancy because of the health effects associated with a more physically active and less stressful life style. In addition, we believed that rural farm families would, on average, have better nutritional habits and/or opportunities than would urban-dwellers. Also, rural farmer are more likely to earn nonmarket income than are urban workers. Because of these reasons, we anticipated that the RURFARM coefficient would be positive.

Studies show that life expectancy on western Indian reservations is generally lower than in the general population, particularly for males. Hence, we expect the percentage of the county population living on Indian reservations to negatively affect county life expectancy. The coefficient of RES, therefore, is expected to be negative.

We thought that larger household size potentially could increase or decrease life expectancy. On the one hand, larger households may put more physical and emotional stress on parents, particularly mothers. Childbearing itself has health and risk effects for women. On the other hand, for children, the number of siblings has implications for physical, psychological, and emotional development. Also, for rural farm families, household size has work (and associated stress and health) implications that may affect life expectancy. Finally, household size may affect the quality
of life of elderly parents who need assistance and support after retirement. Our assumption is that the more children available to help elderly parents, the better the quality of the help, and the higher the parents’ life expectancy, ceteris paribus. With potential positive and negative effects of average household size on life expectancy, we had no prior expectation as to the sign of the HHSIZE coefficient.

Past research as to the effect of marriage on life expectancy has found that marriage increases life expectancy, particularly for men. For children, there is evidence that living in a two-parent household has beneficial effects. On this basis, we thought that the MARRIED coefficient would be positive.

People with higher incomes are better able to purchase good quality food, shelter, health care, and other amenities. Also, people with higher incomes are more likely to be working in safer and healthier environments. We anticipated that income would be positively associated with longevity, but believed that the effect might be nonlinear. Hence, we included both income per capita and squared income per capita in the model. We expected at least one of the income variables to have a positive coefficient.

Because poverty reduces people’s access to adequate nutrition, health care, shelter, and protection from environmental problems, we expected the POVERTY coefficient to be negative.

Higher incidence of violent crime would probably reduce life expectancy not only because of the direct threat to mortality, but also because of the indirect effects associated with increased stress and larger claims on income to hedge against crime as incidence of crime increases. Hence, we include violent crime in the model, even though it is a direct cause of mortality. We expected the VIOLCRIM coefficient to be negative.

We believed that stress, pollution, and incidence of communicable disease would all increase as population density increased, hence, we expected the POPDENS coefficient to be negative.

We thought that the higher the percentage of a county population with at least 12 years of education, the higher would be life expectancy, other things equal. We believed that people with more education are less likely to contract certain diseases, are more likely to obtain appropriate health care, are more likely to have a nutritious diet, and are more likely to work in less-polluted environments. Because of these reasons, and based on the results of previous studies, we expected the EDUCATN coefficient to be positive.

Unemployment makes it more difficult for people to access health care, good diet and other quality of life factors. Also, unemployment creates additional stress for the unemployed and their families. Even though low average income leads to similar effects on longevity, the distribution of income is also crucial. Hence, unemployment, (like the percentage of the population below the poverty line) is expected to have an independent detrimental effect on life expectancy. We expected the UNEMP coefficient to be negative.

The next two variables, the percentage of county population over age 5 speaking a language other than English at home (LANGUAGE) and the percent foreign-born (FORNBRN) are problematic. One might expect that speaking a language other than English or being foreign-born could lead to discrimination in employment and greater difficulty obtaining education. On the other hand, because of immigration laws, many immigrants must have skills that are in short supply in the United States in order to be allowed in immigrate. For these people, education and income might be expected to be higher than average. However, in either case, these effects are handled separately with the employment, income and education variables. Other longevity effects of being foreign-born are not clear. Because immigrants are self-selected, individuals who are ambitious and persistent
enough to immigrate may have other characteristics that lead to either higher or lower life expectancy. Likewise, speaking a language other than English at home could indicate a failure to assimilate that might also affect life expectancy. This possibility is buttressed by the fact that in the Mountain States, the mean percentage of county populations foreign-born (which includes some native English speakers) is less than 5 percent, while the mean percentage of county populations speaking a language other than English at home is over 15 percent. We had no prior expectation as to the sign of the LANGUAGE and FORNBRN coefficients.

The next five variables are intended to capture effects of geography and environment on life expectancy. We believed that the latitude variable would help capture climatic and environmental effects that might affect longevity. For example, northern latitudes experience larger temperature extremes than do southern latitudes. The variety and cost of fresh foods also varies from north to south in the Mountain States. We believed that more moderate temperatures and a longer growing season in southern latitudes would positively affect health and longevity, hence we expect the LATITUDE coefficient to be negative. Similarly, we believed that elevation would likely affect longevity, primarily because of environmental factors. Higher elevation is generally associated with better quality air and water, which should increase life expectancy. Also, the lower humidity found at higher elevation is often believed to reduce health problems associated with respiratory difficulties. However, higher elevation is also associated with a higher concentration of damaging UV rays. Because we believed the net effect of elevation would enhance longevity, we expected the LNELEVAT coefficient to be positive. We had no prior expectation on the sign of the INSOLATION coefficient, since it is not clear whether exposure to sunlight has a net positive or a net negative effect on health. Likewise, we had no prior expectation on the impact of annual precipitation (PRECIP) or average annual temperature (TEMP) on life expectancy.

The 23 ancestry variables included in the model show the percent of the county population reporting each of the following as primary ancestry: Czech (CZECH), Danish (DANISH), Dutch (DUTCH), English (ENGLISH), French (except Basque) (FRENCH), French Canadian (FRCANAD), German (GERMAN), Greek (GREEK), Hungarian (HUNGARY), Irish (IRISH), Italian (ITALIAN), Norwegian (NORWEG), Polish (POLISH), Portuguese (PORTUGS), Russian (RUSSIAN), Scotch-Irish (SCTIRSH), Scottish (SCOTTISH), Slovak (SLOVAK), Swedish (SWEDISH), Swiss (SWISS), United States or American (USA), Welsh (WELSH), and West Indian (excluding Hispanic origin groups) (WESTINDN). The control group is “other or not reported.” These ancestry variables are included for two main reasons. First, ancestry may carry with it cultural and social attitudes and habits that affect longevity. Second, ancestry may carry with it genetic qualities that affect life expectancy, such as disease resistance. We had no prior expectation as to the sign of the various ancestry coefficients, except for those representing Northern European ancestry, which we expected to be positive. This expectation is based on the longer average life expectancies currently enjoyed by populations in Northern Europe and the British Isles relative to most other countries. To the extent that these life expectancies are determined by genetics and/or cultural and social attitudes; and in the second case, to the extent that these attitudes are shared by Northern European immigrants to the U.S. and their descendants, we would expect the coefficients of DANISH, DUTCH, ENGLISH, GERMAN, IRISH, NORWEG, SCTIRSH, SCOTTISH, SWEDISH, SWISS, AND WELSH to be positive.

The eight race variables included in the model show the percent of the county population reporting each of the following as primary race: Black (BLACK), American Indian, Eskimo, or Aleut (AMINESAL), Chinese (CHINESE), Filipino (FILIPINO), Japanese (JAPANESE), Asian
Indian (ASININDN), Korean (KOREAN), and Vietnamese (VIETNMSE). White is the control group. As with the ancestry variables, race and origin may affect longevity independently because of genetic factors or because of cultural and social attitudes and habits. Based on previous studies of life expectancy of black Americans and life expectancy on American Indian reservations, we expected the coefficients of BLACK and AMINESAL to be negative, and have no expectation for the signs of the other coefficients. The three Hispanic origin variables include the percent of the county population reporting each of the following as primary origin: Mexican (MEXICÁN), Puerto Rican (PRTORCAN), and Cuban (CUBAN). We had no prior expectation as to the sign of the Hispanic origin coefficients.

Dummy variables are included for 7 of the states in order to capture the effects of differences in state laws controlling health care, environmental protection, law enforcement, public assistance, prostitution, gambling, and other factors that might affect life expectancy; as well as differences among states in funding of education, health care, public safety, etc. These dummy variables may also capture life style and cultural differences among states and regions. Arizona is the control variable. We had no prior expectation as to the sign of the state dummy coefficients.

III. ECONOMETRIC RESULTS

An econometric model was formulated and tested for both male life expectancy by county and female life expectancy by county, incorporating all of the independent variables listed above. The model is linear in the variables, except for the natural log of elevation. The model for male life expectancy had an $R^2$ of .847, and the model for female life expectancy had an $R^2$ of .842. Table 2 shows the summary results from the analysis of determinants of life expectancies for males and females born in Mountain States counties in 2000.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Male Life Expectancy</th>
<th>Female Life Expectancy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sign of coefficient</td>
<td>Sign of coefficient</td>
</tr>
<tr>
<td>EDUC</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>VIOLCRIM</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>POPDENS</td>
<td>-</td>
<td>not significant (n.s.)</td>
</tr>
<tr>
<td>MARRIED</td>
<td>+</td>
<td>n.s.</td>
</tr>
<tr>
<td>HHSIZE</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>URBAN</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>RURFARM</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>RES</td>
<td>-</td>
<td>n.s.</td>
</tr>
<tr>
<td>FORNBRN</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Northern European ancestry</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>BLACK</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>AMINESAL</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>POVERTY</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>PRECIP</td>
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<td>-</td>
</tr>
<tr>
<td>INSOLATION</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>LATITUDE</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>ELEVATION</td>
<td>n.s.</td>
<td>-</td>
</tr>
</tbody>
</table>
IV. CONCLUSIONS

Although life expectancy varies greatly across Mountain States counties, as seen in table 1, the model used in this study can explain more than 84% of the county-level variability in life expectancy for both males and females. We conclude that educational attainment, percent of the county population classified as urban, percent classified as rural farm, percent foreign-born, percent reporting Northern European ancestry, insolation and north latitude of the county are all positively associated with life expectancy for both men and women. Violent crime rate, percent black, percent American Indian, Eskimo, or Aleut, percent living in poverty, and annual precipitation are negatively associated with both male and female life expectancy. The percentage of married households has a significant positive effect for male life expectancy, but is insignificant for female life expectancy. Household size is positively related to male life expectancy, but negatively related to female life expectancy. Population density and percent of population living on reservations have a negative impact on male life expectancy, but are not statistically significant determinants of female life expectancy. Likewise, elevation of the county has a negative impact on female life expectancy, but is not a significant determinant of male life expectancy. Other things equal, living in Nevada has a negative effect on life expectancies for both men and women, and living in Colorado or New Mexico has a positive effect on life expectancy for men, ceteris paribus.

Given the significant changes in life expectancies in individual Mountain States counties between 1990 and 1999, as seen in table 1 and appendix 1, it is interesting to note that the significant determinants of life expectancies in the current study are generally the same as those identified in the 2002 study. This suggests that our model is quite robust over time. It would be an interesting extension of the current study to test the robustness of the model directly, and to look at the determinants of the changes in life expectancy by county for the 1990-2000 period.

Endnotes

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O'Hare WP. Black Demographic Trends in the 1980s. The Milbank Quarterly, 1987; (65) suppl.1: 35-55.


APPENDIX 1

Life Expectancy for Females (1990)

Life Expectancy for Females (1999)
Change in Life Expectancy for Females (1990–1999)

Life Expectancy for Males (1990)
Life Expectancy for Males (1999)

Change in Life Expectancy for Males (1990–1999)
Abstract

Determinants of Life Expectancies in Mountain States Counties, 1990 and 2000

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Recent studies indicate that the economic value of a single year of life is about $70,000, and increases in life expectancy in the U.S. since 1950 are worth $12,000 or more per person per year. Hence, understanding the determinants of life expectancy has important policy implications. Previous studies of mortality or life expectancy have looked at relatively small cohorts of people over time, or have looked at mortality or life expectancy at the national or state level. Recently, the authors completed a study of the determinants of life expectancies for males and females in Mountain States counties for 1990. The current study updates the earlier work by identifying the determinants of female and male life expectancies by county for 2000 and by examining changes in the impacts of various determinants between 1990 and 2000. By looking at county-level life expectancies, we can take into account the large variability in life expectancies within states that is largely obscured by looking only at differences in life expectancy between states. In this study, we develop and test a model of the impact of demographic, economic, educational, social, and geographic factors on mean life expectancy by county for males and females born in 2000. We find that the percentage of population on rural farms, the percentage of married households, the level of education, the percentage speaking a language other than English at home, the percentage foreign-born, and county elevation have significant positive effects on life expectancy for both males and females; while the percentage of population below the poverty level, violent crime rate, population density, unemployment rate, and latitude have significant negative effects. Income has a nonlinear effect on life expectancy, whereas household size has a positive impact on average male life expectancy, but a negative impact on average female life expectancy.