Population Review

Volume 48, Number 1, 2009
Type: Article pp. 41-65

Socio-Economic Status and Life Expectancy in the United States, 1970-1990

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Abstract

The relationship between socio-economic status (SES) and life expectancy for 1970 and 1990 is examined in eight states randomly selected from each of eight of the nine census divisions in the United States. High SES populations in seven of the eight states gained additional life expectancy over low SES populations between 1970 and 1990. In the remaining state, the gap between high and low SES populations found in 1970 narrowed by 1990, but did not disappear. The findings have implications for the study of social inequality and its relationship to health outcomes. They also suggest that the United States is unlikely to meet one of two key national health policy goals, the elimination of health disparities by 2010.

Keywords

Health outcomes, policy goals, health disparities

Background

Using regression analysis, Swanson and Stockwell (1986) examined life expectancy in 1930 and 1980 in Ohio and found that while differences narrowed between 1930 and 1980, significant geographic variations in life expectancy persisted. They noted that these geographical areas are themselves associated with socio-economic status (SES) differentials (Darroch and Marston 1971, Duncan and Duncan 1955). Swanson (1992) extended the sub-state geographic analysis of Swanson and Stockwell (1986) to sub-state SES differentials and found that between 1970 and 1990 high SES populations in Arkansas not only experienced absolute gains in life expectancy, but also relative gains in life expectancy over low SES populations.

Along with race and gender, SES is one of the three cornerstones of social stratification in the United States (Massey 2007). It has been linked in many studies to mortality differentials (Congressional Budget Office 2008, Ezzati et al. 2008, Gortmaker and Wise 1997, James and Cossman 2006, Hummer 2005, Kitagawa and Hauser 1973, McGehee 1994, Rogers Hummer and Nam 2000, Singh and Siahpush 2006, Stockwell 1961, Stockwell 1963, Stockwell and Laidlaw 1977, Stockwell and Wicks 1984, Stockwell Swanson and Wicks 1987, Stockwell Swanson and Wicks 1988a, Stockwell Swanson and Wicks 1988b, Stockwell Goza and Balisteri 2005, and Stockwell Bedard Swanson and Wicks 1987). Because of the pervasiveness of the findings, Hummer (2005) postulated that socioeconomic differences are fundamental causes of health disparities in the United States, a point also made by Link and Phelan (1995).

Life Expectancy is arguably the single most important indicator of the general health of a population (Lamb and Siegel 2004) and it has long been documented that variations in life expectancy exist among the broad geographic divisions within the United States, as well as among individual states (Dublin et al. 1949, Glover 1921, Oosse 2003).[1] However, until the work of Stockwell and Swanson (1986), virtually nothing was known about sub-state variations. [2]

The years 1970 and 1990 are selected for this study because they represent what may be regarded as the "bookends" of a pivotal social policy period in the U. S., where federal support of social welfare programs was at a high point circa 1970 (via the New Deal under Roosevelt and the War on Poverty under Johnson, among other programs), but by 1990 (shortly after the end of the Reagan era) federal support was significantly smaller (Reese, 2005; Stockwell Goza, and Balisteri 2005).

The decline in federal support during this period coincided with growing SES inequality in the United States.[3] Weinberg (1996) finds, for example, that the distribution of income among households was far more equal in 1970 (Gini Ratio = .394) than in 1990 (Gini Ratio = .428). Massey (2007) elaborates on this theme and finds a significant and continuing increase in social inequality since the late 1960s. Moreover, there is evidence that this increase in social inequality is associated with increased infant mortality rates among those at the low end of the SES scale (Stockwell Goza and Balisteri 2005).

Materials and Methods

In order to have a reasonable level of representation of the United States as a whole, one state from each of eight of the nine census divisions was randomly selected for this study. None of the five states from the New England Census Division was selected because the number of counties in each (Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont) is insufficient for the analysis. The state with the largest number of counties, Maine, has 16, while Rhode Island, the state with the smallest number, has only five.

The random selection procedure in MS-Excel was used to select states within each of the remaining eight census divisions. As many "draws" were made as there are states in each census division so that there was an ordered set of states within each census division from which to draw. This was done because for some states, the 1970 census data available online from the U.S. Census Bureau were found to be incomplete or corrupted.[4] California and Texas were excluded because of the so-called "Hispanic Mortality Paradox,' which could confound the analysis in these two states.[5] The set of states included in the analysis is listed in Table 1 by Census Division.

Table 1. States Included in the Analysis, by Census Division

Census Division	State	Number of Counties*
East North Central	Ohio	88
East South Central	Mississippi	83
Middle Atlantic	Pennsylvania	67
Mountain	Colorado	63
Pacific	Washington	39
South Atlantic	Florida	67
West North Central	South Dakota	66
West South Central	Louisiana*	64

*In Louisiana, parishes are used as county equivalents.

For the same reasons described by Swanson (1992), a regression-based technique is used to estimate life expectancy at birth (Swanson 1989), an earlier version of which was used by Swanson and Stockwell (1986). Until the advent of this method for estimating life expectancy, there was no reliable way to examine life expectancy for small populations because life expectancy was calculated through the construction of a life table, which has rigorous data requirements that are difficult to meet for small populations (Kintner 2004). The model used here was tested by Swanson (1989) and found to be sufficiently accurate for its use here. The model is defined as:

$$e_o = \{82.276 - (4.24*CDR) + (3.02*Ln(P65+)) + (.0267*CDR^2) + (.1773*Ln(P65+)^2) + (.8707*[(CDR)*(Ln(P65+))]\}$$

where

e_o	is life expectancy at birth
CDR	is the Crude Death Rate (expressed as deaths per 1000 population)
Ln(P65+)	is the natural base logarithm of the percent of the population aged 65 & over

While this model was found to work well for small populations, it has two conditions under which it can produce unreliable estimates: (1) a substantial "special" population, such as is found in a 55+ retirement community; and (2) a small population with very few deaths, such that the crude birth rate can fluctuate substantially from year to year. In terms of the former condition, a very high difference between the percent aged 65 and over at the state level and a given county warrants further examination. In terms of the second, it is advisable to not use the model if the number of deaths is much less than 50. None of the counties in this study was found to be severely impacted by the presence of large retirement populations. However, there are counties and county-equivalents that otherwise would have been included in the analysis but were excluded because the number of deaths was below 50 in one or both of the two years. These counties are listed by state in the Appendix.

As was the case in the study of Arkansas (Swanson 1992), the analytical unit consists of a county population. As also was the case of the Arkansas study by Swanson (1992), this study is an "ecological" design, one that is appropriate because life expectancy is being examined, which is a characteristic of a population, not an individual (Swanson and Stephan 2004: 764). Moreover, no attempt is made to cross the "group-level/individual-level" boundary, so the analysis itself is not subject to the "ecological fallacy" (Freedman 2002)

Mortality data needed to estimate 1970 and 1990 life expectancy values are taken from 1970 and 1990 vital statistics reports produced by the U.S National Center for Health Statistics (1974, 1994), respectively. Population data for 1970 and 1990 are taken from reports for the 1970 and 1990 censuses (U.S. Bureau of the Census 1973, 1992), respectively. County populations are grouped into two sets for 1970 and 1990: (1) low SES, the 1st quartile in terms of median household income; and (2) high SES, the 4th quartile in terms of median household income. Median household income data are taken from a special report by the Census Bureau (no date). Because the 1970 and 1990 censuses asked for income in the preceding year, the median income data are actually for 1969 and 1989, respectively. All amounts are expressed in 1989 dollars.

To measure change in life expectancy between 1970 and 1990, a dummy variable regression model was constructed for each of the two SES populations by state:

$$e_o = a + b(YR)$$

where

- e_o is life expectancy in and 1970 and 1990 for a given SES population as found from the equation shown above
- a is the intercept (1970 mean life expectancy for the same SES population)
- b is the change in mean life expectancy between 1970 and 1990 for the SES population in question
- YR is a dummy variable for year (YR=0, in 1970; YR=1, in 1990)

The one-tailed test ($p=.05$) is applied to the slope coefficient, b, in each of the two equations to determine if there is a statistically significant change in life expectancy for the SES population in question. Because there is a positive correlation between life expectancy for each SES population in 1970 and 1990, the standard error is diminished. However, this effect is mediated by the extremely small sample sizes and the net result is that a given t-test is not highly subject to a Type I error. The null hypothesis is that there is no change (i.e., b=0); and the alternative hypothesis is that there is positive change (i.e., b >0). This "one-tailed" test structure is appropriate because there is evidence to indicate that, on average, life expectancy increased between 1970 and 1990 (Swanson 1992, U. S. Department of Health and Human Services 2000).

Results

The estimated life expectancy values for each of the two SES populations in 1970 and 1990, by county, are given for each state in Tables 2a through 9a and 2b through 9b, respectively. All significance results are done using a 1-tailed, two-sample t-test assuming unequal variances in the two samples.

To examine the changes in life expectancy, two dummy variable regression equations were constructed using the life expectancy values. One equation represents the change in life expectancy for low SES populations from 1970 to 1990 and the other represents the change for high SES populations from 1970 to 1990. As stated earlier, the slope coefficient in each of these models provides a measure of change in life expectancy (in years) for each of the populations. This allows for a comparison between the low and high SES populations within each state. These equations are found in for each state in tables 2c through 9c, respectively.

In Colorado, mean life expectancy for the low SES population is 72.60 in 1970 (Table 2a), while that for the high SES population is 73.73 (Table 2b), a difference of 1.13 years. This difference is not statistically significant ($p = .10$). In 1990, mean life expectancy for the low SES population is 76.07 (Table 2a), while that for the high SES population is 77.67 (Table 2b), a difference of 1.60 years, which is statistically significant ($p < .001$).

Table 2a. 1970 and 1990 Life Expectancy at Birth for
Low SES Populations (By Quintile) in Colorado

County	1970 Life Expectancy	County	1990 Life Expectancy
Baca	70.62	Alamosa	75.62
Bent	76.50	Baca	76.39
Conejos	75.72	Bent	74.57
Delta	73.17	Chaffee	78.43
Fremont	71.53	Conejos	78.51
Huerfano	71.53	Delta	77.40
Las Animas	73.27	Fremont	74.48
Prowers	70.55	Huerfana	77.50
Yuma	74.23	Las Animas	75.34
Alamosa	74.45	Lincoln	76.59
Montezuma	70.54	Logan	74.20
Otero	69.82	Otero	75.17
Phillips	73.48	Phillips	76.71
Rio Grande	69.18	Prowers	75.39
Washington	74.41	Pueblo	75.52
		Rio Grande	76.13
		Washington	75.32
MEAN	72.60	MEAN	76.07

Table 2b. 1970 and 1990 Life Expectancy at Birth for High SES Populations (By Quintile) in Colorado

County	1970 Life Expectancy	County	1990 Life Expectancy
Adams	72.58	Adams	75.48
Arapahoe	73.81	Arapahoe	78.00
Boulder	74.84	Boulder	77.77
Douglas	70.87	Douglas	80.11
Jefferson	72.86	El Paso	76.98
Chaffee	78.59	Garfield	76.77
Denver	71.32	Jefferson	76.78
El Paso	72.95	La Plata	77.79
Garfield	71.18	Larimer	78.22
Larimer	74.63	Moffat	78.05
Logan	72.79	Routt	78.86
Moffat	73.04	Teller	77.28
Pueblo	79.19		
Weld	73.60		
MEAN	73.73	MEAN	77.67

Table 2c. Dummy Regression and Statistical Test Results: Changes in Life Expectancy by SES Population in Colorado between 1970 and 1990

SES	a	b	Se(b)	T-score	*P*(b=0)	r^2
Low	72.60	3.47	0.64	5.44	< 0.001	.50
High	73.73	3.94	0.78	5.04	< 0.001	.51

For Colorado (Table 2c), the slope coefficient (3.94) in the dummy variable regression equation for the high SES population is statistically significant ($p<.001$). This suggests that the high SES population did experience gains in life expectancy between 1970 and 1990 – nearly four years. The slope coefficient (3.47) in the dummy variable regression equation for the low SES population also is statistically significant ($p < .001$), which suggests that this population gained approximately 3.5 years in additional life expectancy between 1970 and 1990. These results confirm what is seen from the data in tables 2a and 2b by showing that high SES populations posted both absolute and relative gains in life expectancy over low SES populations between 1970 and 1990. On average, the relative gain was about half a year.

Mean life expectancy in Florida for the low SES group is 72.05 in 1970 (Table 3a), while that for the high SES group is 72.21 (Table 3b), a difference of 0.16 years that is not statistically significant ($p = .145$). In 1990, mean life expectancy for the low SES group is 74.06 (Table 3a), while that for the high SES group is 78.30 (Table 3b), a statistically significance ($p < .001$) difference of 4.24 years.

Table 3a. 1970 and 1990 Life Expectancy at Birth for
Low SES Populations (By Quintile) in Florida

County	1970 Life Expectancy	County	1990 Life Expectancy
Columbia	68.52	Bradford	72.41
DeSoto	70.18	Charlotte	75.81
Escambia	71.01	Hardee	74.06
Gulf	73.11	Hillsborough	74.91
Hendry	74.48	Holmes	77.27
Manatee	70.19	Jackson	72.37
Marion	70.12	Lee	73.10
Martin	70.53	Monroe	72.92
Monroe	69.83	Osceola	72.71
Nassau	78.56	Polk	73.66
Sumter	80.86	Volusia	73.85
Union	69.53	Walton	75.00
Washington	69.75	Washington	74.73
MEAN	72.05	MEAN	74.06

Table 3b. 1970 and 1990 Life Expectancy at Birth for
High SES Populations (By Quintile) in Florida

County	1970 Life Expectancy	County	1990 Life Expectancy
Bay	69.17	Columbia	81.13
Bradford	70.38	DeSoto	78.13
Dade	73.42	Dixie	78.96
Duval	75.76	Escambia	81.18
Gasden	73.26	Franklin	75.82
Hardee	67.85	Gasden	81.96
Hernando	71.59	Gilchrist	73.61
Levy	72.19	Highlands	76.29
Okaloosa	71.56	Indian River	77.79
Orange	73.31	Lafayette	79.72
Osceola	75.08	Martin	77.80
Seminole	73.19	Palm Beach	74.98
St. Johns	71.92	St. Lucie	80.56
MEAN	72.21	MEAN	78.30

Table 3c. Dummy Regression and Statistical Test Results: Changes in Life
Expectancy by SES Population in Florida between 1970 and 1990

SES	a	b	Se(b)	T-score	P(b=0)	r^2
Low	72.05	2.01	1.12	1.79	= 0.09	.12
High	72.21	6.10	0.67	6.46	< 0.001	.63

The regression results for Florida are found in Table 3c. The slope coefficient (6.9) in the dummy variable regression equation for the high SES group is statistically significant (p<.001). This suggests that the high SES group did experience gains in life expectancy between 1970 and 1990. However, the slope coefficient in the dummy variable regression equation for the low SES group is not statistically significant (p = 0.085), which suggests that this group did not experience gains in life expectancy between 1970 and 1990. These results support the data in tables 3a and 3b by showing that high SES populations in fact posted relative gains in life expectancy in Florida over low SES populations between 1970 and 1990. As just stated, the high SES populations gained, on average, over six additional years in life expectancy while the low SES populations remained at the 1970 level, making no gains.

In Louisiana, mean life expectancy in 1970 for the low SES population is 71.06 (Table 4a), while that for the high SES population is 70.18 in 1970 (Table 4b). This difference is not statistically significant ($p = 0.11$). In 1990, mean life expectancy for the low SES population is 72.09 (Table 4a), while that for the high SES population is 74.19 (Table 4b), a statistically significant ($p < .001$) difference of 2.1 years.

Table 4a. 1970 and 1990 Life Expectancy at Birth for
Low SES Populations (By Quintile) in Louisiana

Parish	1970 Life Expectancy	Parish	1990 Life Expectancy
Avoyelles	72.05	Avoyelles	72.05
Claiborne	74.27	Claiborne	74.27
De Soto	71.53	De Soto	71.53
East Carroll	68.33	East Carroll	68.33
Evangeline	68.86	Evangeline	68.86
Franklin	72.26	Franklin	72.26
Madison	68.99	Madison	68.99
Natchitoches	71.17	Natchitoches	71.17
Red River	73.80	Red River	73.80
Richland	69.37	Richland	69.37
St. Helena	71.33	St. Helena	71.33
Tensas	69.68	Tensas	69.68
West Carroll	72.08	West Carroll	72.08
MEAN	71.06	MEAN	72.69

Table 4b. 1970 and 1990 Life Expectancy at Birth for
High SES Populations (By Quintile) in Louisiana

Parish	1970 Life Expectancy	Parish	1990 Life Expectancy
Bossier	71.48	Ascension	73.27
Calcasieu	70.36	Bossier	74.62
East Baton Rouge	70.85	Calcasieu	74.06
Jefferson	71.54	East Baton Rouge	74.44
La Salle	70.25	Jefferson	74.24
Plaquemines	66.99	Lafourche	74.26
St. Bernard	71.18	Livingston	74.97
St. Charles	72.63	St. Bernard	74.05
St. John the Baptist	69.87	St. Charles	75.18
St. Mary	68.80	St. John the Baptist	74.01
St. Tammany	69.79	St. Tammany	74.23
Terrebonne	68.36	West Baton Rouge	72.94
MEAN	70.18	MEAN	74.19

Table 4c. Dummy Regression and Statistical Test Results: Changes in Life Expectancy by SES Population in Louisiana between 1970 and 1990

SES	a	b	Se(b)	T-score	*P*(b=0)	r^2
Low	71.06	1.63	0.68	2.41	= 0.02	.19
High	70.18	4.01	0.48	8.29	< 0.001	.76

For Louisiana the regression results are shown in Table 4c. The slope coefficient (4.01) in the dummy variable regression equation for the high SES population is statistically significant (p<. 001). This suggests that the high SES population did experience gains in life expectancy between 1970 and 1990 – approximately four years. The slope coefficient (1.63) in the dummy variable regression equation for the low SES population in Louisiana also is statistically significant (p =. 02), which suggests that this population gained approximately 1.6 years in additional life expectancy between 1970 and 1990. The results confirm what is seen from the data in tables 4a and 4b by showing that high SES populations posted both absolute and relative gains in life expectancy over low SES populations in Louisiana between 1970 and 1990. On average, the relative gain was about 2.4 years (2.4 ≈ 4.01 – 1.63).

In 1970, there is a difference of 1.34 years in mean life expectancy for Mississippi between the two SES groups (Table 5a and Table 5b). This difference is statistically significant (p = 0.01). In 1990, there is a difference of 4.1 years in mean life expectancy between the two SES groups (Table 5a and Table 5b). This difference also is statistically significant (p < 0.001).

Table 5a. 1970 and 1990 Life Expectancy at Birth for Low SES Populations (By Quartile) in Mississippi

County	1970 Life Expectancy	County	1990 Life Expectancy
Amite	71.93	Attala	76.88
Bolivar	69.41	Bolivar	71.52
Carroll	73.21	Claiborne	73.49
Claiborne	70.84	Coahoma	74.11
Coahoma	67.98	Franklin	73.74
Franklin	70.19	Holmes	70.76
Holmes	67.72	Humphreys	69.55
Humphreys	66.20	Issaquena	75.38
Issaquena	66.85	Jefferson	74.16
Jeff Davis	70.12	Kemper	76.46
Kemper	72.01	Leflore	71.13
Leake	69.20	Noxubee	70.41
Noxubee	69.11	Pike	72.99
Quitman	67.45	Quitman	71.18
Sharkey	68.53	Sharkey	69.26
Sunflower	68.85	Sunflower	71.71
Tallahatchie	67.93	Tallahatchie	73.64
Tunica	66.71	Tunica	69.20
Wilkinson	69.57	Walthall	73.03
Yazoo	66.52	Wilkinson	69.00
MEAN	69.02	MEAN	72.38

Table 5b. 1970 and 1990 Life Expectancy at Birth for High SES Populations (By Quartile) in Mississippi

County	1970 Life Expectancy	County	1990 Life Expectancy
Adams	70.08	Desoto	76.88
Alcorn	69.77	Grenada	71.52
Clay	71.69	Hancock	73.49
Desoto	71.84	Harrison	74.11
Forrest	69.99	Hinds	73.74
George	70.25	Itawamba	70.76
Grenada	69.52	Jackson	69.55
Hancock	71.94	Jones	75.38
Harrison	70.41	Lamar	74.16
Hinds	70.58	Lauderdale	76.46
Itawamba	70.76	Lee	71.13
Jackson	69.97	Lowndes	70.41
Jones	68.84	Madison	72.99
Lauderdale	68.42	Monroe	71.18
Lee	72.02	Newton	69.26
Lowndes	70.14	Pearl River	71.71
Monroe	70.37	Pontotoc	73.64
Oktibbeha	69.55	Rankin	69.20
Pearl River	69.39	Smith	73.03
Rankin	76.98	Tate	69.00
Stone	66.97	Union	76.88
Warren	68.44	Warren	71.52
MEAN	70.36	MEAN	74.46

Table 5c. Dummy Regression and Statistical Test Results: Changes in Life Expectancy by SES Population in Mississippi between 1970 and 1990

SES	a	b	Se(b)	T-score	*P*(b=0)	r^2
Low	69.02	3.36	0.69	4.89	< 0.001	.39
High	70.36	4.10	0.46	8.95	< 0.001	.66

The dummy variable regression equations found in Table 5c for Mississippi are statistically significant ($p<.001$) and they support the data in tables 5a and 5b by showing that high SES populations in fact posted relative gains in life expectancy over low SES populations between 1970 and 1990. The high SES populations in Mississippi gained, on average, 4.10 years in life expectancy while the low SES populations gained on average 3.36, a relative difference of .74 years between 1970 and 1990.

For Ohio, mean life expectancy for the low SES population is 70.29 in 1970 (Table 6a), while that for the high SES population is 71.18 (Table 6b), a statistically significant difference ($p = .013$) of 0.89 years. In 1990, mean life expectancy for the low SES population is 74.89 (Table 6a), while that for the high SES population is 77.65 (Table 6b), a difference of 2.76 years that is statistically significant ($p < 0.001$).

Table 6a. 1970 and 1990 Life Expectancy at Birth for Low SES Populations (By Quintile) in Ohio

County	1970 Life Expectancy	County	1990 Life Expectancy
Adams	69.42	Adams	76.29
Athens	70.92	Athens	75.72
Brown	69.96	Belmont	74.74
Gallia	70.25	Gallia	76.25
Highland	68.81	Guernsey	73.13
Jackson	68.80	Harrison	74.48
Meigs	72.15	Jackson	72.71
Monroe	70.18	Lawrence	74.66
Morgan	73.05	Meigs	73.58
Noble	70.56	Monroe	77.71
Perry	70.60	Morgan	76.89
Pike	70.31	Perry	74.18
Ross	71.72	Pike	75.51
Scioto	69.61	Ross	75.04
Tuscarawas	69.61	Scioto	72.78
Vinton	69.87	Tuscarawas	75.91
Washington	69.10	Vinton	72.79
Wyandot	70.22	Washington	75.60
MEAN	70.29	MEAN	74.89

Table 6b. 1970 and 1990 Life Expectancy at Birth for High SES Populations (By Quintile) in Ohio

County	1970 Life Expectancy	County	1990 Life Expectancy
Butler	71.45	Butler	77.35
Clermont	71.34	Champaign	75.93
Cuyahoga	70.04	Clermont	77.33
Erie	69.87	Defiance	75.76
Franklin	70.69	Delaware	80.38
Geauga	69.16	Fairfield	77.14
Greene	72.14	Fulton	77.80
Lake	70.90	Geauga	80.51
Lorain	70.14	Greene	77.71
Lucas	70.21	Hancock	75.82
Medina	72.10	Lake	78.53
Montgomery	71.46	Medina	79.07
Portage	73.65	Miami	76.99
Stark	71.53	Ottawa	77.47
Summit	72.11	Putnam	77.08
Trumbull	70.66	Union	75.97
Warren	71.59	Warren	79.26
Wood	72.17	Wood	77.58
MEAN	71.18	MEAN	77.65

Table 6c. Dummy Regression and Statistical Test Results: Changes in Life Expectancy by SES Population in Ohio between 1970 and 1990

SES	a	b	Se(b)	T-score	*P*(b=0)	r^2
Low	70.29	4.60	0.44	10.48	< 0.001	.76
High	71.18	6.47	0.42	15.29	< 0.001	.87

For Ohio, the regression equations are found in Table 6c. The slope coefficient (6.50) in the dummy variable regression equation for the high SES population in Ohio is statistically significant ($p<.001$). This suggests that the high SES population in Ohio did experience gains in life expectancy between 1970 and 1990 – approximately 6.5 years. The slope coefficient (4.60) in the dummy variable regression equation for the low SES population in Ohio also is statistically significant ($p < .001$), which suggests that this population gained approximately 4.6 years in additional life expectancy between 1970 and 1990. This result confirms what is seen from the data in tables 6a and 6b by showing that high SES populations in Ohio posted both absolute and relative gains in life expectancy over the state's low SES populations between 1970 and 1990. On average, the relative gain was more than two years.

In Pennsylvania, mean life expectancy for the low SES population is 69.47 in 1970 (Table 7a), while that for the high SES population is 71.29 (Table 7b), a difference of 1.82 years that is statistically significant ($p <.001$). In 1990, mean life expectancy for the low SES population is 75.67 (Table 7a), while that for the high SES population is 76.29 (Table 7b), a difference of .62 years that also is statistically significant ($p <.001$).

Table 7a. 1970 and 1990 Life Expectancy at Birth for Low SES Populations (By Quintile) in Pennsylvania

County	1970 Life Expectancy	County	1990 Life Expectancy
Bedford	67.56	Beaver	76.35
Clarion	71.42	Cambria	76.91
Clearfield	69.44	Cameron	77.25
Fayette	68.16	Clarion	76.39
Fulton	71.67	Clearfield	75.60
Greene	68.34	Clinton	75.10
Huntingdon	69.89	Fayette	75.26
Jefferson	69.72	Forest	73.10
Northumberland	68.58	Greene	76.13
Potter	69.65	Jefferson	75.11
Schuylkill	67.48	Northumberland	74.80
Somerset	70.51	Potter	75.37
Sullivan	70.37	Somerset	76.88
Wayne	69.82	Sullivan	75.10
MEAN	69.47	MEAN	75.67

Table 7b. 1970 and 1990 Life Expectancy at Birth for High SES Populations (By Quintile) in Pennsylvania

County	1970 Life Expectancy	County	1990 Life Expectancy
Allegheny	70.08	Bedford	77.30
Beaver	70.58	Bucks	75.82
Berks	71.15	Chester	76.84
Bucks	72.40	Cumberland	76.20
Chester	71.15	Dauphin	75.09
Cumberland	72.21	Delaware	75.67
Delaware	71.47	Lancaster	76.29
Lancaster	71.35	Lehigh	76.34
Lebanon	70.59	Monroe	75.51
Lehigh	71.15	Montgomery	77.12
Mercer	70.50	Northampton	76.89
Montgomery	72.19	Perry	75.18
Northampton	71.10	Pike	77.39
York	72.20	York	76.40
MEAN	71.29	MEAN	76.29

Table 7c. Dummy Regression and Statistical Test Results: Changes in Life Expectancy by SES Population in Pennsylvania between 1970 and 1990

SES	a	b	Se(b)	T-score	*P*(b=0)	r^2
Low	69.47	6.20	0.45	13.64	< 0.001	.88
High	71.29	4.99	0.28	17.73	< 0.001	.92

The regression equations for Pennsylvania are found in Table 7c. The slope coefficient (4.99) in the dummy variable regression equation for the high SES population is statistically significant (p<. 001). This suggests that the high SES population in Pennsylvania did experience gains in life expectancy between 1970 and 1990 – approximately five years. The slope coefficient (6.20) in the dummy variable regression equation for the low SES population in Pennsylvania also is statistically significant (p <.001), which suggests that this population gained approximately 6.2 years in additional life expectancy between 1970 and 1990. This result confirms what is seen from the data in tables 7a and 7b by showing that while the 1970 life expectancy gap was narrowed, high SES populations in Pennsylvania still had higher life expectancy than low SES populations in 1990.

Mean life expectancy for the low SES population in South Dakota is 71.03 in 1970 (Table 8a), while that for the high SES population is 72.74 (Table 8b). This difference is not statistically significant (p = 0.23). This is not surprising given the small number of counties available to test, especially in the low SES set. In 1990 (Table 8a), mean life expectancy for the low SES population is 73.00, while that for the high SES population is 76.91 (Table 8b), a difference of 3.9 years that also is not statistically significant (p =0.07). Again, this result is affected by the small sample size, especially in the low SES set.

Table 8a. 1970 and 1990 Life Expectancy at Birth for Low SES Populations (By Quintile) in South Dakota

County	1970 Life Expectancy	County	1990 Life Expectancy
Aurora	70.57	Aurora	74.81
Douglas	72.53	Charles Mix	75.94
Gregory	74.58	Corson	73.74
Hutchinson	77.18	Douglas	80.27
Marshall	74.19	Gregory	76.54
Shannon	59.27	McCook	76.83
Todd	65.41	Shannon	62.73
Turner	74.51	Todd	63.16
MEAN	71.03	MEAN	73.00

Table 8b. 1970 and 1990 Life Expectancy at Birth for High SES Populations (By Quintile) in South Dakota

County	1970 Life Expectancy	County	1990 Life Expectancy
Beadle	70.79	Beadle	75.44
Brown	73.29	Brown	76.15
Codington	72.92	Grant	72.09
Hughes	74.60	Hughes	75.93
Lawrence	71.08	Lake	79.68
Meade	74.23	Lawrence	77.98
Minnehaha	73.62	Lincoln	75.74
Pennington	74.32	Meade	78.41
Potter	69.77	Minnehaha	77.75
		Moody	77.68
		Pennington	79.18
MEAN	72.74	MEAN	76.91

Table 8c. Dummy Regression and Statistical Test Results: Changes in Life Expectancy by SES Population in South Dakota between 1970 and 1990

SES	a	b	Se(b)	T-score	*P*(b=0)	r^2
Low	71.03	1.97	3.10	0.64	= 0.54	.03
High	72.74	4.18	0.89	4.70	< 0.001	.55

The slope coefficient (4.17) in the dummy variable regression equation for the high SES population in South Dakota is statistically significant ($p<.001$), as can be seen in Table 8c. This suggests that the high SES population did experience gains in life expectancy between 1970 and 1990 – approximately four years. The slope coefficient (1.97) in the dummy variable regression equation for the low SES population in South Dakota is not statistically significant ($p =.54$), which again is due largely to the small sample size for the low SES set. If one ignores the statistical test for the low SES set (Table 8a) and assumes that the model is a good approximation of its change in life expectancy, then it would appear that with a gain of about two years, the low SES populations in South Dakota have gained half as many additional years as did the high SES populations, on average (Table 8b).

In 1970, mean life expectancy for the low SES population in Washington (Table 9a) is 72.15, while that for the high SES population is 72.42 (Table 9b), a negligible difference of 0.27 years that is not statistically significant (p = 0.35). In 1990, mean life expectancy for the low SES population is 76.14 (Table 9a), while that for the high SES population is 77.32 (Table 9b), a difference of 1.18 years that also is not statistically significant (p = 0.07). As was the case in South Dakota, these results are affected by the small sample size.

Table 9a. 1970 and 1990 Life Expectancy at Birth for
Low SES Populations (By Quartile) in Washington

County	1970 Life Expectancy	County	1990 Life Expectancy
Asotin	69.67	Asotin	74.54
Chelan	72.00	Columbia	76.62
Kittitas	73.82	Grant	75.89
Okanogan	70.74	Grays Harbor	74.34
Pacific	70.50	Kittitas	77.50
Pend Oreille	72.18	Klickitat	75.36
San Juan	75.41	Okanogan	76.18
Stevens	73.23	Pacific	76.21
Yakima	71.80	Pend Oreille	75.85
		Whitman	78.95
MEAN	72.15	MEAN	76.14

Table 9b. 1970 and 1990 Life Expectancy at Birth for
High SES Populations (By Quartile) in Washington

County	1970 Life Expectancy	County	1990 Life Expectancy
Benton	72.37	Benton	77.04
Clark	71.82	Clark	75.99
Cowlitz	72.06	Island	79.20
Douglas	74.95	King	76.40
Franklin	70.85	Kitsap	76.09
King	71.85	Pierce	75.44
Kitsap	72.59	San Juan	81.67
Pierce	71.55	Snohomish	76.86
Snohomish	72.70	Thurston	77.22
Thurston	73.45		
MEAN	72.42	MEAN	77.32

Table 9c. Dummy Regression and Statistical Test Results: Changes in Life
Expectancy by SES Population in Washington Between 1970 and 1990

SES	a	b	Se(b)	T-score	P(b=0)	r^2
Low	72.15	3.99	0.72	5.52	< 0.001	.64
High	72.42	4.90	0.72	6.79	< 0.001	.73

The dummy regression equations for Washington are found in Table 9c. The slope coefficient (4.90) in the dummy variable regression equation for the high SES population is statistically significant ($p<.001$). This suggests that the high SES population in Washington did experience gains in life expectancy between 1970 and 1990 – approximately 4.9 years. The slope coefficient (3.99) in the dummy variable regression equation for the low SES population also is statistically significant ($p < .001$), which suggests that this population gained approximately four years in additional life expectancy between 1970 and 1990. This result confirms what is seen from the data in tables 9a and 9b by showing that high SES populations in Washington posted both absolute and relative gains in life expectancy over low SES populations between 1970 and 1990. On average, the relative gain was more than one year.

In summary, high SES populations are found in seven of the eight states to have gained not only additional years of life expectancy absolutely, but also relative to low SES populations in seven of the eight states in the sample. The relative gains ranged from half a year to six years, with an overall average of about two years. Pennsylvania was the single state where the life expectancy gap between high SES and low SES that existed in 1970 (about 1.8 years) had narrowed by 1990 (to .62 years).

In five of the eight states, there was no statistically significant difference in 1970 life expectancy between the state's low and high SES populations. However, by 1990, all of the eight states had statistically significant differences in life expectancy between their low and high SES populations. This was the case even in Pennsylvania, which had a moderate, but statistically significant, difference in 1970 and a negligible, but statistically significant, difference in 1990.

Finally, in 14 of the 16 dummy variable regressions, a statistically significant slope coefficient was found. The only two where this was not found were both for low SES populations, one in Florida and the other in South Dakota. This suggests that there may have been no change in life expectancy for these two populations, a tentative conclusion supported by their very low coefficients of determination, which are $r^2 = .12$ and .03, respectively.

Discussion

Before summarizing the findings, it is useful here to discuss two issues that may come to mind in regard to the analysis, which basically is comprised of examining cross-sectional data at two points in time. This type of analysis is a natural approach given that a period-based measure of life expectancy measure is being used, which is itself cross-sectional in nature. The first issue is comprised of fertility and migration, which along with mortality, form the components of population change. All three of these components of population change affect the high and low SES populations examined here between 1970 and 1990. Migration is particularly salient. The second issue is the social mobility of a given population, where it might be upward or downward. Both of these issues can interact with one another, so it is useful to address them together.

In regard to the first issue, consider that a low SES (county) population in 1970 could be impacted by migration such that by 1990 this (county) population is no longer in the low SES group. Similarly, a high SES population in 1970 could be impacted by migration such that it is no longer in this group by 1990. The issue of social mobility for a given population can be viewed as a variation on the first issue, whereby it is not the coming and going of people that affect changes in SES but, rather, income changes specific to the population. For example, it could be the case that a major source of employment comes into being in a county subsequent to 1970 that improves the household incomes of the residents. Similarly, a major source of employment in 1970 may no longer be in the county in 1990 and, as such, household incomes are depressed. Finally, it can be through a combination of migration and social mobility that the county populations change in terms of SES groups between 1970 and 1990.

It is for precisely these reasons that the analysis reported here does not attempt to follow a population in a given SES set in 1970 into 1990. Instead, the analysis examines the low and high SES populations as found at each of the two time points. This is entirely appropriate because the period (cross sectional) life table needs to be matched with cross-sectional (period) SES groups. By doing this, the analysis remains on track to its goal – the association of SES with a period-based measure of life expectancy. It simultaneously provides a tractable solution to the issue of dealing with temporal effects such as upward and downward social mobility and migration.

Turning to a summary of the results, with the exception of Pennsylvania, the results found here are consistent with those found in Arkansas (Swanson 1992) in that seven states of the eight states analyzed here saw high SES populations gain additional years in life expectancy relative to low SES populations between 1970 and 1990. These results, in turn, are generally consistent with those reported by the Congressional Budget Office (2008), Ezzati et al. (2008), and Singh and Siahpush (2006).

The reasons for these absolute and relative gains by high SES populations may be due to what is observed by Stockwell, Goza, and Balistreri (2005) in regard to infant mortality rates, namely that income inequality has been increasing in the United States since 1970, the beginning of a trend in which many social welfare programs were cut back by the federal government.[5] The fact that the relative gains varied by state, with southern states having larger relative gains than states outside the south, suggests that state-level programs may have ameliorated federal program cuts and in Pennsylvania's case, overcome them. In this regard, it is of interest to examine median household incomes (as noted earlier, all amounts are expressed in 1989 dollars) in these states (U.S. Census Bureau no date). These data are found in Table 10.

Table 10. 1970 and 1990 Median Household Income by State (in 1989 dollars)*

Census Division	1970*	1990*
Colorado	$26,509	$30,140
Florida	$22,559	$27,483
Louisiana	$20,567	$21,949
Mississippi	$16,432	$20,136
Ohio	$29,203	$28,706
Pennsylvania	$26,902	$29,069
South Dakota	$20,229	$22,503
Washington	$28,718	$31,183

*The values from the 1970 census are for 1969 and the values from the 1990 census are for 1989 (Source: U.S. Bureau of the Census, no date).

In 1970, Mississippi ranked last (50th) among the states in terms of median household income ($16,432), while Louisiana ($20,576) and Florida ($22,559) ranked 44th and 37th, respectively and South Dakota ($20,299) ranked 47th. It would have been difficult for these states to make up for lost federal monies with state funds. In 1990, Mississippi ($20,136) again ranked last (50th), with Louisiana ($21,949) and South Dakota ($22,503) ranked 47th and 46th, respectively and Florida ($27,483) ranked 28th. In regard to Ohio, it ranked 12th in 1970 with a median household of $29,203 that was not only much higher income than any of these states, but also higher than that in Colorado ($26,509), Pennsylvania ($26,902), and Washington ($28,718). However, Ohio was only one of three states (the other two being Michigan and Montana) that experienced a decline in median household income between 1970 and 1990, dropping from 12th highest at $29,203 in 1970 to 25th in 1990 with a median household income of $28,706. While median household income in Ohio was declining, it was increasing in Colorado (from $26,509 to $30,140), Pennsylvania, (from $26,902 to $29,069) and Washington ($28,718 to $31,183). It would have been difficult to implement or maintain social welfare programs in Ohio, given its income decline as would have been the case in Florida, Louisiana, Mississippi, and South Dakota, given their low 1970 incomes. However, all else being equal, it would not have been so difficult in Colorado, Pennsylvania, and Washington, with their relatively high median household incomes in 1970 and their increases by 1990. This may account for the fact that the life expectancy gap narrowed in Pennsylvania, while in Colorado and Washington, the high SES populations posted the lowest relative gains in life expectancy over the low SES populations - patterns different than those observed in Ohio, Florida, Louisiana, Mississippi, and South Dakota. These results also suggest that spatial inequalities in health outcomes exist across the United States.

SES is one of three primary mechanisms of social stratification in the United States (Massey 2007) and it has been found to have a broad range of health access and health outcomes in the United States (Gortmaker and Wise 1997, James and Cossman 2006, Hummer 2005, McGehee 1994, Stockwell Goza and Balistreri 2005). Income is not the only dimension of SES, but it is arguably the most significant in the United States (Massey 2007) and as observed by Riley (2001: 143), it serves as "…an enabling factor, which boosts or diminishes life expectancy, depending on how it is spent." Riley (2001) also observes that moderate investments in health care in the modern era can produce striking advances in life expectancy. The key in accomplishing this is to have investments in health care follow a social strategy that improves patient access to doctors and nurses rather than technical medicine (Riley 2001: 120). This observation is particularly salient for the United States, virtually the only "modern" country lacking universal healthcare. It also is salient for individual states.

These findings are of practical interest because in its "Tracking Healthy People 2010" report, the U. S. Department of Health and Human Services (2000) cites the elimination of health disparities by the end of this decade as one of its two key goals. Clearly, the findings that these disparities increased between 1970 and 1990 in seven of the eight states do not bode well for meeting this goal nationally by 2010, whether in spatial terms, SES terms, or a combination of the two. The findings also provide support for the argument by Stockwell, Swanson, and Wicks (1988a, 1988b) that declining relative standards in living for the low and lower middle SES populations along with the imposition of national policies that limited their health care were likely to be factors contributing to a lack of narrowing of mortality differentials between them and high SES populations subsequent to 1970. Singh and Siahpush (2006) also explicitly state that widening SES gaps in life expectancy may be related to increasing temporal inequalities in the material and social living conditions, both in absolute and relative terms. The Congressional Budget Office (2008), however, does not mention the possibility that decreased federal funding of social welfare programs may be at least part of the reason for the widening life expectancy gap it found between low and high SES groups. Rather than listing any structural factors, it lists as possibilities, four individual-level factors: (1) smoking; (2) Obesity; (3) self-management of disease; and (4) health lifestyles and use of health care.

As stated earlier, the finding that SES-based life expectancy differentials tended to increase during the period 1970 to 1990 is consistent with the literature. Unfortunately, the widening differentials represent a major break with the past. Shortly before his death in 1969, the pioneering actuary, demographer, and biostatistician, Mortimer Spiegelman (1968) wrote that that gender, race, spatial, and SES mortality differentials in the United States had been narrowing since 1940. He concluded his paper by stating that (national) leaders were now responsible for seeing that adequately staffed and functioning health facilities were conveniently accessible to the public in order for these trends to continue. He clearly believed that the country's leadership would shoulder this responsibility because he foresaw that even smaller mortality differentials were in the country's future. Unfortunately, from the standpoint of national policy, it appears that his optimism was misplaced.

What are the next steps in examining the relationship between SES and life expectancy? First, the results here suggest that state supported program can play a role in offsetting federal cuts to social welfare programs. This needs to be examined more carefully across the states using relevant budget information. Second, in addition to extending the analysis to other states, which would provide more of an idea on the role of state governments in maintaining social welfare and other programs for low SES populations, it will be important to examine how race interacts with SES and life expectancy. Swanson and Stockwell (1988) found, for example, that while race moderated the geographic association with life expectancy in Ohio, the association was not spurious. Swanson and McGehee (1996) found similar results in regard to race and SES in Arkansas, where between 1970 and 1990: (1) High SES Black populations gained more than three additional years of life expectancy over Low SES Black populations; and (2) High SES White populations gained more than 0.5 years of life expectancy over Low SES White populations. It is expected that similar moderating effects of race will be found elsewhere, but this is a working hypothesis to be tested. Similarly, it will be important to examine differentials by Hispanic and no-Hispanic ethnicity. This effort will be challenging in some states because of the "Hispanic Mortality Paradox" (Hummer et al. 2007), but if it can be sorted out, determining the effect of ethnicity on life expectancy in conjunction with SES should be valuable for both substantive and policy reasons.

There are factors beyond income that play a role in access to health care and health outcomes. (Rogers Hummer and Nam 2001, Kirby 2008). One area for further research would be to examine some of these other factors, such as educational attainment and health insurance, in regard to life expectancy.

Finally, with the arrival of census 2010 it will be useful to see if the trends found between 1970 and 1990 changed subsequently to 1990. Such an examination should include race (and ethnicity), for as McGehee (2005) notes, the economic restructuring that has occurred in the United States and the accompanying increase in income inequality, has disproportionately affected minorities. Including these factors would provide a current picture on where the U.S. stands in terms of meeting the "Healthy America 2010" goal of achieving the elimination of health disparities, not only spatially and by SES, but also by one of the other two cornerstones of social stratification in the United States, race (and ethnicity).

Endnotes

1. Through this paper we use the term 'life expectancy' to refer to 'life expectancy at birth.'

2. In 2008, Ezzati et al. constructed sex-specific life expectancies for counties for every year from 1961 to 1999. However, they were forced to combine the 3,141 counties into 2,068 units because of the lack of data needed to avoid unstable death rates. This represents about two-thirds (66%) of the total counties. They merged smaller counties with adjacent counties to form units with a total population of at least 10,000 males and 10,000 females. In the study reported here, only counties with less than 50 deaths were excluded. For the 537 counties used in this study this limitation resulted in the exclusion of 48 counties in 1990, leaving 91 percent available for analysis. Had the excluded counties been merged with adjacent ones, there would have been virtually no reduction. All of this is not to say that the regression method is in competition with a complete (abridged) life table. Clearly, a life table provides much more information than does life expectancy alone, even when, as is the case in the study by Ezzati et al. (2008) only three of the 39 years for which they constructed life tables had census quality population data in the denominators (the remaining years had estimated age-sex specific data). However, where it is neither desirable to merge counties nor the need to maintain a high number of them for analysis, then the regression estimation method may be preferable.

3. A remarkably similar process occurred in the United Kingdom during approximately the same period that social and spatial health inequalities first narrowed and then widened in the United States. Shaw et al. (1999) found that social and spatial inequalities in health had narrowed in the U.K. between the late 1950s and the early 1980s, but steadily widened since the early 1980s, the latter period coinciding with the Thatcher government.

4. The U.S. Census Bureau makes 1970 census data available online in two formats, PDF files and zipped files at http://www.census.gov/prod/www/abs/decennial/1970cenpopv1.htm, last accessed November 2008. To estimate life expectancy, the model used here requires the total population and the population aged 65 years and over. These data are available for 1970 in different parts of "General Population Characteristics" which in general can be found at the preceding website. However, in several states, not only were the PDF versions found to be incomplete, lacking the part of the report containing age data by county, but the zipped files containing these same parts were corrupted. These states included Kentucky and Montana, among others.

5. The Hispanic Mortality Paradox is a situation whereby low SES populations have lower death rates than high SES populations when large numbers of Hispanics (primarily of Mexican origin) are present. Hummer et al. (2007) argue that the paradox is due to the fact that many Mexicans leave the United States for Mexico when death is imminent. More than 25 percent of the populations of California and Texas are of Hispanic origin, so these two states were eliminated from the sample frame. However, they were analyzed outside the scope of the study reported here and the expected confounding effects were found in Texas while a diminished relationship between SES and life expectancy was found in California.

6. Bennetts (1982) and Gilder (1980) discuss some of the cuts that occurred and their effects.

Appendix.

Note: Counties (by State) that were excluded from the analysis because of too few deaths (less than 50) in a given year.

<u>Colorado</u>: Clear Creek, Hinsdale, Jackson, Mineral, Pitkin, San Juan, and Summit are excluded from the HIGH SES set in 1970 and Clear Creek, Eagle, Elbert, Gilpin, Park, Pitkin, and Summit are excluded from the HIGH SES set in 1990. Costilla, Crowley, Custer, and Saguache are excluded from the LOW SES set in 1970 and Costilla, Crowley, Saguache, and Sedgwick are excluded from the LOW SES set in 1990

<u>Florida</u>: Union had only 44 deaths in 1970, but the estimated life expectancy did not appear to be wildly unreliable and since it was close to 50, it was retained as part of the LOW SES set.

<u>Louisiana</u>: Cameron Parish, that otherwise would have been in the HIGH SES set in both 1970 and 1990 was excluded because the number of deaths was below 50 in both of the two years.

<u>Mississippi</u>: No counties used in the analysis had fewer than 50 deaths in a given year.

<u>Ohio</u>: No counties used in the analysis had fewer than 50 deaths in a given year.

<u>Pennsylvania</u>: No counties used in the analysis had fewer than 50 deaths in a given year.

<u>South Dakota</u>: Custer, Haakon, Lyman, and Stanley are excluded from the HIGH SES set in 1970 and Custer and Scully are excluded from the HIGH SES set in 1990. Buffalo, Hanson, Hyde, Jerauld, and Ziebach are excluded from the LOW SES set in 1970 and Bennett, Buffalo, Dewey, Mellette, and Ziebach are excluded from the LOW SES set in 1990.

<u>Washington</u>: Skamania County is excluded from the High SES set in 1990 and Garfield County is excluded from the Low SES set in 1970.

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