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SOCIOECONOMIC DIFFERENTIALS IN CHILD MORTALITY IN THE UNITED STATES

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Socioeconomic Differentials

in Child Mortality in the United States

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ABSTRACT

Despite considerable reason for scholarly and policy interest in socioeconomic mortality differentials, research on socioeconomic differences in child and teenage mortality in the United States has been neglected because of severe data limitations. Exploiting data obtained for other purposes, this paper reports for the first time on the relationship between socioeconomic group and mortality among children and teenagers. Socioeconomic mortality differentials among children are large--at least as large as those among adults. The major source of socioeconomic mortality differences among children is apparently differential risk to accidental death. Within the child population, the strength of socioeconomic effects varies directly with the relative importance of accidents as a component of overall mortality.

Socioeconomic Differentials in
Child Mortality in the United States

Mortality differentials among socioeconomic groups are an enduring concern of social demographers (Antonovsky, 1967; Meyers, 1978; Fox, 1979; Vallin, 1979). In most populations for which mortality data are classified by the education, occupation, income or social class of the deceased, persons from higher socioeconomic groups experience lower mortality. Mortality differentials among socioeconomic groups show the potential for future mortality reduction, since a reallocation of social and economic resources may reduce mortality among all groups to the level of the most advantaged groups (Kitagawa, 1972). When socioeconomic mortality differentials can be isolated with precision (such as for specific occupations, for example), they may reveal means of reducing environmental sources of mortality. Socioeconomic mortality differences, moreover, are informative indexes of social inequality in their own right. Recent research on differential mortality in the United States has furthered understanding of socioeconomic factors that affect mortality. The 1960 Matched Records Study (Kitagawa and Hauser, 1973) and, more recently, the 1973 CPS-Social Security Administration match data (Rosen and Taubman, 1979) have revealed sizeable variation in adult mortality by educational attainment and income. And the 1964-66 National Natality and Infant Mortality surveys have documented substantial effects of maternal education and poverty status on infant mortality (Kitagawa and Hauser, 1973; Gortmaker, 1979).

A gap in the documentation of socioeconomic effects on mortality in the United States is socioeconomic variation in mortality of persons aged 1-20. Apart from analyses of aggregate areal data,[1] there has been no research on the effects of socioeconomic factors on the mortality of children and teenagers. Except for England and Wales, this topic has been neglected throughout the developed world (Meyers, 1978; Fox, 1979; Vallin, 1979). For the United States, data from which to compute directly the mortality of children from families of differing socioeconomic levels do not exist. No socioeconomic information is included on the death certificates of children (with the exception of those older teenagers whose "usual occupation" is reported). Nor have children's death certificates been linked to census information on the socioeconomic conditions of their families.[2] High-quality data on family socioeconomic characteristics for a sample of deceased children are needed. But because child deaths are relatively rare events, such data would be costly to obtain. Until funds are available for mounting such an effort, the limited available data must be used to obtain low-cost estimates.

This paper reports analyses of socioeconomic differentials in mortality of persons under 20 in the United States. Exploiting a neglected source of child mortality data, the June 1975 Current Population Survey (CPS), which obtained women's accounts of the survival status of their children, it reports child mortality estimates specific to the educational attainment of children's mothers and to the income of their families and compares the strength of socioeconomic mortality differentials among children and teenagers to those observed for adults in the 1960 Matched Records Study (Kitagawa and Hauser, 1973). In addition, this paper develops a hypothesis to explain where and when socioeconomic differentials in child mortality are strongest. It demonstrates that the strength of socioeconomic differentials in child mortality varies significantly among subgroups of the under-20 population, and this variation is approximately proportional to the importance of accident mortality as a cause of death within subgroups.

That socioeconomic variation in child mortality has not been studied for the United States may reflect the unexamined assumption that because child mortality is so low, socioeconomic differentials are unimportant. There are, however, reasons for interest in the extent, pattern, causes, and trends of a relationship between socioeconomic level and child mortality. First, although child mortality rates in the United States are lower than infant and adult rates and lower than at any time in the past, an unfavorable gap in child mortality levels between the United States and several European nations persists (United Nations, 1978). Just as for adults, significant socioeconomic child mortality differentials would indicate a path for further mortality reduction (Kitagawa, 1972). Second, where socioeconomic child mortality differentials have been studied, such as in England and Wales, they have been found to be substantial (Great Britain, Office of Population Censuses and Surveys, 1977). Third, although socioeconomic child mortality differentials have not been documented for the United States, they may be at least as large as those for other age groups and may be increasing over time, possibilities discussed more fully below. Fourth, there is potential for further child mortality reduction inasmuch as a high proportion of child deaths result from environmental causes, especially accidents. In 1975, for example, 51 percent of deaths to persons aged 5-14 resulted from accidents (Garfinkel, Chabot, and Pratt, 1975). Knowledge of the extent to which mortality varies by socioeconomic level may suggest ways to target efforts to reduce environmentally caused child deaths. Finally, although it is morally problematical to select the ages at which greatest efforts at mortality reduction should be directed, the total years of life saved from reduction in child mortality will be greater than from similar reductions in adult mortality (Vaupel, 1976).

SOURCES OF SOCIOECONOMIC DIFFERENTIALS

Socioeconomic differentials in survival rates arise from many sources: differences in exposure to mortality risks in the workplace; in diet, housing, recreation, and clothing; in access to health care; and in ability to prevent or respond to medical crises because of differences in education and access to health information. The processes which generate mortality differences among socioeconomic groups would be complex to describe even were detailed life histories of the deceased recorded. Since such data are scarce, no empirical examinations of the reasons for socioeconomic mortality differences have been carried out (Fox, 1979).

Insight into socioeconomic variation in mortality can nonetheless be obtained from information on how major <u>causes</u> of children's deaths vary by socioeconomic level. Although unavailable for the United States, such information can be obtained for England and Wales because fathers' occupations are reported on children's death certificates. Table 1 shows the cause composition of mortality of children aged 1-14 in England and Wales in 1970-72 and the United States in 1975, and standardized mortality ratios by occupational class for England and Wales. By far the biggest

Table 1

Major Causes of Children's Deaths, England and Wales (1970-72) and United States (1975) and Class Differences in Mortality, England and Wales (1970-72), for Children Aged 1-14

Cause of Death, by Sex	Percentage of All Children's Deaths, England & Wales, 1970-72	Standardized Mortality Ratios for Children by Occupational Class of Father, England & Wales, 1970-72* I	II	IIIn	IIIm	IV	V	SMR(V) / SMR(I)	Percentage of All Children's Deaths, United States, 1975
Boys									
All causes	100.0%	74	79	95	98	112	162	2.19	100.0%
Neoplasms	15.9	99	103	125	98	96	135	1.36	11.2
Respiratory	12.5	101	66	101	105	108	136	1.35	5.4
Congenital anomalies	11.7	76	100	91	104	123	114	1.50	7.0
Accidents, poisonings, and violence	38.6	44	67	76	92	114	208	4.73	56.4
Other	21.4								20.0
Girls									
All causes	100.0	89	84	93	93	120	156	1.75	100.0
Neoplasms	16.7	104	107	124	98	102	117	1.13	13.0
Respiratory	15.5	87	83	79	96	135	150	1.72	7.5
Congenital anomalies	15.6	102	90	105	94	123	101	.99	10.4
Accidents, poisonings, and violence	26.0	63	66	72	84	120	214	3.40	43.7
Other	26.2								25.4

Sources: Great Britain, Office of Population Censuses and Surveys (1977) and U.S. Department of Health, Education, and Welfare (1979a).

*Occupational classes are I - professional; II - managerial and lower professional; IIIn - skilled nonmanual; IIIm - skilled manual; IV - partly skilled; V - unskilled.

component of child mortality in both England and Wales and the United States is mortality resulting from accidents, poisonings, and violence. (Further examination of this category shows that it consists largely of deaths from motor-vehicle-related accidents, both to pedestrians and to motor-vehicle passengers.) Although death rates from all causes are inversely related to parents' occupational class, this relationship is much stronger for accidents than for any other major cause. Accidents are the major cause of death to vary with socioeconomic class as well as the major cause of death overall. Thus socioeconomic differentials in access to safe recreational areas, in exposure to hazardous driving conditions, and, for the younger children, in parental vigilance may be important sources of the variation in child mortality among socioeconomic groups. Of course, the pattern for the United States may differ radically from that of England and Wales, but this is unlikely given the similar mortality levels in the two countries. For adult males in the United States, there are stronger socioeconomic differentials in mortality for accidents than for any other cause, although for females the pattern is less clear (Kitagawa and Hauser, 1973). Thus a major (possibly <u>the</u> major) source of socioeconomic variation in child mortality is differential accident mortality rates.

This argument has three general empirical implications. First, groups for whom accidental deaths constitute a higher proportion of all child deaths should exhibit stronger socioeconomic differentials. Socioeconomic differentials should be stronger for men than for women, for blacks than for whites (at some age groups), and for teenage children than for younger children, reflecting that men, blacks, and teenagers have higher proportions of deaths from accidents. Second, socioeconomic mortality differentials for children may be stronger than for adults. In 1975 the proportion of deaths resulting from accidents in the United States ranged from 40 percent for children aged 1-4 to a maximum of 56 percent for youths aged 15-19 and then declined sharply with age, averaging only 14 percent for the 20-65 age group (Garfinkel et al., 1975). Of course socioeconomic conditions affect mortality via other causes, particularly for adults, who have experienced for many years environmental conditions that vary with class. Nonetheless, socioeconomic mortality differentials for children may be at least as large as those for adults. (For England and Wales, this appears to be the case--Vallin, 1979.) Finally, socioeconomic differentials may be increasing over time, even though child mortality has declined. Between 1950 and 1975 the proportion of children's deaths resulting from accidents rose steadily from 26 to 39 percent for those aged 1-4 and from 37 to 51 percent for those aged 5-14 (Garfinkel et al., 1975; U.S. Department of Health, Education, and Welfare, 1979a). If socioeconomic mortality differentials are much stronger for accidents than for other causes, then as the proportion of child deaths from accidents increases, socioeconomic differentials in child mortality will increase as well. The first two of these implications are examined below. The third is explored in ongoing work (Mare, 1980).

DATA AND MEASUREMENT

The estimates of socioeconomic differentials in child mortality reported in this paper are based upon the June 1975 CPS, a survey of approximately 45,000 households in the U.S. civilian noninstitutional population. The survey obtained fertility histories for ever-married women aged 75 and under and a subsample of single women aged 18 to 75. The women were asked their numbers of children ever born and, where applicable, the date of birth, sex, and current location of their first three and last two children (U.S. Department of Commerce, 1976). For up to five of the women's children, information on location was obtained through the question:

Where does the child live now?

Child resides in this household. . . .o

Child resides elsewhere:

in (his/her) own household . . . . .o

with relatives: grandparents. . . .o

father. . . . . . .o

other . . . . . . .o

Child deceased . . . . .o

Don't know . . . . .o

Thus the survey provides direct responses on the survival status of up to five children for each woman. Respondents reported date of birth and location of approximately 77,000 children, of whom 3000 had died. Many of the respondents were at advanced ages in 1975, however, and thus their children may have died well past childhood. Of the 77,000, 40,290 were born more recently than 1955, and of these, 780 were reported deceased. These 780 observations, in concert with living children aged less than 20 in 1975, are the basic observations for the analysis.

Women did not report the dates of death for deceased children, but rather whether or not the child was dead in June 1975. Thus it is not possible to calculate age-specific death rates directly from the data. But since the child's birth date is obtained, the survey measures whether or not the child has died by a specifiable age and, in the aggregate, measures the proportion of children surviving to a specific age interval. The principal mortality measures used in this analysis are ratios of deceased children born x to x + n years before June 1975 to children born in that interval, that is $(1 - \frac{{}_nL_x}{n\ell_0})$ where ${}_nL_x$ is the number of persons aged x to x + n in the life table population and ℓ_0 is the radix of the life table. The ${}_nL_x$ calculated for various age intervals, however, are not a life table population for a period or a cohort because each ${}_nL_x$ is based on a unique sequence of age-specific death rates over the x to x + n years prior to the survey. These measures nonetheless describe approximately the age pattern of child survival (provided that trends in mortality are not extreme). Although the $(1 - \frac{{}_nL_x}{n\ell_0})$ are used for most of the analysis for comparing child and adult socioeconomic mortality differentials, probabilities of dying between successive ages are also inferred using procedures discussed below.

The Appendix evaluates the June CPS mortality data. For white respondents, proportions dying are underestimated in the CPS by approximately 25 percent, which is similar to matching failure rates in major matching studies for adult mortality (Kitagawa and Hauser, 1973; Rosen and Taubman, 1979). For blacks, however, the CPS underestimates survival proportions by approximately 50 percent. Estimated mortality differentials may be attenuated by undercount (see Appendix). The underestimates of mortality for whites probably do not seriously distort estimated differentials, but for blacks the results should be interpreted cautiously because the underestimates are so large and the sample of deaths so small.

The CPS provides socioeconomic information on women reporting fertility histories and on their households, including educational attainments, occupations, and current employment of household members, and total family income. The CPS measures pertain to June 1975 and may have changed significantly over the lifetimes of children reported by the women. Family income in 1975, for example, may poorly measure average family economic conditions experienced by children born in 1960. Thus income provides an unsound basis for estimating the association between economic well-being and child survival. The analyses, therefore, focus on the relationship between mother's schooling (measured in grades completed) and child mortality because adult educational attainment is typically stable and measures average socioeconomic conditions experienced during childhood (Kitagawa and Hauser, 1973). Since schooling measures different aspects of socioeconomic status from occupational, income, or labor force measures, and may not reflect all family socioeconomic circumstances that differentially affect mortality, mortality differentials by total family income for those families that reported their income are also presented, but these estimates are less reliable than those by mother's schooling.

SCHOOLING AND INCOME EFFECTS

Table 2 reports percentages of children dead by years since birth, race, sex, and mother's schooling. For most age-race-sex groups there are substantial differentials in percentages of children dead by

Table 2

Percentages of Children Dead and Number of Observations by Mother's Schooling, Years Since Birth, Race, and Sex of Child, and Associations Between Mother's Schooling and Child Mortality ($\ln\alpha$)

Years since Birth, Race, & Sex of Child	Mother's Schooling: Less than 12 Grades — Percentage Dead	Less than 12 Grades — Number of Observations	12 Grades or More — Percentage Dead	12 Grades or More — Number of Observations	$\ln\alpha$*	($\pm 2\sigma_{\ln\alpha}$)
White males						
0-4	1.94%	1034	1.53%	3018	.24	(±.5)
5-9	2.98	1172	1.96	3173	.43	(±.4)
10-14	3.36	1429	1.94	3441	.57	(±.4)
15-19	3.81	1547	2.18	3528	.58	(±.3)
White females						
0-4	1.24	970	0.99	2816	.23	(±.7)
5-9	1.85	1134	1.34	3059	.33	(±.6)
10-14	1.79	1399	1.52	3426	.17	(±.5)
15-19	2.31	1428	1.66	3304	.34	(±.4)
Black males						
0-9	2.34	427	1.41	638	.52	(±.9)
10-19	3.22	621	1.50	532	.78	(±.8)
Black females						
0-9	1.72	405	2.18	643	-.25	(±.5)
10-19	2.94	579	2.47	567	.18	(±.7)

*$\alpha = n_{dl}n_{ah}/n_{dh}n_{al}$, where n_{dl}, n_{ah}, n_{dh}, and n_{al} denote numbers of children dead for mothers with low education, alive for mothers with high education, dead for mothers with high education and alive for mothers with low education respectively within each age-race-sex group ($-\infty < \ln\alpha <$ B). $\ln\alpha = 0$ signifies no association. See Bishop, Feinberg, and Holland (1975) for discussion.

mother's schooling. For example, among white boys whose mothers are high school dropouts, 3.36 percent have died by age 10-14 in contrast to 1.94 percent for boys whose mothers are high school graduates. Because the sample of deaths is small, mother's schooling is dichotomized. More detailed educational classifications (available from the author on request) suggest that child mortality declines monotonically as mother's schooling increases, but that the sharpest contrast is between children of high school graduates and those whose mothers attend but do not complete high school. Lower mortality rates for children of better-educated mothers occur at every age for whites and for black males, but differentials are minimal for black females. The black percentages however, are based on very few deaths (47 for males and 52 for females). Education differentials are apparently stronger for boys than for girls, a speculation borne out by statistical tests (not shown here). The relative size of socioeconomic differentials among age-race-sex groups is measured more precisely in the penultimate column of Table 2, which reports the logarithm of the odds ratio of dead to living children between mother's schooling categories. (For example, $\ln\alpha$ for white boys born 0-4 years before 1975 is $\ln[1.94/(100 - 1.94)]/[1.53/(100 - 1.53)] = .24$.) Large values of $\ln\alpha$ imply a larger disadvantage to children of high school dropouts. This measure is invariant under changes in mortality levels or proportions of mothers in each education group (Bishop, Feinberg, and Holland, 1975), and thus permits comparisons among groups with differing average mortality and differing duration of mother's education. The $\ln\alpha$ show that mortality differentials by mother's schooling are stronger for boys than for girls and suggest that for boys the association is stronger with respect to survival to the teenage years than

Table 3

Percentages of Children Dead and Number of Observations by Annual Family Income, Years since Birth, Race, and Sex of Child, and Assocations Between Income and Mortality (lnα)

Years since Birth, Race, and Sex of Child	Annual Family Income: Less than $10,000 — Percentage Dead	Less than $10,000 — Number of Observations	$10,000 or More — Percentage Dead	$10,000 or More — Number of Observations	lnα*	($\pm 2\sigma_{ln\alpha}$)
White males						
0-4	2.09%	1530	1.40%	2357	.41	(±.5)
5-9	2.89	1245	1.95	2878	.41	(±.4)
10-14	3.51	1282	2.03	3307	.56	(±.4)
15-19	3.98	1156	2.33	3524	.55	(±.4)
White females						
0-4	1.11	1440	1.05	2196	.06	(±.7)
5-9	2.15	1253	1.21	2732	.58	(±.5)
10-14	1.83	1207	1.51	3314	.20	(±.5)
15-19	2.27	1100	1.74	3276	.27	(±.5)
Black males						
0-9	2.28	659	1.05	380	.80	(±1.1)
10-19	2.72	699	1.76	398	.44	(±.9)
Black females						
0-9	1.44	692	3.38	326	-.87	(±1.0)
10-19	2.16	742	3.40	353	-.46	(±.8)

*$\alpha = n_{dl}n_{ah}/n_{dh}n_{al}$, where n_{dl}, n_{ah}, n_{dh}, and n_{al} denote numbers of children dead in low-income families, alive in high-income families, dead in high-income families, and alive in low-income families respectively within each age-race-sex group ($-\infty < \ln\alpha < \infty$). $\ln\alpha = 0$ signifies no association.

for survival up to age 10. The last column of the table shows approximately 95 percent confidence intervals for $\ln\alpha$. Few of the simple associations between mother's schooling and child mortality are by themselves statistically significant, but global effects of mother's schooling on mortality are highly significant, providing clear evidence of socioeconomic effects on children's survival chances.

An alternative socioeconomic indicator is annual family income, which may index familial access to health care and environmental safety more strongly than does maternal schooling. Table 3 reports percentages of children dead by annual family income in 1974-75, for years since birth, race, and sex of child. Income is dichotomized, but more detailed tabulations suggest that the income-mortality relationship is monotonic. Child mortality differentials by family income are similar to those for maternal schooling. Higher-income children have an advantage for all race-sex groups except black girls, and there is a stronger advantage for boys than for girls. Compared to the differentials based on mother's schooling, however, there is less tendency for mortality differentials among family income groups to increase with age among boys, perhaps because family income is a less reliable index of socioeconomic conditions experienced by older children than of those experienced by younger children. Despite the unreliability of the income measurement, however, clear socioeconomic differentials appear for most groups, and income effects are as strong as those for mother's schooling.

In principle, family income indexes economic influences on child mortality whereas mother's schooling measures a more general set of family influences. To see whether either has a predominant influence, consider the effects of income and education simultaneously. Table 4

Table 4

Percentages of White Children Dead by Total Family Income, Mother's Schooling, Years since Birth, and Sex

Years since Birth and Sex	Mother's Schooling	Percentage Dead by Annual Family Income: Less than $10,000	Percentage Dead by Annual Family Income: $10,000 or More	Percentage Dead, Total
Males	<12	2.16%	2.14%	2.15%
0-9	≥12	2.09	1.62	1.74
	Total	2.45	1.70	1.96
Males	<12	4.64	2.87	3.68
10-19	≥12	2.75	1.99	2.13
	Total	3.74	2.18	2.59
Females	<12	1.54	1.69	1.60
0-9	≥12	1.77	1.04	1.23
	Total	1.67	1.13	1.32
Females	<12	1.98	2.16	2.08
10-19	≥12	2.10	1.48	1.59
	Total	2.04	1.63	1.74

shows percentages dead by sex and ten-year age intervals by both family income and mother's schooling for white children, and Table 5 presents goodness of fit statistics for alternative models fitted to the table from which Table 4 was calculated. For boys, there are clear independent influences for mother's schooling and annual family income. The very low value of χ^2 for a model of additive schooling and income effects (one degree of freedom) indicates no three-way interaction among schooling, income, and mortality, but the schooling and income effects together fit the data much better than either alone. For females, the results are less clear. Girls whose mothers graduated from high school and whose families have higher incomes have lower mortality rates than do girls either from low-income families or whose mothers did not graduate from high school. The apparent reversals of socioeconomic mortality differences within the low-education or low-income groups are not statistically significant. The χ^2 values for females do not imply that any single model fits the data better than the others. The test statistics suggest a possible three-way interaction as reflected in the unusually low mortality for girls advantaged on both mother's schooling and income. But the only clear implication of these results is that all socioeconomic effects are weaker for females than for males.

COMPARISON OF ADULT AND CHILD DIFFERENTIALS

There are clear socioeconomic influences on child mortality. But how great are they? In particular, how do patterns for children compare to those for adults who exhibit pronounced socioeconomic differentials? Child mortality differentials may be at least as strong as those for

Table 5

Goodness-of-Fit Statistics for Effects of Mother's Schooling and Annual Family Income on Child Mortality by Age and Sex for Whites*

Sex, Age Group, and Sample (N)	Model	Likelihood Ratio χ^2	Degrees of Freedom	p
Males 0-9	No effect	8.10	3	.04
(8014)	Schooling only	2.57	2	.28
	Income only	2.95	2	.23
	Schooling and income	0.02	1	≥.50
Males 10-19	No effect	26.19	3	.00
(9269)	Schooling only	8.52	2	.01
	Income only	10.22	2	.01
	Schooling and income	0.33	1	≥.50
Females 0-9	No effect	6.22	3	.10
(7622)	Schooling only	4.67	2	.10
	Income only	2.51	2	.29
	Schooling and income	2.09	1	.15
Females 10-19	No effect	4.86	3	.18
(8898)	Schooling only	2.24	2	.33
	Income only	3.17	2	.21
	Schooling and income	1.50	1	.22

*Tests are based on Table 4.

adults. As noted, accident mortality is a larger component of total mortality for children and teenagers than for adults, and socioeconomic mortality differentials from accidents are stronger than for any other cause among children in England and Wales and among adult males in the United States (Great Britain, Office of Population Censuses and Surveys, 1977, Table 1; Kitagawa and Hauser, 1973). It is difficult to investigate this conjecture because socioeconomic mortality differentials cannot be observed for all ages from a single data source. In addition, the meaning of socioeconomic status changes as a person ages: whereas a child's socioeconomic standing is best indexed by parental characteristics, adults' standing is best indexed by their own socioeconomic characteristics, and, for teenagers, the proper index is unclear. It is possible, nonetheless, to compare adult and child socioeconomic differences by constructing comparable measures for whites from the June CPS for children (specific to mother's schooling) and from the 1960 Matched Records Study for adults (specific to their own schooling). Life table functions are available for white adults from Census and Matched Records Study data (U.S. Department of Commerce, 1963, pp. 15-40).[3] Of these, a suitable age-specific mortality index is the probability of death (specific to schooling) between ages x and x + n (${}_nq_x$). Such measures cannot be calculated directly for children but can be inferred from the ${}_nL_x$ based on the CPS and age patterns of mortality in Model Life Tables (Coale and Demeny, 1966). The ${}_nq_x$ for children specific to mother's schooling are estimated by inflating the ${}_nL_x$ for undercount of children's deaths, using the undercount proportions in Table A1 (assuming equal undercount rates for each education group), and using the adjusted ${}_nL_x$ to select Model Life Tables which provide the corresponding ${}_nq_x$'s. Table 6

Table 6

Estimated Probabilities of Dying ($_nq_x$) between Selected Ages by Sex and Schooling and Associations ($\ln\alpha$) between Schooling and Mortality, U.S. Whites*

Age	Males			Females		
	$_nq_x \times 100$			$_nq_x \times 100$		
x to x + n	<12	≥12	lnα‡	<12	≥12	lnα‡
0-5	2.54	1.98	.319	1.86	1.48	.278
5-10	0.32	0.20	.469	0.19	0.13	.409
10-15	0.31	0.18	.561	0.16	0.13	.197
15-20	0.59	0.36	.512	0.29	0.20	.378
25-35	2.24	1.30	.554	1.25	0.86	.378
35-45	4.38	2.71	.497	2.46	1.68	.389
45-55	9.78	7.68	.265	4.90	3.93	.231
55-65	21.05	18.30	.174	12.06	8.51	.388
65-75	40.26	38.12	.090	26.53	21.65	.268

*$_nq_x$ denotes the probability of dying between exact ages x and x + n conditional on survival to age x. Estimates for x = 0, 5, 10, 15 were computed using percentages dead reported in Table 2, adjusted for undercount using the ratios reported in Table A1 to interpolate between model life tables. (See Coale and Demeny, 1966.) Model "West" tables were used in all cases. Estimates for x = 25, 35, 45, 55, 65 were computed from age-sex-schooling specific death rates estimated from the 1960 Matched Records Study (as reported in Kitagawa and Hauser, 1973; and from U.S. Dept. of Commerce, 1963, pp. 15-40). For ages 0-20 "schooling" refers to mother's schooling; for ages 25 and over it refers to individual's own schooling.

‡$\alpha = [{_nq_x}^{<12}(1 - {_nq_x}^{\geq 12})] / [(1 - {_nq_x}^{<12}) ({_nq_x}^{\geq 12})]$. $\ln\alpha = 0$ denotes no association ($-\infty < \ln\alpha < \infty$).

reports the estimated probabilities, including measures of association ($\ln\alpha$) between mortality and schooling specific to age and sex. For each sex-schooling group the $_nq_x$ conform to the typical age pattern of mortality: low mortality during childhood relative to infancy and adulthood. At all ages, however, there is advantage to the higher schooling groups, consistent with the analyses reported above and previous analyses of the adult data (Kitagawa and Hauser, 1973). In simple differences between death probabilities, the largest contrast is between education-specific mortality probabilities at the oldest ages. But these differences reflect the higher mortality of older persons and the greater variance of probability measures toward the center of the (0,1) interval. A preferred measure of socioeconomic differentials is $\ln\alpha$, which is invariant under changes in mortality levels. For males, the negative effect of schooling on mortality exhibits a curvilinear pattern in $\ln\alpha$, which peaks for teenagers and young adults and is lower for the youngest children and older adults. Socioeconomic mortality differences, therefore, are very large in late childhood relative to those at other ages. For women, socioeconomic mortality differences are, on average, smaller than for men and approximately uniform throughout the life cycle. The pattern for women suggests that the role of accidents in mortality levels and differentials is less important for women than for men. For women, accidents constitute a lower proportion of deaths at all ages and are less strongly related to socioeconomic status (U.S. Department of Health, Education, and Welfare, 1979a; Kitagawa and Hauser, 1973). For females as well as males, however, socioeconomic mortality differentials for children and teenagers are at least as strong as those for adults.

ACCIDENTAL DEATH AND SOCIOECONOMIC DIFFERENTIALS

Underlying the interpretation of socioeconomic child mortality differentials advanced here has been the premise that socioeconomic differentials in accident mortality are a major determinant of overall socioeconomic mortality differentials. Table 1 shows this directly for England and Wales, but evidence for the United States must be obtained indirectly. An implication of this argument is, as noted, that socioeconomic mortality differentials will vary in strength among subgroups of the child population in accordance with the importance of accident mortality in the subgroups. From vital statistics (U.S. Department of Health, Education, and Welfare, 1957, 1964, 1969a, 1976), the proportions of deaths resulting from accidents, poisonings, and violence was calculated for each age-race-sex (years since birth) group for whom mortality differentials are reported in Table 2. The relationship between group-specific socioeconomic mortality differentials, as indexed by $\ln\alpha$ in Table 2, and the percentage of deaths resulting from accidents is shown in Figure 1. There is a strong positive relationship between the percentage of deaths from accidents (p) and $\ln\alpha$ for the association between maternal schooling and child mortality. The correlation weighted for the differential variances among the $\ln\alpha$ is .65. The estimated linear relationship is weakened by the estimated differentials for blacks, which make up most of the serious outliers in Figure 1. On the white observations alone, the weighted correlation between p and $\ln\alpha$ is .74. The extreme values for blacks may result from sampling variability in the $\ln\alpha$. Figure 1 shows the progressively greater importance of accident mortality from early childhood to the late teens, the greater rela-

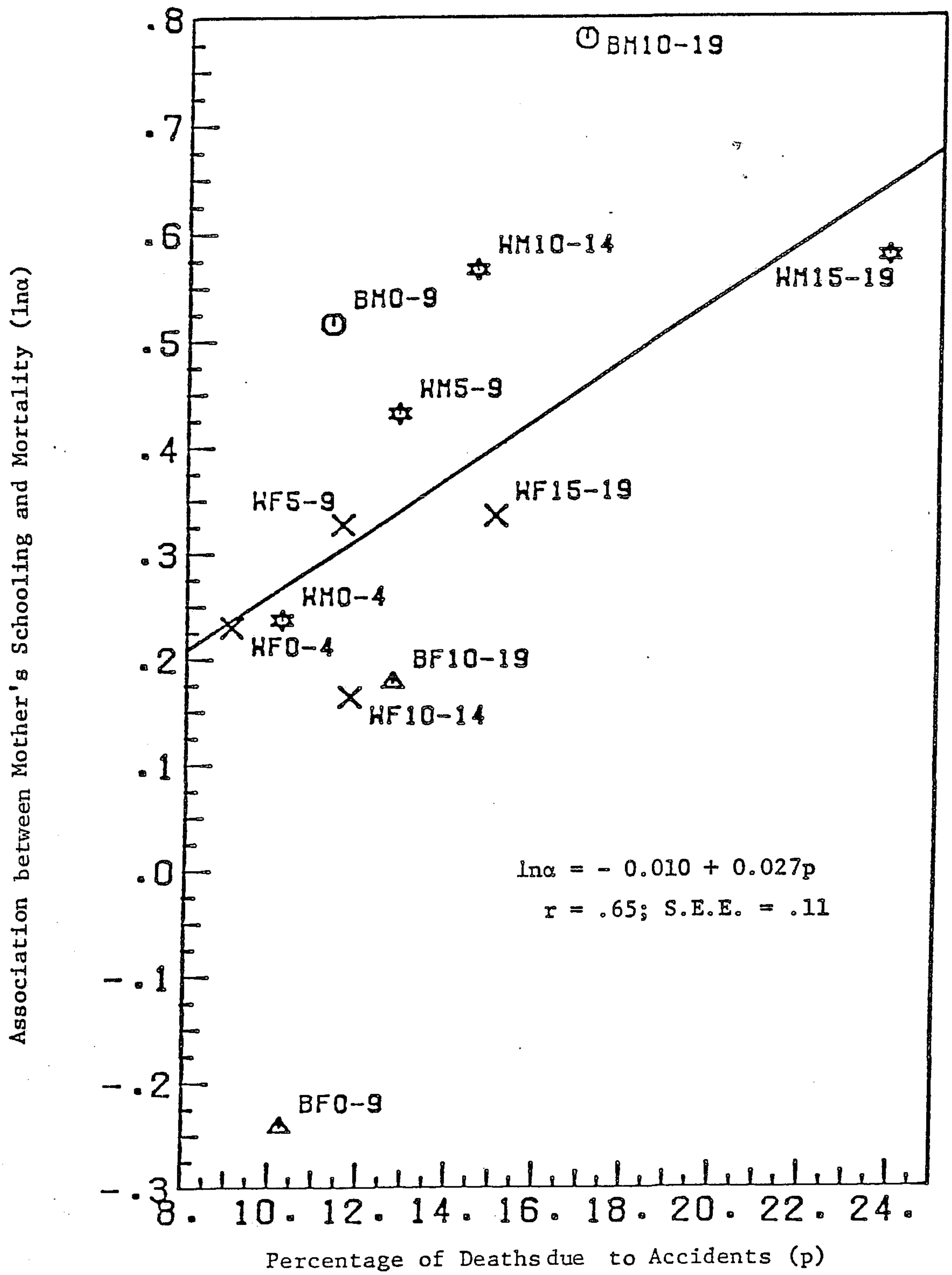

Fig. 1. Relationship between percentage of deaths due to accidents (p) and association between mother's schooling (≥12 grades vs. <12 grades) and child mortality for selected age-race-sex groups (lnα). WM, WF, BM, BF denote white males and females and black males and females respectively. lnα is taken from Table 2; p is calculated from published vital statistics. (See U.S. Department of Health, Education, and Welfare, 1957, 1964, 1969a, 1976.) Regression line was estimated by weighted least squares using weights recommended in Theil (1970) to take account of differential reliability of lnα among groups.

tive importance of accidents for boys than for girls, and the corresponding higher socioeconomic differentials for teenagers and boys relative to young children and girls. These results suggest that the effect of accident mortality on socioeconomic mortality differences observed directly for England and Wales also obtains for the United States.

CONCLUSION

This report has demonstrated that there are significant socioeconomic mortality differentials among persons under 20 in the United States; that despite the low child mortality levels relative to those of adults and infants, socioeconomic differentials are substantial and indeed reach a peak in the late teenage years; and that a primary source of socioeconomic variation in mortality arises because of large differential risks to accident mortality among socioeconomic groups. If the role of accident mortality in generating socioeconomic mortality differentials is as strong as the results suggest, a direct implication of this research is that socioeconomic mortality differentials may be increasing over time as the accident proportion of overall child mortality increases (Garfinkel et al., 1975). This prediction, however, remains to be demonstrated.

Although the empirical results are clear, they are based on the bare minimum of data from which mortality differences can be inferred. The CPS sample of child deaths is small, underrepresents children in large families, ignores orphans, precludes direct calculation of age-specific death rates, and provides no retrospective information that might better measure children's environments than family characteristics at the survey date. Simply to secure reliable estimates of differential mortality, therefore, the results of the present analysis should be replicated using other methods and data sources.[4]

Taking the results of this analysis at face value, they indicate that accident prevention--recently singled out as a major health goal for children and teenagers by the Surgeon General (U.S. Department of Health, Education, and Welfare, 1979b)--has the potential for not only drastically cutting the number of early deaths, but also reducing inequality in life chances. But the results also suggest that differentials in environmental risks are linked to broader socioeconomic differences in the population. Amelioration of socioeconomic inequalities, therefore, may be a necessary condition for significant reduction in child mortality.

Appendix: Quality of CPS Mortality Data

The June CPS data yield estimates of percentages of children dying by years since birth, which correspond to life table parameters $(1 - \frac{{}_nL_x}{5\ell_0}) \times 100$. These can be compared to vital statistics-based life table estimates. Comparison estimates from vital statistics were obtained by adjusting 1972 life table population values $({}_nL_x^{72})$ for mortality trends using life tables approximately centered within the four five-year intervals of 1955-75. Table A1 presents the adjusted life table parameters and the June CPS estimates by race and sex and the adjustment equations. The comparisons imply that between 65 and 85 percent of white deaths and between 40 and 60 percent of black deaths recorded in the vital statistics are represented in the CPS. Several explanations for the underestimation of death percentages in the CPS can be suggested, but their validity is questionable. One possibility is that because the CPS birth history supplement was given to only a subsample of never-married women, illegitimate births are underrepresented in the CPS reports. If illegitimacy is positively linked to mortality, then the death rate for excluded children exceeds that for reported children. Evidence on this is nonexistent for children generally, but mortality of illegitimate *infants* is higher than that for legitimate infants. In 1960, rates were 33 and 22 per thousand respectively for whites and 51 and 40 respectively for nonwhites (U.S. Department of Health, Education, and Welfare, 1973); in Wisconsin, in 1969, the rates were 24 and 15 respectively for whites and

Table A1

Comparison of Survival Percentages $(1 - \frac{{}_5L_x}{5\ell_0}) \times 100$ from Life Tables Based on Vital Statistics to June 1975 CPS Estimates

	White Males			White Females			Nonwhite/ Black Males			Nonwhite/ Black Females		
	Life Table*	CPS	Ratio	Life Table*	CPS	Ratio	Life Table*	CPS	Ratio	Life Table*	CPS	Ratio
0-4	1.94	1.63	.84	1.46	1.06	.73	3.35	1.56	.47	2.76	1.63	.59
5-9	2.68	2.23	.83	2.04	1.48	.73	4.65	1.99	.43	3.82	2.33	.61
10-14	3.22	2.36	.73	2.44	1.60	.66	5.67	2.25	.40	4.58	2.67	.58
15-19	3.62	2.68	.74	2.54	1.86	.73	6.32	2.63	.42	5.21	2.73	.52

Sources for life table: U.S. Department of Health, Education, and Welfare (1959, 1964, 1969a, 1976).

*Life table estimates are as follows (superscripts denote year of life table):

$${}_5L_0 = {}_5L_0^{72}; \qquad {}_5L_5 = {}_5L_5^{72}\left(\frac{\ell_5^{67}}{\ell_5^{72}}\right)$$

$${}_5L_{10} = {}_5L_{10}^{72}\left(\frac{\ell_5^{62}}{\ell_5^{67}}\right)\left(\frac{\ell_{10}^{67}}{\ell_{10}^{72}}\right); \qquad {}_5L_{15} = {}_5L_{15}^{72}\left(\frac{\ell_5^{57}}{\ell_5^{62}}\right)\left(\frac{\ell_{10}^{62}}{\ell_{10}^{67}}\right)\left(\frac{\ell_{15}^{67}}{\ell_{15}^{72}}\right)$$

For further explanation, see text.

31 and 29 respectively for blacks (Slesinger and Travis, 1975). This difference may explain part of the CPS undercount for whites, but seems unlikely to explain the substantial undercount for blacks. Moreover, a significant fraction of illegitimate children are reported in the CPS not only in the never-married subsample but also to ever-married women who bore children prior to marriage. A second possibility is that the CPS estimates are biased downward as a result of mortality to adult women. Because children of deceased mothers are not reported in the CPS, adult female mortality is related to socioeconomic factors, and children from lower-status families have higher mortality, child deaths may be undercounted. The quantitative importance of this effect, however, is unclear. A third possibility is that many mothers are unable or unwilling to recall child deaths, a tendency which may or may not be related to the mother's socioeconomic level.

NOTES

[1]See, for example, Stockwell, Wicks, and Adamchak (1977).

[2]Decedents under 20 in the 1960 Matched Records Study were matched to their individual census records, but no attempt was made to link family socioeconomic information from the census to the children (see Kitagawa and Hauser, 1973). The data permitting such a linkage have not been retained. The 1962-63 National Mortality Survey included deceased children, but the sample is too small to permit reliable estimates of differentials. See, for example, U.S. Department of Health, Education, and Welfare (1969b).

[3]See Kitagawa and Hauser (1973) for a report of Matched Records Study data.

[4]See Mare (1980) for a survey of possible strategies.

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