Premature Mortality in the United States: The Roles of Geographic Area, Socioeconomic Status, Household Type, and Availability of Medical Care

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ABSTRACT

Objectives. This study examined premature mortality by county in the United States and assessed its association with metro/urban/rural geographic location, socioeconomic status, household type, and availability of medical care.

Methods. Age-adjusted years of potential life lost before 75 years of age were calculated and mapped by county. Predictors of premature mortality were determined by multiple regression analysis.

Results. Premature mortality was greatest in rural counties in the Southeast and Southwest. In a model predicting 55% of variation across counties, community structure factors explained more than availability of medical care. The proportions of female-headed households and Black populations were the strongest predictors, followed by variables measuring low education, American Indian population, and chronic unemployment. Greater availability of generalist physicians predicted fewer years of life lost in metropolitan counties but more in rural counties.

Conclusions. Community structure factors statistically explain much of the variation in premature mortality. The degree to which premature mortality is predicted by percentage of female-headed households is important for policy-making and delivery of medical care. The relationships described argue strongly for broadening the biomedical model. (*Am J Public Health.* 1999;89:893–898)

Premature mortality has been proposed as an important measure to guide health policy. According to a report issued by the US General Accounting Office in 1996, "premature mortality is the best single proxy for reflecting differences in the health status of states' populations."[1(p2)] Increased life span, the corollary of potential mortality, was the first goal set for the nation in *Healthy People 2000*.[2] Years of potential life lost was the measure used in 1995 revisions of *Healthy People 2000*[3] and in draft objectives for *Healthy People 2010*[4] to describe disparities among states and selected populations. This measure is seldom used, however, as a guide for policy-making at the state or local level. We calculated years of potential life lost to measure premature mortality at the county level and to indicate where health is poorest in the United States. Using a multiple regression model, we then explored effects of socioeconomic and health resource factors on premature mortality.

Although medical advances are commonly believed to be responsible for improvements in health and life expectancy in the United States during the past century, many studies have established strong associations between socioeconomic factors and death rates.[5–20] We considered socioeconomic factors to explore why death comes early. Although we included variables for hospital and physician availability, our statistical model shows how attributes of community structure and area explain variation in premature mortality.

Methods

Measurement of Dependent Variable

Age-adjusted years of potential life lost were calculated for 3073 counties in 49 of the 50 states in the United States. Alaska and 8 counties in other states were excluded because of missing data. We measured premature mortality as life-years lost before 75 years of age. We used 75 years because it approximates current life expectancy in the United States and gives weight to deaths from chronic disease occurring in later life. This age point became a national benchmark with the midcourse revisions of *Healthy People 2000*[3] and is an appropriate metric for gauging the efficacy of primary medical care.

We used mortality data from the Area Resource File, compiled by the Bureau of Health Professions.[21] Death certificates, from which these data were taken, conventionally attribute death according to decedent's county of residence.

Years of life lost before 75 years of age was calculated for each county by dividing the 3-year average number of deaths for the years 1990 to 1992 in each age group by a factor to adjust for variation in age structure and then multiplying by the difference in years between 75 years of age and the midpoint of the age group. The adjustment factors were derived from age-group proportions of the population younger than 75 years in the 1940 Standard Million Population. Years of life lost for all age groups in each county were then summed to produce age-adjusted premature mortality before 75 years of age

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for the county and aggregations of interest. Years of potential life lost before age 75 was expressed as a rate per 10 000 population younger than 75 years. MapInfo 5.0 (MapInfo Corp, Troy, NY) was used to map premature mortality.

Unit of Analysis

The county was the unit of analysis. Counties were classified as metropolitan, urban, or rural by collapsing the 10 categories of the 1995 US Department of Agriculture Rural-Urban Continuum Codes. This classification produced 816 metropolitan counties, 852 urban counties, and 1405 rural counties.

Model

Multiple regression was used to assess the effects of independent variables on premature mortality. The field model of Evans and Stoddart was used as a theoretical guide for the analysis.[22,23] In our model (Figure 1), we posited that both social environment and availability of health services affect premature mortality.

Others have used age, race, income, and education as socioeconomic factors in such studies. Our expanded model included chronic unemployment, vacant housing, local government spending, and local welfare spending as community structure variables. We also included the proportion of family households headed by women with children (no spouse present) as an indicator of community structure. Twenty-three percent of children younger than 18 years live in female-headed households in the United States (16 million). This proportion has more than doubled since 1970.[24]

The model suggests that health service and community structure variables affect the young and old in different ways. Health service variables are most likely to affect mortality among older people, and community structure variables are most likely to affect mortality among younger people. Children living in female-headed households are 5 times more likely to be poor than those living with both parents.[25] Half of these children live in poverty,[25] and they are much more likely to die young.[26]

Regression Analysis

Years of potential life lost before 75 years of age was regressed on sequentially expanded models of the independent variables thought to be associated with premature mortality. In the first stage of the model, we used 6 independent variables typically employed in similar studies to predict premature mortality. In the second stage, we expanded the model by adding specific racial minority groups as independent variables, dichotomizing physicians as specialists or generalists, and introducing 4 more socioeconomic variables. White population percentage was excluded in the expanded model for simplicity and to minimize collinearity. In the third stage, we introduced synthetic variables to explore interactions of 2 variables contributing most to explanation in the model. We then used the stage 3 model separately for the metropolitan, urban, and rural classifications of counties. Finally, we used 2-way analysis of variance to discern how the variables interact to predict premature mortality.

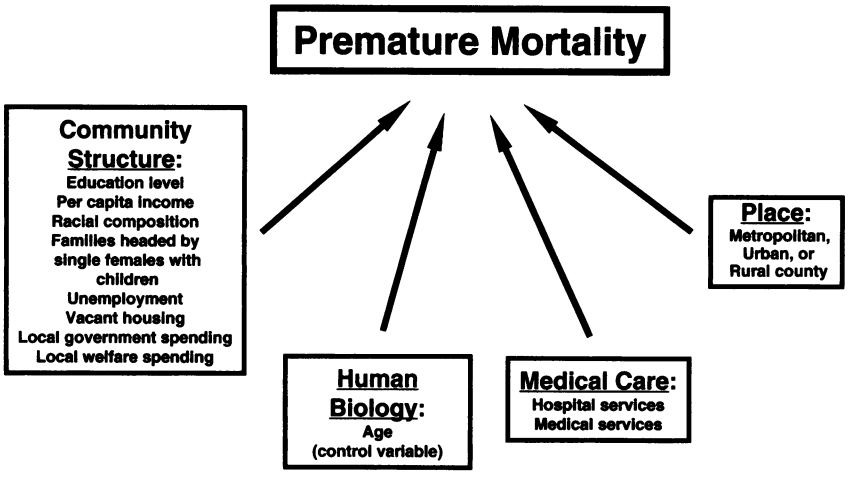


FIGURE 1—Model of factors predicting premature mortality for multiple regression analysis.

Measurement of Independent Variables

To measure the impact of availability of medical care, we considered, as have others, number of hospital beds and physicians. Earlier studies found unexpected positive relationships between mortality and the availability of health care resources (i.e., areas with more hospital beds and physicians are likely to have higher mortality rates).[5,7,10,19] Recent studies, however, have suggested an association between availability of primary care physicians and lower mortality.[27–29] In this study, we considered availability of all active physicians in a county, as well as the availability of generalist and specialist physicians separately. Generalists were defined as those involved in general practice, family practice, general internal medicine, and pediatrics. Availability in terms of all 3 variables was measured as physicians per 10 000 population. Availability of hospital care was defined as beds per 10 000 population. Data for all health service variables are for the year 1990.

Although premature mortality was age adjusted, we suspected that age structure might have an independent effect; therefore, we included percentage of county population older than 65 years in 1990 as a control variable. Race was defined as percentage of county population in each race category in 1990. To measure historical effects of community structure factors on premature mortality, we used 1980 data or averaged data from previous years. For the education variable, we used the proportion of the county's population that was 25 years or older and had fewer than 9 years of education in 1980.

Income reflected the average of per capita income in the county in 1980 and 1990. Chronic unemployment rates were the averages of rates for 1975, 1980, 1985, and 1990. Vacant housing reflected the average percentage of houses reported vacant in 1980 and 1990. Local government spending and local welfare spending were averages of per capita spending in 1977, 1982, and 1987. The proportion of family households headed by women with children (no spouse present) was the average of 1980 and 1990. Data were derived from either the *Area Resource File*[21] or *USA Counties 1996*.[30]

Because these data represented virtually all counties in the country, the probability of drawing an incorrect conclusion was not a statistical issue. Values for statistical significance may be of interest to readers in gauging effect size, but we used a standardized partial regression coefficient (β) of .05 or greater as a threshold for substantive significance. For each multiple regression procedure, all independent variables were entered in a single step.

To discern interactions of other independent variables with percentage of households

headed by women, we constructed interaction terms by multiplying the difference between observed values and respective means of each variable in the term.[31] Variables with interaction effects greater than our threshold for a substantial effect were retained in the expanded model. Two-way analysis of variance was then used to specify interaction effects while restricting the analysis to sets of 2 independent variables. Values for these variables were recoded into 3 equal categories: high, medium, and low.

Results

Table 1 shows descriptive statistics for the dependent and independent variables for all counties and those classified as metropolitan, urban, and rural. With 1991 as the midpoint of the 3-year average, the premature mortality rate for all counties was 869.8 per 10 000 population. The rate for rural counties was the highest (890.8). Premature mortality rates for the urban (868.6) and metropolitan (867.5) counties were virtually equal. The average rate was highest in urban areas (897.9) and lowest in metropolitan areas (825.9).

The map of years of potential life lost by county (Figure 2) revealed a marked concentration of premature death in the Southeast and Southwest, as well as wide variation across rural counties.

The variables that defined community structure and health service resources varied by geographic area. Metropolitan areas had higher income per capita, more educated citizens, fewer elderly residents, and more doctors per person than the other areas (Table 1). The percentage of family households headed by women was highest in metropolitan areas (7.7%) and lowest in rural counties (5.9%). There was little difference in local government spending per capita but a great difference in local spending for public welfare. Metropolitan counties spent almost twice as much as rural counties on public welfare. More of the housing stock was vacant in rural areas, and residents of such areas were oldest, poorest, and least educated. Furthermore, rural areas had the fewest physicians per person. Unemployment rates were similar (7% to 8%) across county types.

Table 2 presents results of the sequential multiple regression models. The first column (stage 1) features the independent variables included in the "classic" model to explain mortality. This simple model explained 44% of the variation in premature mortality across counties. The strongest effect in the first stage was that of racial composition of the population ($\beta = -0.50$). The higher the percentage of White population in the county, the lower the years of potential life lost. The next strongest predictor was per capita income ($\beta = -0.20$). Counties with a greater percentage of adults at low education levels had more premature mortality ($\beta = 0.18$). As suspected, higher percentage of elderly people had a positive but small relationship to premature mortality ($\beta = 0.05$). Relative availability of hospital beds had no relationship to premature mortality, but number of physicians per 10 000 population exhibited a modest direct relationship with mortality ($\beta = 0.11$). This relationship was contrary to the supposition that greater availability of doctors is associated with longer lives, but it is consistent with previous studies.

TABLE 1—Descriptive Statistics: US Counties

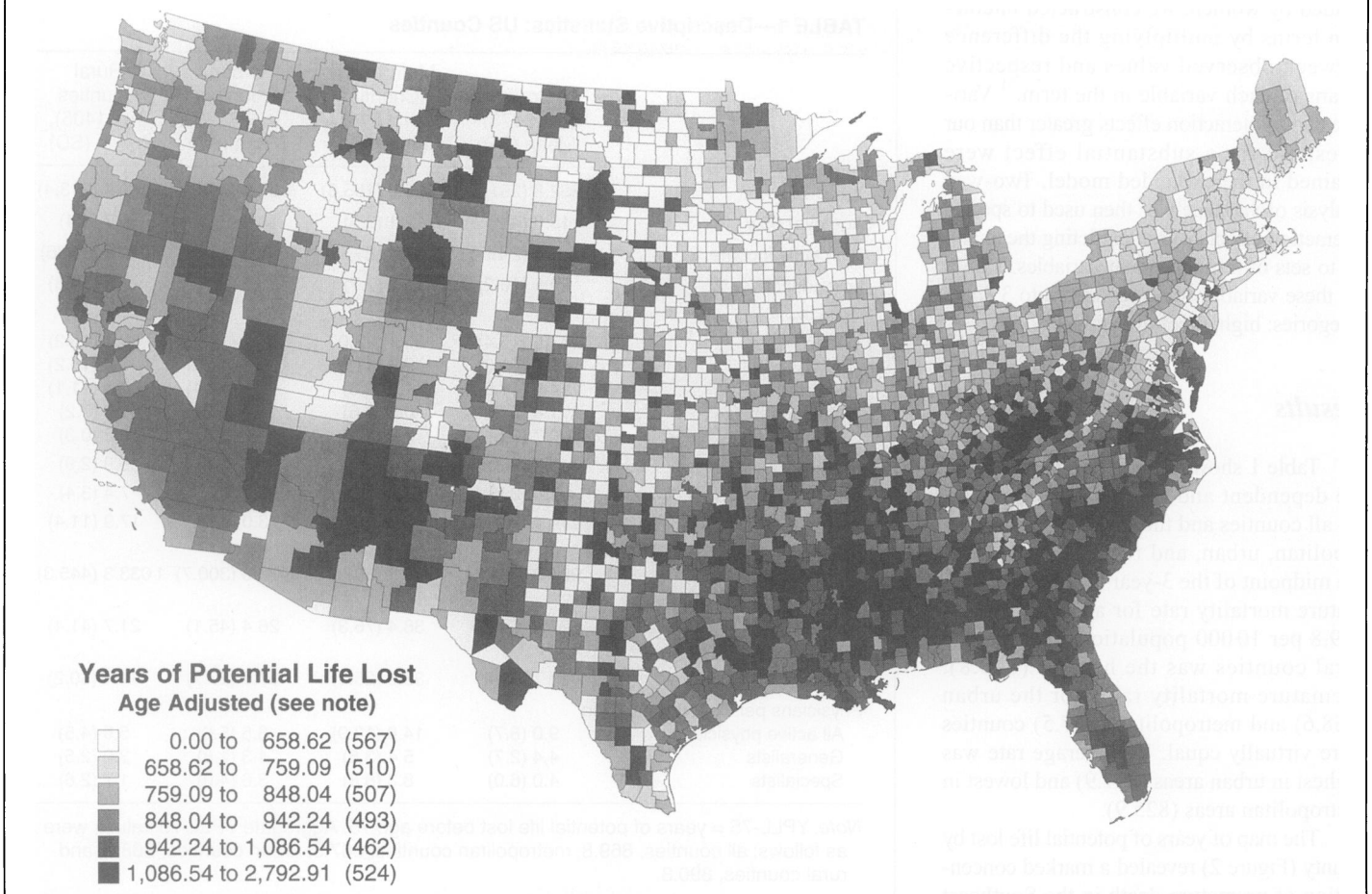
	All Counties (n = 3073), Mean (SD)	Metropolitan Counties (n = 816), Mean (SD)	Urban Counties (n = 852), Mean (SD)	Rural Counties (n = 1405), Mean (SD)
YPLL-75	862.8 (261.3)	825.9 (185.6)	897.9 (213.1)	862.9 (313.4)
Age over 65 y	15.0 (4.3)	12.1 (3.5)	14.9 (3.4)	16.7 (4.4)
Per capita income, $	11 424 (2 497)	13 204 (2 754)	10 950 (1 676)	10 678 (2 236)
Low education, %	24.5 (10.2)	19.2 (7.7)	25.0 (9.1)	27.3 (10.8)
Race, %				
White	87.5 (15.4)	86.1 (13.0)	86.1 (15.9)	89.1 (16.2)
Black	8.6 (14.3)	9.8 (11.9)	9.6 (14.9)	7.2 (15.2)
Hispanic	4.5 (11.2)	4.9 (9.8)	5.0 (12.4)	4.0 (11.1)
American Indian	1.4 (5.8)	0.6 (1.6)	1.5 (5.9)	1.9 (7.2)
Asian/Pacific Islander	0.7 (2.5)	1.4 (3.0)	0.7 (3.5)	0.2 (0.3)
Female households, %	6.7 (2.8)	7.7 (2.7)	7.0 (2.4)	5.9 (2.9)
Unemployment, %	7.4 (2.9)	7.0 (2.0)	8.0 (2.8)	7.4 (3.4)
Vacant housing, %	14.1 (9.9)	8.9 (5.7)	13.0 (7.6)	17.9 (11.4)
Local government spending per capita, $	994.8 (399.4)	986.0 (399.2)	939.6 (300.7)	1 033.3 (445.3)
Local welfare spending per capita, $	27.5 (54.2)	38.4 (76.3)	26.4 (45.1)	21.7 (41.4)
Hospital beds per 10 000 population	39.7 (39.4)	33.6 (25.1)	37.6 (27.7)	44.4 (50.2)
Physicians per 10 000 population				
All active physicians	9.0 (8.7)	14.8 (13.0)	8.5 (5.6)	5.9 (4.5)
Generalists	4.4 (2.7)	5.4 (3.5)	4.3 (1.8)	3.9 (2.5)
Specialists	4.0 (6.0)	8.3 (8.8)	3.6 (4.0)	1.7 (2.6)

Note. YPLL-75 = years of potential life lost before age 75. Aggregate YPLL-75 values were as follows: all counties, 869.8; metropolitan counties, 867.5; urban counties, 868.6; and rural counties, 890.8.

The expanded model (Stage 2) had considerably more explanatory power ($R^2 = 0.54$). With expanded racial categories and other community structure factors added, the income effect disappeared, but the effects of low education and elderly proportion were enhanced slightly. Proportions of Black population and American Indian population had pronounced effects on premature mortality ($\beta = 0.25$ and $\beta = 0.18$, respectively). As in the previous stage, the effect of hospital bed availability was not substantial, but an interesting effect of physician specialty appeared.

The inverse coefficient for availability of specialist physicians ($\beta = -0.12$) suggested a beneficial association with premature mortality, but the coefficient for primary care physicians (generalists) did not. A single community structure variable, unemployment, explained about as much variation in premature mortality as either measure of physician availability. Two community structure variables, local government spending ($\beta = -0.07$) and local welfare spending ($\beta = -0.05$), were inversely related to premature mortality. The variable exhibiting the largest effect on premature mortality in this stage was percentage of family households headed by single women ($\beta = 0.36$).

In stage 3, modest interactions were found between proportion of female-headed households and 3 other community structure variables (percentage of Black population, percentage of American Indian population, and chronic unemployment). Two-way analysis of variance (data not shown) established that higher mean rates of premature mortality occurred in counties with higher proportions of female-headed households in all 3 categories (high, medium, or low) of each of the other interacting variables. Although possibly an anomaly, mean premature mortality was highest in the interaction



Sources. Area Resource File (Washington, DC: Bureau of Health Professions, Office of Research and Planning; 1996) and *USA Counties 1996* ([CD-ROM]. Washington, DC: US Bureau of the Census; 1996).

Note. Values were age adjusted (to the 1940 US Standard Million Population) per 10 000 population under 75 years of age. The total number of counties used in the calculations was 3073; 3063 are portrayed in this map. Classification categories were based on the equal count of the crude US premature mortality rate.

FIGURE 2—Years of potential life lost, by county: 1990–1992 average.

in which American Indian proportion was low and proportion of female-headed households was high. All of the interactions were consistent across geography.

Next, the expanded model was applied to each of the 3 geographic groupings of counties. The model had the greatest predictive power for metropolitan counties, explaining more than two thirds of the variation ($R^2 = 0.71$). It was least effective for the rural counties but still explained more than half of the variation. Female-headed household remained a strong predictor across all 3 classifications of counties. In the stage 3 model used for metropolitan counties, the main effect of female-headed household ($\beta = 0.36$) was the strongest predictor, followed by low education ($\beta = 0.32$) and percentage of Black population ($\beta = 0.30$). Vacant housing had a substantial effect ($\beta = 0.16$). The association of primary care with premature mortality was inverse ($\beta = -0.10$). The coefficient for specialists did not exceed our statistical effect threshold. The interactions of proportion of Black population and proportion of American Indian population with proportion of female-headed households were substantial.

The stage 3 model was also strong in terms of explaining variation in premature mortality among urban counties ($R^2 = 0.69$). The main effect of percentage of Black population provided the best single explanation ($\beta = 0.45$), followed by proportion of female-headed households ($\beta = 0.32$) and low education ($\beta = 0.21$). However, welfare spending, unemployment, vacant housing, elderly population, and percentage of American Indian population also contributed to the explanation. The effect of physician availability (both specialties) was in the desired direction but short of our arbitrary threshold for a substantive effect. A modest interaction effect involving unemployment and female-headed household was evident for urban counties.

In rural counties, the main effects of proportion of female-headed households and percentage of Black population continued to be the strongest predictors ($\beta = 0.38$ and $\beta = 0.26$, respectively). The low education, American Indian population, and unemployment variables contributed, as did availability of physicians. The moderating effect of welfare spending seen in the urban model was also suggested in rural counties. The direction of effect of specialty in the rural counties was opposite that indicated in metropolitan counties.

Discussion

This study reveals curious and compelling relationships not previously considered. We found that there were slightly more years of life lost in rural areas than in urban or metropolitan areas but that southeastern

TABLE 2—Prediction of Age-Adjusted Years of Potential Life Lost Before Age 75 by Sequentially Expanded Models

Independent Variable	Standardized Regression Coefficient (β)					
	Stage 1	Stage 2	Stage 3	Metropolitan	Urban	Rural
Age over 65	0.05***	0.08***	0.11***	0.06*	0.19***	0.06*
Per capita income	–0.20***	0.00	0.00	0.02	–0.02	0.01
Low education	0.18***	0.21***	0.21***	0.32***	0.21***	0.14***
Race proportion						
White	–0.50***	...	...	...	...	...
Black	...	0.25***	0.31***	0.30***	0.45***	0.26***
Hispanic	...	–0.02	–0.01	–0.01	–0.03	–0.01
American Indian	...	0.18***	0.13***	0.04	0.19***	0.13***
Asian/Pacific Islander	...	0.00	0.00	0.05*	0.01	–0.03
Female households	...	0.36***	0.38***	0.36***	0.32***	0.38***
Unemployment	...	0.13***	0.12***	0.09**	0.14***	0.13***
Vacant housing	...	0.04**	0.03*	0.16***	0.09***	0.00
Local government spending	...	–0.07***	–0.03	0.00	0.04	–0.06*
Local welfare spending	...	–0.05***	–0.07***	–0.01	–0.13***	–0.10***
Hospital beds	0.02	0.02	0.03*	0.09*	0.03	0.04
Physicians	0.11***	...	...	...	...	...
Generalists	...	0.11***	0.11***	–0.10	–0.05	0.13***
Specialists	...	–0.12***	–0.14***	0.03	–0.05	–0.09***
Female households × Black	...	...	–0.05*	0.19***	–0.06	–0.12**
Female households × American Indian	...	...	0.08***	0.10**	–0.03	0.07*
Female households × Unemployment	...	...	–0.12***	–0.02	–0.13***	–0.10***
R^2	0.44	0.54	0.55	0.71	0.69	0.52
F	394.8***	226.3***	201.4***	102.6***	98.1***	79.6***
No.	3073	3073	3073	816	852	1405

* $P < .05$; ** $P < .01$; *** $P < .001$.

and southwestern states bear a disproportionate share of this burden. We also found considerable variation by area in the strength of explanation provided by community structure variables.

The relative contributions of low education, percentage of American Indian population, chronic unemployment, vacant housing, and local welfare spending varied markedly, but the predictive power of larger Black populations held across geographic groupings. The strong association between proportion of female-headed households and premature mortality also held across the metropolitan/urban/rural continuum. There were modest to strong interactions as well. In metropolitan and rural counties with high proportions of Black population and female-headed households, the interaction predicted additional premature mortality. Chronic unemployment was a predictor, not only by itself but also in combination with high proportion of female-headed households, particularly in urban and rural counties. Perhaps community structure provides more social cohesion or collective efficacy in metropolitan areas,[32] which ameliorates trends toward increasing mortality.[33] The substantial associations of the community structure variables with premature mortality certainly require further examination.

Greater availability of physicians showed little statistical association with longer life. In the classic model, with physicians undifferentiated by specialty, the small effect was not in the desired direction. In the expanded model for the United States in the aggregate, the statistical association of specialist availability with premature mortality was in the expected direction and was substantive. The association shown for generalists was in the expected direction and substantive for metropolitan counties; for the rural counties, it was positive. These findings also require further examination.

Why does the presence of specialists contribute to longer life in rural but not metropolitan areas? It is possible that a critical mass of medical as well as social infrastructure in metropolitan areas contributes to longer life. There may be a better organized array of health resources in which the generalist works effectively, whereas in rural areas the generalist's contribution may not compensate for inadequate resources and disproportionate severity of disease. Current recommendations include increasing the percentage of physicians trained as generalists to 50%,[34–37] doubling the current proportion of generalists, and distributing these physicians more equally to rural areas.[38] Skeptics may ask whether greater availability of medical care will make much difference in the health of communities. Our analysis showed little relationship.

This inquiry has a number of limitations. The first is ecological. Our approach captured the sociodemographic characteristics of 248 million people in 3073 counties. We assumed homogeneity in socioeconomic status and resource characteristics within each county. Characteristics of individuals, their access to care, and age at death were not linked. A second important limitation is that the variable describing female-headed household did not account for the age, race, or marital status of the female head of household. Children of never-married mothers live in circumstances much different from those of children living with divorced mothers.[39] We also acknowledge that the health service variables did not describe other important aspects of a county's health system. Another important limitation is the use of race classifications. We wonder, as do others, whether or not race actually measures anything important.[40–42] Data on social class would be more useful but are not available.

Conclusions

We found that premature mortality is a practical metric for comparing health status of counties. Race and education were confirmed as strong predictors of early death, but we found that chronic unemployment also

predicts premature mortality at the county level. Geography is a factor, but there is considerable variation in how strongly community structure variables predict premature mortality. We have shown how important a single factor, female-headed household, is in predicting aggregate life span in a population. The associations are compelling. Premature mortality correlates with and is well predicted by community structure. Proportion of female-headed households could be a summary indicator of that pathology.

As federal and state policymakers seek to improve health, they should consider whether resources might not be better spent on programs to reduce social pathology (e.g., education, job training, economic development, and adolescent pregnancy prevention) instead of on more medical care. Social policy can diminish, cause, or exacerbate the social factors that underlie illness as we choose or choose not to encourage family integrity, improve education and economic equality, discourage teen pregnancy, and so forth. Rudolf Virchow, the father of modern pathology, stated 150 years ago that "medicine is a social science, and politics is nothing more than medicine on a large scale."[43] For physicians and other health providers, the data we present strongly suggest that more attention should be given to the social components of the biopsychosocial model. Physicians and others should learn how to become more effective in health promotion and prevention to encourage patients to change behaviors. They might also become advocates for social and political interventions beyond the medical model. □

Contributors

C. J. Mansfield contributed to study conception and design, data analysis and interpretation, and writing the first draft of the paper. J. L. Wilson contributed to study design and data analysis and interpretation. E. J. Kobrinski contributed to study conception and design and data interpretation. J. Mitchell contributed to data analysis and interpretation. All authors revised the article and approved the final version.

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