Deaths Due to Injuries Among Employed Adults: The Effects of Socioeconomic Class

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Background. Few studies have investigated socioeconomic status (SES) and external causes of death (*ie*, deaths attributable to injuries). These deaths are of particular interest because they are potentially preventable and they represent the second leading cause of years of life lost under age 75.

Methods. We studied 261,723 deaths from external causes in 27 states from 1984 to 1997 among employed persons age 20–64. Numerator data came from occupation on the death certificate. Occupation-specific denominator data came from the U.S. Census. A Nam-Powers SES score was assigned to each occupation based on its relative income and education in the U.S. Census.

Results. After adjusting for age, sex, year and race, SES was strongly associated with mortality from all external causes combined for men (rate ratios = 2.9, 2.3, 1.5, and 1.0 by ascending SES quartile), and to a lesser extent for women (rate ratios = 1.6, 1.0, 1.1, and 1.0). A similar pattern was seen for each of the specific external causes (motor vehicle deaths, suicide, homicide, injuries other than by motor vehicle, and medical complications).

Conclusions. We estimate 41% of deaths from external causes are attributable to having a SES below the top quartile (both sexes combined).

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In 1998, the U.S. death rate from external causes (also called injuries, ICD 9th revision codes E800–E999) was 56 per 100,000. This was the fourth most common major category of death behind diseases of the heart (272/100,000), cancer (202/100,000) and stroke (60/100,000), and ahead of diabetes (24/100,000) and nonmalignant lower respiratory disease (42/100,000).[1] Unlike most other causes of death, which are most common in the elderly, external causes tend to affect people of all ages. This category was ranked second in potential years of life lost in persons under age 75 (1,749/100,000), just behind cancer (1,785/100,000) and ahead of diseases of the heart (1,406/100,000).[1] Among males under age 75, external causes were ranked first in years of life lost. External causes comprise motor vehicle deaths (16/100,000), other unintentional injuries (*eg*, falls, drowning, poisoning, deaths by fire) (21/100,000), suicide (11/100,000), homicide (7/100,000) and medical complications (1/100,000).[1] Deaths from these causes merit special attention because most are potentially preventable.

The literature regarding SES and mortality from external causes is sparse. The lack of comprehensive national data on SES and cause-specific mortality in the United States has made studies on this topic difficult. Here we study this association with data from 27 states from 1984 to 1997 for working persons age 20–64.

Methods

We used Nam-Powers scores[2] to measure SES. Nam-Powers scores are based on occupation; they are continuous scores from 1 to 99 based on the income and education of each occupation in the U.S. Census. Nam-Powers scores are well known and commonly used to measure SES.[3] They are one of a class of SES measures based on access to material resources.[4] Occupations coded to U.S. Census codes were available to us from death certificates (providing the numerators for rates) and for the population of each state from U.S. Census data (providing the denominators for rates).

Dr. E. Terrie provided us with a list of occupations and their corresponding scores (written communication, 1996). Table 1 gives the scores for selected occupations. We grouped all occupation-specific deaths and populations into sex-specific quartiles of SES based on the sex-specific overall person-time distribution. The cut-

TABLE 1. Nam-Powers (SES) Scores for Selected Occupations, Based on the 1990 Census

Occupation	SES Score
Doctor	99
Lawyer	99
Epidemiologist	93
Teachers, elementary	83
Registered nurse	81
Postal clerk	71
Insurance adjuster	67
Car salesman	58
Secretary	51
Plumber	50
Auto mechanic	41
Carpenter	40
Truck driver	40
Bartender	34
Mail clerk, not postal	34
Butcher	30
Waiter/waitress	23
Garbage collector	23
Shoe repairer	23
Roofer	16
Cashier	15
Textile sewing-machine operator	12
Maid	8

points for quartiles were scores of 37, 55, and 78 for men and scores of 29, 49, and 73 for women.

Numerator data for rates consisted of all deaths from external causes, categorized as motor vehicle deaths (ICD 9th revision codes E810–E819), suicide (E950–E959), homicide (E960–E978), other injuries (E800–E809, E820–E869, E880–E929, E980–E999) and medical complications (complications from medical/surgical procedures, E870–E879, E930–E949). Deaths were included if the death certificates listed usual occupation and if the deaths occurred between ages 20 and 64 during 1984–1997, in all states that participated in the National Occupational Mortality Surveillance (NOMS) program. The NOMS data came from 27 states that coded usual occupation and industry from 1984 to 1997 on their death certificates using U.S. Census codes,[5,6] in a program coordinated by the National Institute for Occupational Safety and Health (NIOSH). The states included Arkansas, Colorado, Georgia, Hawaii, Indiana, Idaho, Kansas, Kentucky, Maine, Missouri, Nebraska, Nevada, New Hampshire, New Jersey, New Mexico, North Carolina, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, Tennessee, Utah, Vermont, West Virginia, Washington and Wisconsin. Not every state was included each year; on average, 19 states and 28 million people were included each year.

We excluded deaths for which usual occupation was not recorded, deaths in the military and deaths of retired persons; housewives, students, volunteers and the unemployed were excluded (20% of all deaths; 7% for men and 43% for women). Housewives made up most of the exclusions. The same exclusions were made in the denominator data. Occupations were missing for only 2% of all deaths. Deaths were stratified by age (5-year

groups), sex and race (white or black). Race groups other than white or black represented less than 1% of the data and were excluded.

Denominator data for rates consisted of occupation-specific state populations for all persons age 20–64 who were currently employed or employed within the last 5 years. We obtained these data from the Census Bureau for each state participating in NOMS (personal communication, Carolyn Carbaugh, U.S. Census, Housing and Household Economic Statistics Division, 2000). Population data were stratified by age, race and sex, as was done with the numerator data. Data for 1984–1990 were based on interpolation between the 1980 and 1990 censuses. Data for 1991–1997 were based on the monthly Current Population Surveys conducted by the Census Bureau.[7,8]

The fact that the numerator consisted of deaths with "usual occupation" whereas the denominator consisted of the population currently employed meant that there was not a one-to-one correspondence between numerator and denominator. However, Illis et al.[9] showed that for males grouped into 40 occupational categories, "usual occupation" corresponded to "current occupation" for subjects of working age about 80% of the time. Furthermore, because we grouped both numerator and denominator data into four approximately equal-sized SES groups (based on person-time), it is reasonable to expect good correspondence of numerator and denominator data within these broad groups.

Additional analyses were conducted for the years 1993–1997 for which data were available to divide external cause deaths into those occurring at work and those occurring elsewhere, using the "injury at work" box on death certificates. Death certificates identify approximately 80% of fatalities attributable to injury at work.[10] In those 5 years, 6% of external cause deaths occurred at work, 83% occurred away from work, and 11% did not have data on place of death. Analyses have been restricted to those without missing data, and have focused on deaths attributable to all external causes (N = 5,199 at work and 70,904 not at work), and attributable to the subcategories of deaths from other injuries (N = 3,038 at work and 16,037 not at work) and motor vehicle deaths (1,329 at work and 23,777 not at work); these two categories accounted for 84% of all external cause deaths at work.

We formed rates for socioeconomic quartiles by dividing age-specific (5-year categories), year-specific, sex-specific and race-specific numerator data by denominator data. Analyses were conducted via Poisson regression using SAS GENMOD[11]; variances of rate ratios were corrected for overdispersion. A first set of models analyzing for SES (four categories) were adjusted for age (5-year categories), race (2 categories), sex and calendar time (either categoric or continuous). A second set of

TABLE 2.   Number of Deaths from External Causes* and Person-Years†, 1984–1997, Employed Population Age 20–64

| SES Quartiles‡ | Causes of Death | | | | | | |
	All External Causes	Motor Vehicle	Suicide	Homicide	Other Accidents	Medical Complications	Person-Years at Risk (Millions)
1 (Lowest)	106,103	33,192	23,953	20,909	27,225	824	92.3
2	72,338	24,732	19,186	9,465	18,366	589	91.7
3	49,140	16,035	15,059	5,539	12,005	502	99.9
4 (Highest)	34,142	10,849	11,542	3,324	8,038	389	102.4
Total	261,723	84,808	69,740	39,237	65,634	2,304	387.0

* Deaths are for persons age 20–64 obtained from death certificates with usual occupation coded, excluding housewives, military, students, retired, or volunteer. ICD-9th revision codes for motor vehicle deaths are E810–E819, for suicides E950–E959, for homicides E960–E978, for medical complications, E879–E879, E930–E949, and for other accidents E800–E809, E820–E869, E880–E929, and E980–E999. Nineteen percent (48,808) of external cause deaths occurred among women.
† Denominators include all persons age 20–64 reporting a current occupation or an occupation within the last 5 years.
‡ SES defined by occupation and corresponding Nam-Powers scores (based on Census income and education for each occupation). SES quartiles defined by dividing person-time. Cutpoints for quartiles for Nam-Powers scores, for men and women combined, were 33, 52 and 75 by increasing wealth.

models were sex-specific, adjusted for age, race and calendar time, and included variables for sex-specific SES quartiles.

To evaluate the possibility of confounding by state because of a nonconstant group of states over time, we analyzed data for a set of 10 NOMS states that were consistently available for the years 1984–1996. Results were virtually identical to those using the complete data set, and are not presented.

Results

Table 2 presents the number of deaths from all external causes (N = 261,723) and for five categories of external causes, as well as the corresponding person-years at risk. There is a strong trend of fewer deaths with higher SES in each cause-of-death category.

Table 3 presents the data for all external causes combined, adjusted for covariates. Analysis by SES quartiles shows a clear trend of higher rates for lower SES quartiles for both sexes combined. Sex-specific analyses found a steeper gradient in rate ratios for men (2.9, 2.3, 1.5, and 1.00 by ascending SES quartile) than for women (1.6, 1.0, 1.1, and 1.0).

If we assume that the death rate in the highest SES quartile (men and women combined) could be obtained for lower SES quartiles through intervention and prevention, and if we treat the other three lower SES quartiles as one group, we find that the attributable fraction of external cause deaths attributable to an SES status below the top quartile is 41%.

Death rates from external causes have been dropping an average of 1.3% a year over the 14-year study period, with no pronounced differences in the decline among SES groups. Restricting the data to nonoccupational deaths (93% of all external cause deaths), we found monotonic trends of decreasing rates with higher SES for both men (rate ratios = 3.0, 2.4, 1.4 and 1.0) and women (rate ratios = 1.6, 1.1, 1.1 and 1.0). For deaths at work there was an inconsistent trend in rate ratios by ascending SES quartile for men (2.1, 3.0, 1.6, and 1.00) and no trend for women (0.9, 1.1, 1.0, and 1.0).

Table 4 shows rates and rate ratios for specific causes. There was a strong trend of higher death rates in lower SES quartiles for each specific external cause, and again the trends were stronger for men than women. For men and women combined, the attributable fractions of deaths attributable to having an SES status below the top quartile were 40% for motor vehicle crashes, 32% for suicides, 51% for homicides and 40% for deaths from other injuries.

TABLE 3.   Mortality Rates Attributable to All External Causes, Employed Persons Age 20–64

	Rate Ratio	95% CI	1997 Rate × 10⁵‡
Model 1*			
All			62.3
Men	3.55	3.46–3.63	96.9
Women§	1.00		27.3
Blacks	1.74	1.71–1.79	100.7
Whites§	1.00		57.9
SES quartile 1 (lowest)	2.52	2.45–2.60	92.4
SES quartile 2	1.92	1.86–1.97	70.4
SES quartile 3	1.36	1.32–1.40	49.9
SES quartile 4 (highest)§	1.00		36.7
Model 2†			
Men			
SES quartile 1	2.87	2.78–2.98	124.3
SES quartile 2	2.26	2.18–2.33	97.9
SES quartile 3	1.46	1.41–1.51	63.2
SES quartile 4§	1.00		43.3
Women			
SES quartile 1	1.58	1.52–1.64	35.7
SES quartile 2	1.03	0.99–1.07	23.2
SES quartile 3	1.11	1.07–1.16	25.0
SES quartile 4§	1.00		22.6

* Model 1 includes terms for age, calendar year, sex, race/ethnicity and SES.
† Model 2 is sex-specific and includes main effects for age, calendar year, race and SES groups.
‡ 1997 rates for reference groups are the observed rates. Other rates are derived from model-generated rate ratios.
§ Reference category.

TABLE 4.   Mortality Rates Attributable to Specific External Causes, Employed Persons Age 20–64

SES Quartile*	Motor Vehicle Deaths			Suicide Deaths			Homicide Deaths			Other Injury Deaths‡		
	Rate Ratio	95% CI	1997 Rate × 10^5†	Rate Ratio	95% CI	1997 Rate × 10^5†	Rate Ratio	95% CI	1997 Rate × 10^5†	Rate Ratio	95% CI	1997 Rate × 10^5†
Men												
SES quartile 1	2.73	2.62–2.85	30.6	2.28	2.19–2.38	42.4	4.05	3.76–4.38	14.1	3.45	3.28–3.63	39.7
SES quartile 2	2.48	2.37–2.59	27.8	1.84	1.77–1.92	34.2	2.61	2.43–2.82	9.1	2.52	2.40–2.65	29.0
SES quartile 3	1.54	1.47–1.61	17.2	1.33	1.28–1.39	24.2	1.61	1.48–1.74	5.6	1.53	1.45–1.61	17.6
SES quartile 4§	1.00		11.2	1.00		18.6	1.00		3.5	1.00		11.5
Women												
SES quartile 1	1.55	1.47–1.64	14.2	1.24	1.16–1.31	7.2	1.29	1.25–1.32	2.6	1.78	1.67–1.91	9.1
SES quartile 2	1.02	0.96–1.08	9.2	0.94	0.89–1.00	5.4	1.01	0.97–1.04	2.0	1.07	0.99–1.54	5.5
SES quartile 3	1.10	1.03–1.16	10.0	0.93	0.87–0.99	5.4	1.07	1.04–1.11	2.1	1.19	1.03–1.21	6.1
SES quartile 4§	1.00		9.2	1.00		5.8	1.00		2.0	1.00		5.1

* Quartile 1 is the highest SES, quartile 4 is the lowest. Model is sex-specific and includes main effects for age, calendar year, race and SES groups.
† 1997 rates for referent groups are the observed rates. Other rates are derived from model-generated rate ratios.
‡ Includes falls, poisonings, drownings, death by fire; excludes medical complications.
§ Reference category.

We divided motor vehicle deaths from 1993–1997 into those occurring at work (5%) or not (95%). A trend of more motor vehicle deaths with lower SES was seen for the deaths occurring outside of work, especially for men (rate ratios = 2.9, 2.5, 1.6 and 1.0 by ascending quartile of SES). Corresponding rate ratios for women were 1.7, 1.2, 1.1 and 1.0. No clear or consistent trends by SES were seen for motor vehicle deaths at work (men = 1.2, 4.2, 1.2, and 1.0; women = 0.9, 0.9, 1.0, and 1.0).

We also analyzed the category of other injury deaths for deaths at work (16%) and deaths away from work (84%) for 1993–1997. For men there were strong SES differences at work (rate ratios = 3.4, 3.4, 1.8, and 1.0, for lowest to highest SES) and off work (rate ratios = 3.7, 2.5, 1.4, and 1.00), whereas for women there was little trend at work (rate ratios = 1.2, 1.8, 0.9, 1.0), but an increase for lowest SES group off work (rate ratios = 1.7, 1.1, 1.0, 1.0).

We also analyzed data for deaths attributable to medical complications (N = 2304), composed of deaths attributable to medical procedures (N = 2,012; 79% occurring in hospitals) or to incorrect dosage of medication (N = 292; 50% occurring in hospitals). SES again played an important role among men (rate ratios and 95% confidence intervals by lowest to highest SES, 2.2 [1.9–2.6], 1.5 [1.3–1.8], 1.4 [1.2–1.7], 1.0), but had only a modest effect among women (1.3 [1.1–1.6], 1.1 [1.0–1.4], 1.2 [0.9–1.4], 1.0). For men and women combined, the attributable fraction of deaths from medical complications attributable to SES status below the top quartile is 26%.

Additional analyses were run separately for whites and blacks. For most causes the SES patterns were similar in both ethnic groups for all outcomes except suicide. However, statistically substantial interactions (at the 0.05) level between race and SES were found for motor vehicle deaths (both whites and blacks showed strong SES gradients, but the gradient among blacks was less pronounced) and for suicides (the SES gradient among blacks was markedly less than the one among whites).

Table 5 shows the 1997 rates for all external causes combined for each sex-race-SES group. Black males in the lowest SES group had the highest rates. Although there are some inconsistencies, rates tended to be higher for men, for blacks and for lower SES across all comparisons.

Discussion

SES has an important influence on the rate of deaths from external causes among employed people age 20–64 in a large number of U.S. states, which together accounted for approximately 15% of the total U.S. population in this age group (employed and non-employed). Presumably, the SES effect is mediated by more proximate individual or community-wide risk factors associated with SES (such as an individual's alcohol abuse or a community's high crime rate). However, whether or not we can identify such proximate risk factors (and often we cannot), the SES effect is a telling measure of potentially preventable deaths from a public health standpoint.

For all external causes combined, rate ratios for men by ascending SES were 2.9, 2.3, 1.5, 1.0 and 1.6, 1.0, 1.1, 1.0 among women. These gradients are more pronounced than the corresponding SES gradients for all-cause mortality from this same population (for men the all-cause rate ratios by quartile of SES were 2.2, 1.7, 1.4 and 1.0, whereas for women they were 1.3, 1.0, 1.1 and 1.0).

The exclusion of the unemployed from our analysis has probably served to underestimate the differences in mortality rates by SES. Cubbin et al.[12] have shown for all external causes combined in the United States rate ratios of 2.8 for the unemployed and 1.6 for blue collar workers compared with white collar workers.

TABLE 5.   Mortality Rates for All External Causes by Race, Sex, and SES, Employed Persons Age 20–64

Age, Sex, SES Quartile*	Rate Ratio	95% CI	1997 Rate × 10^5†
Black men			
SES quartile 1 (highest)	5.27	5.06–5.50	244.0
SES quartile 2	3.81	3.60–4.03	176.4
SES quartile 3	2.64	2.45–2.85	122.2
SES quartile 4 (lowest)	1.83	1.03–2.04	84.7
White men			
SES quartile 1	2.85	2.76–2.96	132.0
SES quartile 2	2.28	2.20–2.37	105.6
SES quartile 3	1.46	1.41–1.53	67.6
SES quartile 4‡	1.00		46.3
Black women			
SES quartile 1	2.36	2.21–2.52	51.7
SES quartile 2	1.61	1.54–1.67	37.0
SES quartile 3	1.90	1.73–2.08	41.6
SES quartile 4	1.47	1.43–1.79	35.5
White women			
SES quartile 1	1.60	1.54–1.67	35.0
SES quartile 2	1.03	0.99–1.07	22.6
SES quartile 3	1.11	1.06–1.15	24.1
SES quartile 4‡	1.00		21.9

* Model includes terms for age, calender year, and indicator variables for eight race/SES groups.
† 1997 rate for white men and women in SES quartile 4 is the observed rate (× 100,000); other 1997 rates are based on model.
‡ Reference category.

In our data the SES effect is stronger and more consistent among males than females. Males have 3–4 times higher rates than females of deaths attributable to external causes, and it is likely that the factors that increase deaths from external causes in men (*eg*, higher rates of alcohol abuse, higher crime rates, and higher work-related fatality) are factors also associated with SES.

The smaller SES gradient among women might be attributable to greater misclassification of SES based on occupation for women compared with men. We explored this issue by comparing our classification of SES based on Nam-Powers scores to educational attainment, which was available for deceased persons from 1989 to 1997 on about 80% of death certificates. The mean Nam-Powers scores for men who died by category of increasing education (less than high school, some high school, high school graduate, some college, college graduate) were 37, 39, 46, 59 and 76, whereas for women who died they were, respectively, 24, 28, 42, 56 and 74. These data suggest a reasonable correlation between our SES variable based on occupation and attained education, in turn suggesting reasonable validity for our SES variable for both men and women. However, despite the agreement between occupation-based SES and education for women, occupation may still be a less accurate SES indicator for women than men, because women may have more frequent job changes, and more time out of the labor force because of child raising. Another possibility is that household income may be more important for predicting mortality than an individual's occupation, and household income may be more accurately represented for men than women. More misclassification of SES for women could contribute to weaker observed SES gradients.

In support of this explanation, others have noted similar SES gradients for males and females after excluding married women.[13]

Blacks and whites show similar effects of SES on injury mortality, both having higher rate ratios for lower SES groups for all categories of external causes. Nonetheless, blacks have a 74% higher rate of death from all external causes even after adjusting for SES. This does not appear to be attributable to lower SES among blacks compared with whites within SES quartiles (*ie*, residual confounding). The black/white rate ratio remains virtually unchanged with finer stratification of SES; for example, for blacks compared with whites, stratification by SES deciles instead of quartiles results in a 73% higher death rate for all external causes; the same phenomenon is seen for all specific external cause categories. Therefore there would appear to be an independent effect of race on external cause mortality above and beyond SES; this independent effect of race has been reported by other authors for both external and other causes of death.[14]

The literature regarding SES and overall external cause mortality is sparse, but generally consistent with our results. Cubbin *et al.*[12] conducted another analysis of all external causes based on U.S. data using a much smaller sample size (1300 deaths), but covering approximately the same time period and age group (18–64 years). They found that men in the lowest-income groups among men had a two-fold age-adjusted death rate from all external causes compared with the lowest-income groups, with a consistent trend of decreasing rates with higher income. The gradient among women was less, with an approximately 50% increase for the lowest-income group, with little trend for middle-income groups. These findings are quite similar to our own. Likewise similar was the approximately 60% higher rate for blacks compared with. whites, and the approximate three-fold increase in rates for men compared with women. Two other U.S. studies, using somewhat different designs, have also found similar SES effects for external causes.[15,16]

Regarding motor vehicle deaths, we found a strong SES gradient for men; among women an excess was only observed in the lowest SES group. Two other studies found a similar relation between motor vehicle fatality and SES.[12,17] Loomis[18] has noted that transportation-related occupations had higher rates of fatal crashes. However, our data did not suggest that the overall SES gradient for motor vehicle deaths was much influenced by blue collar occupational risk, in that only about 5% of motor vehicle deaths oc-

curred at work in our data. Risk factors for fatal crashes include older age of the vehicle, failure to use a seat belt, alcohol abuse, the use of less crash-worthy vehicles[19] and driving on rural roads.[20] Braver[17] has shown that lower SES victims of fatal crashes were less likely to use seat belts less and had higher blood alcohol levels. The relation of SES to other risk factors remains to be explored. It may be that poorer people drive more on rural roads and drive older less expensive vehicles with fewer safety features, making them less crash-worthy.

We found a strong SES gradient for suicide for men, although only a weak one for women. Cubbin et al.[12] found little SES effect for suicide for either sex, based on 300 deaths. Lampert et al.[21] (1000 male suicides) and Kellerman et al.[22] (400 suicides) found strong inverse SES gradients, as did the Centers for Disease Control[23] using vital statistics data and education. Overall, the majority of U.S. studies indicate that suicides rates are higher among males with lower SES, although this SES association may be absent for females. Stress and mental illness, both associated with lower SES, are likely to be factors in suicide rates.

Regarding homicide, we found a very strong SES gradient for males and a weak one for females. These findings are consistent with four other U.S. studies in the literature.[12,23,24,25] Homicide rates in our data and in the entire United States began decreasing in the 1990s, parallel with an improving U.S. economy and with a decrease in all serious crime.

The category of "other injuries" is by definition heterogenous, including among its major causes in 1998 falls (35%), poisoning (11%), drowning (7%) and fire (5%). This category showed the same pattern as other categories of external injuries, ie, a strong SES gradient among males and a weak one among females, concentrated in the lowest female SES quartile. Cubbin et al.[12] found a four-fold difference in rates for this category for the lowest income compared with the highest among males, and a 50% increase among females; both of these findings closely parallel our own.

In summary, we have found that all major categories of death from external causes among ages 20–64 are related to SES for both men and women. We estimate that approximately 41% of such deaths are preventable if those in the lowest three quartiles of SES had the same income and education as those in the top quartile of SES.

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