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Socioeconomic Status and Life Expectancy in Indiana, 1970-1990

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Abstract: This paper examines the relationship between socioeconomic status (SES) and life expectancy in Indiana in 1970 and 1990. SES is of interest because along with race and gender, it is one of the three cornerstones of social stratification in the United States and it has been found to have a strong association with various health outcome measures, including life expectancy. The period 1970 to 1990 is of interest because social welfare programs that were at a peak in 1970 had been significantly reduced by 1990. The analysis shows that high SES populations in Indiana gained an average of half a year of additional life expectancy over low SES populations. These findings support earlier findings that SES plays a role in differential life expectancy subsequent to 1970 and have implications for current national health policy in that one of the two key goals of the US Department of Health and Human Services is the elimination of health disparities by 2010. Suggestions for further research include adding race and ethnicity.

Keywords: Health disparities, social policy, socio-economic inequality.

Using regression analysis, Swanson and Stockwell [1] examined life expectancy in 1930 and 1980 in Ohio and found that while differences narrowed between 1930 and 1980, significant variations in life expectancy persisted among the state's suburban, urban, and rural areas. They noted that the geographical areas of suburb, city, and rural county are themselves associated with socioeconomic status (SES) differential [2, 3].

Extending the sub-state geographic analysis of Swanson and Stockwell [1] to subs-state SES differentials, Swanson [4] found that SES had substantive and statistically significant effects on changes in life expectancy at birth in Arkansas between 1970 and 1990: During this period, high SES populations in Arkansas experienced both absolute and relative gains in life expectancy over low SES populations such that by 1990 the differential was over two years.

SES is of substantive interest because along with race and gender, it is one of the three cornerstones of social stratification in the United States [5] and it has been linked in many studies to mortality differentials [6-19]. Because of the pervasiveness of these findings, Hummer [8] postulated that socioeconomic differences are fundamental causes of health disparities in the United States, a point also made by Link and Phelan [20].

Life Expectancy (at birth) is of substantive interest because it is arguably the single most important indicator of the general health of a population [21] and it has long been documented that variations in life expectancy at birth exist among the broad geographic divisions within the United States, as well as among individual states [22, 23]. However, until the work of Swanson and Stockwell [1], virtually nothing was known about sub-state variations.[1] Swanson, McGehee and Hoque [24] have examined the socioeconomic status and life expectancy in eight states and found significant variations in life expectancy by SES. They found that high SES populations in seven of the eight states gained additional life expectancy over the low SES populations between 1970 and 1990. In the one remaining state, the gap between the high and low SES populations narrowed by 1990.

The years 1970 and 1990 are selected for this study in Indiana because they represent what may be regarded as the "bookends" of a pivotal social policy period in the US, where social welfare programs were at a high point in 1970 (via the New Deal under Roosevelt and the War on Poverty under Johnson), but by 1990 (shortly after the end of the Reagan era) were significantly smaller [19].[2] A concrete example of this is found in Weinberg [25] , who finds that the distribution of income among households was far more equal in 1970 (Gini Ratio = .394) then in 1990 (Gini Ratio = .428). Massey [5] 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 [19] . Thus, it is natural to examine this question using what is perhaps the ultimate indicator of overall health, life expectancy at birth.

Indiana provides an excellent location for an examination of the relations between SES and life expectancy. In terms of median household income Indiana ranked 16th among the 50 states in 1970 and dropped to 24th in 1990 (see Appendix Table **1**). In terms of population size Indiana ranked 12th in 1970 and 15th in 1990. Also, as far as we know, no one has examined the relationship between SES and life expectancy in Indiana.

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MATERIALS AND METHODS

For the same reasons described by Swanson [4], a regression-based technique is used to estimate life expectancy [26] , an earlier version of which was used by Swanson and Stockwell [1] . Until the advent of this method for estimating life expectancy at the sub-state level, there was no reliable way to examine life expectancy across either a set of sub-state areas such as counties or a set of populations in these sub-state areas sorted by SES (or other characteristics). This was due to the fact that the usual way to calculate life expectancy is through the construction of a life table, which has rigorous data requirements that are difficult to meet for specific sub-state areas [27].

The model used here was tested by Swanson [26] and found to be sufficiently accurate for estimating life expectancy at birth for county populations in the United States. 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 years and 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 less than 50. None of the counties in this study was found to be severely impacted either by the presence of large retirement populations or because the number of deaths was substantially less than 50 in both of the two years, 1970 and 1990.

As was the case in earlier work, the analytical unit is a county population in Indiana (N=92). Mortality data needed to estimate life expectancy by county in 1970 and 1990 were taken from 1970 and 1990 vital statistics reports provided by the U.S. National Center for Health Statistics [28, 29] respectively. Population data for 1970 and 1990 are taken from reports for the 1970 and 1990 censuses [30, 31] respectively. Median household income data are taken from a special report compiled by the US Census Bureau [32]. 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. County populations are grouped into two sets for 1970 and 1990: (1) low SES, the 1st quintile, the (approximately) 20% (n= 18) of the state's 92 counties with the lowest median household income; and (2) high SES, the 5th quintile, the (approximately) 20% (n =18) of the state's counties with the highest median household income.

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

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

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 (the mean life expectancy for the same SES population in 1970) 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 t-test (p=.05) (assuming unequal variance across the tested samples) is applied to the slope coefficient, b to determine if there is a statistically significant change in life expectancy for the population in question between 1970 and 1990. While this test is straightforward, simple, and widely used, and understood, its use here raises three issues. The first and most general is that the income groups are "random samples" only in the sense of that they come from a super population," a hypothetical population under which the high and low income groups are viewed as manifestations of an infinite number of possible outcomes [33]. Second, the "samples" over time are not entirely independent in that many of the counties representing the low and high income groups within each state, respectively, in 1990 also are found in the same respective groups in 1990. This means that the standard errors underlying the t-test are inflated. The third issue is that there is a positive correlation between life expectancy in 1970 and 1990. This also means that the standard errors are again inflated. Thus, the tests are characterized by low levels of statistical power and are therefore susceptible to Type II errors (failing to reject a false null hypothesis), where 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). However, the "one-tailed" test structure of the tests is appropriate because there is evidence to indicate that, on average, life expectancy increased between 1970 and 1990.

Given the preceding qualifications, if a given slope coefficient is found to be statistically significant then the null hypothesis that b=0 is rejected and it is assumed that the value of b found in the equation represents the change in life expectancy that occurred for the income group in question between 1970 and 1990. If a given slope coefficient is not found to be statistically significant, then the null hypothesis is not rejected and one acts as if the value of b is zero, barring additional evidence to the contrary. That is, to act as if there was no change in life expectancy for the population in question between 1970 and 1990, knowing that there is a high probability of making a Type II error.

RESULTS

The estimated life expectancy values for each of the two SES populations in 1970 and 1990, by county, are given in Tables **1** and **2**, respectively. In 1970, the mean life expectancy at birth for the low SES population is 70.87, while that for the high SES population is 71.54. A t-test (unequal variances) found that this difference was not statistically significant (p = 0.06). In 1990, the mean life expectancy at birth for the low SES population is 74.1, while that for the high SES population is 75.3, a difference of 1.2 years. Using the (unequal variance) t-test, this difference was found to be statistically significant (p =.003).

Table 1. 1970 & 1990 Life Expectancy at Birth for Low SES Populations in Indiana

County	1970 Life Expectancy at Birth	County	1990 Life Expectancy at Birth
Clay	71.41	Clay	73.97
Crawford	71.42	Crawford	72.10
Gibson	71.78	Daviess	75.19
Greene	69.36	Greene	74.88
Knox	69.23	Jay	75.49
Martin	69.23	Knox	73.64
Orange	70.73	Martin	76.07
Owen	71.90	Orange	74.08
Parke	70.11	Owen	75.47
Perry	70.93	Pike	72.77
Pike	70.96	St. Joseph	72.51
Pulaski	69.44	Starke	73.66
Shelby	73.66	Sullivan	73.49
Starke	68.37	Switzerland	75.07
Sullivan	70.07	Vermillion	72.07
Switzerland	73.35	Vigo	74.39
Vermillion	69.16	Washington	75.30
Washington	73.51	Wayne	74.29
Mean	70.87	Mean	74.14

To examine the changes in life expectancy, two dummy variable regression equations were constructed using the life expectancy values. The results of these regressions equations are given in Table **3**. The slope coefficient (3.76) in the dummy variable regression equation for the high SES population is statistically significant ($p<.001$), as can be seen in Table **3**. This suggests that the high SES population did experience gains in life expectancy between 1970 and 1990 – nearly four years. The slope coefficient (3.27) in the dummy variable regression equation for the low SES population also is statistically significant ($p <.001$), which suggests that this population gained just over three years in additional life expectancy between 1970 and 1990. This result confirms what is seen from the data in Tables **1** and **2** 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 0.49 years (3.76 – 3.27).

DISCUSSION

The results found for Indiana are consistent with those found in Arkansas [4] in that both states saw high SES populations gain additional years in life expectancy at birth relative to low SES populations between 1970 and 1990. In Arkansas, the gain was higher than the half year found in Indiana – more than two years, The reasons for these relative gains by high SES populations in both Arkansas and Indiana may be due to what is observed by Stockwell, Goza, and Balisteri [19] 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 programs were cut back.

As noted earlier, the effects of SES on life expectancy are of substantive interest because SES is one of three primary mechanisms of social stratification in the United States [5] and it has been found to have a broad range of health access and health outcomes in the United States [6, 7, 8, 10, 19]. These effects also are of practical interest because in its "Tracking Healthy People 2010" report, the US Department of Health and Human Services [34] 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 Arkansas and Indiana do not bode well for these states meeting this goal by 2010. The findings also provide support for the argument by Stockwell, Swanson, and Wicks [16, 17] that declining relative standards in living for the low and lower middle SES populations along with the imposition of national policies that limited

Table 2. 1970 & 1990 Life Expectancy at Birth for High SES Populations in Indiana

County	1970 Life Expectancy at Birth	County	1990 Life Expectancy at Birth
Allen	72.20	Allen	75.07
Bartholomew	71.33	Boone	74.48
Boone	72.37	Dearborn	75.39
Clark	72.82	Dubois	75.69
Elkhart	72.14	Hamilton	77.32
Hamilton	71.80	Hancock	74.55
Hancock	71.73	Hendricks	75.58
Hendricks	72.64	Howard	75.04
Howard	70.73	Jefferson	72.86
Johnson	71.02	Johnson	73.70
Lake	69.10	Kosciusko	74.96
Laporte	71.26	Morgan	75.33
Madison	71.13	Porter	75.36
Marion	70.44	Posey	76.79
Morgan	71.90	Tipton	76.14
Porter	72.24	Warrick	74.11
Spencer	71.78	Wells	77.25
Wells	71.09	Whitley	75.72
Mean	71.54	Mean	75.30

Table 3. Dummy Regression & Statistical Test Results: Changes in Life Expectancy by SES Population in Indiana between 1970 & 1990

	a	b	Standard Error of b	T-Score (b=0)	P(b=0)	Ho: b=0
High SES $R^2 = .78$	71.54	3.76	0.34	8.29	<.001	Reject Ho
Low SES $R^2 = .59$	70.87	3.27	0.47	2.41	<.001	Reject Ho

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.

One of the next steps in this research effort will be to examine how race moderates the effects of SES on life expectancy at birth in Indiana. Swanson and Stockwell [35] found, for example, that while race moderated the geographic association with life expectancy in Ohio, the association was not spurious. Swanson and McGehee [36] 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 on SES will be found in Indiana, but this is a working hypothesis to be tested.

In addition to extending the analysis in regard to race, 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" [37], but if it can be sorted out, determining the effect of ethnicity on life expectancy at birth in conjunction with income should be valuable for both substantive and policy reasons.[3]

ENDNOTES

1. In 2008, Ezzati *et al.* [38] 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 we use here is in competition with a complete (abridged) life table. Clearly, a life table provides much more information than does life expectancy at birth alone, even when, as is the case in the study by Ezzati *et al.* [38] 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.

2. As social and spatial health inequalities first narrowed in the United States (before 1970) and then widened (subsequent to 1970), it is worthwhile to note that a remarkably similar process occurred in the United Kingdom during approximately the same period. Shaw *et al.* [39] 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. From a policy standpoint, it is of more than passing interest that the widening in the U.S. begins in earnest about the time that Ronald Reagan came to power and in the U.K., about the time that the Thatcher government came to power.

3. 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.* [37] 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 and a diminished relationship between SES and life expectancy was found in California. It also may be the case that ethnicity is not reported correctly on death certificates [40], which may interact with the Paradox.

Appendix Table 1. 1970, 1990 & 2000 Median Household Income by State (in 1999 Dollars)*

State	1970			1990			2000	
	1970 Rank	1970 Dollars	1999 Dollars	1990 Rank	1990 Dollars	1999 Dollars	2000 Rank	1999 Dollars
United States		$8,486	$33,249		$30,056	$39,213		$41,994
Alabama	48	6,419	25,151	41	23,597	30,786	42	34,135
Alaska	1	11,817	46,301	2	41,408	54,023	4	51,571
Arizona	25	8,199	32,125	27	27,540	35,930	27	40,558
Arkansas	49	5,356	20,986	48	21,147	27,589	48	32,182
California	11	9,302	36,447	8	35,798	46,704	8	47,493
Colorado	22	8,423	33,002	18	30,140	39,322	10	47,203
Connecticut	2	10,877	42,618	1	41,721	54,431	2	53,935
Delaware	10	9,309	36,474	9	34,875	45,500	9	47,381
Florida	37	7,168	28,085	28	27,483	35,856	33	38,819
Georgia	35	7,346	28,783	23	29,021	37,862	20	42,433
Hawaii	3	10,675	41,826	5	38,829	50,658	6	49,820
Idaho	32	7,482	29,316	38	25,257	32,952	36	37,572
Illinois	7	9,706	38,029	12	32,252	42,078	13	46,590
Indiana	16	8,921	34,954	24	28,797	37,570	22	41,567
Iowa	28	7,880	30,875	36	26,229	34,220	30	39,469
Kansas	30	7,578	29,692	29	27,291	35,605	26	40,624

Appendix Table 1. Contd…

State	1970			1990			2000	
	1970 Rank	1970 Dollars	1999 Dollars	1990 Rank	1990 Dollars	1999 Dollars	2000 Rank	1999 Dollars
Kentucky	45	6,537	25,613	45	22,534	29,399	44	33,672
Louisiana	44	6,538	25,617	47	21,949	28,636	47	32,566
Maine	36	7,315	28,661	26	27,854	36,340	37	37,240
Maryland	5	10,101	39,577	4	39,386	51,385	3	52,868
Massachusetts	8	9,563	37,469	6	36,952	48,209	5	50,502
Michigan	6	9,997	39,170	15	31,020	40,470	16	44,667
Minnesota	17	8,753	34,295	17	30,909	40,325	11	47,111
Mississippi	50	5,221	20,457	50	20,136	26,270	49	31,330
Missouri	29	7,672	30,060	34	26,362	34,393	34	37,934
Montana	33	7,436	29,135	44	22,988	29,991	46	33,024
Nebraska	34	7,426	29,096	37	26,016	33,942	31	39,250
Nevada	9	9,505	37,242	16	31,011	40,458	17	44,581
New Hampshire	18	8,652	33,900	7	36,329	47,397	7	49,467
New Jersey	4	10,371	40,635	3	40,927	53,395	1	55,146
New Mexico	38	7,096	27,803	40	24,087	31,425	43	34,133
New York	13	9,268	36,313	11	32,965	43,008	19	43,393
North Carolina	39	7,025	27,525	33	26,647	34,765	32	39,184
North Dakota	40	6,909	27,070	43	23,213	30,285	41	34,604
Ohio	12	9,279	36,356	25	28,706	37,451	23	40,956
Oklahoma	43	6,596	25,844	42	23,577	30,760	45	33,400
Oregon	23	8,296	32,505	30	27,250	35,552	24	40,916
Pennsylvania	20	8,548	33,492	22	29,069	37,925	28	40,106
Rhode Island	19	8,617	33,763	13	32,181	41,985	21	42,090
South Carolina	41	6,835	26,780	35	26,256	34,255	38	37,082
South Dakota	47	6,450	25,272	46	22,503	29,359	40	35,282
Tennessee	42	6,631	25,981	39	24,807	32,364	39	36,360
Texas	31	7,538	29,535	32	27,016	35,246	29	39,927
Utah	21	8,482	33,234	20	29,470	38,448	15	45,726
Vermont	27	7,961	31,192	19	29,792	38,868	25	40,856
Virginia	24	8,293	32,493	10	33,328	43,481	12	46,677
Washington	14	9,125	35,753	14	31,183	40,683	14	45,776
West Virginia	46	6,487	25,417	49	20,795	27,130	50	29,696
Wisconsin	15	8,997	35,251	21	29,442	38,412	18	43,791
Wyoming	26	8,035	31,482	31	27,096	35,351	35	37,892

* The values from the 1970 Census are for 1969, the values from the 1990 Census are for 1989, & the values from 2000 were for 1999 Source: U.S. Census Bureau [32].

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