Social Epidemiology and the Fundamental Cause Concept: On the Structuring of Effective Cancer Screens by Socioeconomic Status

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IN A PIONEERING STUDY OF DEATHS IN THE FRENCH city of Mulhouse during the period 1823 to 1834, Villerme (1840) uncovered dramatic evidence of an association between life expectancy and occupational position: people from the class of “managers, merchants and directors etc.” could expect to live 28.2 years, whereas people from the class of factory workers could expect to live only 17.6 years. Since Villerme’s report, studies have repeatedly demonstrated that people who are favorably situated in the socioeconomic hierarchy live longer than those whose status is lower (Chapin 1924; Coombs 1941; Antonovsky 1967; Pappas et al. 1993). An important recent example comes from the National Longitudinal Mortality Study (Sorlie, Backlund, and Keller 1995), which found that people at the bottom of the education and income distributions were two to three times more likely to die during a ten year follow-up period than those at the top of these distributions.

When one considers the dramatic changes that have occurred in social and health conditions between the times that Villerme and Sorlie conducted their studies, the persistence of the association between socioeconomic status (SES) and mortality is remarkable. There have been dramatic changes in life expectancy, in the diseases afflicting human

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beings, and in health care systems. Amid all these changes, the persistence of the association between SES and mortality stands as an important fact in need of explanation.

The standard approach to understanding the association is to seek to identify the risk factor mechanisms that appear to account for the association in the current historical context. Thus, to account for the relatively recent findings of Sorlie and colleagues, one might focus attention on behavioral risk factors like smoking, exercise, diet, and other factors likely to influence the development of cardiovascular disease and cancer—the big killers of our time. However, doing so, while valuable for understanding the current situation, fails to explain the persistence of the SES association. The marked changes in health conditions over time suggest that the risk factors used to explain present distributions of cardiovascular disease and cancer are very different from the risk factors that would account for past distributions of cholera and tuberculosis. The risk factor mechanisms have changed while the SES association has persisted. This suggests that there is something fundamental about the association between SES and mortality that causes it to emerge under dramatically different health conditions. What explains this persistence? Why should socioeconomic status have such an enduring association with mortality?

An important clue can be found in one of the classic principles of social epidemiology. In writing about the connection between society and disease, Susser, Watson, and Hopper write: “Societies in part create the disease they experience and, further, they materially shape the way in which diseases are to be experienced” (1985, 17). The words “create” and “shape” are at the heart of this important principle of social epidemiology, and they provide critical insights for understanding the persistent association between SES and mortality. These words tell us that the connections between social conditions and disease are dynamic—social forces actively create and shape patterns of disease.

Consistent with this principle, we have proposed that the reason SES has been so consistently associated with disease is that it embodies resources like knowledge, money, power, and prestige that can be used differently, in accordance with changing situations, to avoid risks for disease and death (Link and Phelan 1995, 1996). People who are relatively better off use their advantage to avoid risks and to adopt protective strategies that enhance health and well-being. Viewed through a broad historical lens, the associations between SES and risk factors are

dynamic—they change as new conditions arise and knowledge is enhanced. When new risk factors (i.e., chemical pollutants) become a threat to health, when new knowledge about risk factors (i.e., smoking) emerges, or when new treatment technologies (i.e., neonatal intensive care units) develop, those who command the most resources are best able to avoid the risks and take advantage of the protective factors, resulting in the emergence of an SES gradient in these factors. This dynamic connection between SES and risk factors has led to the observation of a persistent association between SES and mortality. We refer to social conditions whose association with mortality persists in this manner as “fundamental social causes” of inequalities in health.

Other explanations for the persistent association between social conditions and mortality have been proposed. One that has been given serious consideration (Adler et al. 1994; Evans, Barer, and Marmor 1994) directs attention to the inherently beneficial effects of being at the top of a status hierarchy or the inherently stressful effects of being at the bottom. Where one resides in the hierarchy affects the nervous and immune systems, which control susceptibility to disease. The idea that being at the bottom of a hierarchy is stressful gains force when considered in tandem with John Cassel’s (1976) observation that when stress induces vulnerability to disease, many disease outcomes are possible. In this way, the “hierarchy–stress” explanation can help account for the association between SES and many disease outcomes. However, we do not believe that it tells the whole story of the social distribution of disease, largely because, unlike the fundamental cause explanation, the hierarchy–stress explanation focuses on factors that remain relatively constant through time. Thus, the hierarchy–stress explanation would predict a relatively constant association between SES and particular diseases, especially stress-related diseases. However, at least in some important instances, this is not the case. For example, the association between SES level and coronary heart diseases changed markedly from a direct to an inverse association over the past 60 years (Antonovsky 1967; Beaglehole 1990). How can this dramatic change be accounted for by the inherent benefits of high status?

Unlike the hierarchy–stress explanation, the fundamental cause explanation predicts, and in fact rests on the idea, that SES patterns in exposure to risks and protective factors and SES patterns in morbidity and mortality will change when there are historical shifts in the profile of diseases, treatments, risk factors, and knowledge thereof. Thus, our

perspective is compatible with empirical facts concerning the changing association between coronary heart disease mortality and SES in a way that the hierarchy–stress explanation is not. For this reason, we believe that other explanations must accompany the hierarchy–stress explanation if a complete understanding of the social distribution of disease is to be achieved. Indeed, an important goal of future research in social epidemiology will be to determine the relative importance of these (hierarchy–stress versus fundamental cause) and other explanations for the social distribution of disease. To that end, we seek to assess the validity of the fundamental cause idea through empirical tests that derive from the reasoning it provides. Specifically, in order to find support for the fundamental cause perspective, it would be necessary to demonstrate that SES differentials in risk factors and protective factors, and in morbidity and mortality, change in ways that are favorable to higher-status individuals when new diseases, risk factors, treatments, and other medical discoveries emerge.

A test of the fundamental cause idea would ideally make use of a large bank of historical data about individuals and their disease experience that would also permit the identification of changes in risk factors, in knowledge about risk factors, and in health care systems. Such a database would enable researchers to examine whether people with more resources experience a health advantage in the context of such changes and to ascertain precisely how this advantage is effected. Comprehensive historical data of this sort are lacking. In their absence, we must rely on locating instances of changing conditions in which we can examine how they affect the SES distribution of risk factors or of morbidity or mortality. In this paper, we propose to test the fundamental cause idea by examining health innovations that have been demonstrably effective in reducing untoward health outcomes. Specifically, we will examine the association between socioeconomic status and the use of two types of screening tests: Pap smears and mammography. Data on the utilization of these screens are likely to be informative with regard to the fundamental cause idea for three critical reasons: First, evidence suggests that use of these screens can lead to early detection of certain health conditions that are less lethal when treated. Second, both screening procedures resulted from technological innovations. This means that at an earlier time in history the use of these screens could not have been related to SES because the screens did not exist. Consequently, the screens could not have contributed to the SES gradient in mortality.

Third, because these screens represent human inventions and not acts of nature, they clearly illustrate Susser, Watson, and Hopper's social epidemiological principle that societies create and shape patterns of disease. To the extent that their introduction and use become patterned by SES, they represent a clear example of such active shaping. Further, the data will show how a disease-preventing innovation can have the unanticipated consequence of becoming a mechanism that links SES to mortality (Merton 1934).

We chose screens for breast and cervical cancer because there are ample data regarding their distribution by SES and because these two types of cancer are important causes of morbidity and mortality for women. It is also true that their respective incidence shows different patterns of association with SES: breast cancer occurs with greater frequency in women of higher SES, whereas cervical cancer occurs with greater frequency in women of lower SES. Until relatively recently at least, mortality distributions mirrored these incidence rates. At first glance, the direct association between breast cancer and SES would seem to contradict the fundamental cause hypothesis. In fact, however, the fundamental cause idea suggests that gradients favoring individuals of higher SES will only emerge when knowledge becomes available that allows persons of higher status to avoid disease and its consequences. The risk factors for breast cancer that have been known about for some time, like age, height, family history, age at menarche, and child-bearing practices, are not easily modifiable for the purposes of disease prevention, and thus an inverse association between SES and breast cancer is not to be expected at this time (Kelsey and Horn-Ross 1993; Newcomb and Lantz 1993). As the mortality-shaping effects of mammography become realized over time, however, such an inverse association should emerge. Thus, from a fundamental cause perspective, the two screens in question provide an interesting contrast: one, the PAP test, has been in place for some time, whereas the other, mammography, is relatively new. The PAP test's influence on mortality distributions has had time to occur, whereas the effects of mammography are just beginning to emerge and probably will not be fully evident for 10 years or so. Thus, if the fundamental cause idea is borne out with respect to the SES distribution of mammography, we could predict a reshaping of SES breast cancer mortality gradients by 2008. This will occur because women from circumstances of higher SES will be more likely to survive breast cancer as a result of earlier detection of tumors through mammography

screening. If this prediction holds true, it will provide striking support for the fundamental cause idea precisely because the incidence of breast cancer is currently directly related to SES.

In this paper, we use two approaches to examine whether the life-protecting screens for cervical and breast cancer are associated with SES. First, we review the literature concerning the association between indicators of socioeconomic status and each of the two screens. This will tell us whether previous studies have found screening to be patterned by SES as predicted by the fundamental cause idea. Moreover, because previous studies were conducted at different times, in different places, and using different methods, the review will offer insight into whether the links with SES are strong enough to withstand the impact of these variations.

Second, we use data from the large-scale Behavioral Risk Factor Surveillance System (BRFSS) that now conducts surveys in all 50 states and in Washington, D.C., under the auspices of the Centers for Disease Control and Prevention. These data include useful information on the two screens as well as indicators of SES over the period 1988 to 1995 for a sizable number of women on a population basis. This means that we will be able to observe the impact of public health efforts to implement these screens widely by examining the percentage of the population adopting them through time.

The data from the literature review and from the BRFSS will allow us the opportunity to determine whether shaping occurs by SES and whether it is relatively widespread and persistent, as the theory of fundamental causes predicts. Our goal in presenting this information is to provide one test—critical to the fundamental cause perspective and distinct from the hierarchy–stress perspective—of our theory that people with more resources gain a health advantage when health-related conditions change.

Screens

Because our research strategy relies on the fact that at one point the screens in question were unavailable and therefore completely unstructured by SES, we will briefly describe the development and implementation of each screen. Because our argument also relies on the effectiveness of the screens, we present the evidence on this issue as well.

Pap

In 1928, Papanicolaou introduced the first cytologic evaluation of the cervix and vagina for cancer diagnosis (Papanicolaou and Traut 1941). The technique was refined in 1946 by Ayre, who introduced the use of a wooden spatula to scrape the cervix and harvest cells directly from the transformation zone (Ayre 1946). In 1980, the American Cancer Society published guidelines for the Pap screen, which included the statement that women between the ages of 18 and 65 should be screened every year (Fink 1988). While the development of the Pap test preceded the era of large clinical trials, its efficacy for both prevention and early detection of cervical cancer is now widely accepted, based in part upon observational epidemiological evidence.

Mammography

Following evidence produced in a clinical trial conducted by the Health Insurance Plan of Greater New York in the 1960s (Shapiro, Strax, and Venet 1971), the use of mammography screening for the early detection of breast cancer has evolved rapidly (White, Urban, and Taylor 1993). In 1973, the American Cancer Society and the National Cancer Institute launched the Breast Cancer Detection Demonstration Project to show that breast cancer screening could be implemented on a large scale (Romans 1993). In 1977, the first recognized guidelines for breast cancer detection were established (Smith 1992). These guidelines have been subsequently revisited and revised on four occasions (1980, 1982, 1987, and 1989). By 1989, sufficient agreement existed among 12 major organizations in the United States to establish a set of consensus guidelines recommending that breast cancer screening begin by age 40 and consist of annual clinical breast examination and mammography at one- to two-year intervals. After age 50, women should be screened with clinical breast examination and mammography annually (Dodd 1992). Clinical trials of mammography screening programs have demonstrated proven benefits for women aged 50 to 64, whereas inconclusive evidence for women aged 40 to 49 has left screening for this group controversial (White, Urban, and Taylor 1993). As with Pap tests, it has been clear for some time that the benefits of mammography have not been as thoroughly realized for women of low socioeconomic status.

Method

Literature Review

We searched Medline (1966–97) and PsychInfo (1967–97) for major studies on the prevalence of Pap and mammography screening by SES. We defined a major study as one that was population based and contained sufficient numbers of women to provide stable estimates upon stratification by education and income. For the most part, national studies were selected. Not only do these studies provide adequate statistical power and generalizability; they also allow us to avoid bias in finding and selecting studies with information on SES and screening. Small, local studies might not report information on SES and screening unless a statistically significant association was identified, which might lead us to miss null findings concerning our hypothesis. National studies are both easier to identify and more likely to report data by education and income regardless of the findings concerning these variables. Finally, to provide a consistent comparison, we restricted attention to studies that listed the prevalence of Pap smears and mammography *in the past year* by at least two levels of education and/or income. Although a one-year period is not the recommended screening interval for all ages, it does allow for more accurate recall than longer time periods (Zapka et al. 1996). Moreover, particularly when inquiring about the Pap test, use of the phrase “*ever* having had” a screen provides little variability because most U.S. women have had at least one Pap smear. Such a measure fails to give any evidence about whether routine screening is accomplished.

The Behavioral Risk Factor Surveillance System

The BRFSS was established by the Centers for Disease Control and Prevention (CDC) in 1984, with 15 states initially participating in monthly data collection. The BRFSS gathers information through telephone-administered surveys on health behaviors related to the leading causes of death from chronic diseases among adults aged 18 years and older, including physical activity, injury, weight control, alcohol consumption, tobacco use, and HIV–AIDS. It also collects data on preventive health practices like mammography use. Additional funding over time eventually allowed the BRFSS to expand to all 50 states and Washington, D.C., by 1994, and to increase the overall number of

completed interviews gradually to about 2,200 per state by 1995 (Behavioral Surveillance Branch 1996).

A unique feature of the BRFSS is state-based prevalence estimates of risk behaviors and preventive health practices. Although sampling strategies and certain questionnaire items differ among states, the BRFSS is uniform enough to permit state-to-state comparisons and pooling of data across states for most items.

Measures

Pap and Mammography Screens. We used questions from the BRFSS to determine whether women were ever screened and whether they were screened during the year preceding the interview. For the Pap test, women were first told, "A Pap smear is a test for cervical cancer"; they were then asked, "Have you ever had a Pap smear?" If a woman answered "yes," she was then asked another question: "How long has it been since you had your last Pap smear?" Women who reported having had a hysterectomy in response to a separate question were excluded from the analysis of the Pap smear screening.

The questions for mammography were identical in form except that the lead-in sentence to the mammography question informed women that "a mammography is an x-ray of the breast to look for cancer." These mammography questions were followed by another: "Was your last mammogram done as a part of a routine checkup, because of a breast problem other than cancer, or because you've already had breast cancer?" Because our interest is in routine screening, we only considered as screened those women who reported that the mammogram was part of a routine checkup.

The validity of self-report measures of screening experience has been questioned for the purpose of ensuring that women are screened at appropriate intervals (Bowmann et al. 1991). However, for the purpose of population surveillance, Zapka's group considers such measures to be adequate (Zapka et al. 1996). For the issue we are addressing in this paper, it is important to note that their study found accuracy of reporting to be unaffected by respondent education and income.

Socioeconomic Status. The BRFSS contains measures of educational attainment and family income that can be used as SES indicators. In keeping with a growing consensus among sociologists and social epidemiologists concerning the operationalization of SES (Liberatos, Link, and Kelsey 1988), we employ these two indicators as separate measures

rather than combining them into a composite scale. Education is assessed in the BRFSS by asking the respondent, "What is the highest grade or year of school you completed?" Responses were placed on a six-point ordinal scale: (1) never attended school; (2) grades 1–8; (3) grades 9–11; (4) grade 12 or GED; (5) one to three years of college; and (6) four years of college or more. Because very few people were categorized in the "never attended school" grouping, we collapsed categories 1 and 2 to make a five-point ordinal scale.

To assess income, BRFSS participants are asked, "Which of the following categories best describes your annual household income from all sources?" Respondents then choose from the following categories: (1) <\$10K; (2) \$10–\$15K; (3) \$15–\$20K; (4) \$20–\$25K; (5) \$25–\$35K; (6) \$35–\$50K; (7) >\$50K, thereby forming a seven-point ordinal scale.

Results

Literature Review

Tables 1 and 2 present the results of studies showing the association between use of the Pap smear ($N = 5$) (Hayward et al. 1988; Ferraroni et al. 1989; Calle et al. 1993; Wilcox and Mosher 1993; Goel 1994) and of mammography ($N = 7$) (Hayward et al. 1988; Centers for Disease Control 1988, 1990a,b; Dawson and Thomas 1990; National Cancer Institute Breast Cancer Screen Cohort 1990; Breen and Kessler 1994; Potvin, Camirand, and Beland 1995) in the past year by levels of education and income. Despite the differences in geographic locales, survey years, age groups considered, and methods of defining levels of education and income among studies, the results are remarkably consistent. For both Pap smears and mammograms, recent use is markedly patterned by SES. In every population-based study listed here, women with higher education and income were more likely to report being screened in the past year than were women with lower education and income.

BRFSS Results

Table 3 shows data on the proportion of women screened via the Pap test and mammography during the year prior to the 1995 interview. These results are instructive in showing that targeted groups are indeed more likely than other groups to be screened. This simultaneously shows that the public health recommendations are followed, at least to some de-

TABLE 1
Population Studies of Papanicolaou Smear Use in the Past Year by Levels of Education and Income

Data source	Geographic area	Survey year(s)	Age group (years)	Sample size	Percent screened in year before interview			
					Lowest education	Highest education	Lowest income	Highest income
Access to Care Survey	United States	1986	20+	4,353	52	81	72	83
National Survey of Family Growth	United States	1988	15–44	8,450	66	77	62	73
National Health Interview Survey: Cancer Control Supplement	United States	1987	18+	12,252	34	46	24	46
National Health Survey	Italy	1986–7	20–79	27,455	11	26	—	—
Ontario Health Survey	Ontario, Canada	1990	16+	16,534	43	55	—	—

TABLE 2
Population Studies of Mammography Use in the Past Year by Levels of Education and Income

Data source	Geographic area	Survey year(s)	Age group (years)	Sample size	Percent screened in year before interview			
					Lowest education	Highest education	Lowest income	Highest income
Access to Care Survey	United States	1986	50+	1,993	16	29	—	—
National Health Interview Survey	United States	1987	40+	6,730	10	23	11	22
National Health Interview Survey	United States	1990	40+	12,860	23	41	24	39
Rhode Island Department of Health's Breast Cancer Screening Program	Rhode Island	1987	40+	852	30	44	21	48
Rhode Island Department of Health Breast Cancer Screening Program	Rhode Island	1989	40+	856	40	46	41	53
National Cancer Institute Breast Cancer Screening Consortium	Suburban Los Angeles	1987–88	50–74	277	8	39	23	39
	Eastern Massachusetts	1987–88	50–74	861	24	40	24	36
	Eastern North Carolina	1987–88	50–74	735	25	43	23	40
	Long Island, NY	1987–88	50–74	2,180	21	33	16	30
	Metropolitan Philadelphia	1987–88	50–74	788	31	43	29	42
	Washington State	1989	50–74	1,473	33	43	34	46
Quebec Health Survey	Quebec, Canada	1987	50–59	1,213	9	19	8	17

TABLE 3
Percent of Women Receiving Selected Screening Tests in the United States, 1995^a

Screening frequency	Screening test		
	Mammography		
	Not recommended (18–39 years) (N = 9,245)	Recommendation disputed (40–49 years) (N = 4,347)	Recommended (≥50 years) (N = 9,040)
Screened in past year	9.8	44.2	55.3
Not screened in past year	90.2	55.8	44.7
	Pap smear		
	Not recommended (>65 years) (N = 3,354)	Recommended (18–65 years) (N = 12,689)	
Screened in past year	50.6	70.5	
Not screened in past year	49.4	29.5	

^aUnweighted sample sizes reported (N). Percents in body of table are weighted.

gree, and is evidence of the construct validity of the self-report measures employed in the BRFSS.

Table 4 shows the association between the socioeconomic indicators of education and income and cervical cancer screening via the Pap test for women aged 18 to 65 in the 11 states with available data for the eight-year period from 1988 to 1995 (California, Illinois, Maine, Maryland, Nebraska, New Hampshire, New Mexico, North Carolina, Oklahoma, South Carolina, and Washington). The Pap test, which has been in widespread use for some time, showed no increase in the frequency of use over the eight-year period in question. Indeed, as shown in figures 1 and 2, recent trends are, if anything, slightly downward in trajectory. There is a fairly consistent association between education and income and recent Pap screening. Specifically, the association between education and Pap screening is generally monotonic, increasing in a lock-step fashion from the lowest educational category to the highest. The association with income is more variable, but is still consistent in indicating that women from households with higher income are more likely to report having been screened.

Table 5 shows the association between socioeconomic status and mammography for women aged 50 and over in the 16 states based on available data for the period from 1988 to 1995 (California, Illinois, Indiana, Kentucky, Maine, Maryland, Minnesota, Nebraska, New Hampshire, New Mexico, New York, North Carolina, Oklahoma, South Carolina, Washington, and Wisconsin). Unlike the Pap test, the use of mammography increased remarkably over this time period, as figures 3 and 4 clearly demonstrate. Moreover, every socioeconomic group experienced increased screening during this interval. Thus, we appear to have caught the wave of the public health implementation of mammography in these data. In every year there is clear evidence that SES influences the distribution of screening. As with the Pap test, the association appears slightly more consistent for education than for household income, but the effect is clearly present for both indicators of SES.

Discussion

We began our inquiry by drawing attention to an important principle of social epidemiology based on the premise that societies shape patterns of disease (Susser, Watson, and Hopper 1985). Understanding how they

TABLE 4
Percent of Women Receiving a Pap Smear Test in the Past Year for the Recommended Age Group (18–65 years)
by Education and Family Income in the United States, 1988–95^a

	1988 (N = 7,869)	1989 (N = 8,151)	1990 (N = 9,087)	1991 (N = 8,977)	1992 (N = 10,035)	1993 (N = 11,251)	1994 (N = 11,571)	1995 (N = 12,689)
Education (years)								
0–8	52.5	62.3	72.5	60.5	60.1	59.7	56.2	54.3
9–11	73.4	62.5	63.6	68.1	63.9	64.0	63.4	67.5
12	72.8	72.1	72.5	76.0	70.8	69.5	67.9	68.6
13–15	73.4	73.3	74.3	77.1	75.6	71.1	71.7	69.8
≥16	78.9	80.1	79.3	77.7	76.9	77.6	73.2	77.9
Family income (dollars)								
<10,000	67.5	64.5	65.5	73.3	64.6	64.4	65.0	61.8
10,001–15,000	72.3	74.8	74.7	71.4	67.4	66.2	64.0	65.8
15,001–20,000	74.3	70.9	73.5	73.1	72.0	61.2	70.3	58.9
20,001–25,000	74.8	73.4	71.2	74.1	73.9	68.5	66.1	73.4
25,001–30,000	74.7	74.2	74.1	76.9	74.6	74.7	71.9	69.3
30,001–50,000	75.7	73.0	77.2	77.6	75.3	72.5	73.6	72.6
>50,000	76.9	80.1	78.4	79.7	78.1	79.3	72.1	78.9

^aUnweighted sample sizes reported (N). Percents in body of table are weighted.

FIG. 1. Percent of women in the recommended age group receiving a pap smear in the past year by years of education.

FIG. 2. Percent of women in the recommended age group receiving a pap smear in the past year by family income.

TABLE 5
Percent of Women Receiving a Mammogram in the Past Year for the Recommended Age Group (≥ 50 years)
by Education and Family Income in the United States, 1988–95^a

	1988 (N = 5,588)	1989 (N = 5,773)	1990 (N = 6,298)	1991 (N = 6,323)	1992 (N = 7,067)	1993 (N = 7,875)	1994 (N = 8,371)	1995 (N = 9,040)
Education (years)								
0–8	22.6	33.5	37.1	36.5	38.3	40.7	42.8	46.6
9–11	32.5	33.1	39.6	39.1	38.0	43.9	49.2	50.0
12	35.1	39.4	45.3	48.1	52.0	53.8	51.2	56.0
13–15	42.6	47.0	46.5	51.5	55.4	57.1	59.9	58.8
≥ 16	43.3	50.9	60.2	59.9	59.4	62.6	62.5	69.3
Family income (dollars)								
<10,000	26.7	34.3	36.3	38.2	40.1	41.3	46.4	48.3
10,001–15,000	35.3	36.8	36.6	40.0	45.8	42.4	46.5	47.0
15,001–20,000	26.8	37.2	48.2	45.1	49.2	49.1	48.5	47.7
20,001–25,000	43.3	39.9	47.0	52.7	53.9	57.8	53.6	53.8
25,001–30,000	40.0	42.6	55.3	60.2	55.3	58.5	58.2	57.9
30,001–50,000	46.9	58.0	56.7	57.6	59.3	65.8	61.4	65.6
>50,000	41.5	51.2	65.5	59.4	68.2	69.9	67.0	74.4

^aUnweighted sample sizes reported (N). Percents in body of table are weighted.

FIG. 3. Percent of women in the recommended age group receiving a mammogram in the past year by education.

FIG. 4. Percent of women in the recommended age group receiving a mammogram in the past year by family income.

do so—that is, grasping the connections between larger social realities and individually based biological ones—can help us avoid the narrowness of modern risk factor epidemiology (McKinlay 1996; Susser and Susser 1996). A social epidemiology guided by what McKinlay has called the “epidemiological imagination” might “protect us from the risk of a myopic view of illness and greatly enhance our understanding of the complex threats to human health and understanding” (McKinlay 1996, 22). In keeping with this insight, more social epidemiologists are investigating the complex links between social and economic inequalities and disease (House, Landis, and Umberson 1988; Marmot et al. 1991; Wilkinson 1992; Evans, Barer, and Marmor 1994, Greenwald et al. 1996; Kennedy, Kawachi, and Prothrow-Stith 1996; Kaplan et al. 1996; Kawachi et al. 1997; Wallace and Wallace 1997).

Our theory of fundamental social causes seeks to contribute to this growing knowledge in the area of social epidemiology by identifying the social factors that shape the distribution of disease. It says that such shaping occurs in a predictable fashion, with the result that people who have more resources in terms of knowledge, money, power, prestige, and social connections are better able to avoid risks, no matter what guise they assume, and to adopt the protective strategies that are available at a given time and given place. Although this theory applies to numerous risks and protective factors, we considered two screens for female cancers, the Pap test and mammography, to be particularly instructive tests of the fundamental cause approach. The reason is that, prior to their discovery, these screens were obviously unrelated to both SES and mortality and thus could not have contributed to an SES gradient in mortality. However, the fundamental cause approach predicts that, once discovered, beneficial innovations like these, which require individual agency and access to health resources, will, upon implementation, come to be associated with socioeconomic status and thereby play a role in SES gradients in mortality.

These results support the fundamental cause idea and its parent principle from social epidemiology concerning societies’ capacity to create and shape patterns of disease. Recent screening via both the Pap test and mammography is consistently related to educational level and household income, just as previous research led us to expect. Our review of the literature and our analysis of the large-scale BRFSS data further supported the theory consistently across the two types of screens. One of these, the Pap test, seems to have reached a peak (or at least a plateau)

of implementation, while reliance on the other, mammography, has substantially increased over the period from 1988 to 1995.

The Pap test, which has been in widespread use for years, is a likely major contributor to the 70 percent decline in mortality due to cervical cancer in the United States over the past four decades (American Cancer Society 1996). With regard to breast cancer, evidence from clinical trials suggests that as much as a 40 percent decline in mortality can be achieved by mammographic screening (White, Urban, and Taylor 1993). Such a decline has not yet been realized in breast cancer mortality trends, but this fact is not surprising. One expects a lag in the effect on mortality for a disease like breast cancer; the implementation of widespread mammography screening is too recent to have achieved its full impact on mortality for this reason. Still, recent evidence has shown a downward turn in mortality (Newcomb and Lantz 1993), and there is clear evidence that tumor size on detection has decreased dramatically from an average of 3.5 centimeters during the years 1979 to 1980 to 2.6 centimeters from 1987 to 1988 (White, Urban, and Taylor 1993). Because tumor size is a strong prognostic factor and because mammography allows for the detection of smaller tumors, it is reasonable to expect that mortality patterns will be affected by screening.

Because these effective screens did not always exist, our results indicate that new SES-linked protective factors have been created. They have shaped mortality patterns and will continue to do so. Thus, our findings exemplify how the actions of humans structure disease patterns according to socioeconomic status and other social variables.

One obvious limitation of our findings becomes apparent when we turn from these two particular screens to the more general propositions implied by the fundamental social causes idea. We have chosen only two screens, which, in the broad scope of things, play a minor role in the association between socioeconomic status and mortality. Further evidence concerning this idea needs to be generated by investigating changes in other health-related factors—different screens or medical treatments, new or reemerging diseases, newly discovered risk factors—and their impact on the SES distribution of risk factors, disease, and mortality. Nevertheless, the reporting of these findings serves an important purpose. The idea that societies create and shape patterns of disease can sound vague, even a little mystical, to those who are not steeped in social epidemiology. This paper provides a concrete example of the way in which human action can lead to social patterns of mortality. It sug-

gests, but does not prove, that such processes also affect other kinds of risk and protective factors. With this caveat in mind, we address three implications of our research and the conclusions we draw from it.

First, embedded in our examples is the fact that the actions of the inventors and implementers of the screens have either already resulted in social inequalities in mortality or will eventually do so. Before the screens were devised and made available to the public, they did not contribute to social inequalities in mortality, yet now they do. How are we to understand this uncomfortable reality? To start, it is essential to recognize that the overall impact of the screens has been to prevent death—there is strong evidence to suggest that these screens are effective. This is the intended and anticipated consequence of the development and implementation of these screens. As sociologist Robert Merton has observed, however, actions often have “unanticipated consequences” as well (Merton 1934). One reason they do is that no action occurs in a “social vacuum,” which means its effects are likely to “ramify into other spheres of value and interest” (Merton 1934, 902). When innovations beneficial to health are developed in our society, their implementation necessarily occurs within the context of inequalities in knowledge, money, power, prestige, and social connections. These inequalities shape the distribution of the health benefit and, in doing so, have an impact on patterns of mortality that neither the developers nor the public health-minded implementers of the innovation were likely to have intended.

Second, while our analysis in terms of unanticipated consequences may seem to cast an aura of inevitability on social inequalities in health, this is only the case if one presumes that social inequalities are immutable. However, policies focused on issues like the minimum wage, housing for homeless people, capital gains taxes, parenting leave, and Head Start programs are part of the national agenda and bear directly on the extent of inequality in our society. Moreover, there is evidence to indicate that variations in levels of inequality in modern Western industrial nations (Wilkinson 1992) and in states in the United States (Kaplan et al. 1996; Kennedy, Kawachi, and Prothrow-Stith 1996) are linked to mortality rates and life expectancy. Together, these considerations lead us to conclude that levels of social inequality are responsive to policy and that these levels of inequality matter for health outcomes.

A third implication of our inquiry concerns its possible role in stimulating further discussion and analysis within social epidemiology about the relative importance of a hierarchy–stress explanation versus a fun-

damental cause explanation in accounting for the SES gradient in morbidity and mortality. As we mentioned in our introduction, a number of investigators have explored the inherently salutary effects of high status (or the detrimental effects of low status) (Adler *et al.* 1994; Evans, Barer, and Marmor 1994). Central to this idea is the notion that it is inherently stressful to be at the bottom of the social hierarchy and that this “stress” operates directly through the nervous and immune systems to influence susceptibility to disease. Our fundamental cause perspective does not require, nor is it limited to, this particular pathway. People benefit from high status not only because it is less stressful to be on top but also because being there leads to benefits that translate into better health. Knowledge about risk and protective factors, and the wherewithal to act on it, leads to socioeconomic differences in smoking, exercise, diet, seat-belt use, screening, and so on. Numerous context-driven risks and protective factors, like the frequency of garbage pick-ups, air and water pollution, and roach and rat infestation, also come to be structured by SES because people with more resources are situated in better contexts, whether or not the motivation for being so placed is concern about health. Moreover, communities with more power can negotiate for better health care systems and can protest more strenuously when health care systems lag in their response to health emergencies.

Thus, socioeconomic factors can affect health in many ways that do not depend on the attachment of any inherent benefit to the nervous and immune systems that might result from hierarchical placement. Thus, although we believe that ultimately both a hierarchy–stress and a fundamental cause explanation will be required to understand the SES gradient in morbidity and mortality, we also believe that their relative importance needs to be assessed. The current research supports the fundamental cause perspective by documenting that an effective innovation (a change) comes to be associated with SES upon implementation, thereby creating a new mechanism linking SES to disease. The benefit of high SES in this instance has nothing to do with the inherent physiological benefits of being at the top of a status hierarchy. As we have acknowledged, however, access to screens for cervical and breast cancer are only a small contributor to the SES gradient in mortality, and there is no reason to suppose that factors associated with both perspectives may not be operating simultaneously to some degree. Still, the two approaches do emphasize different sources for the SES–mortality association, and sorting out which of them appears to be more potent could not only be

an intellectually intriguing enterprise but also a practically important one to engage the attention of social epidemiologists.

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