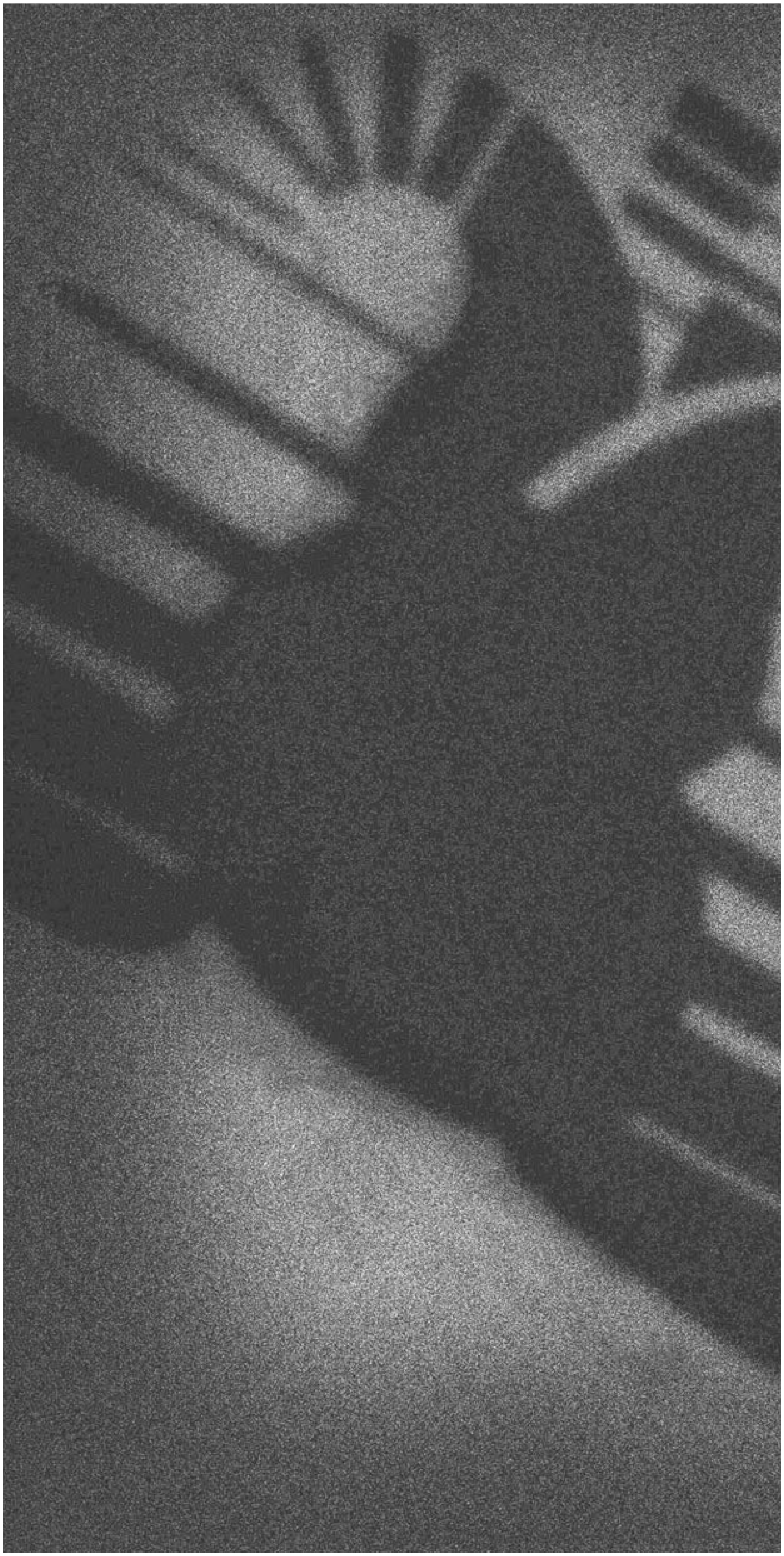
Report of the Conference on Socioeconomic Status and Cardiovascular Health and Disease

November 6-7, 1995

NATIONAL INSTITUTES OF HEALTH
NATIONAL HEART, LUNG, AND BLOOD INSTITUTE



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For Administrative Use

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EXECUTIVE SUMMARY

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Disease prevention is an essential part of the mission of the National Heart, Lung, and Blood Institute (NHLBI). Over the years, the Institute has developed some remarkably effective preventive strategies based on research to identify the major risk factors for cardiovascular disease (CVD). It is no surprise that the sharp declines in CVD mortality that occurred during the past 30 years coincided with our understanding that such factors as smoking, hypertension, high blood cholesterol, obesity, and diabetes increase a person's risk of developing CVD.

Gratifying as this progress is, we still have far to go. Much evidence indicates that the beneficial trends in CVD mortality have not been felt equally across all segments of society. Rather, the most striking improvements in cardiovascular health have occurred among wealthier, better-educated Americans, while progress among groups with lower socioeconomic status (SES) has lagged. The observation that the gap between high-SES and low-SES populations may be widening is particularly disturbing.

To address these important public health issues, the *Conference on Socioeconomic Status and Cardiovascular Health and Disease* was convened November 6-7, 1995, in Bethesda, Maryland. More than 120 persons attended, representing such fields as cardiovascular and preventive medicine, epidemiology and biostatistics, behavioral and social sciences, and health policy research. The goals of the meeting were to assess the extent to which SES is related to CVD mortality, morbidity, and risk factors in men and women of various ages, races/ethnicities, and geographical locations; to assess time trends in the SES–CVD association; to explore possible biological, psychosocial, and lifestyle-related pathways by which SES may relate to CVD; to identify strategies for reducing SES-based disparities in cardiovascular health; and to recommend promising avenues for future research on this topic.

Several crosscutting themes emerged from the conference presentations and discussions. First is the need to improve our understanding of the concept of SES and the ways in which it reflects the conditions of everyday life for people of various strata. This task will involve development of more sophisticated and refined measures of SES. The importance of seeking input from other related fields (e.g., sociology, demography, economics) was emphasized.

The conference also highlighted the importance of rapidly transferring new scientific knowledge into practice and, most critical, of more effectively applying what we already know about risk reduction strategies (e.g., smoking cessation, blood pressure control, diet), especially to population strata that have not yet been reached. In this regard, the superb national leadership taken by the NHLBI through its education programs was repeatedly acknowledged.

Irrefutable evidence that an SES gradient in CVD risk exists—that there is room for improvement at every SES level—speaks to the importance of a population-wide approach to reducing the burden of CVD. Sustained and focused efforts among all SES groups of various races/ethnicities are needed.

SESSION HIGHLIGHTS

Session I: Setting the Stage

The first session focused on U.S. national data relating SES to CVD morbidity and mortality; to lifestyle, biomedical, and psychosocial risk factors; and to medical care utilization. Presenters gave an overview of data in the *Chartbook of U.S. National Data on Socioeconomic Status and Cardiovascular Health and Disease*, which had been prepared as background to the conference.

The national data document that SES relates to CVD, to lifestyles, and to major lifestyle-related biomedical CVD risk factors (with variations by age, gender, ethnicity, and specific aspects of lifestyle, as well as with variations over time). The general finding is that more adverse patterns of these variables exist for lower-SES strata than for higher-SES strata in the U.S. population. For instance, a wealth of information on smoking shows strong and consistent relationships with SES (i.e., for all age groups, both genders, and all racial/ethnic groups, the lower the SES, the higher the prevalence of smoking and the lower the quit rate during recent decades).

Strong and consistent inverse relationships also prevail—for adults of every age and both genders, for blacks, non-Hispanic whites, Hispanics, Asian Americans, Native Americans—between SES and high blood pressure, and between SES and obesity. Lower-SES groups have higher rates of both hypertension and obesity than higher-SES groups. Upward trends in body weight and in prevalence of overweight during the last decades have been more marked in lower- than higher-SES strata.

Other SES–risk factor relationships are less strong and consistent—for example, the relationship between SES and serum cholesterol. However, trend data from successive national population surveys indicate that declines in adult average serum cholesterol levels have been smaller in lower- than in higher-SES strata. National data are limited about such relevant aspects of lifestyle as diet and physical activity and their time trends across SES strata.

National data are also sparse with respect to psychosocial risk factors across SES strata. In particular, data are lacking on psychosocial variables for SES groups of various ethnic backgrounds. Furthermore, little information exists about such variables as job change, unemployment, job and income instability, work-related psychosocial variables, social support, and social isolation, and how these variables influence relationships of SES to CVD, CVD risks, and their trends.

As the *Chartbook* documents and the presenters noted, national mortality data show clearly that for major ethnic groups in the U.S. population, lower-SES strata have higher mortality rates than higher-SES strata for coronary heart disease (CHD), all CVD, and all causes. National morbidity surveys give generally concordant findings.

Discussants noted that SES is related to many aspects of daily life, experiences at work and in the community, stresses and strains, and access to and utilization of medical care, including preventive services and state-of-the-art diagnostic and therapeutic services. To understand better how SES influences CVD, an epidemiology of everyday life that encompasses these phenomena needs to be developed.

Recommendations

- Promote measurement of SES, in both observational and interventional research, using established, valid, reproducible, acceptable indices appropriate for a given study and its aims. Encourage data analysis approaches that include use of information on SES as both a control and a stratification variable.

- Develop, validate, and incorporate more sophisticated measures of SES and SES-related aspects of everyday life into research with a major focus on SES and CVD. In studies of women, minorities, and rural residents, give explicit attention to special features that may condition the definition, meaning, and impact of SES.

- Investigate the relationships between SES and CVD initiation, progression, prognosis, morbidity, disability, and death. Emphasize greater use of methods to measure preclinical disease (e.g., echocardiography, electrocardiography, sonographic measurement of carotid artery intima–media wall thickness, measurement of ankle–arm blood pressure ratio) to achieve earlier and more comprehensive assessments of the impact of SES-related exposures on CVD. Link such findings to data on nonfatal and fatal clinical CVD.

Session II: Pathways Linking SES and CVD

Several presenters reviewed data on SES–CVD relationships and on possible pathways of these relationships, in men and women from specific U.S. population strata (i.e., blacks, whites, Hispanics, Asians and Pacific Islanders, Native Americans, rural populations, and employed groups). Two other presenters discussed evidence from psychosocial studies and from research on stress, work, and social support. The last speaker addressed medical care access, utilization, and costs.

In agreement with national data, findings from studies of specific U.S. population groups generally show an inverse relationship between SES and CVD (i.e., higher CVD rates with lower SES). Two broad pathways were noted linking SES and CVD: 1) less favorable patterns of established major lifestyle and biomedical risk factors (smoking, adverse diet, sedentary lifestyle, high serum cholesterol, high blood pressure, obesity, diabetes) in lower- compared with higher-SES strata; 2) less favorable patterns of psychosocial factors (hostility, depression, low social support, social isolation, racism, job instability–insecurity–strain–powerlessness, unemployment) in lower- compared with higher-SES strata. Data are sparse on possible SES-related biological mediators of relationships between psychosocial factors and CVD (e.g., altered sympathetic and parasympathetic nervous system function, altered hypothalamic–pituitary–adrenal axis function, altered cellular–molecular biology of key cells), and on social–environmental mechanisms whereby lower SES leads inordinately—from early childhood on—to development of more adverse behavioral and psychosocial patterns.

Men with low levels of all established biomedical risk factors (blood pressure, cholesterol, smoking, diabetes, previous heart attack) have been found to experience lower CHD and CVD mortality rates than men without such a favorable profile. Such a favorable profile is found in less than 10 percent of the population. These findings indicate that controlling the established biomedical risk factors has the potential to achieve low CHD–CVD rates for all groups in the United States, including low-SES strata of various racial/ethnic backgrounds.

These observations underscore the importance of primary prevention and control of the established major biological risk factors for CHD–CVD. Improved understanding of the reasons why lower-SES groups have more adverse levels of the major risk factors, the pathways producing these patterns, and the contributory role of more adverse behavioral and psychosocial patterns is key to achieving this goal. Also important is improved understanding of the lifestyle, behavioral, psychosocial, cultural, metabolic, and genetic components of maintaining low-risk status into middle age. Such knowledge will lead to development and application of better approaches for the primary (including "primordial") prevention and control of the major risk factors, with a focused emphasis on lower- as well as higher-SES strata of all racial/ethnic groups.

Recommendations

- Investigate relationships between SES and development/evolution of lifestyles, behaviors, and risk factors, including both adverse and favorable patterns.

- Analyze existing data and data currently being collected by trials and demonstration projects to document further the effectiveness of interventions in lower- and higher-SES groups of various races/ethnicities; report and disseminate such data and their implications for programs to control CVD in lower-SES groups.

- Conduct research to enhance understanding of mechanisms underlying clustering of adverse lifestyles, behaviors, and risk factors in lower-SES groups of various races/ethnicities.

- Study SES and precursors of adult lifestyles and behaviors, from childhood on, including influences of the family, community, school, and workplace.

- Elucidate the mechanisms whereby conditions of everyday life for lower-SES groups—exposures during prenatal life, infancy, childhood, and adulthood—contribute to the development of more adverse patterns of lifestyles, behaviors, risk factors, and psychosocial traits. Include studies of the roles of racism; sexism; deprivation; relative and absolute income levels and their trends; knowledge and attitudes; home, school, workplace, community, and mass-media exposures; peer pressures; housing conditions; relationships to organizations; early exposures to food, alcohol, and drugs; and barriers to adoption of heart-healthy behavior.

- Investigate the interrelationships between psychosocial traits and lifestyles in lower-SES groups with the aim of clarifying environmental and biological mediators and pathways of these interrelationships (including neurological, endocrine, cellular, and molecular pathways) and thereby enhancing understanding of how psychosocial factors and acculturation influence CVD risk.

Session III: Experience in Educational and Preventive Interventions Across SES Groups

This session focused on preventive strategies that, if applied more broadly, have potential to reduce the SES gradient in CVD health and disease. Speakers reviewed evidence from clinical trials and a broad range of intervention studies to determine whether observed reductions in CVD risk factors, morbidity, and mortality extended equally to low- and high-SES participants, including those from ethnic minorities. Findings clearly indicate that, although there is more to be learned, much is already known about how to reduce CVD in low-SES groups.

Interventions in several large NHLBI-supported primary prevention trials were efficacious in reducing CVD risk factors, morbidity, and mortality in multiple SES–race substrata, although only limited special efforts were made to tailor the interventions for lower-SES, nonwhite participants. Interventions consisted of antihypertensive drug treatment involving stepped care as well as multifactor behavioral interventions aimed at smoking cessation, reduction of total serum cholesterol, weight control, increased physical activity, and reduction of salt and alcohol intake. Lower SES was not a barrier to intervention success for either the drug treatment or the behavioral components. In one antihypertensive trial, the SES gradient in mortality was eliminated in the intervention group.

Studies in communities, worksites, and schools confirm that public health interventions can be designed to benefit all segments of society. Favorable changes in lifestyles and lifestyle-related biomedical risk factors have been achieved across all SES groups in community interventions that have used a broad, multimedia communication approach with special efforts to target and involve low-SES, culturally diverse groups. Worksite interventions incorporating on-site classes and payroll incentives have also achieved favorable results in both blue- and white-collar employees. The success of school-based programs in achieving similar magnitudes of risk factor reduction in both low- and high-SES students is particularly noteworthy given the schools' potential for building lifelong heart-healthy habits and, thereby, contributing importantly to the key strategic goal of preventing the development of major risk factors.

Preliminary findings from programs specifically designed to address the need for nutrition education materials suitable for English-speaking adults with limited literacy skills indicate that the approaches developed result in high utilization of intervention materials among ethnically diverse, low-SES persons and can lead to gradual, sustained progress toward favorable risk factor change over time. Most programs use multimedia, client-centered instructional approaches that include interactive computer technology, videotapes, audiocassettes, compact discs, and printed materials.

Across all SES groups, self-help is the method of choice for smoking cessation by more than 90 percent of smokers. Programs that combine media presentations with telephone counseling hotlines or distribution of self-help materials have been particularly effective with lower-SES smokers. A community organization approach used in one study had the greatest effect in low-SES individuals. Counseling of smokers by physicians or dentists has also been shown to increase their likelihood of quitting smoking significantly.

Sedentary lifestyle is particularly prevalent among lower-SES persons and ethnic minorities. Experience from community-based heart-health programs suggests that interventions promoting moderate- rather than vigorous-intensity activities are more likely to be successful, and that exercise campaign events tied to preexisting community structures or traditional community events have the greatest participation levels. Worksite interventions have demonstrated that clinically significant increases in physical activity can be achieved in both low- and high-SES employees.

The National High Blood Pressure Education Program and National Cholesterol Education Program have been prime movers in the substantial progress made in achieving the Healthy People 2000 blood pressure and cholesterol objectives. Their achievements underscore the effectiveness of science-based public health strategies that rely on broad-based cooperation between government and the private sector in overcoming the barriers to reducing CVD in all sectors of the population.

The overall conclusion is that more widespread application of interventions already known to work across multiple SES and ethnic groups can make a substantial contribution to eliminating the SES gradient and ending the CVD epidemic in all segments of society.

Recommendations

- Incorporate nonsmoking messages into educational efforts targeting all SES-ethnic groups, with a particular focus on more habituated smokers and on do-it-yourself approaches to smoking cessation.

- Evaluate existing obesity intervention programs; look for successes and develop approaches based on them, with the aim of achieving national goals for obesity prevention and control for all SES strata, including reversal of the decades-long rise in obesity rates among children, youth, and adults.

- Intensify efforts to increase consumption of heart-healthy foods—reduced in total fat, saturated fat, cholesterol, salt, refined sugars, and calories—in lower-SES communities.

- Enhance efforts to prevent and control high alcohol intake among lower-SES groups of various races/ethnicities.

- Enhance efforts to achieve daily or near-daily physical activity by lower-SES groups from childhood on and to increase the proportion of people who regularly engage in moderate activity.

- Emphasize the potential contribution of stress reduction to modifying risk factors and subsequent CVD morbidity and mortality.

- Encourage assessment of literacy as a relevant aspect for improving ability to intervene effectively in lower-SES groups; use group-specific programs appropriate for literacy level and sensitive to group culture.

- Develop effective strategies to promote favorable behavior changes in lower-SES groups.

- Conduct demonstration research in communities, workplaces, and schools with persons from lower-SES groups of various ethnicities. Include participation of community outreach workers (including workers trained and supervised by nurses and dieticians) and community representatives in all aspects of such projects (i.e., planning, intervention, data evaluation) to enhance the potential for lasting accomplishments.

REPORT ORGANIZATION

The report that follows is organized in three sections that parallel the structure of the conference. Each section includes an overview of the session, prepared by its chair, and summaries of the individual topical presentations, prepared by the presenters and their colleagues.

Rosters of conference chairs and speakers, contributing authors, and NHLBI coordination staff are provided at the end of this report.

SESSION I:

Setting the Stage

SESSION I OVERVIEW

Millicent Higgins, M.D., Chair

Session I presented highlights of the very extensive data gathered in the *Chartbook of U.S. National Data on Socioeconomic Status and Cardiovascular Health and Disease* and included discussions of measurement of socioeconomic status (SES) and the nature of its association with cardiovascular disease (CVD). These presentations, as well as comments from conference participants, are reflected in this overview.

Socioeconomic Status

The *Chartbook* used education, income, and occupation as measures of SES; each is strongly related to some aspects of CVD mortality, morbidity, and risk factors, and these measures are correlated with one another. However, each provides some unique information and has its strengths and weaknesses.

Completion of formal education usually precedes the onset of CVD and is not influenced by the disease process. Because education is stable, it can be used over time and throughout the adult age range. Income, on the other hand, can vary over time and may be a less valid measure of SES at the extremes of the age range. Personal income and family income may be hard to ascertain or interpret. Measures such as the poverty-to-income ratio were reported in some studies, but little attention has been given to measuring assets such as home ownership, value of housing, and car ownership; assets as well as income need further consideration, especially for elderly populations.

Occupation is predominantly useful for those who are employed and at the age where having a job is the norm. Occupations may change over time and be influenced by the presence of disease, as well as influence the development of disease. An advantage of occupation is that it has been used extensively in Europe to define social class, but there are issues of comparability and of combining categories for international comparisons. Ownership of a business and authority in the workplace are sometimes used to classify people according to their occupations. Classifying married women according to their husbands' occupation or social class may be less appropriate now than in the past, and inappropriate in some societies. Education, occupation, and income do not cover some aspects of social class and may be inadequate to describe associations or suggest mechanisms by which social class is related to health and disease.

Additional social and demographic variables, such as living alone and marital status, are available from the National Longitudinal Mortality Study; deprivation was assessed in another study. Most presentations and data described and evaluated SES as an attribute of individuals, though household income and family size were assessed in a few studies and familial aggregation and cultural inheritance of social class were mentioned. SES of an individual or family should also be considered in context with respect to place, time, and the social environment of the community. The appropriateness of descriptors of SES varies with sex, age, and race; over time; and from culture to culture.

Cardiovascular Health and Disease

Measures of CVD included extensive national mortality data and a little information on case fatality rates. Limitations of death certificate information are well known and include inaccurate recording and coding of specific causes of death. Measures of morbidity were fewer; prevalence is often based on self-reports of disease and is influenced by ascertainment, by incidence and duration of illness, and by case fatality. Incidence data are sparse. Measures of severity of disease and of access to care were limited to information on hospital admissions, physician visits, and performance of diagnostic and therapeutic procedures for CVD.

Recent information on biological risk factors including blood pressure, serum cholesterol, other lipids, and body mass index was provided by the third National Health and Nutrition Examination Survey (NHANES III). Lifestyle factors are not as easy to measure precisely, but information on diet and physical activity and their relationships to SES variables were presented. There is a wealth of information on smoking that shows very strong and consistent inverse relationships with SES. The *Chartbook* and presentations also included information on the frequency and distribution by SES of some psychosocial risk factors including life events, social networks, and personality characteristics. Some psychosocial variables were strongly related to SES.

Although preclinical evidence of disease was not discussed in Session I, it is an important component of CVD that can be assessed using markers such as carotid artery intimal-medial wall thickness and ankle-arm blood pressure ratio. These newer measures allow studies of a broader range of cardiovascular conditions from fatal events, to type and severity of clinical presentations, preclinical disease, and risk factors.

CVD-SES Relationships

Some consistent patterns were apparent, particularly in recent U.S. data. Low SES was related to CVD morbidity, mortality, and some risk factors, and to less utilization of some components of medical care. Age, sex, and race, as well as socioeconomic factors, are related to access and use of medical care. Some of the data suggest conflicting patterns. Outpatient visits are as frequent or more frequent in poor people. The literature suggests that a given disease diagnosis costs more in poor people because they present later in the disease and need a higher level of care and more procedures. Utilization data paired with incidence, prevalence, and mortality data are needed. Some of the risk factor relationships with SES are not as strong or consistent in the three racial/ethnic groups (i.e., whites, blacks, Hispanics), in men and women, and across the age range. Researchers need to take these variations into account, as well as to assess the quality and strength of the science base in order to increase understanding of the complex interactions between SES and CVD.

There were marked gradients in CVD among occupational groups in European countries, and considerable variation in the strengths of associations between SES and mortality from all CVD, ischemic heart disease, and stroke. Intriguing differences were apparent in northern Europe compared with southern Europe. United Kingdom data provided detail about the gradient of risk across the range of SES and the extent to which occupational level and income provided similar or different insights. Information on deprivation was used as another marker of SES differences in these studies. Some of the European data suggested that income was not the main determinant of the SES gradients, which were just as great in countries where income inequalities were smaller as in countries in which they were large.

Time trend data were available from the United States over recent years and from the United Kingdom over a longer period. There has been a reversal in the relation between SES and CVD mortality in men, but the pattern in women has not changed. Prior to the mid-1960s, mortality rates were higher for men in the upper SES groups but then the situation reversed. In fact, the gap between extremes of SES strata has widened recently, especially among men in the United States. In some developing countries, mortality from CVD is still greater at the upper end of the SES distribution.

It is clear that SES differences in CVD morbidity and mortality are mediated, in part, by the major risk factors, but there is a component of the SES-CVD relationship that is not explained by those associations. Despite the limitations of available data, and imperfect measures of SES, there is strong evidence that SES is a major determinant of cardiovascular health and disease and that further research into the nature of these relationships is warranted.

RESEARCH NEEDS AND RECOMMENDATIONS

- Better measures of SES are needed, especially for women and minorities. Definitions and methods should be validated and standardized. Information is lacking or sparse for several racial and ethnic groups and for rural residents who have not been studied extensively in the past. More sophisticated measures and multiple measures of SES and of aspects of everyday life are desirable, but a simple measure—such as education—would be a useful addition to observational studies and clinical trials, which cannot collect more detailed information.

- Further investigations of relationships between SES and development of risk factors, severity, and course of CVD as well as diagnosis, treatment, and utilization of medical care are needed. Such information would identify groups where the need for prevention or therapy is greatest and improve understanding of the ways in which SES variables influence initiation and course of CVD.

- Circumstances are changing rapidly, and relationships between SES and components of CVD need continued monitoring. National and regional data are needed for the United States and other countries to expand the range of experience and increase understanding of the ways in which SES and cardiovascular health and disease interact.

- Relationships between psychosocial risk factors and biomedical risk factors are in need of further study. The biological pathways by which psychosocial factors and acculturation influence risk must be understood better to improve prediction and prevention of CVD.

- More knowledge is needed about the precursors of adult health behaviors, including the influence of the family and the community on health behaviors. Many healthy and unhealthy behaviors are learned in childhood in the home and they aggregate in families. Children and families should be included in research on SES and cardiovascular health and disease.

- Research is needed to identify effective strategies to promote behavior change in low-SES groups as well as to improve recruitment and retention of such people in observational studies and clinical trials.

- Studies of cost should be added to our research projects. Information about how SES affects cost-effectiveness of preventive and therapeutic approaches is lacking. Policymakers need to know more about health care costs and their relationship with SES. Measures of utilization such as physician visits, hospitalizations, and use of procedures should be related to measures of disease frequency and severity, but these are not generally available and they require well-designed investigations for their collection, analysis, and evaluation.

BIOLOGIC AND METHODOLOGIC APPROACHES TO THE ASSOCIATION BETWEEN SOCIOECONOMIC FACTORS AND CARDIOVASCULAR DISEASE

George A. Kaplan, Ph.D.

Examination of the data presented in the *Chartbook of U.S. National Data on Socioeconomic Status and Cardiovascular Health and Disease*, as well as numerous other sources, reveals an inverse gradient between various measures of socioeconomic status (SES) and mortality and morbidity from the major cardiovascular diseases (CVD) (1). The "better off" experience less disease, and the "worse off" more disease. This pattern of increased risk of poor health outcomes with decreasing SES is found for most, but not all, diseases across the world, and when using a variety of SES measures (2). There are some exceptions to this pattern, and it has not always been true for all groups for CVD. However, in virtually all the developed countries at the current time for which there are good data, higher SES is associated with lower CVD risk.

These are compelling and remarkably consistent findings. The observation of consistent, patterned differences in risk of disease between groups or places is the starting place for epidemiological analysis. Although it is important to continue to document the nature of SES inequalities in CVD, a full understanding will require a clarification of the operative biological **and** social pathways. Parallel with passage through various stages of the life course, there are exposures to a variety of socioeconomic states and risk factors, all linked over time (Fig. 1). Just as risk factors may vary in importance depending on age and stage of disease progression, different aspects of SES may loom more or less important over time. Thus, researchers should not expect either a single risk factor or a single aspect of SES to be equally important at all stages in the natural history of coronary heart disease (CHD). Similarly, patterns of exposure to socioeconomic factors and risk factors are dynamic, not static. Risk factor exposures change over time, and exposures to socioeconomic conditions may also change over time. These changes, as well as the converse—the extent to which they track over time—may have important implications for understanding of the links between SES and cardiovascular health.

The links between SES and risk factors are, of course, of paramount importance in understanding the association between SES and CHD. While some of the epidemiological literature on this association attempts to establish SES as an "independent" risk factor, it must perforce act through more proximal pathways. Thus, it is important to understand these links between measures of SES and the existing risk factors for CHD.

Socioeconomic Factors in the Natural History of Coronary Heart Disease

In understanding how SES factors might be associated with the development and manifestations of CHD, it is convenient to divide the natural history of CHD into three major stages: preclinical disease, triggers and events, and recovery. What follows, a discussion of the pathophysiological links between SES and these

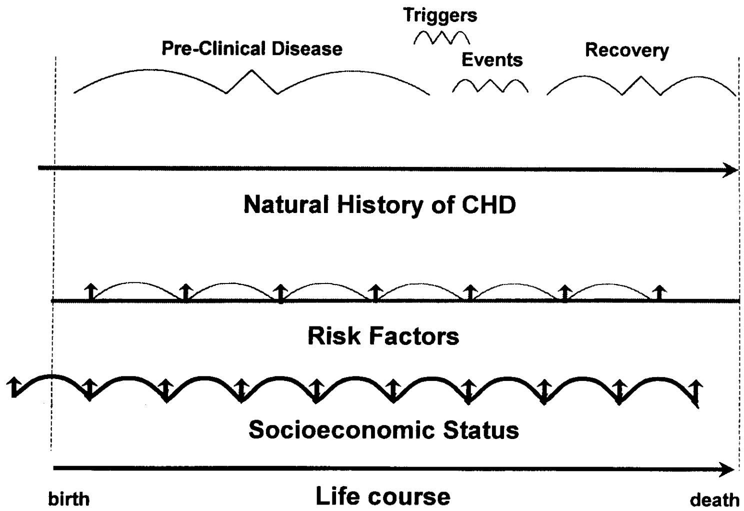

Figure 1.—*Relationship Between Age, SES, Risk Factors, and the Natural History of Atherosclerotic CHD.*

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stages of CHD, is based, for the most part, on consistent reports in the literature. In some cases, in the absence of any information, it is based on biological plausibility.

The molecular and cellular events leading over the long term to atherosclerotic changes have been summarized by a number of authors (3). The preclinical disease stage refers to the early stages of alteration of the arterial walls and environment in which there are neither major obstructions to blood flow nor symptoms. In this stage, there is the gradual progression from fatty streaks to hard plaque with calcification and, ultimately, clinically significant obstruction. The focal role of endothelial injury stemming from mechanical, immunological, viral, or other forces is well recognized, with subsequent endothelial dysfunction leading to disturbances in interactions between the endothelium and macrophages, platelets, smooth muscle cells, T lymphocytes, among others, and changes in vasomotor properties of the artery. Changes in the nonthrombogenic character of the endothelium lead to platelet adhesion, accelerating lesion development via increased levels of platelet-derived growth factor and other substances and leading to smooth muscle cell proliferation and migration.

Table 1 indicates a list of factors that are related to SES, variously measured, and are also related, in some studies, either to coronary atherosclerosis, found on angiography or autopsy, or, as a model of coronary atherosclerosis, to carotid atherosclerosis or progression of carotid atherosclerosis. Given the recent interest in the early origins of CVD, it is important to point out that many maternal exposures influence prenatal development and might, conceivably, have some impact on later atherosclerotic developments. While the pathways are complex, this might be seen as the intrauterine transmission of SES. Considerable evidence now indicates that the standard coronary risk factors (blood pressure, smoking, obesity, lipids, alcohol, physical activity) are related to preclinical atherosclerosis, and in many studies higher levels of these risk factors are found in lower SES groups, although the consistency of this is weakest for lipid measures. SES is also associated with fibrinogen levels, and possibly other pathways influencing both fibrinolysis and coagulation (4).

Although less studied, a variety of psychosocial factors also seem to be strongly associated with coronary and extracoronary atherosclerosis and SES. In one study, 4-year progression of carotid atherosclerosis was associated with levels of hopelessness (5). Hopelessness, in turn, was inversely related to income level. The effects of psychosocial variables on atherogenesis may operate via promoting higher levels of other, more traditional risk factors, or by potentiating the effects of these other risk factors via changes in lipid peroxidation, fibrinolysis, or other mechanisms. In addition, tendencies toward chronic vascular hyperactivity to chronic psychological stress, which may be more prevalent among those who are of lower SES, may also be associated with increased atherogenesis.

When we consider the second stage, that involved in the precipitation of acute events, SES may also have an important role. In this stage of the natural history of CHD, the important events are primarily those related to plaque fissuring and instability, and a cascade of additional factors and events leading to an occlusive thrombus, or other complications (Table 1). Of course, coronary spasm secondary to atherogenic changes or superimposed on these changes, and arrhythmias also are of considerable importance in this stage. Given the effects of smoking, physical activity, and alcohol consumption on coagulation and fibrinolysis, it is not surprising that factors likely to be associated with SES could potentially act as triggers of acute events. Many investigators now believe that factors such as anger, disruption of social ties, mental stress, and emotional distress, and their associated hemodynamic, neuroendocrine, and hemostatic effects may be major contributors to the timing of acute events. Importantly, existing data suggest that these events are more common among those with lower SES. An example of the magnitude is found in a study of silent myocardial ischemia, assessed by radionuclide ventriculography, in response to mental stress in patients with coronary artery disease (6). When patients were asked to give a short speech about personal faults and undesirable habits in front of others, presumably a quite stressful experience, they evidenced almost as high a frequency of wall motion abnormalities as when they underwent a graded maximal exercise test.

Table 1.—SES and CHD

SES and Preclinical CHD	SES and CHD Triggers	SES and CHD Recovery
Prenatal exposures	Smoking	Increased severity
Blood pressure	Heavy exertion	Greater comorbidity
Smoking	Alcohol	Poorer access
Obesity	Anger	Poorer quality of care
Physical inactivity	Social instability	Poorer adherence
Diet	Mental stress	Socioenvironmental factors
Lipids	Intense emotional distress	
Alcohol	Hyper-reactivity	
Hostility/anger		
Social instability		
Depression		
Job strain		
Hopelessness		
Vascular reactivity		

Factors identified with SES are associated with CVD and events at multiple stages. The preclinical disease stage (left panel) refers to the early stages of alteration of the arterial walls and environment in which there are no symptoms or major obstructions to blood flow. In this stage there is the gradual progression from fatty streaks to hard plaque with calcification and, ultimately, clinically significant obstruction. Reflected at left are various factors related to SES, linked in some studies either to coronary atherosclerosis on angiography or autopsy, or to carotid atherosclerosis or progression of carotid atherosclerosis. Certain of these factors are likely to be associated with both SES and events that occur in the triggering and acute stage (center panel). Finally, SES could be related to poorer recovery from acute events via a number of pathways (right panel).

SES could be related to poorer recovery from acute events via a number of pathways (Table 1). Poorer recovery may reflect greater severity of disease and greater comorbidity, each of which would be expected to be present with lower SES. Each of these could be seen, to some extent, as a failure of primary and secondary prevention. For example, a number of studies have shown relatively limited access to preventive medical care and screening among those who are poorer or who live in poorer areas. It is of some interest that most of the mortality differentials associated with educational differences in the Hypertension Detection and Followup Program were eliminated in the stepped-care treatment group (7).

Overall access to care and to health coverage varies by SES, and poorer access or absence of insurance may translate to lower quality of care. There is also some evidence that state-of-the-art interventions are available mainly for those who are higher SES. While it fits into the other stage also, there is evidence that those who live in poorer areas also have less access to healthy foods, and are targeted by the tobacco and alcohol industries. In addition, rehabilitation and supportive services may be less available to those who are of lower SES. Finally, more difficult working conditions and neighborhoods, greater family problems, and greater demands in other domains may all contribute to worse recovery among those in lower SES groups. All of these factors would translate into poorer survival and recovery after acute events.

Conceptualization and Measurement of Socioeconomic Factors

SES factors that might influence cardiovascular health (Table 2) can be measured in many ways. Terms that describe such measurements are often used within epidemiological analyses without proper recognition of their intellectual roots in sociology (8). While it is probably not necessary for epidemiologists to concern themselves with the arcane world of sociological theory, a general reading helps the epidemiologist to be aware of differences in meaning and emphasis that may be of some importance in understanding both the measurement of socioeconomic factors and their impact on health.

Not all measures of SES are equivalent. Each carries with it different problems in measurement, interpretation, and implications with respect to underlying causal pathways. For example, education is taken by some as the best measure because it is easy to measure with high response rates, valued by the researcher, and not subject to reverse causation—health problems in adulthood cannot logically cause differing levels of educational achievement at an earlier time. However, educational achievement is often socially patterned, so highest level of education completed may simply be a proxy for whatever forces are important in determining completion of school. Because there are still large discrepancies in educational opportunities between groups that vary by gender, race or ethnicity, and class, level of education should not necessarily be seen as reflecting forces that are solely located within the individual. There are also large variations by birth cohort in level of education completed—with a general trend toward more and more education in more recent birth cohorts. Thus, the behavioral, social, and psychological factors associated with a given level of education may vary by age and birth cohort. In such a case, asking if the association between education and CHD varies by age may raise numerous interpretive problems. Finally, the consequences of more or less education (e.g., income, housing, job security) may vary by age, race or ethnicity, and gender.

Income is less often measured in epidemiological studies because of somewhat higher nonresponse rates and the possibility that poor health might lead to declines in income. However, income is critically important, as it provides access to other beneficial things (e.g., goods and services, high-quality education, medical care, good housing). To not measure it is to miss the potential links between material conditions and health. However, measuring income is not simple: individual or family income can be measured, it can be adjusted for family size or not, and noncash benefits such as Medicare or food stamps can be included or not.

Table 2.—Socioeconomic Factors Influencing Cardiovascular Health

Socioeconomic Status	Living Conditions
Social Class	Wealth
Education	Housing Tenure
Income	Car Ownership
Occupation	Deprivation
Employment Status	Poverty
Occupational Grade	Income Inequality

Economic resources as represented by wealth may also be important to measure, although this has not been done very much in epidemiological analyses. Measures of wealth based on such assets as bank accounts, stocks and bonds, pensions, and home equity may be critical as they represent resources that may potentially buffer the impact of stressors on health, or may make certain health care resources more available after acute events. More commonly, measures of assets such as car ownership and home ownership have been used, although in the latter case there has seldom been information on size of mortgage.

Occupation is often measured, although the focus is generally not on specific agents that might be associated with increased risk. Instead, categorizations are used that involve status, roles, power, prestige, lifestyle, job characteristics, income, education, traditions, beliefs, and values. For example, a reasonably consistent set of 12 categories has been used since 1910 by the U.S. Bureau of the Census, and the Registrar General of Great Britain has used a categorization since 1911 (currently six categories). It is also possible to categorize people within a broad occupation, such as the classification of civil service workers in Great Britain as administrative, professional-executive, clerical, or other (9). General problems with occupational classification include a usual lack of occupational histories so that downward mobility due to health problems cannot be ruled out, substantial heterogeneity within occupational classifications, and large secular trends in the jobs that fall in specific categories. Most important, such broad classifications do not go very far in pinpointing what characteristics, in particular, are associated with increased risk. Some progress in that regard has been made in the recent work relating job strain and CHD, which suggests that people in jobs characterized by high psychological demands and low decision authority may be at increased risk (10). It is also important to consider employment status because that, too, has been linked to disease and health outcomes.

Many studies use measures of SES that are based on characteristics of the areas in which people live. Characteristics of areas [e.g., census tracts, block groups, zip codes, Standard Metropolitan Statistical Areas (SMSAs)] that are used include income, education, proportion in poverty, occupational distribution, crowding, housing conditions, relative equity of income distribution, and many other indicators. Often, the choice of an area-based measure of SES reflects the lack of availability of individual measures. However, area-based measures can capture characteristics of the locations in which people live that are different from individual characteristics, and these area or community characteristics may be of great significance for health. For example, one study showed that residence in a poverty area was associated with increased risk of death over and above a variety of individual characteristics (11).

In many analyses in which information about SES is not available, classifications of race or ethnicity are used instead. While SES levels do vary by race and ethnicity, substituting race and ethnicity for social class information leaves much to be desired. For example, examination of the distribution of whites, blacks, and Hispanics by quintiles of income for the United States shows that there is substantial overlap of the three populations in the middle of the income distribution. This overlap means that there will be substantial misclassification if race or ethnicity and SES are treated as identical. In addition, race, ethnicity, and SES represent different systems of stratification with implications for health which cannot be held equivalent. Indeed, associations between SES indicators and cardiovascular outcomes may vary by race and ethnicity. For these reasons, and others, race and ethnicity should not be used as proxies for SES information.

Understanding the Connection between Social Class and Cardiovascular Disease

The most common way of addressing our understanding of the association between SES and CVD has been to use multivariate models to examine the extent to which particular risk factors account for the association and the extent to which the association is "independent" of these risk factors. Probably the most exhaustive attempt at this examined the association between income quintiles and risk of death over approximately 6 years, with adjustment for age and 22 additional risk factors (plasma fibrinogen, serum HDL, serum apolipoprotein B, blood leukocytes, serum copper, mercury in hair, serum ferritin, blood hemoglobin, serum triglycerides, systolic blood pressure, body mass index, height, cardiorespiratory fitness, cigarette smoking, alcohol consumption, leisure-time conditioning physical activity, depression, hopelessness, cynical hostility, organizational participation, quality of social support, and marital status) (12). With adjustment for these 22 risk factors, there was no longer an association between income and risk for either all-cause or cardiovascular death. This pattern of results (i.e., a decrease in an association with addition of potential confounder) is commonly taken as indicating that the association between SES and disease has been explained.

However such an approach takes on only part of the task of understanding (12). For example, many of these risk factors show trajectories that reflect the influence of SES (2). Thus, children from poorer

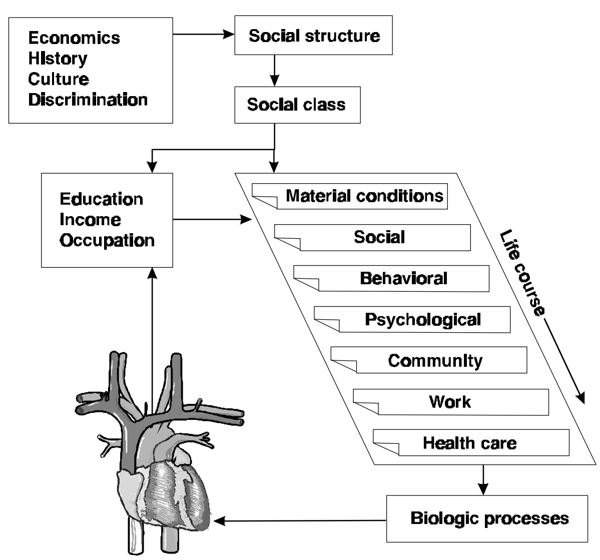

Figure 2.—*Critical Components of the Relationship Between SES and CVD.*

families are more likely to begin smoking. Because SES is causally antecedent to smoking, smoking cannot be said to explain the association between SES and CVD. What this type of analysis does is to help us understand **how** SES manifests itself in increased risk of disease. Much more is still to be learned by such analyses, as we dissect out the critical set of pathophysiological pathways that result in the inverse association between SES and cardiovascular outcomes.

From a public health point of view, it is unlikely that the identification of these pathways will tell us much about how to lower the excess cardiovascular mortality among those who are less "well-off." The problem is not likely to be solved by pharmacological means or other physiological interventions. Instead, we will have to emphasize study of **why** particular risk factors are differentially distributed by SES (13). Such an approach will require examination of multiple factors (Fig. 2) and include an appreciation of life-course trajectories of SES and risk factors. Such a perspective exposes a variety of loci in which the connections between SES and CVD can be broken. Many of these loci are not the usual focus of CVD prevention efforts. However, as Geoffrey Rose (1992) pointed out so eloquently in his final book, *The Strategy of Preventive Medicine*, " The primary determinants of disease are mainly economic and social, and therefore its remedies must also be economic and social."

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SOCIOECONOMIC STATUS AND CARDIOVASCULAR DISEASE MORTALITY: NATIONAL LONGITUDINAL MORTALITY STUDY

Paul D. Sorlie, Ph.D.
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Eric Backlund, M.S.

The National Longitudinal Mortality Study (NLMS) is a prospective study of mortality in persons who were interviewed during various Current Population Surveys conducted monthly by the Bureau of the Census (1). Detailed social, economic, and demographic information on a sample of the U.S. population is obtained by household interview. These surveys provide, among other information, the monthly unemployment rate in the United States. This analysis uses information from approximately 600,000 persons age 25 years or more. The National Death Index was used to identify approximately 65,000 persons from these surveys who died during the years 1979 through 1989. Underlying cause of death was obtained from the death certificate. A person-years approach for calculating annual death rates and a proportional hazards model for calculating relative risks were utilized to describe the relationship between education, income, and mortality from cardiovascular disease (CVD).

Our analyses focus on the following:

- the strength of the income and education associations with mortality;
- the independence of the associations when income, education, and other socioeconomic status (SES) characteristics are considered together;
- the consistency of the associations in ethnic and gender groups; and
- the differences in the strength of associations in the NLMS relative to the Kitagawa–Hauser study in 1960 (2).

Figure 1 presents the relative mortality from CVD for categories of family income for men and women 25 to 64 years of age. When adjusted for age and race, there is a steadily declining mortality by increasing income so that the mortality at $50,000 or more is one-third that of the lowest income categories. After further adjustment for SES (i.e., education, marital status, employment status, and household size), the relationship is not as strong, as would be expected, but there is still a substantial effect of income independent of these other variables.

Figure 2 presents the relative mortality from CVD by education. Again, CVD mortality decreases with increasing education; as seen for income, the risk at the highest education level is about one-third that at the lowest. This relationship remains evident after adjustment for SES (i.e., income, marital status, employment status, and household size). It is noteworthy that the steepest declines in mortality risk occur at the highest levels of education, namely, beyond high school.

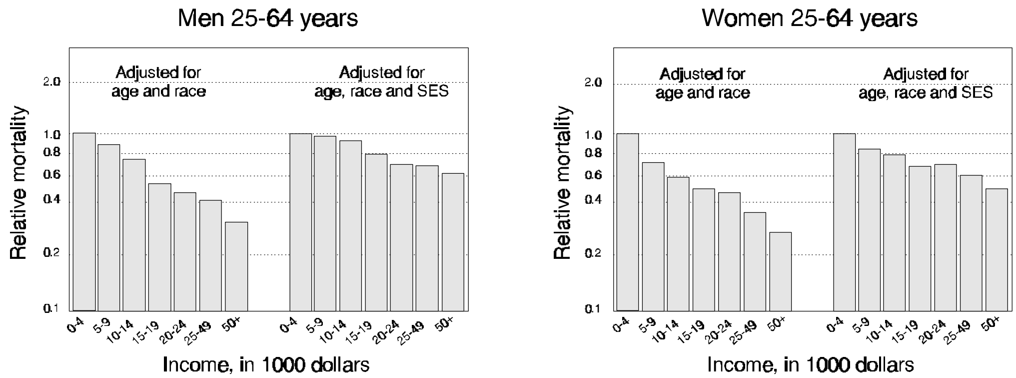

Figure 1.—*Relative Cardiovascular Mortality by Income.* *Estimates were obtained from the proportional hazards model using indicator variables for each income category with the lowest income as the reference point. The* y*-axis displays the relative risk on a logarithmic scale.* **Source**: *NLMS.*

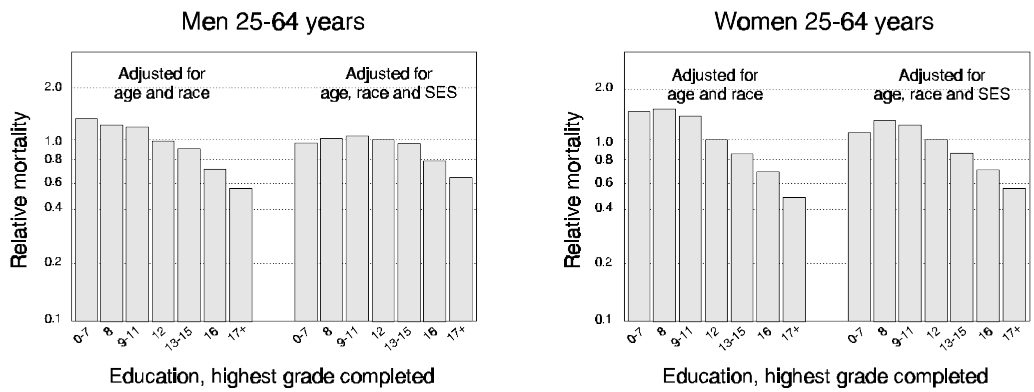

Figure 2.—*Relative Cardiovascular Mortality by Education.* *High school graduate is used as the reference group.* **Source**: *NLMS.*

Figure 3 reflects CVD mortality rates for three levels of education—less than high school, high school, and greater than high school. The annual mortality rates are shown for blacks, whites of Hispanic background, and non-Hispanic whites. Each group shows strong and steady decreases in CVD mortality with increasing education.

The last question to be addressed is how these data compare to similar data collected in 1960 from the Kitigawa–Hauser Study (2). These results (Fig. 4) are courtesy of Drs. Preston and Elo of the University of Pennsylvania, who analyzed the NLMS data available in a public use data set (3). The 1960 data (left) indicate that the difference in the death rate from the lowest education to the highest was 3.9 deaths per 1,000 for men 25 to 64 years of age. Dividing this difference by the annual death rate (8.0 per 1,000) to obtain a ratio of the death rate reveals that the difference is 0.49 of the death rate for that group as a whole. NLMS data for the 1980s (right) show a difference of 4.1 deaths per 1,000 (about the same as in 1960), but the ratio of 0.80 is much higher since the average death rate is lower. Because this graph is plotted on a log scale, the slope for the 1980s is steeper than that for 1960. Thus, for this age group of men, the impact of education on mortality is stronger now than in 1960.

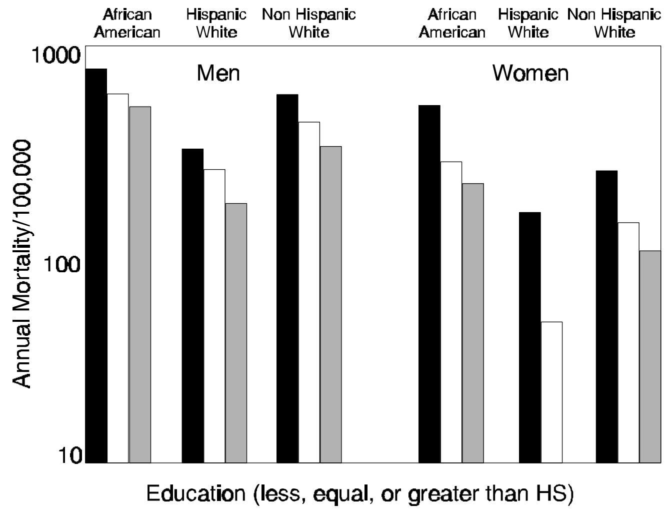

Figure 3.—*Cardiovascular Mortality by Education, Sex, and Race: Age 45 to 64 years.* **Source**: *NLMS.*

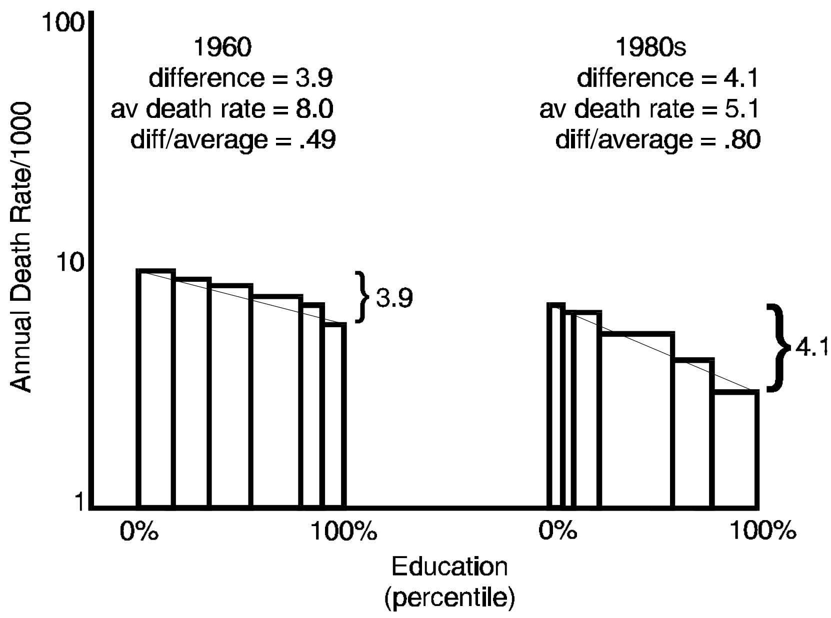

Figure 4.—*Estimation of Slope Index of Inequality: White Men, 25 to 64 Years.* *The slope index of inequality represents the decrease in the death rate from the lowest education to the highest education, with education scaled as a percentile. The bars indicate the death rates for each level of education. The width of each bar represents the percent of population at each education category. The line shows the slope of a regression of the death rates on education scaled as cumulative percentiles of the actual education levels. "Difference" is the difference in the death rate from the lowest to the highest education level. "Average death rate" is the death rate for the group as a whole.* **Source:** *Preston and Elo (3).*

Table 1.—Magnitude of the Education Versus Mortality Gradient:
Ratio of the Decrease in the Mortality Rate to the Average Mortality Rate*

	1960	1980-1985
White Men		
25-64 years	0.49	0.80
65 + years	0.13	0.54
White Women		
25-64 years	0.56	0.41
65 + years	0.44	0.55

*Slope index of inequality / Mortality rate
Source: *Preston and Elo (3).*

Table 1 shows the difference in mortality across the education scale (slope index of inequality) as a ratio of the death rate for each sex and age group. This is the same statistic that was described in the Figure 4 (note the 0.49 and the 0.80). These results show that the mortality differentials for men in the current NLMS data are larger than the differentials found in 1960. For women, the mortality differentials do not appear that much different from the earlier study. Simply put, this means that for men the mortality gap between those with high and low education as a percent of the level of mortality has widened.

In conclusion, this summary of results from the NLMS shows that the CVD mortality differentials by education and income are very strong, that income and education each contribute independently to the differentials in mortality, that this finding is evident and consistent in men and women and in blacks, Hispanic whites and in non-Hispanic whites. There is further evidence that for men, the mortality gradient by education is stronger now than it was in 1960.

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SOCIOECONOMIC FACTORS IN ISCHEMIC HEART DISEASE MORBIDITY AND MORTALITY

Jacob J. Feldman, Ph.D.
Diane M. Makuc, Dr.P.H.

This report describes data on educational differentials in morbidity from the first National Health and Nutrition Examination Survey (NHANES I) Epidemiologic Followup Study (NHEFS). Point prevalence estimates are the only morbidity data appearing in the pre-conference *Chartbook on U.S. National Data on Socioeconomic Status and Cardiovascular Health and Disease*, but incidence and case fatality are more informative measures of morbidity. Prevalence and death rates can be viewed as a function of incidence and survival (1,2). In designing interventions to lessen the disease burden among the disadvantaged, we need to know at what stages in the process disparities develop.

NHEFS is the only nationally representative database that provides information on socioeconomic status (SES) differentials in heart disease incidence and survival for the United States. The study is being conducted by the National Center for Health Statistics (NCHS) with funding from some 12 other Federal agencies, primarily components of the National Institutes of Health. The basic design of this longitudinal cohort study is depicted in Figure 1 and in various NCHS publications (3,4).

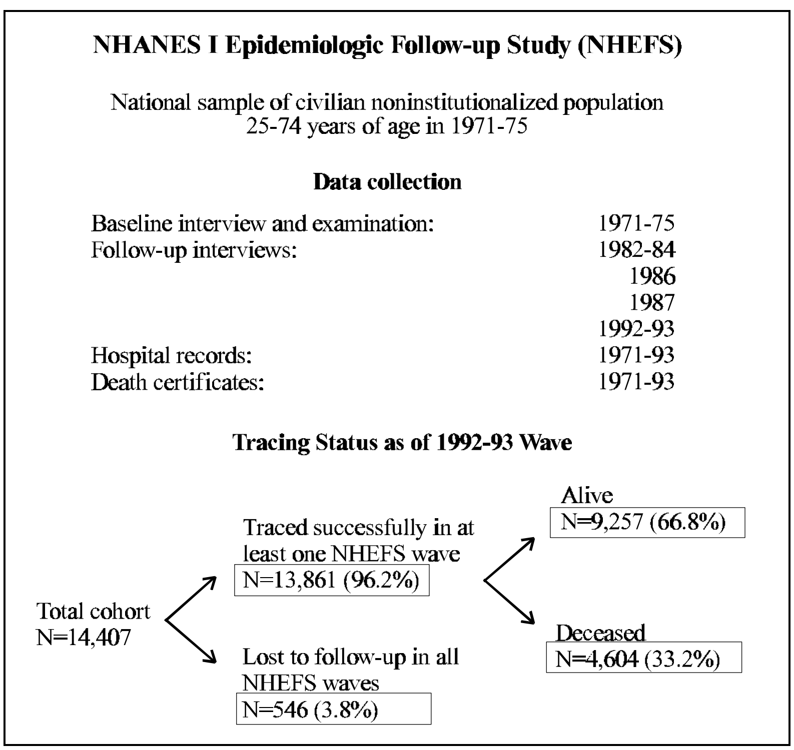

Figure 1.—*Basic Design of the NHEFS.*

Table 1.—Definition of Incident IHD Cases

• No history of heart disease at baseline • Never had a heart attack or heart failure • No heart medication during past 6 months *but during follow-up period* *either* • Death certificate with any mention of IHD (ICD-9 codes 410-414) *or* • Hospital record with an IHD diagnosis

The analysis is based on observations for the entire period from 1971 through 1993. As this is the first analysis that includes the only recently collected data for the 1987-1993 period, the results are preliminary. More intensive analysis of these data may be expected to result in the identification of some data errors and, therefore, a moderate number of edits. However, it is certain that the basic findings will be sustained.

There have been more than 150 publications and presentations based on the earlier waves of NHEFS; many of them have been concerned with cardiovascular disease (CVD) and have treated SES as a covariate in analyses focusing on other risk factors (5). The SES differentials themselves were the major focus of two earlier papers of particular relevance. Trends over the past several decades in the differentials were examined in a paper by Feldman, Makuc, Kleinman, and Cornoni-Huntley (6). (Excerpts from that paper were reprinted in the 1994 *Report of the NHLBI Task Force on Research in Epidemiology and Prevention of Cardiovascular Diseases*.) For older white males, earlier research had shown no relationship between educational attainment and heart disease mortality in 1960 (7). On the other hand, the NHEFS observations covering the period from 1971 to 1984 showed a steep heart disease mortality gradient in relation to educational attainment. The decline in heart disease death rates in the 1970s and 1980s appeared, for males, to have occurred only among the more educated. The rates for the less educated older males changed very little over that period. It was also found that, among older white females, the more highly educated were already experiencing lower heart disease mortality rates in 1960 than the less educated. This gradient did not appear to grow steeper over time. Cox proportional hazards regression models for age–gender strata of the NHEFS data—assessing the educational attainment–heart disease mortality relationship controlling for smoking, overweight, hypertension, and cholesterol—were also presented. Educational attainment remained a highly significant risk factor, the estimate of relative risk being reduced rather little in the full model. The decrease in the risk of heart disease mortality with increased education did not appear to be the result of the covariates. A number of alternative explanations of the trend over time in the education–heart disease relationship were discussed.

In a second paper, Makuc, Feldman, and Gillum separated into incidence and case fatality components the educational differentials in mortality from ischemic heart disease (IHD) and total heart disease, again based on observations from the 1971-1984 period of NHEFS (8). Among both men and women, the less educated experienced higher incidence rates for IHD and total heart disease than did more educated individuals. In Cox proportional hazards regression models, a relatively strong SES differential remained after controlling for smoking, body mass index, hypertension, cholesterol, and diabetes. The less educated also experienced appreciably shorter survival times after onset than did the more educated. Certain of the confidence intervals were rather broad because of the relatively small number of incident cases in some

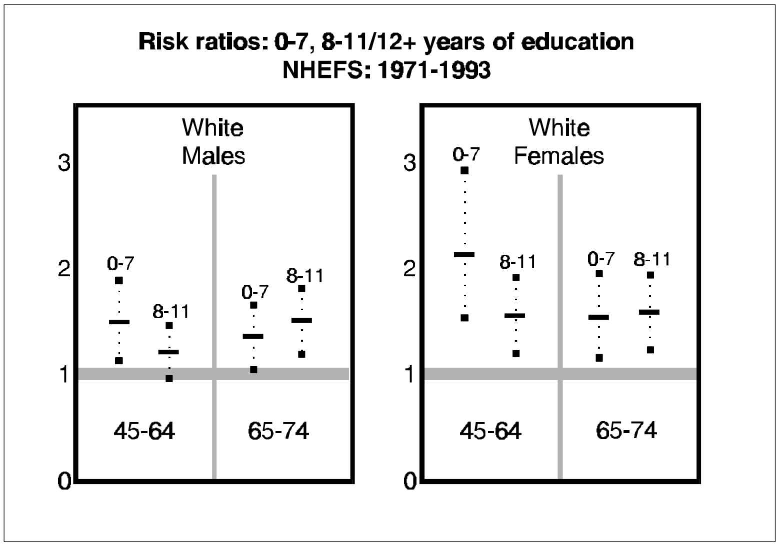

Figure 2.—*Risk Ratios for IHD Incidence by Education for White Men and Women Ages 45 to 64 and 65 to 74 at Baseline in NHEFS, 1971-1993.* *High school graduation or above is used as the reference group. Age at baseline, in single years of age, has been entered as a covariate in these proportional hazard models. The vertical lines indicate 95 percent confidence intervals surrounding the estimates of relative risk.*

age–gender strata. Extending the database to include an additional 10 years of heart-related events facilitates analyses of survival differentials.

Incidence, NHEFS, 1971-1993

We require either hospital record or death certificate evidence in ascertaining cases of IHD (Table 1). There are some problems of underascertainment and of dating of the onset due to failure or delay in diagnosis, delay in hospitalization, reporting errors, and the inability to gain access to certain hospital records. The likely extent of such errors, and their potential impact on inferences based on this database, will be considered in a later publication. One might assume, however, that the less educated, because of inferior access to care, would be likely to be diagnosed and hospitalized later in the course of illness, a phenomenon that would underestimate their relative risk.

Figure 2 presents estimates of the relative risks of IHD incidence for white males and females in two age groups according to educational attainment, with high school graduation or above as the reference group. Without exception, estimates indicate that those who had not graduated from high school were more likely to have developed IHD by any given age than those who had graduated from high school. The risk ratios for the less educated remain high at older ages. The estimates presented in Figure 2 are derived from a model parametrized in terms of age at baseline, but we have also performed analyses based on age at the time of risk that confirm the persistence of the SES gradient in incidence at quite advanced ages. These findings are particularly noteworthy because it has been previously observed that the impacts of many CVD risk factors tend to diminish with increasing age (9). Notwithstanding the fact that the SES differentiation in atherosclerosis and other preclinical cardiovascular pathology probably begins decades earlier in the lifespan, the incidence differentials remain large at advanced ages. It is conceivable that the relative weights of the various etiological factors responsible for the incidence gradient change over the lifespan.

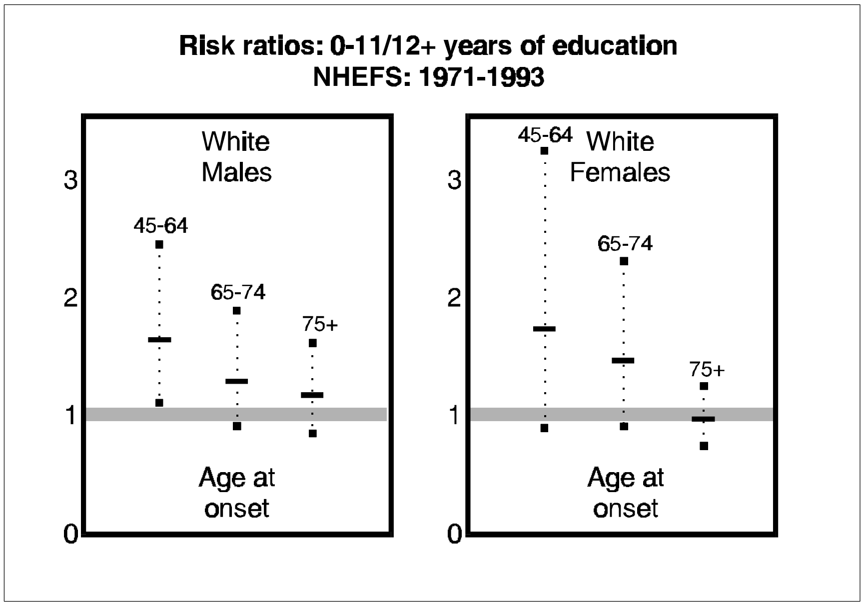

Figure 3.—*Risk Ratios for IHD Deaths among IHD Cases by Education for White Men and Women in NHEFS, 1971-1993.* *Age at onset and gender are stratifying variables; a separate proportional hazards model was estimated for each of the six groups. Age at onset, in single years of age, was also entered into the model as a covariate.*

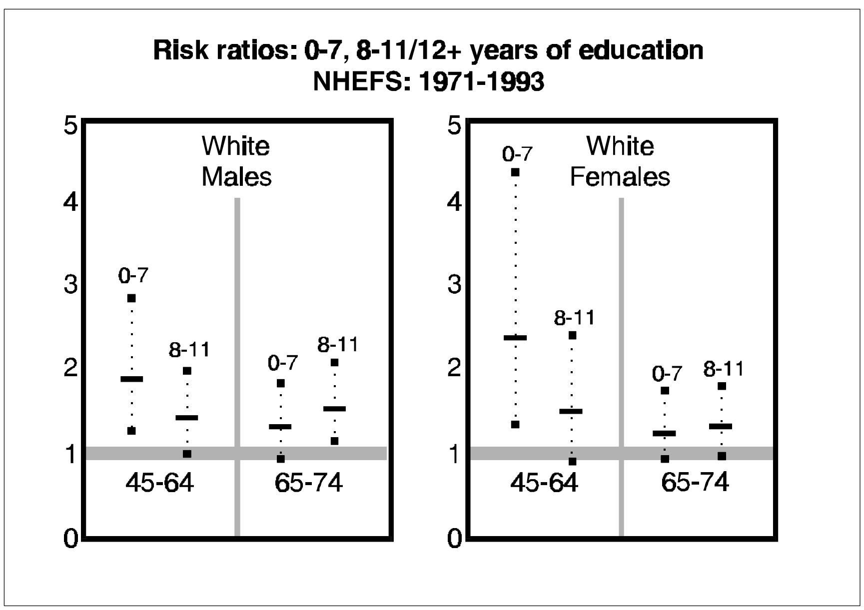

Figure 4.—*Risk Ratios for IHD Deaths by Education for White Men and Women, Ages 45 to 64 and 65 to 74 at Baseline, in NHEFS, 1971-1993.* *Age at baseline, in single years of age, has been entered as a covariate in these proportional hazards models.*

Case Fatality

We define survival time as the interval between the date of onset and the date of death with IHD coded as the underlying cause. Deaths from causes other than IHD were treated as observations censored at the date of death. Differentials in survival time for IHD are shown in Figure 3. The more educated had longer survival (in terms of a trajectory of lower ischemic heart disease mortality rates) after onset in five of the six age–gender strata. The survival advantage of the more educated appears, in the present dataset, to be greatest at the youngest age at onset but the trend is not statistically significant. It is not possible to determine from the present dataset the extent to which the differentials in survival primarily reflect differences in disease severity or whether the outcome differences reflect other factors related to SES.

Mortality and Prevalence

Proportional hazards models for IHD mortality, following the same structure as the incidence models in Figure 2, have also been estimated for the 1971-1993 database (Fig. 4). Substantial differentials by educational attainment were found in all four age–gender strata. Both incidence rates and the trajectory of the mortality hazard from IHD after disease onset were considerably less favorable among the less educated. These two tendencies compound to produce the large observed age-specific mortality differentials.

The prevalence of IHD is a function of incidence and survival time (1,2). The educational differentials in prevalence tend to be smaller than for incidence and mortality, as the longer survival time of the more educated increases the number of IHD cases alive at any given point in time. (Survival models shown in Figure 3 predict death from IHD while prevalence is a function of the all-cause mortality hazard subsequent to onset. The estimates of the SES risk ratios for all-cause models are consistent with those for IHD.) Estimates of the average point prevalence of IHD cases among white males aged 65 or older for NHEFS during the 1992-1993 period exhibit practically no gradient at all for educational attainment. Averaging over the 6-year period 1988-1993, the National Health Interview Survey (NHIS) shows a positive self-reported IHD point prevalence gradient with education for non-Hispanic white males aged 65 or older (i.e., the more highly educated have somewhat higher point prevalence rates than the less educated). On the other hand, in younger age groups, the more highly educated report lower point prevalence than the less educated. The Medicare Current Beneficiary Survey (MCBS) shows a flat relationship between educational attainment and self-reported IHD point prevalence for white males aged 65 or older (10). The NHANES III for 1988-1991 shows the highest point prevalence of cases with either self-reported myocardial infarction or angina (Rose Chest Pain Questionnaire) among the more highly educated for white men aged 65 or older. As in the NHIS, there is a higher-order interaction between age, educational attainment, and point prevalence; in the age groups below 65 years, the more highly educated have the lowest point prevalence rates. On the basis of the incidence and survival differentials, one can deduce that heart disease patients among the more educated white males age 65 or older have, on average, been living with diagnosed IHD for a longer period of time than those with less education. While the mean survival times differ, it is uncertain how similar the shapes of the distributions of durations since onset are for the populations with differing educational attainment. It could be informative to investigate the shapes of those distributions. Analysis of the NHEFS data covering the 1971-1984 period for the white population indicated a higher rate of heart-related surgery among the more highly educated (11). Analyses of 1993 Medicare data based on SES characteristics of the zip code of residence suggest a more or less flat relationship between the rates for various atherosclerosis-related surgical procedures and SES for white beneficiaries (12). To the extent that the size of the pool of prevalent cases of IHD influences the surgical procedure rate, the relatively small SES differentials in surgical rates for the older white population are consistent with the weak SES gradient in point prevalence.

Further Research

This is the first presentation based on the NHEFS database extended to 1993. A number of more detailed analyses are under way. Earlier analyses focused primarily on the white population because of sample size considerations. An analysis performed on the 1971-1987 data showed that educational differentials in mortality were similar for black and white males (11). With the heart disease events occurring in the 1987-1993 period added to the database, more definitive investigations of educational differentials in heart disease among blacks have become feasible and will be conducted.

In the analyses of the NHEFS database thus far, the events of the entire period from 1971 to 1993 are aggregated. Although great changes have taken place since 1960, we have not examined individual-level data for changes in differentials in more recent decades. The 1979-1989 National Longitudinal Mortality Study data presented by Dr. Sorlie also have been treated as deriving from a single time period (13). As the SES gradient shifted so markedly between 1960 and the early 1970s, it seems probable that the gradient has continued to shift since then in one direction or the other. Modeling by specifying time period stratification and the use of time as a covariate may help clarify this question.

Medicare Part A benefit records have, since 1984, been linked to the NHEFS database. These will provide the basis for the methodological research regarding the completeness of ascertainment and problems with the accuracy of the dating of onset. In addition, these linked benefit records facilitate research into SES differentials in the cost of services related to heart disease.

In examining various risk factors as covariates in our proportional hazards models, we have relied exclusively on measurements from the 1971-1975 baseline examination. Data on potential risk factors were collected in the 1982-1984, 1986, and 1987 waves. The inclusion of measures from these waves in our models may well elucidate the mechanisms through which the SES differentials operate. In addition, following, through successive waves, cases with onset early in the study period should increase our understanding of SES differences in the natural history of IHD. While primary prevention may be the ideal, intervention at later stages in the disease process may also be effective in reducing SES differentials.

Conclusions

Our analysis of the NHEFS database, extended to 1993, has shown a strong SES gradient for the incidence of IHD in the white population for both males and females extending throughout the age span. Analyses of data from the first decade of the study were not able to account for the SES differentials in terms of the risk factors for which data were available. We also found a strong SES gradient for case fatality in the white population for both males and females, particularly at the younger ages. On the other hand, there does not currently appear to be a marked SES gradient in the prevalence of IHD among older white males. This presentation was the first based on the extended NHEFS database. More detailed analysis of these data holds promise of elucidating some of the mechanisms underlying the SES gradients.

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Socioeconomic Status and Biomedical, Lifestyle, and Psychosocial Risk Factors for CVD: Selected U.S. National Data and Trends

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Christopher T. Sempos, Ph.D.

During the past 30 years, there has been a marked decline in U.S. death rates from cardiovascular disease (CVD), including coronary heart disease (CHD) and stroke. Although every segment of the population has benefited from this decline, not all population subgroups have benefited to the same extent. This observation is almost certainly a result of the differential effect of the numerous biomedical, lifestyle, and psychosocial risk factors on the prevalence of CVD. The relationship between socioeconomic status (SES) and these risk factors is important. As noted in the *National Heart, Lung, and Blood Institute (NHLBI) Report of the Task Force on Research in Epidemiology and Prevention of Cardiovascular Diseases*, "Membership in less affluent and less educated groups is associated with higher levels of cigarette smoking, high blood pressure, obesity, and physical inactivity. These groups also tend to consume more adverse diets and to lack access to health care services, particularly prevention services"(1).

The major risk factors for CVD are well known and include:

- Abnormal blood lipids and lipoproteins
- Elevated blood pressure
- Smoking
- Obesity
- Physical inactivity
- Diabetes mellitus
- Adverse dietary patterns
- Psychosocial factors

While there are other potential CVD risk factors, both old and emerging, the list describes those risk factors with the largest potential for reducing or preventing CVD with improved status in the general population. The focus of this analysis is a review of national data and national trends using two surveys conducted by the National Center for Health Statistics (NCHS) of the Centers for Disease Control and Prevention.

The National Health and Nutrition Examination Survey (NHANES) is a complex, multistage, national probability sample of the civilian noninstitutionalized population of the United States. Conducted periodically by NCHS and unique in that it includes both an interview component and a standardized physical examination as part of the survey (2), each NHANES produces information on many of the risk factors for CVD in its examination component. The National Health Interview Survey (NHIS), an interview survey conducted annually by NCHS (3), obtains data on the incidence of acute illness and injuries, the prevalence of chronic conditions and impairments, the extent of disability, and utilization of health care services. Both surveys have the capability to assess the relationship between SES and various CVD risk factors at a given point in time, as well as to assess trends in various CVD risk factors over time. The ability to assess trends is possible since many of the questions or examination methods have remained comparable over time.

The findings are primarily based on information found in the *Chartbook of U.S. National Data on Socioeconomic Status and Cardiovascular Health and Disease* (4). Although the *Chartbook* contains information from a number of surveys and surveillance systems, only findings from the NHIS and NHANES surveys are used as examples in this analysis. Findings for the other studies shown in the *Chartbook* were generally similar to those shown for the NHIS or NHANES.

A large number of biomedical, lifestyle, and psychosocial risk factor findings are presented in the *Chartbook*. All of these variables have been implicated as risk factors for CVD based on previous studies, and many were discussed extensively in the *NHLBI Report of the Task Force on Research in Epidemiology and Prevention of Cardiovascular Disease*. It was logical to believe that similar conclusions would be found when more recent data from NHANES III and the 1993 NHIS were analyzed. However, this was not always the case.

Table 1 categorizes certain CVD risk factors into two groups based on an overall assessment of their relationship to the three SES variables used in the *Chartbook* analyses (i.e. education, income, and occupation). These SES variables were not related in any consistent manner to at least half of the previously defined risk factors in these two national surveys. Although the categorization into two groups is possibly an oversimplification, the fact remains that the relationship between many of these risk factors and SES is uncertain.

One of the CVD risk factors that did show a strong relationship with SES was smoking. Higher levels of cigarette smoking were associated with persons who are less educated and less affluent. Figure 1 shows the prevalence of cigarette smoking among men and women ages 45 to 64 years by education, sex, and race/ethnicity group from the 1993 NHIS. For all six race/ethnicity–gender groups, the highest prevalence of smoking was observed in the group with less than high school education. This pattern was similar to that observed in the 25 to 44 and 65+ years age groups (not shown). Similar results were found when income and occupation were used as the surrogate for SES. The lowest income group had the highest prevalance of cigarette use, and the blue collar and service groups had the highest smoking prevalences among the occupation categories. However, the relationship between income, education, or occupation and cigarette usage was different for the Hispanic subgroup. Whether this inconsistent pattern for the Hispanic population resulted from smaller sample sizes that did not allow for consistent patterns to be observed, an inadequate definition of SES for this population subgroup, or a truly different relationship within this population group remains unresolved.

With respect to trends over time, the overall conclusion is that for most sex–race/ethnicity–SES subgroups there has been a decrease in the prevalence of cigarette smoking. For example, the prevalence of smoking among 25 to 44 year old black and white males decreased from 1976 to 1993 in all educational subgroups (Fig. 2). However, the decrease is less obvious in some of the lowest education groups. In contrast, among

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Table 1.—Strength of Association Between CVD Risk Factors and SES Measures

Weak	*Strong*
Blood pressure	Overweight
Cholesterol	Cigarette smoking
Diet	Diabetes
Psychosocial factors	Physical activity

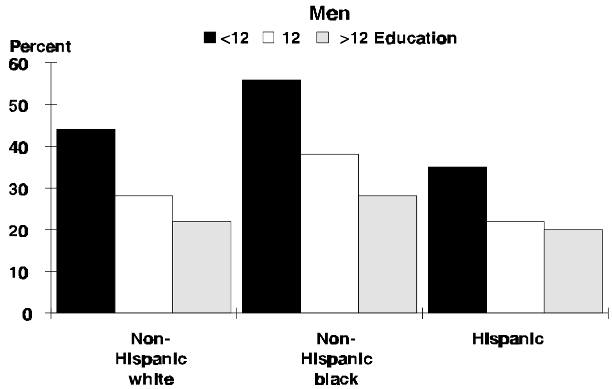

Figure 1.—*Current Cigarette Smoking by Race/Ethnicity and Education: Men and Women Ages 45 to 64.* **Source**: *NHIS, 1993.*

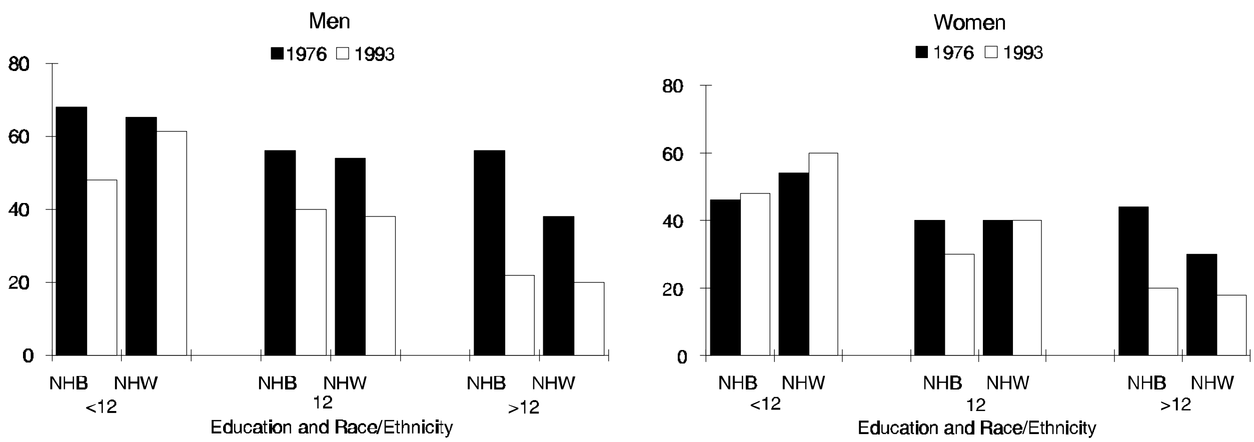

Figure 2.—*Trends in Cigarette Smoking by Education and Race/Ethnicity: Men and Women Ages 45 to 64.* *NHB = non-Hispanic black; NHW = non-Hispanic white.* **Source:** *NHIS, 1976, 1993.*

25 to 44 year old black and white women, the percent who smoked cigarettes actually stayed the same or increased in the lowest educational subgroup. Thus, while a generally decreasing pattern in cigarette smoking was observed when comparing NHIS data for 1976 and 1993, the decrease was much more significant in the highest SES subgroups. Similar patterns were observed when income was used as the SES variable. This finding is likely to be related to the increasing gap in CVD death rates between various race/ethnicity groups.

The relationship between the SES variables used in the *Chartbook* and many other CVD risk factors was much more complicated than that observed for cigarette smoking and was affected by the way the analyses were conducted. The observed relationship between overweight and income in the NHANES III (1988-91) data is such an example. For these analyses, overweight was defined as a value greater than the age-sex specific 85th percentile cut points for body mass index for 20 to 29 year old males and females from NHANES II (5). The table in the *Chartbook* used data from the first phase of NHANES III, and family income was classified into four different groups. In general, differences were observed in the prevalence of overweight by income status. However, the pattern was not consistent among men and women and among the various racial/ethnic groups. Moreover, for many subgroups the survey sample sizes were too small to make meaningful comparisons.

Figure 3 presents similar analyses using another measure of income status and fewer categories. The alternative definition of income status is the poverty income ratio (PIR). PIR is a standardized variable calculated from annual census tables that takes into account family size, family composition, and total family income. It also allows comparison of findings from various surveys over time, which would not be possible with income data alone.

For this alternative analysis, the sample sizes were adequate to divide PIR into three categories. The lowest category (less than or equal to 1.30) uses a cut point that determines eligibility for selected government sponsored food assistance programs. The upper category is a calculated PIR greater than 3.50, and the middle category is between these two cut points.

The relationship between income status and overweight is different for men and women. In addition, the relationship differs between race/ethnicity groups. For non-Hispanic white men, the prevalence of overweight is lower in the upper income group, whereas, for both non-Hispanic black men and Mexican-American men the opposite is true: the prevalence of overweight is lowest in the poorest income group (Fig. 3). For non-Hispanic white women, the pattern is similar to that for white men, that is, the lowest prevalence is found in the upper income category. While this pattern is also observed in Mexican-American women, non-Hispanic black women show very little change in the prevalence of overweight regardless of income status. Thus, the "effect" of low income on the prevalence of overweight is not consistent among the major U.S. population groups, and the "effect" is not the same in men as in women. This leads one to conclude that the relationship of SES to some of these CVD risk factors is complex and not easily definable.

Many more examples could be shown using other biomedical, lifestyle, or psychosocial risk factor data found in the *Chartbook*. The relationship between these risk factors, SES, and health outcomes such as cardiovascular health is complex and reflects the complex manner in which social and economic status and race interact in the United States. This topic has been discussed recently in a number of articles. Dr. Gregory Pappas noted in an editorial in the *American Journal of Public Health* that "the complex ways in which social and economic class and race create disadvantages and produce disparities in health must be

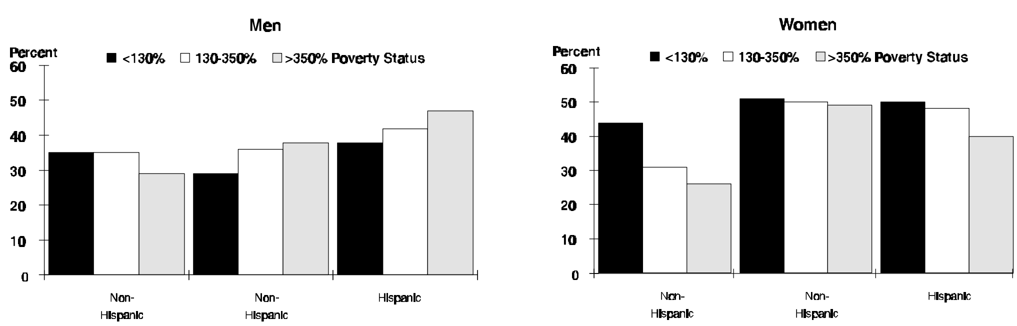

Figure 3.—*Age-adjusted Prevalence of Overweight by Poverty Status and Race/Ethnicity: Men and Women Ages 20 and Over.* **Source**: *NHANES III, 1988-91.*

more fully investigated" (6). Based on these findings, more investigation is needed. It is extremely difficult to summarize all the findings on SES and CVD. It is possibly due to the lack of a consistent and agreed-upon definition of SES or "social class." Although "class" is a difficult and sometimes contentious term, Dr. Pappas contended that some measure of it is necessary in order to examine disparities in health among various racial and ethnic populations. Agreement on a standard measure of "class" or SES is critical to the process as well.

Similar issues and conclusions were also noted in a *Public Health Reports* article by Moss and Krieger (7). In an introduction, Dr. Phillip R. Lee, the Assistant Secretary for Health, acknowledged the limitations of SES measures (especially occupation) in many of the Federal, state, and local health data and indicated that many of the recommendations from that conference would be implemented in the coming months and years.

With the currently available national survey data and with agreed-upon indicators of "social class" or SES, some evaluation of disparities in health among population subgroups is possible. The recently completed second phase of NHANES III will be available in the near future. This will allow analyses of the full 6-year study with increased sample sizes that will clearly resolve some of the limitations that were encountered by the *Chartbook* developers when creating tables based on the first phase of data from that survey. In addition, NHANES III has a number of SES variables (including occupation) collected in a standardized manner, which will allow numerous analyses of SES and cardiovascular health based on the wealth of information collected in that survey. Many of these variables were consistently collected across previous NHANES surveys and will provide the basis for assessing trends over time. These data, in conjunction with information from the NHIS and other non-national or subpopulation-specific national data sets, will greatly increase our knowledge of the relationship between SES (or social class) and CVD. We have the beginnings of that information data base today in the *Chartbook*. The rest remains for us to analyze, interpret, and implement in the future.

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SES AND MEDICAL CARE UTILIZATION RELATED TO CVD: SELECTED U.S. NATIONAL DATA AND TRENDS

Paul Eggers, Ph.D.

Although there is a great deal of research on the effects of socioeconomic status (SES) on global utilization rates, such as physician visits and hospitalizations, there is very little on cardiovascular disease (CVD) specific use rates. This is due to at least two reasons. The first is sample size. Surveys are usually designed to obtain health care use and expenditure data on overall medical services. Rarely are diagnosis-specific use rates sufficiently sampled for analysis, even for large categories such as CVD. Second, many surveys rely on patient recall for the identification of utilization. Nonmedically trained respondents are very poor in identifying cause-specific utilization. They can usually recall important medical events, i.e., hospitalization, but the underlying diagnosis related to the event is usually poorly understood or remembered.

A good review of the literature on race and CVD utilization was recently published by Earl Ford and Richard Cooper (1). Oberman and Cutter found that blacks who received coronary arteriography were only 40 percent as likely to receive a coronary artery bypass graft (CABG) as were whites (2). Maynard, et al, found that the use of CABG was 30 percent lower for black males and 10 percent lower for black females than for their white counterparts (3). Gillum used the National Hospital Discharge Survey (NHDS) to show that blacks received angiography only one-half as frequently as did whites and were 70 percent less likely to receive a CABG (4). Ford, et al, also examined NHDS data, but controlled for the rate of CVD by using discharge rates for myocardial infarction (MI) (5). They estimated a two-fold racial difference in CABG use, in contrast to the three-fold difference shown by Gillum. Wenneker and Epstein examined Massachusetts hospitalizations for persons admitted with CVD or chest pain (6). Blacks had 20 to 30 percent fewer angiographies and about one-half the number of revascularizations. This analysis included a control for estimated income.

Maynard, using data from Seattle, showed that, although blacks were equal to whites in use of angiography and thrombolytic therapy, their rates of revascularization were still only about one-half those of whites (7). Hannon, et al, attempted to control for potential hospital technology bias by limiting their analysis to hospitals that actually provide these cardiovascular procedures (8). Still, they found similar racial differences.

Two recent studies have used the Medicare data base to look at the race issue. Goldberg, et al, found that, in 1986, aged black males were only 20 percent as likely as aged white males to receive a CABG (9). For black women, the relative use rate was 40 percent. Goldberg did not attempt to control for the rate of catheterization. Franks, et al, also using Medicare data, did examine catheterization rates (10). They found aged black males hospitalized with an MI to be 50 percent less likely than aged white males to receive a catheterization. For females the relative use rate was 70 percent. Contingent upon catheterization, both black males and females were only 60 percent as likely as their white counterparts to undergo any revascularization (either percutaneous transluminal coronary angioplasty [PTCA] or CABG).

Ford and Cooper reached several conclusions. They include:

- The question of whether race or SES accounts for many of the observed differences in health and health care utilization is controversial and remains unanswered.

- The demonstration of racial differences in the Medicare data, where one could argue that economic factors should constitute less of a barrier, shows that factors other than economic ones play an important role.

- During the 1980s, after arteriography, PTCA, and CABG were routinely available, blacks were far less likely to undergo these procedures.

- A surveillance system, preferably one that is nationally based, should be established to monitor various aspects of health care utilization, including the use of cardiac procedures.

Very few of the national studies on race and cardiovascular utilization directly address the issue of SES. The remaining part of this paper presents data from two national data bases with SES variables included.

The National Medical Expenditure Survey (NMES)

The NMES was a set of surveys that collected information about use of and expenses for health services for the year 1987. This survey included about 14,000 households representing the civilian, noninstitutionalized population of the United States. Data were collected through three personal surveys and a single telephone survey. Respondents were asked to record medical events in a calendar or diary. Physician visits were identified from "provider probes" for visits to medical doctors, hospital emergency rooms, and hospital outpatient departments. Hospital admissions were similarly identified by a probe for either an overnight stay or an admission and discharge the same day. Demographic information was obtained from the primary respondent from each family.

Figures 1 and 2 depict NMES-determined physician visit and hospitalization rates, respectively. For whites, there is a fairly clear gradient for use by education level. Persons with more than high school education see a physician for a cardiovascular problem less than one-half as often as those with less than a high school education (264 and 574 visits, respectively). The effect of education on use rates among blacks is less dramatic. However, both high school graduates and those with more education have about one-third fewer visits than those with less. The gradient is more consistent for both racial groups with respect to income. For both groups, the highest income category has less than one-half the use rate of the lowest income group, with intermediate levels for the other income groups.

Hospitalizations are shown in Figure 2 for all conditions, all cardiovascular conditions, and for ischemic heart disease by educational groupings. The first thing that is evident is the very low rate of cardiovascular hospitalization—thus, the rates have fairly high errors of estimation. Nevertheless, educational gradients seem evident. For blacks, those with less than high school education have approximately twice the overall hospitalization and up to 5 times the cardiovascular hospitalization of those with high education levels. Among whites the gradient is not so pronounced. However, for all three measures of hospitalization, decreases are associated with increased income levels.

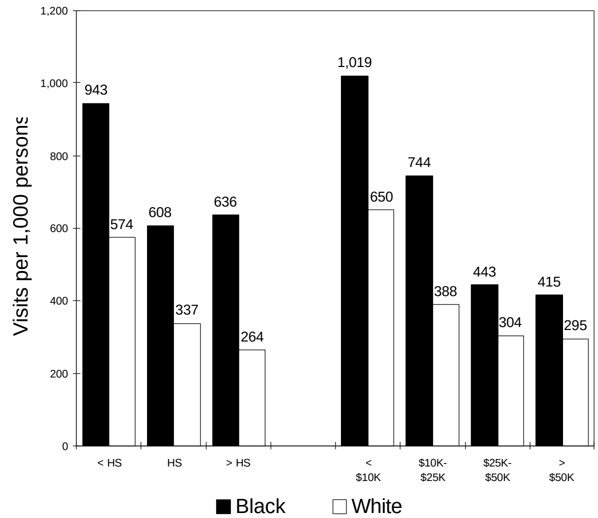

Figure 1.—*Physician Visits for Any Cardiovascular Condition by Education, Income, and Race.* *Rates shown are for persons ages 25 to 64, both sexes.* **Source**: *Adapted from 1987 NMES.*

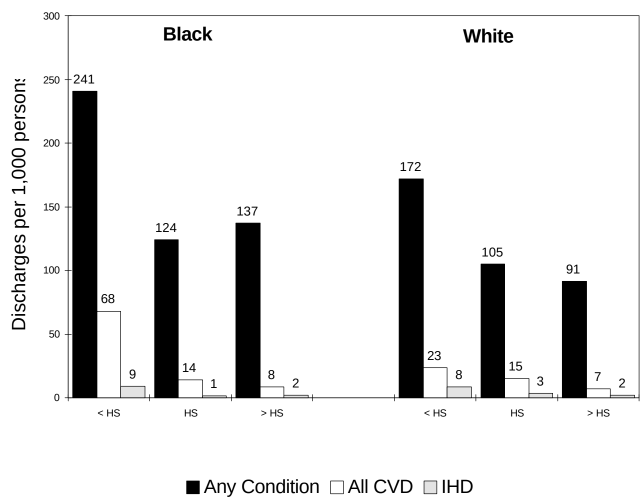

Figure 2.—*Hospitalizations by Education and Race for Patients Ages 25 to 64.* *Hospitalization rates are shown for all conditions, all cardiovascular conditions, and ischemic heart disease (IHD) in both sexes by educational groupings.* **Source**: *Adapted from 1987 NMES.*

Medicare Link With Census Data

In order to explore the issue of the effect of SES in the Medicare population, U.S. Census data were used as a proxy measure for SES, specifically income. Briefly, utilization rates were calculated for Medicare beneficiaries by the zip code of their residence. The median income for each zip code obtained from the 1990 U.S. Census was used to estimate household income for all aged persons living in a zip code. Zip codes were then aggregated into four income levels, and utilization rates were developed. The population was limited to aged Medicare beneficiaries who were not members of health maintenance organizations

(HMOs). The counts were based on total months of non-HMO enrollment. These data were taken from the Medicare denominator file for 1993. For each zip code, person-year equivalents (total months of non-HMO enrollment divided by 12) were calculated for each of three age groups (65 to 74, 75 to 84, 85 and over) for males and females separately, and for white, black, and other race categories.

Medicare Trends in Cardiovascular Utilization (1986 to 1993)

The Health Care Financing Administration (HCFA) is the agency responsible for the Medicare program. Medicare covers almost the entire U.S. population over the age of 65 (about 31 million), as well as three million disabled persons and 200,000 persons with end-stage renal disease. About 90 percent of the Medicare population receives care in a fee-for-service environment. Each of the fee-for-service encounters generates a bill that can be linked to the individual beneficiary. The fact that Medicare is almost universally available to persons over age 65 means that population-based use rates can be calculated for fairly specific kinds of services. Medicare beneficiaries account for approximately 11 million hospitalizations annually. For each of these hospitalizations, information is available for both diagnoses and procedures in ICD9-CM format. As many as five diagnostic conditions and up to three procedures are reported. All procedures were considered but only the principal condition was examined. Data were arrayed for the years 1986 through 1993.

About one-fifth of all hospitalizations among aged Medicare beneficiaries are for CVD. Although hospitalization rates for all heart disease do not differ greatly between black and white beneficiaries, as seen in Figure 3, black beneficiaries are much less likely to be hospitalized for ischemic heart disease (Fig. 4).

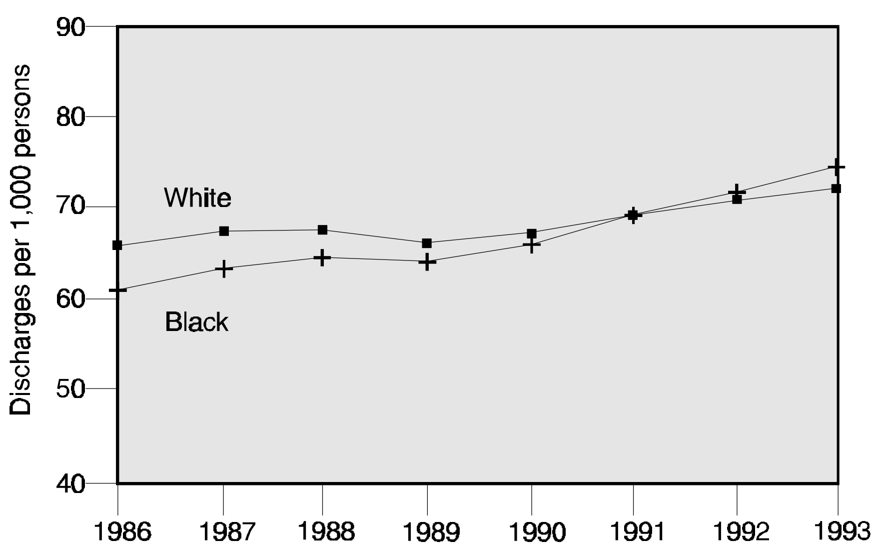

Figure 3.—*All Heart Disease Hospitalizations of Medicare Beneficiaries by Race.* *Between 1986 and 1993, the hospitalization rate for whites increased by 10 percent while the black rate increased by 23 percent, increasing the black-to-white use ratio from 0.92 to 1.03.* **Source**: *HCFA.*

Revascularization rates are depicted in Figures 5 and 6. Cardiac catheterization (not shown) increased rapidly for both white and black beneficiaries during these years. The white rate increased by 75 percent, from 9.5 procedures per 1,000 to 16.4 procedures per 1,000. The black rate more than doubled, from 5.0 procedures per 1,000 to 11.5 procedures per 1,000. The black-to-white use ratio increased from 0.52 in 1986 to 0.70 in 1993. CABG rates (Fig. 5) increased at comparable rates (to catheterization) during these years. As with the other use measures, the increase was greater for black beneficiaries than for white beneficiaries. In 1986, the CABG black-to-white use ratio was 0.28. By 1993 this had increased to 0.40. The largest increase in utilization during these years was for PTCA (Fig. 6). PTCA was performed only one-half as frequently as CABG in 1986 but by 1993 the PTCA rate exceeded the CABG rate for both black and white beneficiaries. The black-to-white differential was greater for both CABG and PTCA than for catheterization. This is consistent with previous studies showing lower revascularization rates for black than for white beneficiaries (11).

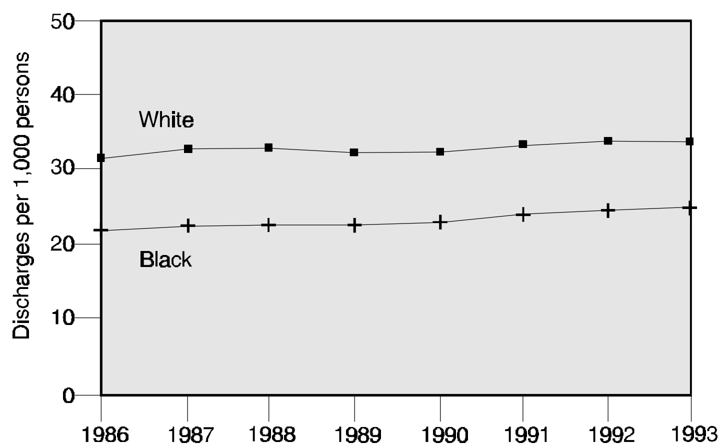

Figure 4.—*Ischemic Heart Disease Hospitalizations of Medicare Beneficiaries by Race.* *Although black Medicare beneficiaries are much less likely than whites to be hospitalized for IHD, their hospitalization rates increased 14 percent between 1986 and 1993, whereas those for whites increased only 6 percent. The result was an increase in the relative black-to-white use ratio from 0.69 to 0.74.* **Source**: *HCFA.*

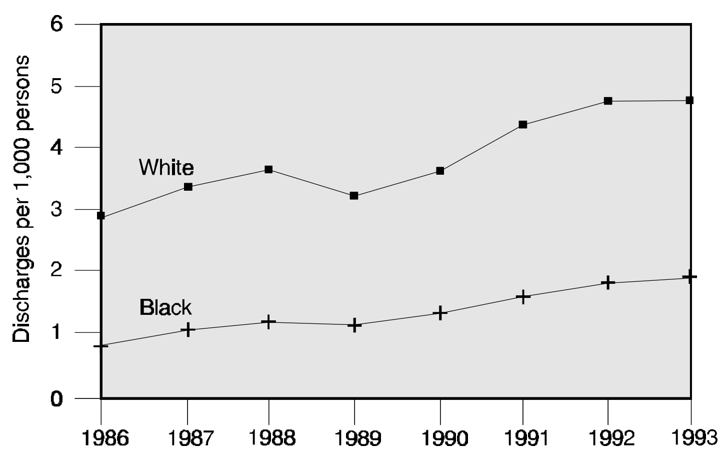

Figure 5.—*CABG Hospitalizations of Medicare Beneficiaries by Race.* *Between 1986 and 1993, hospitalizations for coronary artery bypass graft (CABG) procedures rose 67 percent for white Medicare beneficiaries and 140 percent for blacks. The black-to-white use ratio increased from 0.28 to 0.40.* **Source***: HCFA.*

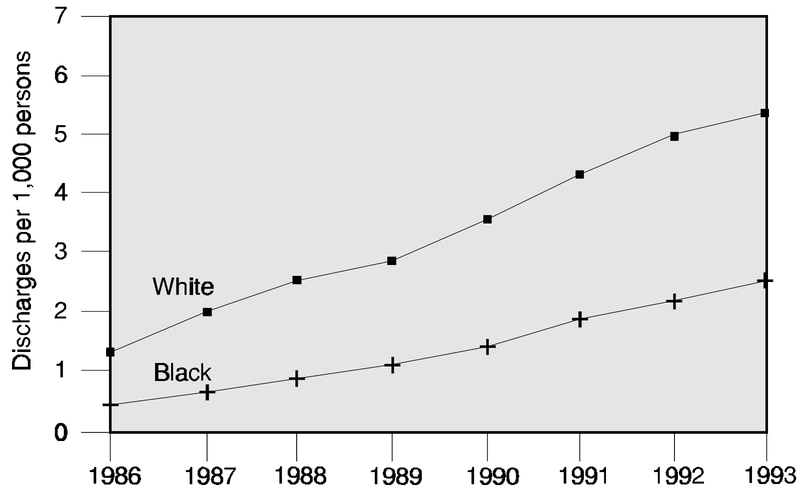

Figure 6.—*PTCA Hospitalizations of Medicare Beneficiaries by Race.* *The greatest increase in hospitalization of Medicare beneficiaries for revascularizations from 1986 to 1993 occurred among those undergoing percutaneous transluminal coronary angioplasty (PTCA). Utilization increased 315 percent for whites and 503 percent for blacks; the black-to-white use ratio increased from 0.32 to 0.46.* **Source**: *HCFA.*

Income and Racial Differences in Cardiovascular Utilization

Figure 7 shows four measures of cardiovascular utilization by income groupings for both white and black Medicare beneficiaries. The income groups are based on median income levels of aged persons by zip code of residence. White beneficiaries are arrayed according to median white income and black beneficiaries are arrayed according to median black income. For white persons, there appears to be an income effect for ischemic heart disease, with rising hospitalization associated with decreasing income. The 37.7 hospitalizations per 1,000 persons in the lowest income quartile is 28 percent greater than the rate for persons living in higher income zip code areas. Little evidence exists of an income differential for cardiovascular procedures.

To the extent that there is an income differential among black beneficiaries for ischemic heart disease, it runs in the opposite direction from that of white persons. The rate in the lowest income quartile (24.3 per 1,000) is 13 percent below the rate (28.0 per 1,000) in the highest income quartile. As with white patients, there are no consistent effects of income on the procedure rates.

Summary

Racial differentials between black and white persons in use of cardiovascular health care services have been well documented by a number of studies. Revascularization among black persons is about one-half that of white persons. At least part of this difference is due to lower rates of catheterization among black persons. However, even among those who receive a catheterization, subsequent revascularization is considerably lower among black persons.

Most of the studies on these racial differences were performed on data from the late 1970s through the late 1980s and were cross-sectional in nature. There is virtually no evidence in the literature of potential trend effects. However, data from the Medicare program suggest that, at least among the elderly population, the racial disparity in use rates may be narrowing somewhat.

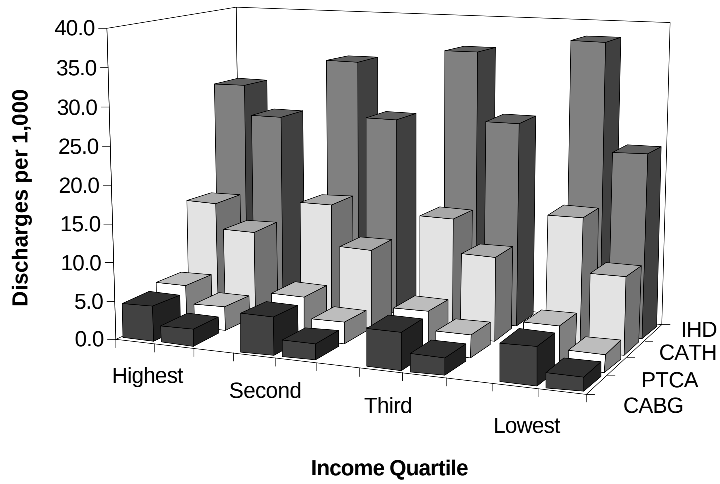

Figure 7.—*Cardiovascular Hospitalization by Race and Income for Patients Ages 65 and Above, 1993*.
Source: *HCFA.*

The role of SES in racial differentials has not been delineated and will be difficult to measure, short of indirect aggregate methods such as linkages with census data. Initial data from the Medicare-Census data link show different income patterns. Among whites, decreasing income is associated with an apparent increased need (as measured by hospitalization for ischemic heart disease) for revascularization, but a steady, if not decreasing, use of revascularization. Among black persons, neither the measure of need nor level of revascularization seems to be related to income levels.

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DIFFERENCES BETWEEN OCCUPATIONAL CLASSES IN CARDIOVASCULAR DISEASE MORTALITY: A COMPARISON OF 11 EUROPEAN COUNTRIES

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Socioeconomic status (SES) differences in health exist in Europe as well as in the United States (1–3). The number of studies on health differences in Europe strongly increased during the 1980s. There has been a parallel increase in the concern with SES differences in health by policy makers in some European countries. Much of the research on health differences in Europe has given special attention to SES differences in cardiovascular diseases (CVD), an interest that was stimulated by the observation that social class differences in CVD mortality in England and Wales have widened since World War II (4). Parallel trends were observed in more recent studies from several other European countries (5–7).

This variability over time raises the question of whether a similar regional variability exists between countries. If large variations are observed for place as well as time, that would highlight the changeable nature of SES differences in CVD. In addition, a closer look at the different countries may reveal which circumstances are associated with smaller or larger inequalities in CVD.

European countries differ widely in standard of living, socioeconomic policies, health care systems, and culture and history. This diversity has resulted in large differences in the overall level of mortality from CVD and in trends over time. For example, the epidemic rise and decline of ischemic heart disease (IHD) mortality occurred earlier and was more pronounced in northern Europe than in France and more southern countries (8). An obvious—but still unanswered—question is whether European countries also differ with respect to the SES distribution of mortality from CVD.

In this paper, 11 countries from northern and southern Europe are compared for SES differences in CVD mortality in men about 45 to 59 years old. The data, from the 1980s, come from an international project sponsored by the European Union. Information on mortality by SES was collected centrally and reanalyzed using a standardized methodology.

Most European countries have nationally representative data on CVD mortality by occupation, but surprisingly few (about five) have similar data with education or income as the SES indicator. Therefore, mortality differences between occupational classes are compared in these countries.

Materials and Methods

Nationally representative data were available on mortality by age, sex, occupation, and cause of death. For England/Wales, Finland, Sweden, Norway, Denmark, and Italy, cause-specific mortality data were available from national longitudinal studies with approximately 10 years of followup. For Ireland, France, Switzerland, Spain, and Portugal, cause-specific mortality data were obtained from so-called unlinked cross-sectional mortality studies. The study period was ca. 1981–90 for most longitudinal studies and ca. 1980–82 for the study from Italy and the cross-sectional studies.

The data presented in this paper refer to men of working age. Men older than 60 years and all women were excluded due to problems with reliability and crossnational comparability of the measurement of occupational class. Data from different countries refer to the same age group in terms of age at death. For studies where men were classified according to their age at death, the age group 45 to 59 years was distinguished. For longitudinal studies in which birth cohorts were followed 10 years, we distinguished the birth cohort aged 40 to 54 years at the start of followup.

Men were classified on the basis of occupation according to the Erikson–Goldthorpe (E–G) scheme (9). This is a social class scheme that is gaining increased acceptance in social sciences in Europe and elsewhere. A commonly used version of the E–G scheme distinguishes the following seven social classes (the percentage of the male working population of northern and western European countries is given in parentheses):

- Employers, administrators, managers, and professionals (20 to 30 percent)
- Routine nonmanual employees (5 to 10 percent)
- Self-employed workers, except professionals and farmers (5 to 10 percent)
- Foremen and skilled manual workers (20 to 30 percent)
- Semiskilled and unskilled manual workers (20 to 25 percent)
- Farmers (5 to 10 percent)
- Farm laborers (0 to 5 percent)

A more condensed version of the E–G scheme collapses these seven classes into three broad groups: all nonmanual and self-employed workers, all wage-earning manual workers, and farmers and farm laborers.

The seven-class version of the E–G scheme could not be constructed for Denmark, Italy, Spain, or Portugal. However, the occupational classifications that were available for these countries could be used to approximate the broad groups of the three-class version.

Ideally, economically inactive men are assigned to an occupational class on the basis of a previous occupation. In most data sources, however, information on previous occupations was lacking for most of the economically inactive men, and these men therefore had to be excluded from the analysis of the association between mortality and occupational class. As a result, however, the magnitude of mortality differences between occupational classes may be substantially underestimated (10). However, this problem can be remedied in part. We have developed adjustment factors for estimating the size of mortality differences among the entire male population from the mortality differences observed among men with known occupation only. These adjustment factors have performed well in a number of tests (11).

The relative mortality level of men in specific occupational classes was measured by means of standardized mortality ratios (SMRs), using national age-specific mortality rates as the standard. Several summary indices were calculated to express the magnitude of mortality differences by occupational class (10). In this paper, we present an often-used summary index with a straightforward interpretation: the (age-standardized) mortality rate ratio (RR) that compares all manual workers to all nonmanual workers.

Comparative research on inequalities in health is treacherous if no extensive attention is paid to potential data problems (10). Three major problems with reliability and comparability of data on mortality by occupation are exclusion of economically inactive men from most data sets, use of social class schemes other than the E–G scheme, and biases inherent to “unlinked” cross-sectional studies. Each of these problems has been evaluated extensively for its potential effect on the RR estimates for specific countries. Details are given in the final report of our project (11).

Data sets were classified according to their level of comparability:

- Data from England/Wales and Sweden were highly comparable. If manual vs. nonmanual RRs for these two countries differed by more than 15 percent, it is unlikely that systematic errors could explain that difference. These two countries were comparable on the basis of both the three-class and the seven-class versions of the E–G scheme.

- Data for most other countries were reasonably comparable. If manual vs. nonmanual RRs for these countries differed by more than about 30 percent, it is unlikely that systematic errors could explain that difference. These countries were comparable only on the basis of the three-class E–G scheme.

- Data for Ireland, Spain and Portugal were poorly comparable. Only tentative comparisons can be made on the basis of the three-class E–G scheme.

Results

Table 1 presents the results for mortality from all CVD. The SMRs for three broad occupational classes are given together with the RRs that represent the magnitude of the mortality difference between nonmanual and manual classes. Countries are ordered from high to low RRs.

The SMRs for the nonmanual class were between 0.90 and 1.00 for most countries, but smaller for England/Wales, Finland, Norway, and Sweden. In most countries, the SMRs for agricultural workers were lower than those for the nonmanual class. The only exceptions were Finland and Portugal. SMRs for the manual class were between about 1.10 and 1.20 for most countries, but were larger for Ireland and smaller for Switzerland and Portugal.

The RRs were largest for England/Wales and Finland. The confidence intervals around these RRs overlap only with those for Sweden and Norway. The manual vs. nonmanual mortality differences in France and the more southern countries were relatively small. However, in these countries the mortality rates of the manual classes were also estimated to be higher than those of the nonmanual classes. The confidence intervals around the RRs for these countries generally do not overlap with those for more northern countries.

Table 2 (first column) presents the RRs for IHD mortality. The rank order of countries from high to low RRs is the same as for all CVD. The manual vs. nonmanual RR was again relatively large in England/Wales and Finland. However, the difference with other northern countries is small and not

Table 1.—Age-standardized CVD Mortality Ratios of Three Broad Occupational Classes and Rate Ratios Comparing Manual to Nonmanual Classes

Country	Standardized Mortality Ratio[a]			Rate Ratio[a] (95% confidence interval)
	Nonmanual	Agricultural	Manual	
England/Wales	79	77	120	1.52 (1.36-1.72)
Finland	80	95	118	1.46 (1.40-1.53)
Sweden	88	79	119	1.36 (1.31-1.41)
Norway	87	86	117	1.34 (1.27-1.41)
Denmark	93	63	119	1.28 (1.22-1.33)
Ireland	98	79	123	1.25 (1.15-1.36)
Spain	93	93	109	1.18 (1.13-1.22)
Italy	98	80	114	1.17 (1.05-1.30)
France	97	85	110	1.12 (1.09-1.16)
Switzerland	100	79	107	1.08 (1.01-1.15)
Portugal	94	110	96	1.03 (0.95-1.10)

[a]All estimates are adjusted for the exclusion of economically inactive men by means of the correction factors discussed in Material and Methods.

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statistically significant. In all southern countries for which data are available, IHD mortality rates were virtually the same for manual and nonmanual classes.

Occupational differences in mortality from cerebrovascular disease were largest in England/Wales, Finland, and Ireland (Table 2, second column). Due to the wide confidence intervals around the RRs, differences with other northern countries cannot be demonstrated with statistical significance. Moreover, southern countries have substantial differences between manual and nonmanual classes in cerebrovascular disease mortality.

In Table 3, the seven-class scheme is applied to the comparison between England/Wales and Sweden. Since farm laborers form a very small part of the population of these two countries, they are combined with the class of unskilled laborers.

In England/Wales, substantial mortality differences were observed in both the nonmanual and manual classes. The mortality rate of unskilled workers was almost twice that of professionals, administrators, managers, and employers. The relative mortality level of most occupational classes in Sweden was virtually the same as in England/Wales. The only exception was for routine nonmanual employees, whose mortality level was close to the national average in England/Wales, but relatively high in Sweden. Their different mortality position in the two countries can largely explain the smaller manual vs. nonmanual mortality rate ratio in Sweden.

Table 2.—Ischemic Heart Disease and Cerebrovascular Disease Mortality Rate Ratios for Manual and Nonmanual Workers[a]

Country[a]	Rate Ratio (95% confidence interval)[b]			
	Ischemic heart disease		Cerebrovascular disease	
England/Wales	1.51	(1.33-1.73)	1.74	(1.21-2.49)
Finland	1.44	(1.37-1.52)	1.52	(1.35-1.70)
Sweden	1.36	(1.31-1.42)	1.30	(1.16-1.46)
Norway	1.36	(1.28-1.43)	1.22	(1.02-1.44)
Denmark	1.28	(1.21-1.34)	1.26	(1.11-1.42)
Ireland	1.23	(1.11-1.35)	1.49	(1.10-2.02)
Spain	1.00	(0.95-1.05)	1.20	(1.11-1.29)
France	1.00	(0.95-1.03)	1.33	(1.24-1.41)
Switzerland	0.97	(0.90-1.05)	1.42	(1.17-1.73)
Portugal	0.78	(0.70-0.86)	1.42	(1.25-1.60)

[a]No data are available for Italy for specific cardiovascular diseases.
[b]Adjusted for the exclusion of economically inactive men.

Discussion

Class differences in CVD mortality were observed for all parts of Europe covered by this study. The common pattern is that CVD mortality rates are relatively high for manual workers, relatively low for nonmanual workers, and lowest for agricultural workers. More detailed analysis of England/Wales and Sweden revealed substantial mortality differences between skilled and unskilled manual workers, and between different classes of nonmanual workers.

Most striking are the dissimilarities among European countries. A north–south contrast was observed in the size of mortality differences and in their pattern by cause of death. Smaller mortality differences were observed in France, Switzerland, Italy, Spain, and Portugal. The contrast with northern countries was striking for IHD, whereas no north–south contrast was observed for inequalities in cerebrovascular disease mortality. The largest mortality differences were consistently observed for England/Wales and, to a lesser extent, for Finland.

Other crossnational variations in this study were small and might be attributable to problems with the comparability and reliability of data from different countries. In this study, data problems were evaluated for their potential effect on the comparability of the RR estimates from different countries (11). As a general rule, only a relatively large difference between the RR estimates for two countries (larger than about 30 percent) could be assumed to provide strong evidence for the existence of a real difference.

Table 3.—Age-standardized CVD Mortality Ratios of 6 Occupational Classes

Occupational class	Age-standardized mortality ratio[a]	
	England and Wales	Sweden
Administrators, professionals	0.69	0.76
Routine nonmanual employees	0.97	1.13
Self-employed workers	0.95	0.96
Farmers	0.67	0.67
Foremen and skilled manual workers	1.11	1.09
Semiskilled and unskilled manual workers	1.29	1.29
Total	1.00	1.00

[a]Adjusted for the exclusion of economically inactive men.

This general rule applied to the data available for France, Switzerland, and Italy. The RRs for these three countries were substantially and consistently smaller than the RRs for more northern countries. It is unlikely that this difference is attributable to data problems alone. The same applies to IHD mortality, but not to cerebrovascular disease mortality. The poorly comparable data for Spain and Portugal could not provide strong evidence on the international position of these countries, but the similarity between the results for all five southern European countries makes it highly likely that these countries have a common pattern of class differences in CVD mortality.

Data for the relatively large differences in CVD mortality observed for England/Wales were of high quality. Problems with data reliability and comparability are probably not the sole explanation for the larger inequality estimates for England/Wales as compared with Sweden and Norway. However, adding to the uncertainty around the large inequality estimates for England/Wales are the large confidence intervals and the overlap of these intervals with those for Sweden and Norway. Therefore, the evidence for larger inequalities in England/Wales should be considered weak.

The comparison between England/Wales and Sweden has long attracted wide interest, for example in the Black Report and ensuing literature. The fact that slightly larger mortality differences were observed for England/Wales than for Sweden agrees with the expectation that inequalities in mortality are smaller in more egalitarian welfare states. However, the broader international pattern observed in this study does not support this expectation. Income inequalities are relatively large in Ireland, Switzerland, Italy, Spain, and Portugal; intermediate in England and France; and relatively small in the four Scandinavian countries (12). Thus, no country with large income inequalities has relatively large inequalities in CVD mortality, and no country with small income inequalities has relatively small inequalities in mortality. This lack of a generalized association does not imply that egalitarian socioeconomic policies are irrelevant to inequalities in CVD mortality. The lack of the expected association underscores, however, that there are other powerful determinants of the magnitude of inequalities in CVD mortality in Europe.

The absence of class differences in IHD mortality in France, Switzerland, Italy, Spain, and Portugal in the early 1980s is puzzling. This situation reminds us of the absence of social gradients in IHD mortality in the United States and northern European countries in the 1950s and 1960s, before the current inverse gradients emerged. The analogy between northern and southern Europe is reinforced by the observations of recent studies from southern European countries that during the late 1980s an inverse social gradient in IHD mortality emerged in these countries as well (7). It seems that the situation in southern countries can basically be understood as a delay in the trends that occurred in the United States and northern European countries one or more decades before.

To conclude, this study has identified large variations between European countries in the association between occupational class and CVD mortality. A north–south contrast was observed in both the size of mortality differences and in its pattern by cause of death. These variations stress the variability of SES inequalities in CVD—the magnitude of inequalities in CVD is not fixed, but susceptible to change.

The differences among European countries do not seem to be strongly related to the egalitarian character of socioeconomic policies in some countries. Further comparative studies, not only among European countries but also between other geographical entities, may teach us under what circumstances inequalities in CVD are large or small, and perhaps identify circumstances that can be modified through intervention.

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SOCIOECONOMIC STATUS AND CARDIOVASCULAR DISEASE: EXPERIENCE IN THE UNITED KINGDOM

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Analyses of mortality differentials according to social class have a long history in the United Kingdom. Although known to people working in the field in the last century, the differentials were given public prominence by the Black report. This was the report of a committee established in the 1970s to examine why social inequalities in health should persist 30 years after the establishment of the National Health Service (NHS). Black and his colleagues reported that indeed social class differences in mortality had not narrowed and in some cases had increased. This was not seen as a failure of the NHS but, rather, an indication that such social differentials in mortality were unlikely to be much affected by equitable provision of medical care.

Black et al. concluded that these social differentials were not the result of artifact, health selection, or cultural factors influencing health behaviors. They attributed these patterns to factors related to the social structure. It is likely that social, structural, and health behavioral factors are related. Work since the Black report has confirmed that social differentials in mortality cannot be attributed to either health selection or artifact (1).

Socioeconomic status (SES) differences in cardiovascular and other mortality have been neither constant over time, nor identical in different ethnic groups. Notably, international differences in mortality from cardiovascular and other diseases may share some of the same causes as SES differences within the United Kingdom.

Part of the debate in Britain has centered on whether the phenomenon to be explained is the relation between poverty and disease, or between inequality and disease risk. The data in Figure 1, from the first Whitehall study, are relevant (2). There is little doubt that poverty, or deprivation, is likely to be bad for health among other things. These data suggest that something else is at work. Each employment grade has worse health and higher mortality rates than the grade above it. Executive-grade civil servants are not poor by any absolute standard, yet they have higher mortality rates than administrators. Even clerical officers, who are far from affluent, with earnings at or below the national average, are not poor by comparison with England at an earlier period in history or with developing countries. This social gradient in mortality suggests the operation of factors across the whole of society.

Although incidental to SES differences in cardiovascular disease (CVD), the data in Figure 1 suggest that there are similar social differentials in a range of different diseases. This is relevant to the search for explanations.

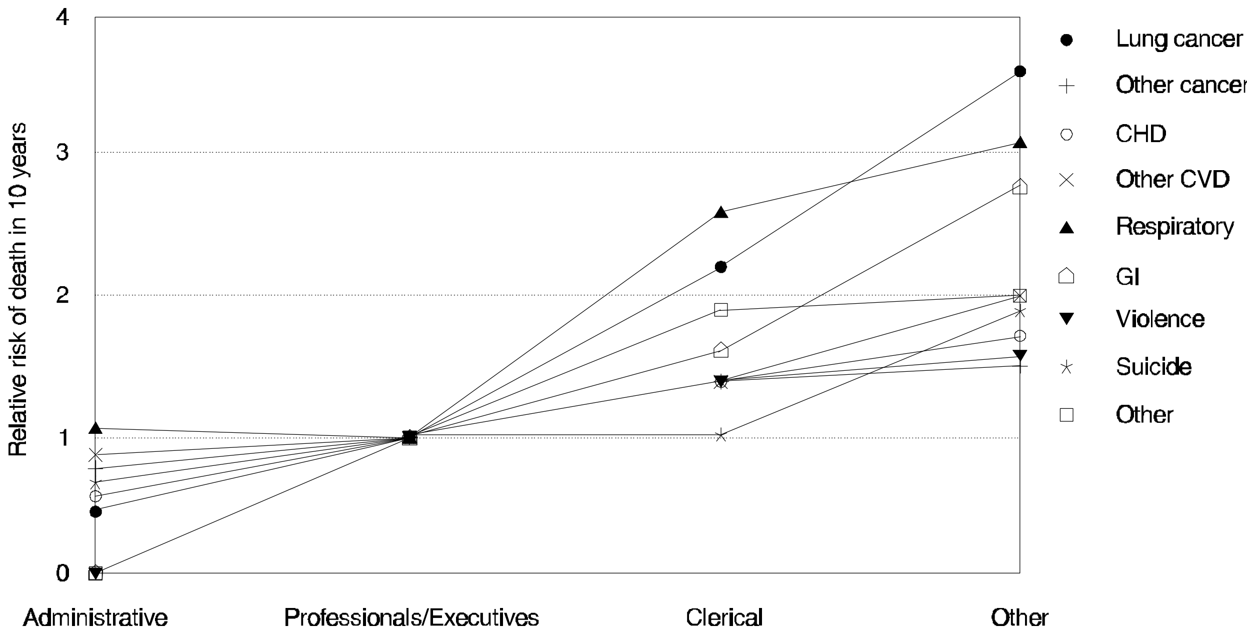

Figure 1.—*Relative Risk of Death by Various Causes in 10 Years by Grade of Employment in the Whitehall Study of British Civil Servants.* *Men were 40 to 65 years old at entry. Relative mortality of the largest group, professionals and executives, is set to 1.*

Time Trends

The traditional measure of SES used in mortality studies in the United Kingdom has been based on occupation. In 1842, Chadwick reported average ages at death as follows: "Gentlemen and persons engaged in professions, and their families . . .45 years; tradesmen and their families . . .26 years; mechanics, servants and labourers and their families . . .16 years." Although for technical reasons, age of death is not currently used, it is likely that Chadwick's data indicated substantial mortality differentials among occupational groups. Since 1911, the Registrar General has reported on mortality according to social class around each decennial census, the last available data in the United Kingdom being for the years around 1981.

Sir William Osler described coronary heart disease (CHD) as being more common in his upper class patients. He was puzzled because he thought that work and worry were prime causes of the disease and that work and worry were "the lot and portion of the poor." Our initial analyses of this question suggested that CHD was more common in higher SES groups in England and Wales in the 1930s and 1950s, but the social distribution changed such that by 1961 CHD mortality was more common in semiskilled and unskilled occupations. A major problem besetting these analyses was potential social class differences in the application of diagnostic labels. A combination of ICD codes representing nonrheumatic heart disease and hypertension avoids much of the social class diagnostic bias and still shows the changed social class distribution (3).

Subsequent analyses suggest that these differentials increased further between the years around the 1971 and the 1981 censuses (4). As yet, national data are unavailable to update these 1983 analyses. There are, however, area-based data that suggest a further widening in social differentials in mortality.

Ethnic Groups and SES

SES differences in CVD mortality not only change over time, but may differ in different subgroups of the population. Figure 2 shows data on mortality by social class and country of birth for England and Wales between 1970 and 1985. Mortality from ischemic heart disease (IHD) has increased among men in manual occupations for each country-of-birth group. Among immigrants from the Indian subcontinent and the Caribbean, IHD mortality is higher in nonmanual than in manual social classes. These data suggest that we have to go beyond social class for an explanation of mortality differentials among immigrant groups in England and Wales, and that the relation of social class to mortality may differ among groups.

One cannot extrapolate from these comparisons to black-white differences in the United States. First, these analyses are examining immigrants. Second, the contribution that SES makes to explaining differences among population subgroups cannot necessarily be generalized from one country to another.

Other Measures of SES

Education

There has been much interest in whether education may be a better predictor of SES differences in health than a measure based on occupation. Education has appeal as a measure because it appears to convey what it is about social position that may be causally related to increased risk. If education were then shown to be a stronger predictor than, say, occupational prestige, this could lead to the presumption that it is education—not factors related to occupation—that is more important in the causal chain leading to ill health. This can be illustrated with data from the Whitehall II study (Fig. 3). The prevalence of smoking and plasma fibrinogen level are strongly related to grade of employment in the Whitehall II study and somewhat more weakly related to years of education. Adjusting the grade differences for education has little impact on the strength of the inverse association. Adjusting education for grade reduces substantially the association between education and the risk factor. One interpretation of these data is that grade is a more precise measure of SES in the Whitehall II study than is the occupation-based measure in the Registrar General's social class scheme applied to the diversity of occupations in the country. In other data sets, education may be a more precise measure.

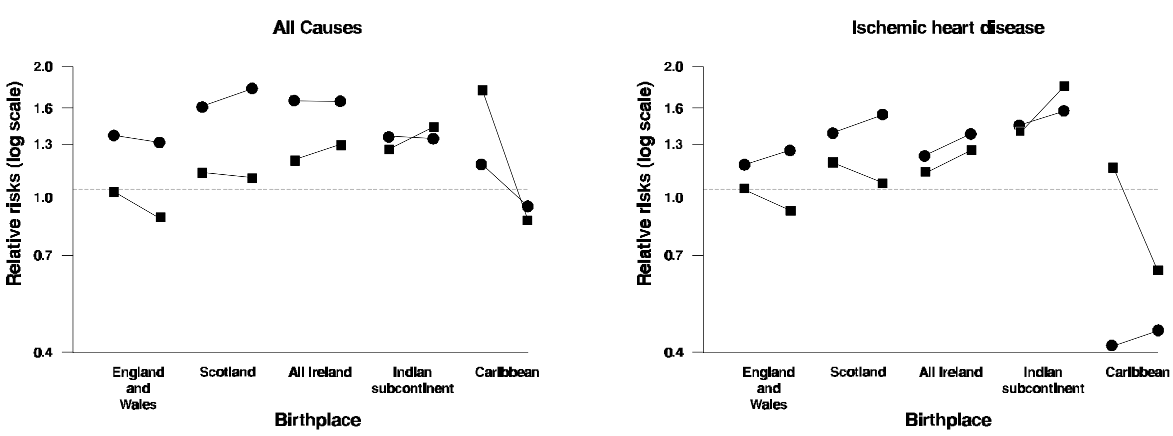

Figure 2.—*All-cause and IHD Mortality by Country of Birth and Social Class.* *Circles indicate manual occupation; squares, nonmanual occupation for 1970-72 (first data point) and 1979-85 (second data point). Relative risk for persons born in England and Wales who had nonmanual occupations and died in 1970-72 is set to 1.*

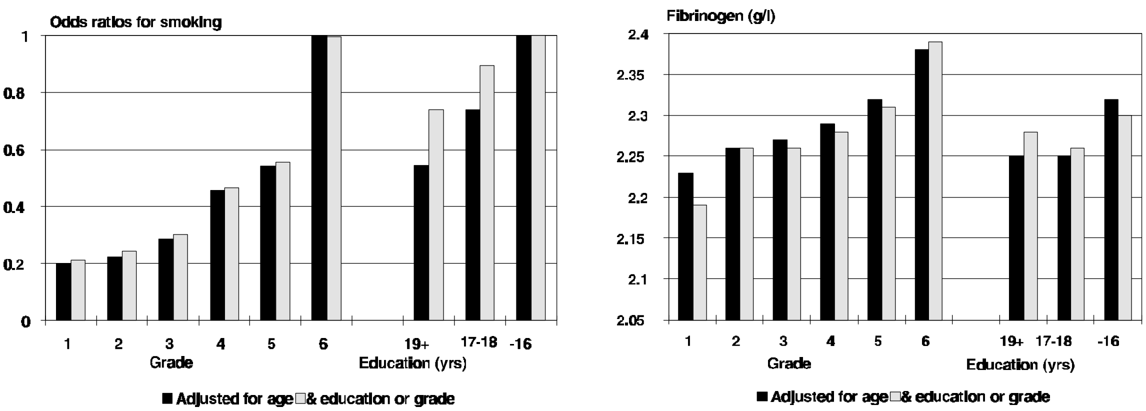

Figure 3.—*Odds Ratios for Smoking (left) and Level of Fibrinogen (right) in Whitehall II Men by Grade and Education.* *Smoking and plasma fibrinogen are strongly related to employment grade and more weakly related to years of education.*

Education may be causally related to cardiovascular health but one should not draw that conclusion simply from the strength of this association. This point was well demonstrated by Blane, who showed, for 107 local areas in England, that mean scores on school examinations were highly correlated (inversely) with measures of social deprivation (5).

Area-Based Measures

A different approach to SES classification is to classify not individuals, but areas of residence. This too has a long history, going back at least to Engels. We used the Townsend measure of social deprivation (housing tenure, access to cars, crowding, and unemployment) to classify over 8,000 small areas in all the regions of England (6). This showed a more or less linear relation between level of deprivation and mortality from IHD (Fig. 4). More recent data from Scotland (7) show that social differentials, using an area-based measure, have been widening. Similar widening trends have been reported from the northern region of England.

Data from Alameda County, California, suggest that such geographical differences cannot all be explained by the characteristics of the individuals who reside in these areas. The suggestion is that there are ecological characteristics that are causally related to SES differences in CVD.

Differences Within and Between Countries

Though my mission is to describe SES differences within the United Kingdom, at University College London we are also exploring reasons for East-West differences in mortality from cardiovascular and other diseases within Europe. The general proposition is that SES differences within a country and international differences across Europe may have a common set of causes. A clue that this may not be altogether fanciful is given by WHO data in Figure 5 (8). These mortality data show that the countries of central and eastern Europe and the so-called Newly Independent States of the former Soviet Union have an increased mortality gap compared with the countries of western Europe. The only major cause of death for which this is not the case is breast cancer. Interestingly, breast cancer is the most important cause of death that is not more common in lower-SES groups in the United Kingdom. We have previously speculated that the particular causes of death that show the steepest social gradient within a country are those causes that show the most marked variations in comparison with other countries (9).

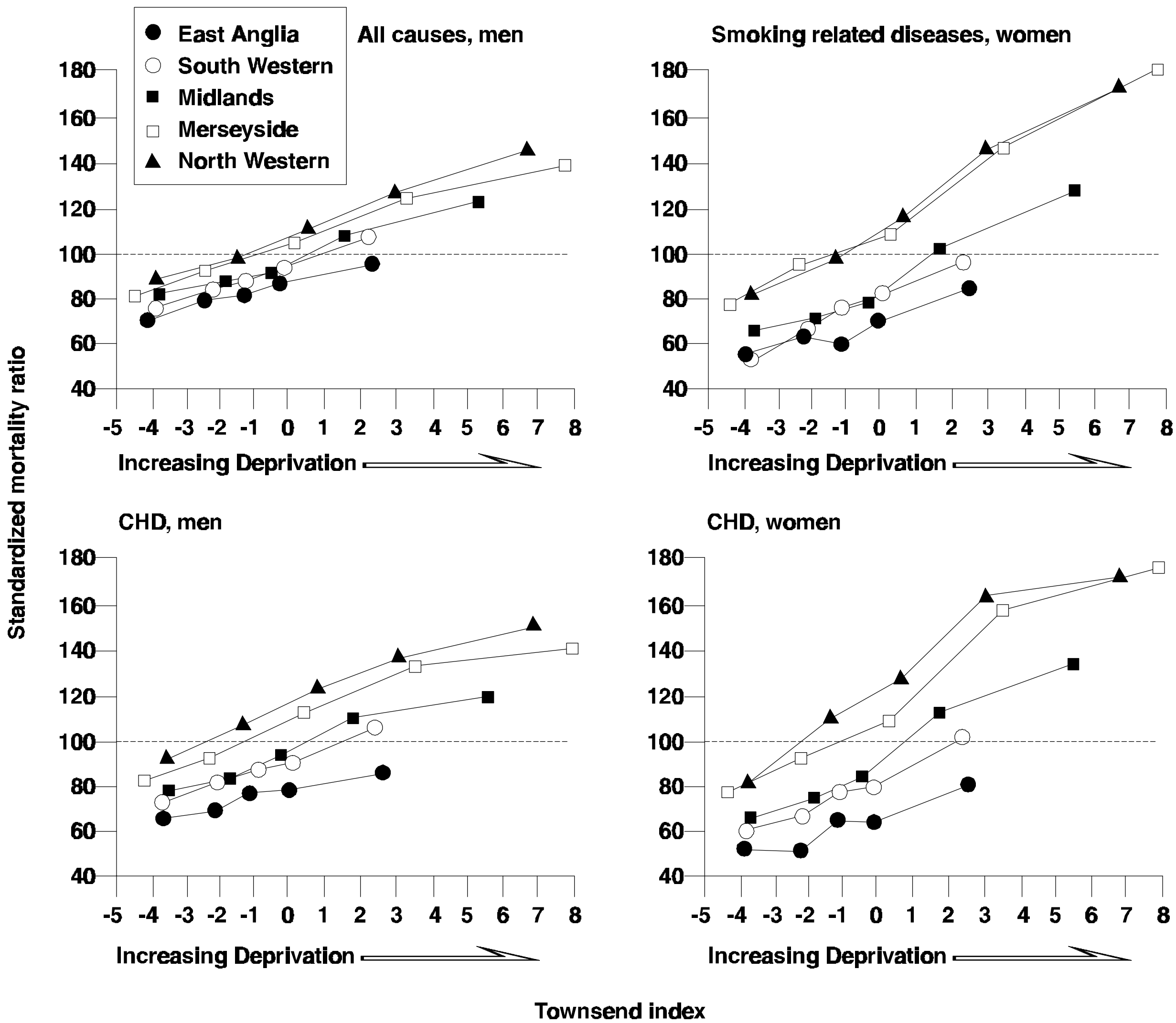

Figure 4.—*Mortality from Different Causes and Degree of Social Deprivation in Men and Women for Five Representative Regions of England.* *Five strata are used in the social deprivation scale.*

Life Course

A body of work from Barker and others suggests that factors operating early in life may make CVD risk manifest in the middle years of life (10). Regional variations in infant mortality have been shown to be associated with mortality from heart disease 50 or more years later. In addition, various markers of fetal and infant growth have been shown to be associated with blood pressure, plasma fibrinogen level, and measures suggestive of insulin resistance. This has sparked off a vigorous debate as to whether the major CVD determinants operate early in life or concurrently. For example, it has been shown that the relation between infant mortality and IHD subsequently could entirely be accounted for by the relation between social deprivation and heart disease (11). The Barker data on risk factors are impressive in their consistency. They do not necessarily mean that SES differences in CVD risk are *all* determined early in life. As Power has pointed out, there may be accumulation of advantage and disadvantage throughout the life course (12).

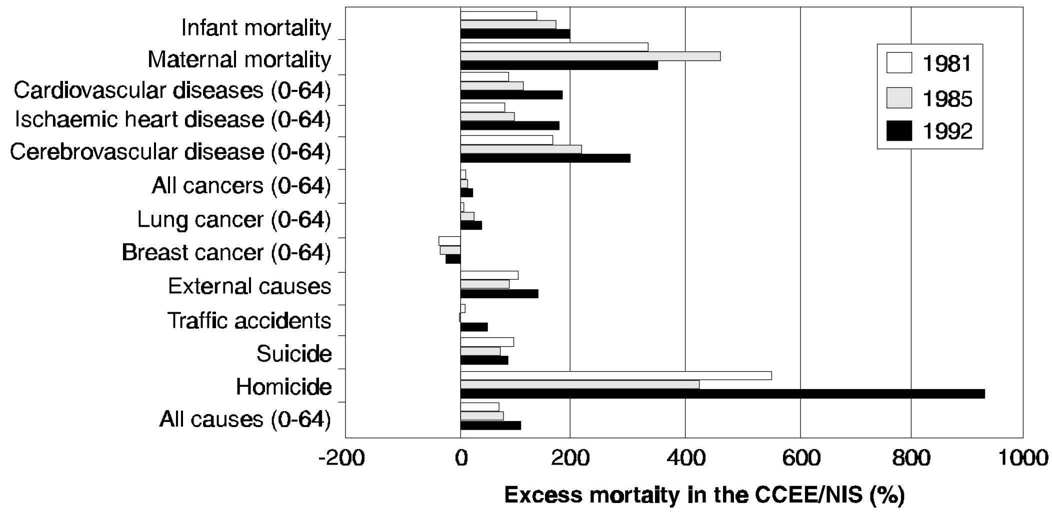

Figure 5.—*Excess Mortality in the Countries of Central and Eastern Europe (CCEE) and the "Newly Independent States" of the Former Soviet Union (NIS) as Compared with Mortality in Western Europe*. *The population-weighted average standardized mortality rate for all countries of the European region, except the CCEE, the NIS, and those for which no data were available, is set to zero.* **Source**: *World Health Organization (WHO) Regional Office for Europe.*

A different issue is the persistence of SES-based health differentials into old age. In the original Whitehall study, SES measures continued to predict mortality differentials at least up to age 84. Grade of employment was related less strongly to mortality after retirement age than before. By contrast, a more general measure, car ownership, although more weakly related to mortality before retirement, did not diminish in its predictive power after retirement. One interpretation of these data suggests that factors related to work diminish in their importance after retirement, but other more general SES measures do not.

Determinants

Whitehall mortality analyses suggest that a major task is to determine the reasons for the SES gradient in mortality. Data from Whitehall II offer a variety of potential explanations (13). Social gradients are evident in:

- Health behaviors—smoking, diet, exercise;
- Psychosocial characteristics—work, social environment, psychological measures such as hostility and sense of control;
- Biological markers—central adiposity and insulin resistance syndrome, plasma fibrinogen level (but not plasma total cholesterol); and
- Indicators of early environment—height, father's social class.

The research agenda is to quantify the importance of these and other factors in generating SES differences in CVD.

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SESSION II:

Pathways Linking SES and CVD

SESSION II OVERVIEW

Redford B. Williams, M.D., Chair

The presentations in this session addressed possible pathways—including biological, behavioral, and psychosocial mechanisms—through which socioeconomic status (SES) may influence cardiovascular disease (CVD). Session speakers presented findings from multiple studies in specific racial and ethnic, rural, and working populations. They also discussed access to medical care and quality of treatment for disease and noted gender differences in the effects of SES on CVD where data were available.

In general, there does appear to be an SES gradient of CVD in the special populations for which data exist. These include black, Mexican-American, Japanese-American, Native American, rural, and working groups. For the most part, the established risk factors and behaviors also show a similar SES gradient, with worsening of the risk factors or behaviors as SES decreases.

There are some notable special features in regard to this generalization. In Mexican Americans, Native Americans, and blacks, the worsening of risk factors with decreasing SES is more pronounced in women than in men.

Two broad pathways were noted linking SES and CVD:

- More unfavorable patterns of established major lifestyle and biomedical risk factors (smoking, adverse diet, sedentary lifestyle, high serum cholesterol, high blood pressure, obesity, diabetes) in lower- compared to higher-SES strata; and
- More unfavorable patterns of psychosocial factors (hostility, depression, low social support, social isolation, racism; job instability, insecurity, strain, and powerlessness; unemployment).

Men with low levels of all established biomedical risk factors (blood pressure, cholesterol, smoking, diabetes, previous heart attack) have been found to experience lower coronary heart disease (CHD) and CVD mortality rates than men without such a favorable profile. Even though such a favorable profile is found in less than 10 percent of the population, this finding suggests that controlling the established biomedical risk factors has the potential to achieve low CHD–CVD rates for all groups in the United States, including low-SES strata of various ethnic backgrounds.

Once clinical CVD is present, the impact of low SES on case-fatality rates and on subsequent natural history of disease is pronounced. Access to care and quality of care may be contributing factors, although relevant data are sparse and both increased and decreased use of medical facilities have been reported among low-SES CVD patients.

Various psychosocial factors (e.g., depression, hostility, social isolation, and high job strain) that have been linked to increased risk of CVD or to poorer prognosis also appear to worsen with decreasing SES. These psychosocial factors and the accompanying biological and behavioral risk characteristics deserve serious attention as potential mediators of the SES gradient of CVD.

The measures of social support that have been used in earlier studies focus primarily on CVD in men and may not be appropriate for women. It may be necessary to include measures of strain as well as of support from the social network.

RESEARCH OPPORTUNITIES

The SES gradient of CVD and its potential mediators have not been studied adequately in certain populations. Data are particularly lacking for rural populations and for subgroups within populations (e.g., Cuban Americans and Puerto Rican women among Hispanics).

The array of potential mediators may not be limited to the established biomedical risk factors and access to care. A number of psychosocial factors also show an SES gradient. For example, as income decreases, hostility scores increase; but the increase with declining income is greater among blacks than whites. Such findings highlight the need to evaluate the role of racism as an important psychosocial mediator of the SES gradient of CVD in certain populations.

At low SES, access to care and quality of treatment are likely to have a strong impact after the onset of CVD. Measurement of the relative contributions of these and other factors to CVD prognosis is important for the development of interventions for established CVD in low-SES individuals.

Several potential biological mediators of CVD pathogenesis may be involved in the mechanism of the SES gradient of CVD. These include:

- Altered sympathetic and parasympathetic nervous system function
- Altered hypothalamic-pituitary-adrenal axis function
- Preclinical indicators of CVD (e.g., carotid intimal wall thickening, as used in the Atherosclerosis Risk in Communities study)
- Altered cellular and molecular characteristics of key cells (e.g., monocytes and macrophages) involved in the pathogenesis of CVD

Another area of interest concerns the mechanisms through which lower SES contributes to the development of the established major biomedical risk factors, as well as psychosocial and accompanying biobehavioral mediators of the SES gradient of CVD. Living conditions for lower SES groups may foster the development of psychosocial and biobehavioral mediators via several mechanisms, including both learning and neurobiological phenomena (e.g., harsh environments, particularly in early childhood, lead to reduced serotonin function in the central nervous system). A developmental perspective may help efforts to understand the social and environmental origins of these mediators. Research is also needed to identify the lifestyle, behavioral, psychosocial, cultural, metabolic, and genetic components of maintaining low-risk status into middle age.

It will also be relevant to adopt integrative approaches, most likely using newer statistical techniques for multivariate causal modeling. These approaches may reveal how potential mediators develop across the life cycle and combine at multiple levels to influence the pathogenesis of CVD in lower-SES groups. As noted above, once clinical CVD is present, additional issues (e.g., access to care and quality of care) come into play.

As we learn more concerning the pathways linking SES and CVD, as outlined above, we need to use the knowledge gained to develop and apply better approaches for the primary (including "primordial") prevention of the established biomedical risk factors, with a focused emphasis on lower- as well as higher-SES strata.

RECOMMENDATIONS

- Expand the knowledge base regarding the SES gradient of CVD to include additional populations, including rural populations.

- Expand the array of potential mediators being studied to include psychosocial risk factors, risk behaviors, and biological factors (including those at the cellular and molecular level) that may be involved in mechanisms of the SES gradient of CVD.

- Identify the mechanisms through which the conditions of everyday life for lower-SES groups contribute to the development of psychosocial, behavioral, and biological mediators of the SES gradient of CVD.

- Develop integrative approaches to evaluate the pathways by which lower SES contributes to the development of CVD.

- Evaluate the role played by access to care and quality of care in the high case-fatality rate and poor natural history among low-SES groups once clinical CVD is present.

- Use our increasing understanding of the pathways linking SES and CVD to develop and apply more effective approaches to the prevention and control of the established biomedical risk factors, as well as potential psychosocial and biobehavioral mediators, in the lower- as well as higher-SES strata.

Black and White Populations

Herman A. Tyroler, M.D., Mark Massing, M.D.,
Marilyn Knowles, M.P.H.

The effect of low socioeconomic status (SES) on the health of blacks is considerable and pervasive. It is manifest from infancy to advanced age, in both females and males, across most categorically defined diseases and is expressed in risk of dysfunction, disability, and death. SES, as an attribute of individuals, measures one's prestige, control of material resources, and social opportunities. Blacks are disadvantaged with respect to each of the traditional indicators for SES—education, occupation, and income level. Being black confers an additional and unique dimension to one's SES as a consequence of the history of slavery and legal segregation and persistent institutional and individual racism. Community-based epidemiological studies offer insight into the individual and societal mechanisms by which SES is related to cardiovascular disease (CVD) in blacks.

The Evans County Study

The epidemiological study of CVD developed in Evans County, Georgia, from a series of clinical observations by Hames, who noted that coronary heart disease (CHD) appeared to occur less frequently among blacks than whites even though hypertension was more common in blacks and their diet was higher in animal fat (1). Hames also noted that black women did not seem to experience the same gender protection from CHD that white women did. In 1960, when the baseline data for the community survey were collected, Evans County was a racially segregated, predominantly rural, agricultural society. SES was calculated based on the occupation, education, and source of income of the head of household, using the McGuire–White method, which was developed and validated for southern rural communities. White men in the upper 50 percent of the McGuire–White score distribution were defined as upper-class or high-SES; those in the lower 50 percent were defined as lower-class. Ninety-five percent of the blacks had scores below the median for whites, and thus were not further categorized. The age-adjusted prevalence of CHD increased stepwise from black men to low-SES white men to high-SES white men (Fig. 1).

Major risk factors also differed among ethnic and SES groups. Mean cholesterol values paralleled CHD prevalence, but smoking was less prevalent among high-SES white men. Blood pressure level varied inversely with SES and was higher in black men and women of all ages than in white men of either social class. When occupations were ranked by physical activity required on the job, CHD prevalence was found to be highest in the most sedentary jobs and lowest in the most active jobs. In particular, farm workers had lower rates of CHD than nonfarmers, and within nonfarm occupations there was a gradient of decreasing CHD from the most sedentary to the most active. The majority of low-SES whites, and practically all blacks, worked in physically active occupations.

The findings in Evans County represent in microcosm the worldwide movement from rural agrarian to town-based nonfarming lifestyles. They also illustrate the changing relationship between SES and CHD risk. A CHD incidence study from 1960 to 1967 confirmed the importance of smoking, blood pressure, and cholesterol as risk factors in both whites and blacks; however, CHD incidence was lower in black than white men after controlling for risk factor levels. In contrast to earlier findings of a higher prevalence of CHD in high-SES white men, the study indicated either no difference with SES or a possible lower

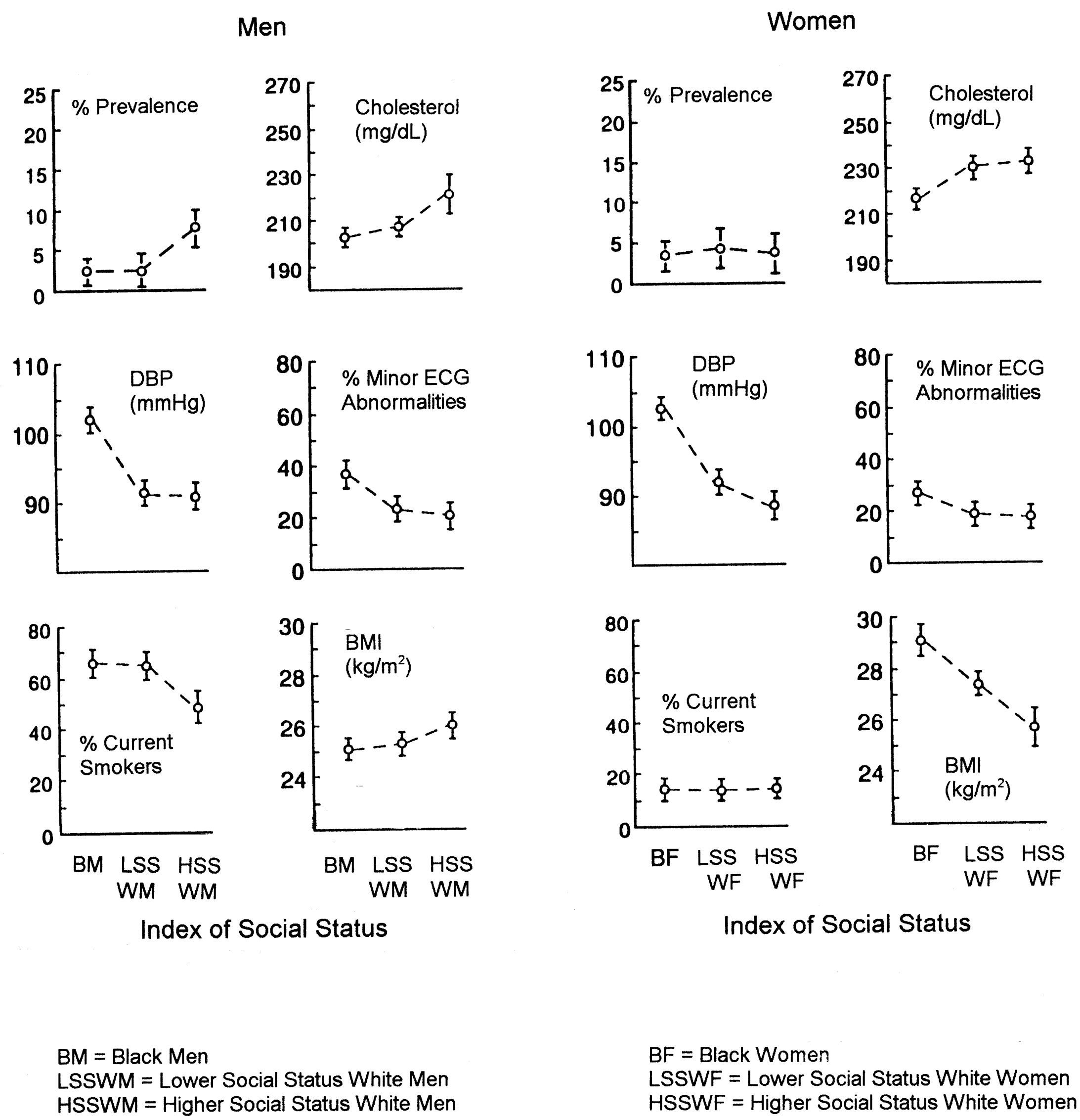

Figure 1.—*The Prevalence of CHD and Risk Factor Levels by Ethnicity, SES and Gender: Evans County Heart Study Participants Age 40 to 64, 1960 to 1962.*

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incidence of CHD in high-SES white men. This reversal of the SES findings accompanied both social and physiological changes between 1960 and 1967. Serum cholesterol levels rose in blacks and low-SES white men to levels previously characteristic of high-SES white men, in whom the values had plateaued by middle age (2). Simultaneously, occupational data began to reflect a transition away from farming and an increase in the proportion of individuals engaged in white collar and town-oriented occupations. These changes may explain the emergence of excesses in CHD in lower-SES groups.

The Charleston Heart Study

This epidemiological study of CVD began in Charleston, South Carolina, in 1960. Charleston, in contrast to Evans County, is metropolitan. Blacks in both studies had a marked excess of hypertension. However, in a collaborative mortality followup study, black men from both studies had a lower incidence of fatal CHD events than whites.

In the Charleston Heart Study, blood pressure levels were positively related to darkness of skin color, as assessed objectively and quantitatively by skin reflectance photometry. One interpretation of this finding was that the degree of African or Caucasian ancestry was causally related to blood pressure levels through genetic and other biological mechanisms. An alternate hypothesis was tested by comparing the incidence of hypertension by social status, which for blacks in the 1960s was inversely correlated with darkness of skin color (3). The incidence of hypertension was positively associated with darkness of skin, but it also was inversely associated with SES. After controlling for SES, skin color was no longer associated with incidence of hypertension. Conversely, controlling for skin color did not eliminate the inverse association of SES with incidence of hypertension.

Thus, both the Evans County and Charleston studies identified an excess of hypertensive disease in blacks, related it to social characteristics, and demonstrated a relationship between SES and CHD. The major CHD risk factors were similarly predictive in blacks and whites, and in both studies, black men had lower risk of CHD than whites (4).

National Longitudinal Mortality Study (NLMS)

The NLMS presented an opportunity to assess the representativeness of findings from the Evans County and Charleston studies in the nation at large. For the 1979 to 1989 followup period, ischemic heart disease (IHD) mortality among middle-aged subjects (ages 45 to 64) decreased stepwise with increasing education level for all four race–gender groups. The mortality increase between low and high education was approximately 3-fold for women and close to double for men. Black–white mortality rate ratios were slightly greater than 1 for middle-aged men and increased with education level. Among men age 65 and older, black–white mortality ratios were less than 1 for all education levels. It is of interest that when a six-step classification was used, the education gradient for mortality appeared to be continuous without any threshold for both black and white men. Similar gradients were apparent for income but were not as consistent for occupational strata. The trend in black–white mortality ratios in women in the same age group was similar but quantitatively somewhat stronger, increasing with education level. At age 65 and older, the mortality ratios for black and white women crossed over at the highest education level.

The association of education with mortality attributed to IHD in the NLMS was similar to that observed in the Evans County and Charleston studies on the 30-year followup, as were the black–white mortality rate ratios. In the Evans County and Charleston studies, indices of SES and ethnicity were related to CHD prevalence, incidence, and mortality after controlling for standard risk factors. Data are not available to perform similar analyses for the NLMS.

The Atherosclerosis Risk in Communities Study (ARIC)

ARIC offered the possibility of investigating preclinical atherosclerosis as one of the intervening steps between SES, risk factors, and clinically manifest disease. It also presented the first opportunity to study these phenomena in a large cohort of blacks (2,634 women, 1,632 men). In subjects ages 45 to 64 the age-adjusted CHD prevalence was 5.9 percent in black men, 8.4 percent in white men, 3.1 percent in black women, and 1.8 percent in white women, findings similar to those reported 20 years earlier from the Evans and Charleston County studies (5).

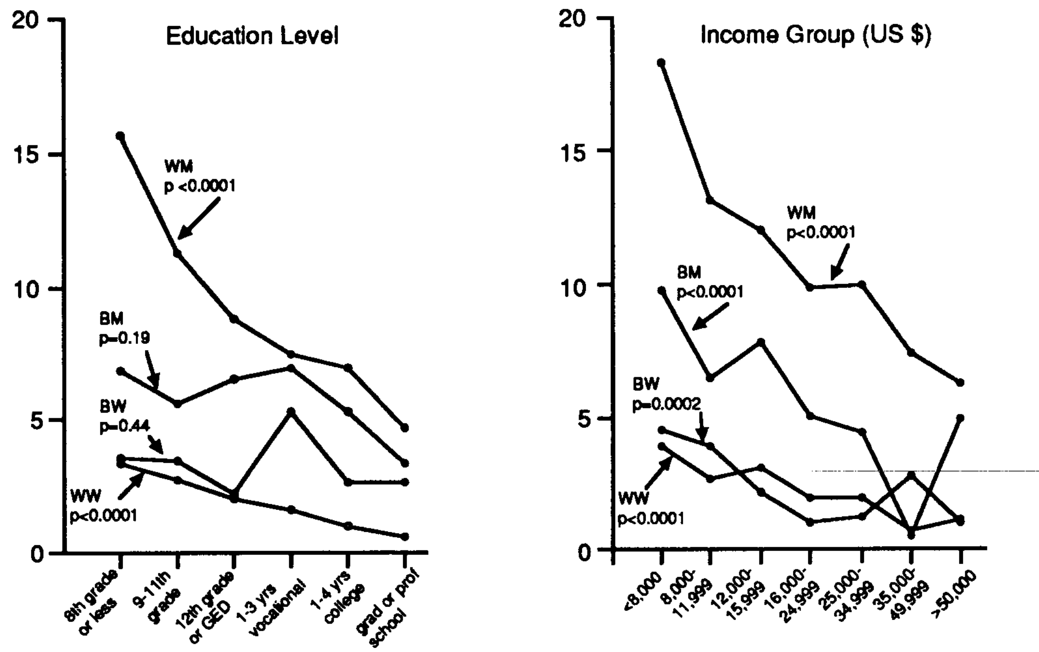

Figure 2.—*Age-Adjusted Percent Prevalence of Coronary Heart Disease by Gender, Race, Education, and Income: The Atherosclerosis Risk in Communities Study, 1987 to 1989.* *Data were adjusted to age 55 years. The p-values show p for trend in proportions.* **Source:** *Diez-Roux, et al. (5), with permission.*

After adjusting for age and gender, there was a 3-fold higher odds ratio of CHD prevalence between the lowest and highest income categories, and odds ratios decreased linearly with increasing income in both whites and blacks (Fig. 2). The *p* value for trend was significant for blacks and whites for the association with income, and although reduced in magnitude, the association persisted after risk factor adjustment. For education, the *p* value for trend was statistically significant for whites both before and after risk factor adjustment but was not significant in either case for blacks.

After omitting subjects with evidence of clinical CHD, ARIC examined the association of subclinical atherosclerosis (assessed by ultrasound and quantitative measures of carotid wall thickness) with SES. Carotid wall thickness increased with decreasing income and education; the trends by education were clearer in whites than in blacks (Fig. 3). However, the associations of carotid wall thickness with SES were eliminated by adjustment for risk factors. This suggests that the same risk factors may interact with SES level indices to have different effects on the development of atherosclerosis. Alternatively, the variables or processes that relate clinical manifestations of CHD to SES may depend on factors different from those responsible for the development of atherosclerosis. The risk factors investigated in ARIC and adjusted for in the SES studies include smoking; diet as assessed by the Keys score; indices of physical activity reflecting leisure time, sports, and work; systolic blood pressure and use of antihypertensive medication; diabetes mellitus; and serum fibrinogen. Conspicuous by their absence are indices of personality, social interactions, and social supports and measures of the social environment, all of which have been invoked and analyzed in other studies of the association of CHD with SES in blacks.

The association of the major CVD risk factors with SES was generally similar between blacks and whites with one conspicuous exception, blood lipid and lipoprotein levels. High-density lipoprotein cholesterol (HDL) levels were higher in black than white men. Moreover, HDL decreased in black men but increased

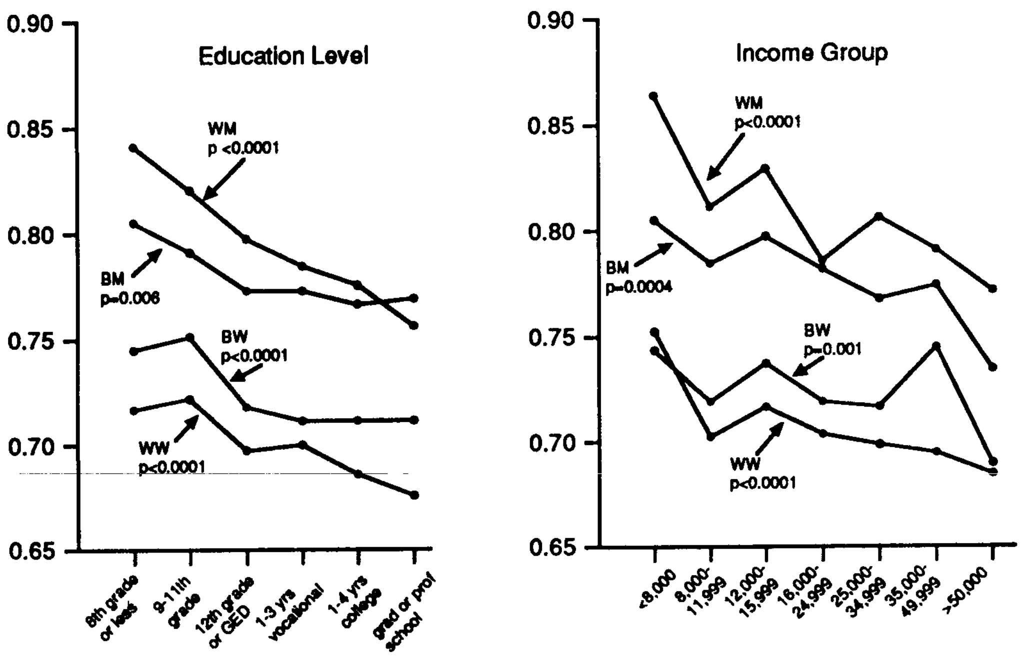

Figure 3.—*Age-Adjusted Mean Intimal-Medial Carotid Artery Wall Thickness by Gender, Race, Education, and Income: The Atherosclerosis Risk in Communities Study, 1987 to 1989.* *Data were adjusted to age 55 years. The p-values show p for trend.* **Source:** *Diez-Roux, et al. (5), with permission.*

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in white men with increasing education level. Low-density lipoprotein cholesterol (LDL) levels varied little across education strata in either black or white men. The net effect was an unfavorable increase in the atherogenic LDL:HDL ratio in black men and a favorable decrease in white men with increasing education. The association of these lipids and lipoproteins with education was much stronger in women; LDL decreased and HDL increased with increasing education, resulting in a favorable decrease in the LDL:HDL ratio for both black and white women.

Indices of smoking, including percent ever smoked, percent current smokers, and integrated pack–years of smoking, each varied markedly and inversely with increasing education, more conspicuously in men than women in both race groups. The percentage of current smokers was higher for black than white men at each education level. The prevalence of hypertension and left ventricular hypertrophy (LVH) was markedly higher in black than white men and women at all education levels and varied inversely with education, more markedly in women than in men. The prevalence of obesity was markedly higher in black women, but decreased considerably with increasing education for both black and white women. The prevalence of diabetes was also markedly higher in black women and varied inversely with education level for women in both ethnic groups.

Thus, the constellation of standard risk factors varied strongly and generally inversely with education level, and the associations appeared continuous without thresholds. With the exception of HDL, associations with education level appeared qualitatively similar in blacks and whites. However, quantitative differences in levels of risk factors and in trends across education levels varied both by ethnicity and by gender.

Coronary Artery Risk Development in Young Adults Study (CARDIA)

CARDIA presents the opportunity to test relationships between SES indices and atherosclerosis in young adults. The data have been published in two age strata, 18 to 24 years and 25 to 30 years (6). Age, gender, and race differences in systolic blood pressure by education level were minimal. Plasma total cholesterol levels were slightly higher among those with education beyond high school for black men and women in each of the two age strata; the findings were less consistent for whites. However, smoking was strongly related to education level. Prevalence of smoking was approximately 30 percent in each race–gender group and decreased from 54 percent for participants with less than a high school education to 12 percent among those with graduate degrees.

National Health and Nutrition Examination Survey: Phase I (NHANES-I) Epidemiologic Followup Study

The followup study of the NHANES-I sample included 683 black men and 1,175 black women first examined in 1971 to 1975 and followed to 1982 to 1984. The predictive strength of CHD risk factors was reported as "remarkably similar for the four sex–race groups" (7). Black men and women had higher age-adjusted CHD mortality rates than whites but lower hospitalization rates. Income and education were each inversely related to CHD events in all race–gender groups, but were no longer statistically significant in multivariate analyses that included systolic blood pressure, serum cholesterol, and current smoking status. Thus, in contrast to the other studies reviewed, the NHANES-I followup study indicated higher CHD risk in black than white men and suggested that the effects of SES on CHD risk were accounted for by the mediating action of the major risk factors. In other studies, Ford and Cooper have also reported that not only do blacks make less use of hospital care for CHD events, but also fewer diagnostic procedures (e.g., angiography) and therapeutic interventions (e.g., coronary bypass surgery and angioplasty) are performed for CHD in blacks than whites.

Psychosocial Studies

Few cohort studies in blacks have examined baseline psychological measures and incident CVD events. However, several studies focus on the exceptional problem of hypertension in low-SES blacks and serve as a bridge from studies in individuals to aggregate-level investigations. Measures of "John Henryism," a behavioral pattern characterizing individuals with limited material resources who struggle to achieve, have been associated with hypertension in low-SES blacks (8). Incongruence of lifestyle—the degree to which lifestyle exceeds education—is associated with higher blood pressure levels (9). Indices of social disorganization derived from county-level aggregate studies have been associated with stroke mortality in young blacks in North Carolina (10). Census-tract SES and social instability variables were used to derive indices of socioecological stress in Detroit, Michigan, and surveys have disclosed higher mean blood pressure levels among blacks in relation to socioecological stress (11). Studies of this type provide an introduction to aggregate-level investigations. The goal of these investigations is not to identify ecological indices as surrogates for individual attributes, but rather to characterize attributes of the social environment that act as predictors of morbidity and mortality.

Aggregate-Level Studies

The educational, economic, and occupational attributes of counties and aggregates of counties called "state economic areas" have been scaled to derive indices of the social environment of their residents. These aggregate-level attributes are highly correlated with one another.

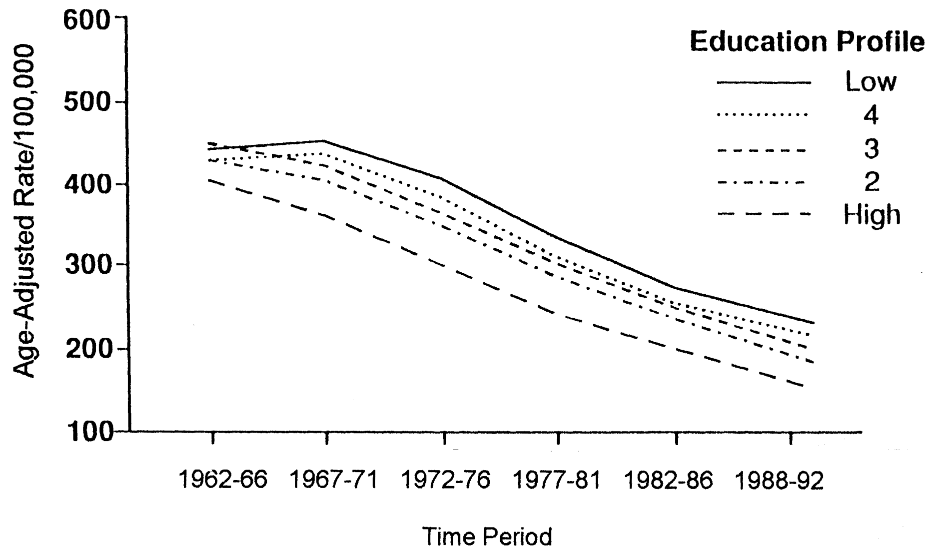

Figure 4.—*Five-Year Average Annual Age-Adjusted CHD Mortality Rate, 1962 to 1992, by Education Profile of State Economic Areas, White Men Ages 35 to 64.*

The proportion of individuals with less than a high school education in a given place of residence has been analyzed in relation to levels and time trends of CVD mortality (12). This education profile is highly associated with the occupational structure, income level, urbanization, access to transportation, and availability of health care facilities in a place of residence. In 1962, during the ascending limb of the CHD epidemic, CHD mortality in middle-aged white men was not clearly associated with the education profile of place of residence, except that those with the highest education had the lowest CHD mortality (Fig. 4). However, by 1969, CHD mortality rates increased with decreasing levels of education in a clear stepwise progression. The gradient emerged because the onset of CHD mortality decline occurred earlier in residential areas with high education profiles than in areas with the lowest education levels. Since 1969, the inverse association has persisted along with the continuous decline in CHD mortality in white men.

The trends indicate an increasing mortality gradient with social environment characteristics in the 1990s. Between 1962 and 1992, mortality was lowest among black men residing in areas with a high education profile. Over time, the highest CHD mortality rates occurred in places of residence with the lowest education level. Trends for black and white women were similar. Absolute levels of CHD mortality were slightly higher for middle-aged black men than for middle-aged white men, and markedly higher for black women than for white women.

Stroke mortality varied inversely and much more strongly than CHD mortality with place-of-residence education level. For black men, there was a 2.5-fold stepwise gradient in stroke mortality from highest to lowest education level in 1963 (Fig. 5). Stroke mortality decreased in all strata over time, but absolute decreases were greater in residential areas with a higher initial stroke incidence, and therefore by 1990 the absolute difference among education strata had narrowed. Although absolute levels of stroke mortality were approximately two-thirds lower in whites than in blacks, the patterns of inverse rank ordering by education level and of the mortality decline (with greater decline from higher starting levels) across all education strata appeared in all four race–gender groups.

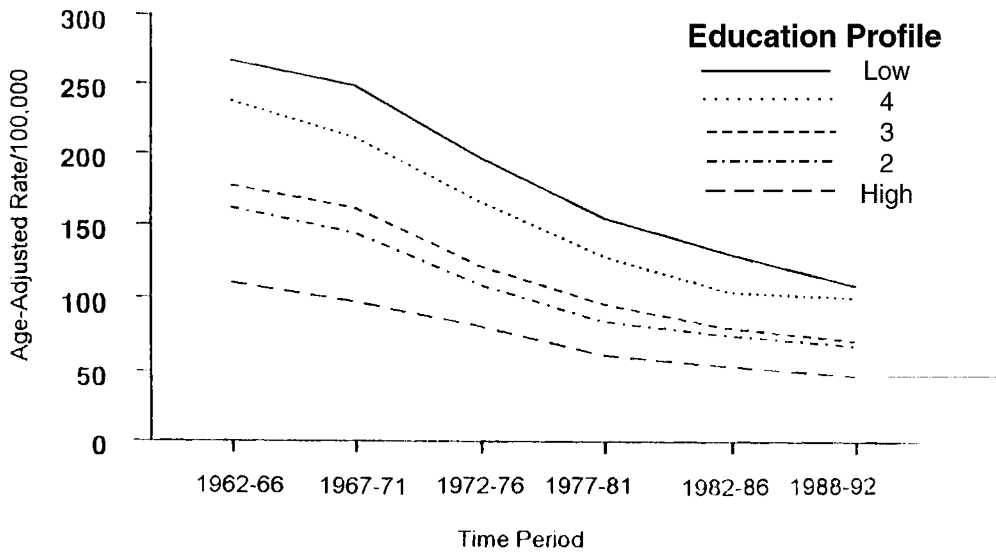

Figure 5.—*Five-Year Average Annual Age-Adjusted Stroke Mortality Rate, 1962 to 1992, by Education Profile of State Economic Areas, Black Men Ages 35 to 64.*

Summary and Implications

Epidemiological studies indicate that SES levels are now inversely associated with CVD in both blacks and whites. The pathways that explain this relationship are interrelated. SES indicators are inversely associated with most of the major behavioral and physiological CVD risk factors in blacks. Most of the CVD risk factors inversely associated with SES are positively associated with the prevalence of preclinical atherosclerosis, a critical waystation on the path to clinically manifest CHD, in blacks and whites.

Controlling for these risk factors eliminates the inverse association of SES with carotid wall thickness, a finding consistent with the idea that CVD risk factors are the intervening links or pathways between SES and atherosclerosis. However, controlling for these risk factors does not statistically explain the association of SES with prevalent CHD in ARIC. This suggests a possible role for other factors, including psychosocial attributes of John Henryism, lifestyle incongruity, access to and utilization of medical care, and currently unidentified stressors, in the transformation of silent to symptomatic atherosclerotic disease. However, in the NHANES-I followup, adjustment for the major risk factors reduces the association of income with incident CHD to statistical nonsignificance.

At the aggregate level, SES affects the magnitude and time trends of CVD mortality in blacks and whites. These studies indicate that the association of SES with CHD at both individual and aggregate levels has varied over time and that the present inverse association is increasing in strength. The inverse association of stroke mortality with SES dates back at least 35 years and persists in blacks and whites despite a two-thirds decrease in the absolute level of stroke mortality.

The marked changes over time demonstrate that the SES effects on CVD mortality in blacks are not fixed and invariant. Although the pathways linking SES to CVD in blacks are multicausal and interrelated, epidemiological observation and intervention studies suggest that harmful pathways can be interrupted and healthy ones can be promoted. Interventions at both the individual and the societal level hold promise for further reducing CVD mortality in blacks and whites.

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PATHWAYS **L**INKING **SES** AND **CVD: H**ISPANIC **P**OPULATIONS

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Hispanic Americans numbered over 22 million in 1992 and today constitute the nation's fastest growing ethnic minority (1,2). Among Hispanics, there are three major, socioculturally distinct subgroups: Mexican Americans, Cuban Americans, and Puerto Ricans. Mexican Americans are the largest subgroup, comprising 62.6 percent of the total U.S. Hispanic population (1,2). Hispanics generally have markedly lower socioeconomic status (SES) than non-Hispanic whites (3). An interesting epidemiological paradox, observed among Mexican Americans in particular, is that this lower SES is not associated with a consistently worse pattern of cardiovascular disease (CVD) risk factors, disease prevalence, or mortality (4).

Until now, little attention has been given to examining the association of SES and CVD ***within*** Hispanic populations. SES data, on Hispanics as a group, are available from the National Longitudinal Mortality Survey (NLMS) and the National Health Interview Survey (NHIS), and data on Mexican Americans are available from the National Health and Nutrition Examination Survey III (NHANES III). These data, compiled specifically for this conference, represent the first efforts to address this issue on a national scale. Only a few published data are available from local studies (5–10), perhaps because SES is often treated as a confounding variable requiring statistical control, rather than an independent variable of intrinsic interest. Published data for Puerto Rican men are available from the Puerto Rico Heart Health Program (10). No published data were found for Cuban Americans.

Three types of pathways may link SES to CVD: biological, lifestyle, and psychosocial. Data from three large epidemiological investigations—the San Antonio Heart Study (SAHS), the Stanford Five-City Project (SFCP), and the Puerto Rico Heart Health Program (PRHHP)—illustrate the pattern of association between SES indicators and selected variables in each pathway.

Methods

Data from the SAHS are based on the pooled sample of Mexican-American participants in Phase I (1979 to 1981) and Phase II (1984 to 1988) of the study. The study populations included 1,393 Mexican-American men and 1,908 Mexican-American women, 25 to 64 years of age, randomly sampled from three socioculturally distinct neighborhoods: a low-income, exclusively Mexican-American barrio; a middle-income transitional neighborhood composed of about 60 percent Mexican Americans and 40 percent non-Hispanic whites; and a high-income suburban neighborhood composed of about 10 percent Mexican Americans and 90 percent non-Hispanic whites. Stratified sampling based on surname listings in the crisscross directory for San Antonio ensured approximately equal numbers of participants in both ethnic groups from the transitional neighborhood and suburbs (5–8).

Data from the SFCP are based on a matched-pairs sample of 756 Hispanics and whites, 25 to 74 years of age, who resided in households randomly sampled from four cities in California and who participated in one of five separate cross-sectional surveys conducted biannually from 1979 to 1990. Subjects were matched for ethnic background, sex, age, education, city of residence, and survey time period (9). Data from the PRHHS are based on 6,208 men, 45 to 64 years of age, from urban areas of Puerto Rico, who participated in the first study examination conducted between 1965 and 1968 (10).

For SFCP and PRHHP, the SES data presented here are for education. For the SAHS, three separate SES indicators—education, household income, and occupation—are examined. For comparison with national data presented in the *Chartbook of U.S. National Data on Socioeconomic Status and Cardiovascular Health and Disease,* these indicators were broken into the following categories: education—less than 12 years, 12 years, greater than 12 years; household income—less than $9,000, $9,000 to $29,999, greater than or equal to $30,000; and occupation—white collar, blue collar, service workers. Correlations among the ranked indicators using Kendall's tau_b were: men—education and income, 0.46; education and occupation, 0.44; income and occupation, 0.34; and women—education and income, 0.46; education and occupation, 0.50; income and occupation, 0.37. The shared variance among SES indicators thus ranged from 11.6 to 25.0 percent, so that each indicator can be clearly recognized as capturing discrete aspects of this underlying construct. Nonetheless, the patterns of association between the three SES indicators and the biological, lifestyle, and psychosocial variables examined were very similar, particularly for education and household income. Data presented are from the SAHS unless otherwise specified.

Biological Pathways

Cholesterol

Higher levels of total cholesterol and the ratio of total to high density lipoprotein (HDL) cholesterol are independently associated with increased risk of coronary heart disease (CHD). For Mexican-American men, higher household income was significantly associated with higher total cholesterol ($p < 0.05$); for Mexican-American women, the association was nonsignificant and in the opposite direction. There was a striking gender–income interaction effect ($p = 0.0001$), with a successively greater gender difference in total cholesterol at successively higher levels of household income. The same pattern of associations was observed for the ratio of total to HDL cholesterol. The primary reason for the latter appears to be a beneficial association between higher household income and higher HDL ($p = 0.0001$) among women in combination with nonsignificant and slightly negative association between household income and HDL among men.

The associations of education with total cholesterol and with the ratio of total to HDL cholesterol paralleled those of income in both genders. Similar associations with occupation were observed in women but not in men.

Obesity

Higher levels of education were significantly associated with markedly lower body mass index (BMI) (kg/m^2) in Mexican-American women ($p = 0.0001$), but with only slightly lower BMI in Mexican-American men though this association is not significant. Parallel associations were observed for all three SES indicators.

Blood Pressure

The pattern of association between education and diastolic blood pressure in Mexican Americans was similar across genders to that observed for BMI. For systolic blood pressure (SBP), higher education had a highly significant and beneficial effect in both genders (men, $p < 0.001$; women, $p = 0.0001$). There was also a striking age–education interaction effect that was somewhat stronger in men ($p = 0.0001$) than in women ($p < 0.03$). The difference in SBP across educational levels was greater for those 45 to 64 years of age (8 mmHg) than for those 25 to 64 years of age (2–5 mmHg). Parallel associations were observed for all three SES indicators.

Hypertension was classified according to the Hypertension Detection and Followup Program criteria as SBP greater than 140 mmHg or diastolic blood pressure (DBP) greater than 95 mmHg. Persons currently taking antihypertensive medications were also considered to have high blood pressure. Higher education and income, but not occupation, were significantly associated with lower prevalence of hypertension in Mexican-American women ($p = 0.0001$). None of the SES indicators were significantly associated with prevalence of hypertension in Mexican-American men.

Diabetes

Diabetes was classified according to World Health Organization (WHO) criteria as fasting glucose greater than or equal to 140 mg/dL or 2-hr postload glucose greater than or equal to 200 mg/dL. Higher SES, as measured by all three indicators, was significantly associated with lower diabetes prevalence in Mexican-American women (for education and income, $p = 0.0001$; for occupation, $p < 0.001$). In Mexican-American men, lower diabetes prevalence was significantly associated with higher education ($p < 0.001$) and household income ($p < 0.05$), but not with higher occupation.

Summary

In Mexican Americans, SES appears to have a greater and more consistent impact on biological pathways to CVD in women than in men. Higher SES is uniformly associated with a better profile of biological risk factors in Mexican-American women.

Lifestyle Pathways

Saturated Fat/Cholesterol Avoidance

The association between each of the SES indicators and saturated fat/cholesterol avoidance (FATAVOID) is illustrated for women. The positive gradient between SES and FATAVOID is particularly striking for education and income. However, the *p*-value for all three indicators is 0.0001. The FATAVOID score is about one-half point higher in the highest SES stratum than in the lowest for occupation, and about 1 point higher for education (scale range: 0–6 points). The same highly significant pattern of association between the SES indicators and FATAVOID was observed in men.

Leisure Time Physical Activity

Gradients for the association between weekly leisure-time physical activity and SES are even steeper than those for FATAVOID. The association is most striking for income, with Mexican-American women in the highest household income category exercising more than twice as often per week as women in the lowest household income category ($p = 0.0001$). The association is least striking for occupation. Mexican-American women in the highest occupation category engage in leisure-time physical activity about 1.6 times per week compared to 1.2 times per week for women in the lowest occupation category ($p < 0.001$). The gradient for education is intermediate between those for household income and occupation ($p = 0.0001$). The patterns of association are similar for Mexican-American men.

Current Cigarette Smoking

All three SES indicators exhibit striking negative and monotonic associations with rates of current smoking. Across indicators, the proportion of Mexican-American women who are current smokers declined from 26 to 30 percent in the lowest SES category to 14 to 16 percent in the highest SES category (p = 0.0001). Once again, the patterns of association are similar for Mexican-American men.

Summary
Based on these analyses, it appears that higher SES is uniformly associated with healthier CVD lifestyle among Mexican Americans for both men and women.

Psychosocial Pathways

Perceived Control Over Health
The association between SES and psychosocial pathways to CVD in Mexican Americans is illustrated by education and perceived control over health (Fig. 1). In both gender groups, there is a strong positive association between education and perceived health control (p = 0.0001). The pattern of association is similar for household income and occupation.

Other psychosocial variables examined include marital status, availability of an intimate confidant, and self-efficacy. For each of these variables, higher SES is associated with scores indicative of greater protection against CVD.

Summary
Psychosocial characteristics and SES appear to travel together. Higher SES is associated with a more favorable profile of psychosocial risk factors for CVD.

SES Interaction Effects

It is important to keep in mind that the association between SES and CVD pathways may involve interactions with age, gender, ethnic group, economic context, and perhaps other factors. Examples include

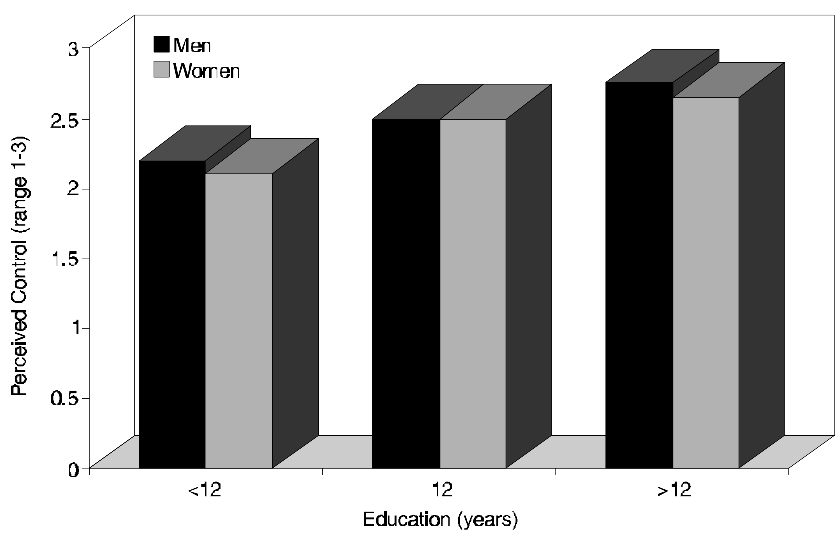

Figure 1.—*Education and Perceived Health Control in Mexican Americans, San Antonio Heart Study.*

interactions with age, in the case of SBP, and with gender, in the case of cholesterol. Data from the SFCP and the PRHHP illustrate similar interactions with ethnic group and economic context.

SES–Ethnic Group Interactions

The SFCP observed two striking education–ethnic group interactions. In the lowest education category, Hispanics had lower DBP levels than whites (ethnic difference: 1–1.5 mmHg). Although DBP levels were lower in both groups at higher levels of education, there was a crossover in ethnic differences in DBP. Among those in the highest education category, Hispanics had higher DBP than whites (ethnic difference: 2.75–3.25 mmHg). A similar interaction effect was observed for education and current smoking. Among those in the lowest education category, almost twice as many whites as Hispanics were current smokers (approximately 48 percent vs. 25 percent, respectively), but among those in the highest education category fewer whites than Hispanics were current smokers (approximately 12 percent vs. 17 percent, respectively).

SES–Economic Context Interaction Effects

The PRHHP illustrates the differential association between SES and CVD pathways in regions with developing economies as compared with developed economies. For urban men in the study, higher SES was associated with a worse profile of biological risk factors for CVD. SBP, serum cholesterol, and glucose intolerance were all successively higher at higher levels of education. Similarly, relative weight and weight gain since age 25 were higher at higher educational levels, and physical activity levels were lower. The percentage of current smokers showed little association with education.

These findings are consistent with the notion that the association between SES and CVD has an ascending and descending limb. Developing countries are on the ascending limb. That is, the affluent at higher levels of SES engage in more sedentary jobs and purchase high-fat foods, while those at lower levels of SES are unable to engage in similarly unhealthy lifestyles. In developed countries, those at higher levels of SES have learned about unhealthy lifestyles and make appropriate changes, while those at lower levels of SES have adopted the unhealthy lifestyles that have been made affordable to them. Within developed countries, it is certainly possible that some geographic areas provide economic contexts more similar to those of developing countries than developed ones.

Summary

It is important to consider the possibility of SES interactions with a variety of variables such as gender, age, ethnic group, and economic context. These interaction effects indicate that the meaning of SES is not the same for all groups or within all contexts. SES indicators (education, household income, occupation) are pointers that hint at differences in the experience and context of daily living among people who score differently on these measures. Learning what these experiences are and which ones are related to CVD will be essential for designing effective interventions to improve cardiovascular health in persons with low SES.

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Socioeconomic Status and 23-Year Cardiovascular Disease and Total Mortality Among Middle-Aged Men: The Honolulu Heart Program

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An association between poor health and low socioeconomic status (SES) has been observed for many years (1). In industrialized countries, individuals of low SES have higher rates of cardiovascular disease (CVD) morbidity and mortality than individuals of high SES, regardless of sex, race, or ethnic background. Correspondingly, low-SES groups tend to have the least favorable health characteristics. Much of the excess CVD risk observed in these individuals is explained by standard risk factors (2,3).

The Honolulu Heart Program provides the opportunity to investigate associations between various measures of SES and 23-year mortality from coronary heart disease (CHD), stroke, and all causes among middle-aged men of Japanese ancestry. Previously reported findings from the Honolulu Heart Program suggest that occupation level, classified as white vs. blue collar work, is not associated with CVD or total mortality (4).

Baseline Examination

The Honolulu Heart Program, begun in 1965, follows 8,006 men of Japanese ancestry, ages 45 to 68 at entry, for the development of CHD and stroke. Details of the selection process for this cohort have been published previously (5). Persons with CHD, stroke, or cancer at baseline were excluded from these analyses.

During the first examination of this cohort in 1965, data were collected on CVD risk factors, including anthropometric measurements, blood pressure, electrocardiograms, serum cholesterol levels, medical history, and behavioral characteristics such as smoking, alcohol consumption, and physical activity. Several variables with a possible SES association were also assessed at baseline. These included home ownership, number of bedrooms in the home, number of persons in the household, education, marital status, occupation, and wife's occupation.

Surveillance Methods

The surveillance system established at the beginning of the study continues to identify cases of CHD and stroke based on selected hospital discharge diagnoses at major medical facilities on the island of Oahu. Deaths are ascertained primarily from obituaries in island newspapers, supplemented with death certificate listings from the state health department. A panel of Honolulu Heart Program physicians reviews the medical records to identify incident cases of CHD and stroke and to determine the cause of death based on standardized criteria (6,7). CHD deaths include fatal events, as well as sudden deaths (within 1 hour of onset) among asymptomatic or apparently healthy subjects. The outmigration rate from Oahu has been less than 1 in 1,000 study participants per year. All but four of the original 8,006 study participants were located for the program's fourth examination in 1991 to 1993.

Data Analysis

A series of stepwise Cox models (8) were used to investigate which measures of SES were associated with mortality from CHD, stroke, and all causes. Age was forced in the models. The stepwise models tested the SES indicators as possible independent variables to determine the most important predictors of CVD and total mortality. After the most important SES predictors were identified, standard risk factors were added to determine whether the associations between SES indicators and CVD mortality are independent or mediated by standard risk factors. These included pack-years of smoking, alcohol intake, cholesterol, triglycerides, hypertension, physical activity, birth in Japan, years lived in Japan, glucose level, body mass index, and percent calories from fat.

As shown in Table 1, none of the measures of SES reached the level of statistical significance required for inclusion in the model for CHD mortality ($p < 0.05$). Home ownership was inversely and significantly associated with age-adjusted stroke mortality. After adjusting for age and the standard risk factors, however, home ownership was no longer significantly associated with stroke mortality, suggesting that standard CVD risk factors mediate these associations. Similar results were observed without adjustment for place of birth and years lived in Japan. Home ownership and marital status were the strongest SES predictors for total mortality after adjusting for age. These variables were inversely and significantly associated with total mortality and remained significantly associated after adjusting for the standard risk factors. Nonmanual occupation was inversely and independently associated with total mortality.

Age-adjusted mean levels for the standard risk factors were calculated by home ownership. Age- and risk factor-adjusted relative risks for CVD and total mortality and 23-year age-adjusted mortality rates were calculated by home ownership, marital status, education, and occupation.

Higher education levels (senior high school, technical school, or university) were protective for 23-year total mortality (Table 2). Education was inversely associated with total mortality after adjusting for age, but was not independent of other risk factors. Home ownership had a significant protective effect for stroke and total mortality. Marriage showed similar trends but was significantly and inversely associated only with total mortality.

Table 1.—Stepwise Cox Regression Analyses for 23-Year CVD Morbidity and Mortality and SES

Outcome	**SES Variable**	**Age-Adjusted Relative Risk; (*p* value)**	**Risk Factor-Adjusted* Relative Risk; (*p* value)**
CHD mortality	No significant associations	—	—
Stroke mortality	Home ownership	0.69 (0.0146)	0.78 (0.1300)
Total mortality	Home ownership	0.78 (< 0.0001)	0.82 (0.0001)
	Marital status	0.79 (0.0030)	0.79 (0.0036)

*Risk factors: smoking (pack-years), alcohol intake, cholesterol, triglycerides, hypertension, physical activity index, Japanese birthplace, years lived in Japan, glucose level, body mass index, and percent calories from fat

Table 2.—Age-Adjusted 23-Year Incidence Rates per 1000 Men for CVD Morbidity and Mortality

Outcome	Education ≥ 12 yrs		Nonmanual occupation		Home ownership		Married	
CHD mortality	+	-	+	-	+	-	+	-
Stroke mortality	42.6	39.5	45.3	36.9	38.9	43.1	39.5	48.8
Total mortality	27.6	27.6	27.2	27.2	25.1	33.9*	27.1	29.6
	274.9	301.8*	279.3	295.0	272.9	339.0*	283.8	367.1*

* $p < 0.05$

Homeowners smoked and drank significantly less than men who did not own homes (Table 3). They also had lower nonfasting glucose concentrations, higher body mass and percentage of dietary calories from fat, and lower physical activity. They were less likely to have been born in Japan and lived there for fewer years on average. These differences, although statistically significant, were small compared with the differences in smoking and drinking. Homeowners were also more likely to be married, to have nonmanual occupations, and to have completed high school.

Education, home ownership, and marriage were significantly and inversely associated with total mortality after adjusting for age (Table 4). Nonmanual occupation, home ownership, and marriage were inversely associated with total mortality after adjusting for the standard risk factors. Home ownership was also significantly and inversely associated with stroke after adjusting for age, but the magnitude of the association was reduced after adjusting for standard risk factors.

Discussion

Some historical background is helpful to understand the social and cultural characteristics of the Japanese Americans living in Hawaii. At the turn of the century, large numbers of Japanese, recruited to work on the sugar plantations, immigrated to Hawaii. More than 85 percent of the men of this cohort are second-generation Japanese Americans and are therefore somewhat homogeneous with regard to their education level and cultural characteristics.

In the Scottish Heart Health Study (9), home ownership was the most discriminatory measure of SES in relation to CHD prevalence. In our study, it was the best predictor of 23-year total mortality. Home ownership may be an indicator of wealth, stability, healthier lifestyles, and better access to medical care. Home owners are also more likely to have high school or higher education, to be married, and to have nonmanual occupations.

Winkleby et al. have suggested that education level is the best SES predictor of CVD risk factor profiles (10). In the present study, education was associated with total mortality, and this relationship was mediated by traditional risk factors. Education however, was not associated with CHD or stroke mortality, possibly because of the cultural and educational homogeneity of this population and the relatively small incidence of CHD and stroke events as compared with total mortality.

Table 3.—Age-Adjusted Risk Factor Levels by Home Ownership in the Honolulu Heart Program, 1965–68

Risk Factor	Home ownership	Other
Smoking (pack-years)	22.3	28.1†
Alcohol intake (oz/mo)	13.4	16.1†
Cholesterol (mg/dl)	218.0	217.4
Triglycerides (mg/dl)	236.1	233.0
Hypertension (%)	21.9	22.6
Nonfasting glucose (mg/dl)	160.2	163.3*
Body mass index	23.9	23.7*
Dietary calories from fat (%)	33.6	32.3†
Physical activity index	32.8	33.3†
Born in Japan (%)	11.2	12.8*
Years lived in Japan	1.6	2.0†
Married (%)	96.0	86.0†
Education $\geq$ high school (%)	52.0	41.0†
Nonmanual occupation (%)	41.0	26.0†

*$p < 0.05$
†$p < 0.01$

Table 4.—Age- and Risk Factor-Adjusted* Relative Risk for 23-Year CVD Morbidity and Mortality

Outcome	Education ≥ 12 yrs		Nonmanual Occupation		Home Ownership		Married Status	
	Age	Risk factors	Age	Risk factors	Age	Risk factors	Age	Risk factors
CHD mortality	1.06	0.99	1.21	1.05	0.86	0.93	0.74	0.77
Stroke mortality	0.98	1.01	0.99	0.98	0.71†	0.75	0.84	0.87
Total mortality	0.90†	0.93	0.94	0.91†	0.77†	0.82†	0.72†	0.76†

*Risk factors: smoking (pack-years), alcohol intake, hypertension, cholesterol, body mass index, diabetes, and physical activity index
†$p \leq 0.05$

The findings of this investigation underscore the importance of SES indicators as correlates of adverse risk factors such as smoking and drinking and as predictors of long-term stroke and total mortality in this cohort of middle-aged Japanese-American men. Further research is needed to determine how to promote better social, behavioral, and living conditions among individuals of lower SES in order to improve their overall health.

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Socioeconomic Status and Cardiovascular Health and Disease in American Indians: The Strong Heart Study

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The Strong Heart Study (SHS) is an epidemiological study of cardiovascular disease (CVD) and its risk factors among three American Indian populations. These include the Pima/Maricopa of Arizona; the Oglala and Cheyenne River Sioux in South Dakota and the Devil's Lake Sioux in North Dakota; and the Apache, Caddo, Comanche, Delaware, Fort Sill Apache, Kiowa, and Wichita tribes in southwestern Oklahoma. Phase I includes 4,549 eligible participants, ages 45 to 74 at the time of clinic visit. Participants in Arizona and the Dakotas live on reservations, whereas most of those in Oklahoma reside in urban communities. Socioeconomic status (SES) and lifestyle data were collected through a personal interview, and biological data such as blood pressure, diabetes, and lipids were obtained through a physical examination and laboratory tests. The detailed protocol has been published elsewhere (1). This paper reports the significant pathways that have been observed to link SES factors and cardiovascular disease (CVD).

METHODS

In the literature, SES factors include education, income, and occupation (2). Data on current employment status and recent occupation were not available for the SHS, so this report focuses only on the first two factors. For these analyses, education level is categorized as less than 12 years, 12 years, and more than 12 years of school. Annual household income is grouped into five levels: less than $5,000; $5,000 to $9,999; $10,000 to $24,999; $25,000 or more, and “unknown,” which applies to subjects who did not know, did not respond, or refused to answer. This last group was included because it constitutes more than 20 percent of the SHS cohort.

The gradients for income are lower than those reported for blacks, Mexican Americans, and whites (3). In fact, more than 65 percent of the participants who reported their income had an annual household income of less than $25,000. Education, income, and other SES variables were analyzed in relation to blood pressure, hypertension, lipids, body mass index (BMI), overweight, diabetes, albuminuria, cigarette smoking, alcohol consumption, physical activity, marital status, sufficient income to pay bills, distance to nearest clinic and hospital, ability to speak native language, and degree of American Indian blood. All analyses were stratified by gender and region. The chi-square test was used to compare prevalence, and analysis of variance was used to compare means of continuous measurements.

RESULTS

Table 1 presents the frequency distributions of education and income by gender and region. More than 50 percent of the participants had at least a high school education (men, 54 percent; women, 51 percent). These percentages were lower than the 66 percent reported based on the 1990 census for all American

Table 1.—Frequency Distributions of Education and Income Among American Indians by Gender and Region

	Men (*n*, percent)				Women (*n*, percent)			
	Arizona	Oklahoma	North and South Dakota	Total	Arizona	Oklahoma	North and South Dakota	Total
Education (years)								
< 12	329 (61%)	180 (28%)	342 (52%)	851 (46%)	598 (63%)	290 (33%)	430 (50%)	1318 (49%)
12	145 (27%)	191 (30%)	173 (26%)	509 (28%)	191 (20%)	286 (32%)	198 (23%)	675 (25%)
> 12	68 (13%)	271 (42%)	142 (22%)	481 (26%)	163 (17%)	309 (35%)	235 (27%)	707 (26%)
Income								
< $5,000	186 (34%)	93 (14%)	205 (31%)	484 (26%)	289 (30%)	145 (16%)	295 (34%)	729 (27%)
$5,000-$9,999	65 (12%)	89 (14%)	148 (23%)	302 (16%)	133 (14%)	117 (13%)	170 (20%)	420 (16%)
$10,000-$24,999	90 (17%)	167 (26%)	167 (25%)	424 (23%)	183 (19%)	220 (25%)	241 (28%)	644 (24%)
≥ $25,000	40 (7%)	132 (21%)	96 (15%)	268 (15%)	55 (6%)	99 (11%)	96 (11%)	250 (9%)
Unknown	165 (30%)	161 (25%)	42 (6%)	368 (20%)	294 (31%)	304 (34%)	62 (7%)	660 (24%)

Indians and Alaska Natives (4). Participants in Oklahoma had a higher average education level than those living in Arizona and the Dakotas. Table 2 compares the education levels of SHS cohorts with those of other ethnic groups.

SHS participants had very low annual household incomes—34 percent had a reported income of less than $5,000. Table 3 compares the prevalence of poverty in SHS cohorts with that in other ethnic groups. The average poverty threshold used for the SHS household was $15,000 and that for the other ethnic groups was $14, 225 (3). The prevalence of poverty among American Indians ages 45 to 64 (66 percent) is 3 times that of blacks (21 percent), nearly 4 times that of Hispanics, and 7 times that of whites. The comparison is similar for those age 65 and over. The median household income for American Indians and Alaska Natives, according to the 1990 census, was $20,025 (4); the median for the SHS cohorts was less than $10,000. Participants in Arizona and the Dakotas had less income than those in Oklahoma.

About 34 percent of men and 42 percent of women with more than 12 years of education live below poverty level, defined in SHS as a household income of $15,000 per year. For all three regions, the prevalence of poverty decreases uniformly with increasing education, a trend that has also been observed in the other three ethnic groups (3). Across all education categories and in all three regions, more women than men reported an income below poverty level. Although equal percentages of men and women (26 percent) have more than 12 years of education, only 9 percent of women reported household income of $25,000 or more compared to 15 percent of men.

Participants with more than 12 years of education tended to be younger than those in the lowest education category (mean age of 54 vs. 58 years, respectively, for both men and women). In addition, both men and women with an annual household income of $25,000 or more had a mean age of 53, compared with an age of 56 for men and 57 for women in the less than $5,000 group.

Cardiovascular Morbidity

The prevalence of self-reported stroke decreased with higher education except in Arizona women. This decrease was similar to that observed in white women (3). Stroke prevalence also decreased with higher

Table 2.—Percent of Population with at Least High School Education by Gender, Age, and Race

	Men		Women	
	45-64 years	65+* years	45-64 years	65+* years
American Indians (SHS)				
Total	57	37	55	36
Arizona	41	28	40	24
Oklahoma	77	52	72	50
North and South Dakota	52	25	54	33
Black	54	27	58	28
Hispanic	45	29	44	25
White	78	57	78	60

*For SHS cohorts, 65+ includes participants aged 65-74 years only.

income among men and women in Arizona and Oklahoma. No stroke was reported for participants in Oklahoma or for Arizona men with $25,000 or more in income. For those with less than 12 years of education or less than $5,000 in income, the highest stroke prevalence among all three regions was observed in the Oklahoma cohort.

For women in all three regions combined, coronary heart disease (CHD) prevalence (as diagnosed through EKG examination and verified by medical charts) decreased with increased education and with increased income.

Biological Pathways

Blood Pressure

For both genders, mean systolic blood pressures were lowest in the North and South Dakota cohort. Mean systolic blood pressure decreased with higher education among women; for all three regions, the difference in mean readings between those with less than and those with more than 12 years of education ranged from 2 to 8 mmHg, with the largest difference observed in women from the Dakotas. A similar downward trend was observed in the other three ethnic groups ages 45 to 64 (3). Systolic blood pressure also appeared to decrease with increasing income. For all women, those with income $25,000 or higher had the lowest mean reading (120 mmHg).

Similar patterns existed for hypertension. The prevalence of hypertension for both genders was lowest in participants from the Dakotas. Among women, prevalence of hypertension decreased with increasing education. The same pattern has been observed among blacks and non-Hispanic whites (3). Although there was no clear-cut downward trend with increasing income (except for women in all three regions combined), it appeared that the lowest prevalence occurred in those in the highest income category. Consistent with self-reported data, Arizona had the highest percentage of hypertensive participants who were aware of their hypertension. Awareness of hypertension increased with higher levels of education for all men and women.

An increasing trend in awareness was also observed with higher income among all women. In the Dakotas, only about half of the women with incomes under $5,000 were aware of their hypertension, compared with

Table 3.—Percent of Population Below Poverty Level by Gender, Age, and Race

	Men and Women		Men		Women	
	45-64 years	65+* years	45-64 years	65+* years	45-64 years	65+* years
American Indians (SHS)#						
Total	66	80	64	75	67	84
Arizona	76	87	76	86	75	88
Oklahoma	53	69	48	58	58	78
North and South Dakota	68	85	68	85	68	86
Black	21	33	—	—	—	—
Hispanic	19	22	—	—	—	—
White	7	11	—	—	—	—

*For SHS cohorts, 65+ includes participants aged 65-74 years only.
#The denominator excludes those with unknown income
— Data not available

about 75 percent of women in higher income groups. The lowest income group in North and South Dakota also had the lowest percentage of hypertensives being treated (47 percent) and only 24 percent had their hypertension controlled. The percent of women with controlled hypertension increased with years of education; however, no such patterns were observed in men. More hypertensive women than hypertensive men were being treated (47 to 77 percent vs. 25 to 69 percent). The percentages increased with higher education and income.

Serum Cholesterol

Total and low-density lipoprotein (LDL) cholesterol levels increased with higher income among men (Table 2). An upward trend was also observed with higher education for all men. The differences in total and LDL cholesterol between the lowest and highest income groups were all substantial: 18 and 27 mg/dL for Arizona, 16 and 19 mg/dL for Oklahoma, 21 and 14 mg/dL for North and South Dakota, and 21 and 21 mg/dL for all men. An upward trend was also observed with higher education for all men. The differences between those with less than and those with more than 12 years of education were smaller than those observed for income (12 for total cholesterol and 13 for LDL cholesterol). Triglyceride levels also increased with higher education or higher income among men in all three regions combined.

The trend for men was reversed for high-density lipoprotein (HDL) cholesterol, which decreased with higher education or higher income. Those with more than 12 years of education or at least $25,000 in income had the lowest mean HDL levels; differences between lowest and highest strata were 4 mg/dL for education and 7 mg/dL for income. This downward trend has not been observed for whites, blacks, or Hispanics (3).

Among women, patterns were not clear, although in the Dakotas, LDL cholesterol increased with higher education or higher income. No trend was observed with total or HDL cholesterol.

Obesity

There was also a slightly increasing trend in BMI with higher education or higher income in men. Although no trend in BMI with income was discerned in women, those with the highest income level tended to be the leanest.

Overweight was defined as having a BMI of 27.8 or more for men and 27.3 or more for women. The prevalence of overweight for men was lowest for those with less than 12 years of education and those with the lowest income level. For women, the prevalence of overweight was lowest in the highest income group.

Diabetes

In all three regions, the prevalence of diabetes was lowest in the highest income group (men, 31 percent; women, 33 percent). This pattern has also been observed among Mexican Americans and non-Hispanic whites (3). There was no clear association between the prevalence of diabetes and education, although among men, participants with 12 years of education had the lowest diabetes prevalence and the relationship seemed to be quadratic.

Albuminuria

There was a downward trend in the prevalence of macro- and microalbuminuria with higher education in all three regions combined. A similar trend was observed in women in each region. The highest prevalence occurred among women in the two lowest income groups. However, in men there seemed to be a region-specific quadratic relationship between prevalence of albuminuria and education.

Lifestyle Pathways

Cigarette Smoking

The North and South Dakota region had the highest prevalence of current smoking for both genders in all categories of education and income. The prevalence of current smoking was lowest among men with more than 12 years of education in all three regions, a finding similar to that for white, black, and Hispanic men ages 45 to 64 (3). There was a downward trend in prevalence with higher income among men in Oklahoma and the Dakotas, similar to the trend for Hispanic and white men.

For women, prevalence of current smoking increased with education levels. In contrast, among non-Hispanic black and white women ages 45 to 64, smoking prevalence was highest at lower income levels (3).

Years of smoking decreased with years of education. The percentage of ex-smokers increased with education and income in the Dakotas, implying that more people with higher education quit smoking.

Alcohol Consumption

Among men in all three regions, participants in the lowest income group had the highest prevalence of current drinking (70 percent, 60 percent, 72 percent, and 69 percent respectively in Arizona, Oklahoma, the Dakotas, and overall). The lowest prevalence in Arizona was among the $10,000-$24,999 income group, whereas in North and South Dakota, the lowest prevalence was among those with incomes of $25,000 or more. Most current drinkers in SHS were also binge drinkers (i.e., five or more drinks per occasion). The prevalence of binge drinking during the past year was more than 60 percent (range, 61 to 98 percent) for all levels of education and income. The mean number of drinks per week showed a decreasing trend with higher income. Men in the highest education and income groups had the lowest number of drinks per week, 7 and 6 drinks, respectively.

Among women, there was an upward trend in the prevalence of current drinking with higher education. The prevalence was significantly higher among women with more than 12 years of education than those with less education. In contrast with the trend for men, current drinking was highest among women with incomes of $25,000 or more. Although the prevalence of alcohol consumption was highest in the highest income group, the mean number of drinks per week was actually lowest for women in that group. Except in North and South Dakota, the mean number of drinks per week decreased for women with higher income. The prevalence of binge drinking ranged from 38 to 88 percent. Women in the $25,000 and over income group binged less than those in the other income groups, but their prevalence of binge drinking still exceeded 37 percent.

Physical Activity

In both genders and in all regions, the prevalence of "no leisure activity during the past year" showed a decreasing trend with higher education, regardless of whether walking was included in leisure activities. The mean number of hours per week spent in leisure activities during the past year was higher for those with more than 12 years of education than for those with less education. Inactivity also decreased with higher income. The Oklahoma region had a lower prevalence of inactivity than the other two regions. These findings agree with reports obtained from the other three ethnic groups (3).

Psychosocial Pathways

Marital Status and Ability to Pay Bills

In all regions and among both genders, the prevalence of being currently married increased with higher education or higher income; the highest prevalence was found in the highest income group. This uniform monotonic trend across all income categories has also been observed in blacks and non-Hispanic whites (3). The ability to pay bills showed a similar relationship with education and income.

Access to Medical Care

The mean distance to the closest clinic was shorter in Arizona and the Dakotas than in Oklahoma. For both genders in Arizona, those with less than 12 years of education tended to live farthest from any clinic. In Oklahoma, men in the lowest and highest income groups lived farthest from the clinic, whereas women in the same groups tended to live closer.

Due to the availability of community hospitals in Oklahoma, the mean distance that participants traveled to the closest hospital was shortest there. Participants with the highest education or income levels tended to travel a shorter distance than those in the other groups. For men in Arizona and for women in the Dakotas, distances traveled did not differ greatly by education or income, perhaps because the participants in each region were using the same hospitals on the reservation.

Acculturation and SES Factors

Native Language and Degree of American Indian Blood

Over 50 percent of the participants in the three regions who spoke their native language had less than 12 years of education. More participants in Arizona (88 percent) and the Dakotas (75 percent) than in Oklahoma (56 percent) spoke their native language, and more of the native-language speakers in those regions, both men and women, had low education than native-language speakers in Oklahoma. Approximately 40 percent of the SHS participants who spoke their native language had a reported annual income of less than $5,000. This proportion was higher in Arizona and North and South Dakota than in Oklahoma. Except in Oklahoma, full-blood American Indians had less education and less income than those of mixed ancestry.

CONCLUSION

Although a direct relationship between education and income with CVD is not clear, pathways between the two SES indicators and CVD risk factors are evident in American Indian populations. Among men, participants with more than 12 years of education had the lowest prevalence of self-reported stroke and current smoking, but they also had a higher BMI. Among women, a much stronger association between education and CVD risk factors was observed. Participants in the highest education group had the lowest prevalence of stroke. A downward trend with higher education was observed for CHD, hypertension, systolic blood pressure, and BMI. A reverse trend was observed with prevalence of current drinking.

In men with higher income, there was an increasing trend in total cholesterol, LDL cholesterol, and BMI, and a decreasing trend in HDL cholesterol. Among women, the highest income group had the lowest prevalence of hypertension, and a downward trend existed between higher income and obesity. Women with higher income seemed to be leaner and had a better HDL lipid profile than men.

The results indicate that, in general, better education is associated with cardiovascular health, and that higher income benefits women more than men.

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SOCIOECONOMIC STATUS AND CARDIOVASCULAR DISEASE IN RURAL POPULATIONS

Thomas A. Pearson, M.D., M.P.H., Ph.D.

Rural inhabitants of the United States constitute a sizeable but silent minority in which low socioeconomic status (SES) and cardiovascular disease (CVD) are more highly prevalent than in urban communities.

The definition of "rural" constitutes a surprisingly difficult challenge, and has been approached in at least two ways. The U.S. Census Bureau defines urban inhabitants as those living in places with 2,500 or more residents and rural inhabitants as those living in places with fewer than 2,500 residents (1). Using this definition, approximately 26.3 percent of the U.S. population is rural, and 85 percent of these people live in places with fewer than 1,000 residents. As a second definition, the Office of Management and Budget defines a metropolitan statistical area (MSA) as an urban population center and those adjacent communities that have economic and social integration with the urban center (2). Approximately 23.4 percent of the U.S. population lives in "nonmetro" areas. These rural areas constitute 83.8 percent of the U.S. land area and 77 percent of its counties (1). In either case, there seems to be good agreement that approximately 25 percent of the U.S. population resides in rural areas. In 1990, this amounted to 56,687,000 rural Americans (3). In this paper, most data will use the MSA versus nonmetro dichotomy to define urban and rural.

The next issue is whether this sizeable rural population differs from the rest of the nation with regard to SES. It has long been recognized that, using any of the measures of SES, rural populations have greater proportions of persons in the lowest SES stratum (3,4). Poverty rates for non-MSA areas annually exceed those of MSA areas for all regions of the country, for all age groups, and for both sexes (5). One may argue that pockets of extreme poverty in central cities are hidden by grouping them with wealthy urban and suburban populations. Although this is certainly true, pockets of rural poor can also be identified. In 1987, poverty rates for farm inhabitants (22.3 percent) exceeded those even of central cities (19.0 percent) (4). Likewise, the trends in poverty favor urban areas. Between 1980 and 1987, poverty rates for those under age 65 rose from 13.5 percent to 18.3 percent in rural areas, whereas the rates rose only from 11.1 percent to 12.6 percent in urban areas (4). Thus, although 23.4 percent of the U.S. population is rural, 29 percent or 9.2 million of the 31.7 million poor people reside in rural areas (3). Similar statistics are available for the proportion of children living in poverty, unemployment rates, and average per capita income (4). All point to a relationship between rurality and low SES.

Another important consideration is the interaction between rurality and ethnicity with respect to SES. Sizeable numbers of Hispanics and blacks reside in rural areas of the West and South, respectively. More than 1.8 million blacks and 700,000 Hispanics live in rural poverty. The largest group of rural inhabitants, however, is white. Rural whites, who constitute 35 percent of poor whites, also constitute the vast majority of the rural poor, although whites constitute only about half of the urban poor.

The interaction of race and rurality with low SES is further defined by time trends in various measures of low SES, such as poverty rates and educational attainment. Figure 1 shows trends from 1969 to 1989 in poverty rates for MSA and nonmetro residents. In every racial and ethnic group, poverty rates are higher

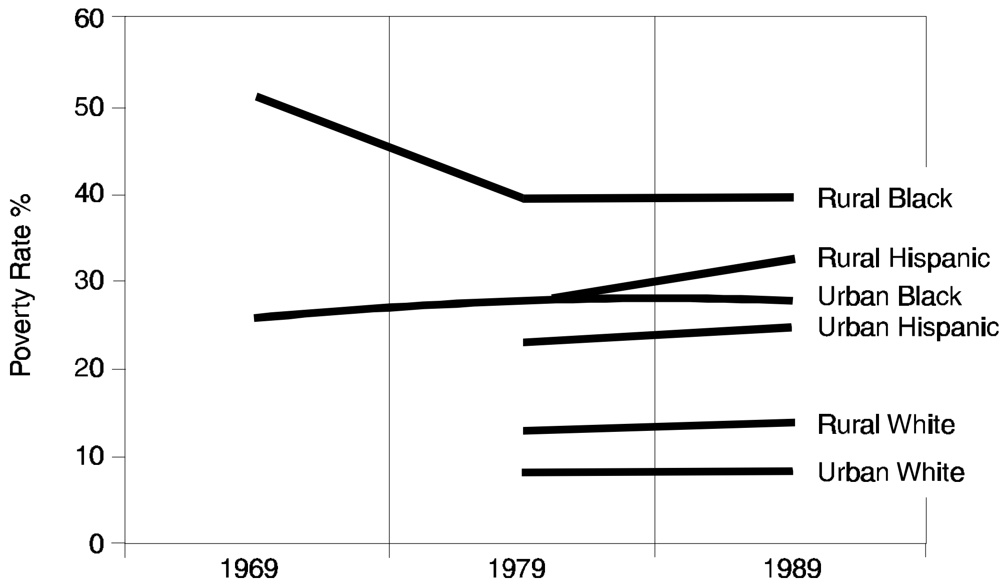

Figure 1.—*U.S. Urban and Rural Poverty Rates by Race and Ethnicity for 1969, 1979, and 1989.* *Urban and rural areas are defined as metropolitan and nonmetro areas.* **Source**: USDA (3).

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for nonmetro than for MSA groups. Between 1979 and 1989, poverty rates were stable for MSA residents, but increased slightly for nonmetro residents in every racial/ethnic group.

Income-derived definitions may not be comparable between urban and rural residents. However, if another definition, educational attainment, is used, the same results are observed. Although substantial gains in education have been realized in all groups, rural residents have poorer levels of education than urban residents in every racial/ethnic group. Thus, by whatever measure used, race/ethnicity and rurality appear to act independently, if not synergetically, in their relationship with low SES.

Finally, the American public commonly equates poverty, especially in minority groups, with urban populations. Media coverage of unrest in the urban ghettos of the 1960s (and the 1990s) has generally showcased the problems of the urban poor (5). The current crisis in urban hospitals has continued to focus on the needs of the poor in central cities. The statistics, however, identify additional needs and challenges of the rural poor. Widely dispersed, geographically isolated, and politically less organized than members of urban communities, the rural poor have been relatively silent about the detrimental impact of poverty in their communities.

CVD Mortality Trends: Loss of the Rural Advantage

In the 1960s and 1970s, urban rates of CVD mortality were well documented as being higher than rural rates in studies in the southeastern states (6) and in Puerto Rico (7). However, more recent analyses have identified a reversal in the trends (Table 1) (5). Age-adjusted rates for total and cardiac mortality can be calculated for each of the 48 states in the continental United States for as far back as 1939. When the mortality rates are correlated with the percent of urbanization in these states, the results show a startling reversal of the protective effect of rurality on total, cardiac, and cancer mortality. Stroke mortality appears always to have been higher in rural states.

Table 1.—Spearman Rank Correlations* Relating Age-Adjusted Death Rates for Whites in the Continental United States to Percent Urban**

Cause of Death	White Males			White Females		
	1939-41	1959-61	1979-81	1939-41	1959-61	1979-81
All Causes	-0.40	-0.10	+0.32	-0.46	-0.55	-0.04
CVD	-0.63	-0.25	+0.38	-0.66	-0.45	+0.15
Cerebrovascular Disease	+0.12	+0.30	+0.48	+0.08	+0.13	+0.31

* For these analyses, negative rates indicate rural states had lower rates than urban states. Positive rates indicate that rural states had higher rates. Values > 0.25 or $\leq$ -0.25 were significant at $p < 0.05$.
Source: Schneider and Greenberg (5), with permission.

These data lead to speculation about the cause of this reversal in trend. Coronary heart disease (CHD) mortality peaked around 1968 and national declines in mortality were well established by 1979 to 1981. A delay in or even an absence of that decline in rural America may be one explanation for the data in Table 1. Evidence for this possibility comes from national data at the county level for white males (Table 2) (8). Between 1968 and 1978, the decline in CHD mortality in nonmetro counties lagged behind that in metropolitan areas, and from 1979 to 1985, the gap widened even further. As a result, CHD mortality rates for rural white males grew to equal or exceed those for males in MSAs in all four regions of the country.

These correlations between CHD mortality and rurality are prone to all the fallacies and biases of any ecologic study. Other data, however, point to the same conclusions. For example, in the National Longitudinal Mortality Study, relative risks for ischemic heart disease mortality are greater for farm-related occupations than for white collar occupations, especially for black men ages 45 to 64 years of age, in whom the occupation with the highest relative risk is farm-related work.

Findings of the National Health Interview Survey from 1988 through 1993 show the same excess of rural CHD. The prevalence rates of ischemic heart disease reported by inhabitants from non-MSAs were always far in excess of those from MSAs, even when broken down by central and noncentral city. Thus, of the 21.5 million Americans with CHD, 6.2 million live in rural areas, and more patients with CHD live in rural areas than in central cities. Similar data are seen for stroke, with rural areas overrepresented relative to their proportion of the population. These data are not age-, gender-, or race-specific. However, they do support the thesis that CVD is more prevalent in rural than in urban areas.

Unfortunately, most of the more recent longitudinal studies are distinctly urban. Most studies conducted in the 1960s and 1970s, with the exception of the Evans County Study (6) and the Puerto Rico Heart Study (7), were based in medium-to-large cities or contained relatively small rural subpopulations. The Strong Heart Study, a longitudinal study of American Indians, contains substantial numbers of rural residents, but it is unclear if the composition of the study population lends itself to the examination of urban–rural differences.

Table 2.—Average Annual Percent Decline in CHD by Region and Urbanization Level, 1968-78 and 1979-85

	Metropolitan percent change			Nonmetropolitan percent change (95 percent confidence interval)	
	Core	Fringe	Small		
1968-78					
Northeast	-3.0	-2.9	-3.2	-3.1	(-3.3, -2.9)
South	-3.9	-3.2	-3.0	-2.5	(-2.6, -2.3)
Midwest	-2.8	-2.5	-2.7	-2.7	(-2.8, -2.5)
West	-3.4	-3.8	-3.5	-3.1	(-3.3, -3.0)
1979-85					
Northeast	-3.4	-3.5	-4.4	-3.1	(-3.6, -2.6)
South	-4.8	-5.4	-3.9	-3.7	(-4.0, -3.4)
Midwest	-5.0	-3.6	-4.2	-3.5	(-3.9, -3.2)
West	-4.3	-3.8	-3.8	-3.6	(-4.0, -3.3)

Source: Ingram and Gillum (8).

SES Gradients in CHD: Do They Exist in Rural America?

Many of the national surveys either do not contain sizeable rural populations or have not analyzed the data to examine SES gradients in rural areas. To examine the influence of SES on CHD and its risk factors, the data set from Health Census '89 was examined. Health Census '89 was a cross-sectional survey of the entire population of Otsego County, New York, a rural county north of the Catskill Mountains. Over 76 percent of Otsego County's population lives in areas with fewer than 2,500 residents. This rural population, 98 percent white, encompasses an extraordinary range of incomes and occupations. After mapping all residences in the county and excluding seasonal homes and group housing (e.g., dormitories, institutions), field staff surveyed all 19,800 households by questionnaire. Responses were received from 17,444 households and 44,565 people, a response rate of at least 86.6 percent.

The survey included questions for all adults in each household regarding demographic information, prevalent diseases, use of preventive services, education, and occupation. Participants were asked if a physician had ever told them they had heart disease. With this used as a definition of CHD prevalence, a sharp gradient in CHD was observed across educational strata. This gradient was present in all age strata and in both men and women. Similar gradients were observed for diabetes and cancer. Thus, if these large gradients in SES exist in rural populations, one logical explanation for the changing urban–rural differences in disease rates may be the increasing poverty in rural areas (5).

Pathways for Possible Rurality Effects on CVD

Lifestyles and Health Behaviors

Low SES is not the only risk factor presented by rurality. Traditionally, agriculturally based rural families have consumed a high-fat, high-calorie diet, often featuring food grown at home. Dairy farmers, for example, typically

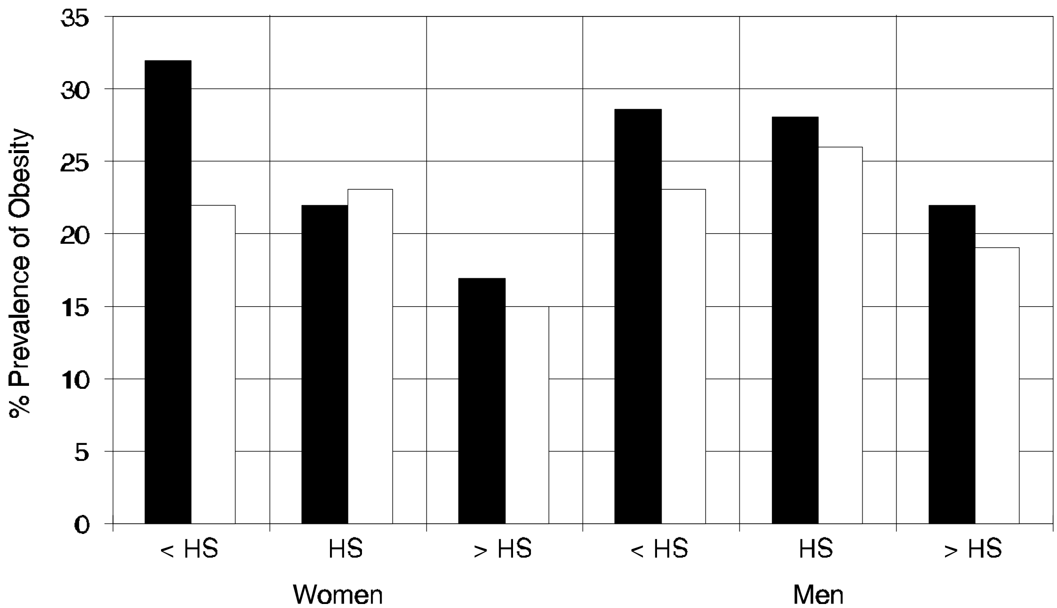

Figure 2.—*Prevalence of Obesity in Men and Women, Ages 25 to 44, in Otsego County, New York, 1989.* *Data are stratified by education level (< HS = less than high school, HS = high school diploma, >HS = more than high school) and by residence in a town of 13,900 (open bars) or in the countryside (closed bars). Obesity is defined as a self-reported body mass index (mass/height^2) of 27.8 kg/m^2 in men and 27.3 kg/m^2 in women.*

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consume their own whole-fat milk. The high caloric intake was traditionally counterbalanced by an equally high caloric expenditure during the day and intense physical labor required for farming, logging, and other activities. However, mechanization of rural occupations has reduced these levels of caloric expenditure, with resulting high levels of obesity. In Health Census '89, high levels of obesity were observed, especially in young adults (Fig. 2). The strong gradient of obesity by education level suggests that low-SES strata have been especially prone to caloric imbalance. Moreover, a comparison of obesity rates between residents of a small town (13,900 people) and rural residents indicated that obesity rates were higher among the rural population.

Isolated, rural populations with poor educational attainment and limited literary skills may have a very different level of reception of the health messages in video, audio, and print media that bombard urban dwellers. Health-promoting organizations, including county health departments, voluntary organizations such as the American Heart Association, and health care providers are less visible and more often absent in rural than in urban settings. The extent of health education programming in schools, churches, and other venues may also be lower and the small single-family businesses that characterize rural areas often do not have worksite health promotion programs.

This lack of public health education translates into strong gradients in deleterious health behaviors in rural areas. For example, those in low SES strata continue to smoke at levels virtually unchanged since the 1950s. In Health Census '89, more than 50 percent of adults 25 to 44 years of age without a high school diploma were smokers, compared with less than 24 percent of persons with education beyond high school. Similarly, levels of leisure time physical activity lag among low-SES groups. These findings all point to a lack of effective health education messages for the rural poor.

Access to Health Care

An important barrier to primary and preventive health services in rural areas is the lack of health care providers. Rural residents are overrepresented among persons residing in areas with health personnel shortages, are more likely to have no usual source of care, more frequently have to travel more than 30 minutes to their health care provider, and have fewer physician visits per year than the general population (4). The long waiting period for an appointment and the extended distances needed for travel to a provider affect all aspects of health care, particularly the provision of preventive care such as the detection and management of high blood pressure and hypercholesterolemia. In Health Census '89, the prevalence of having been screened for blood cholesterol level was strongly related to education level (Fig. 3). However, in every instance, more town residents than rural residents received cholesterol screening.

Similarly, lower access to care given by internal medicine or cardiology specialists may be a barrier to the diagnosis and treatment of chronic cardiac diseases. The poor economic viability of rural hospitals and their frequent closure have added to the distances rural patients must travel to receive either primary or specialty care (9). From 1980 to 1987, 364 hospitals in the United States closed, 45 percent of them in rural areas (10).

The role of rural poverty in this health care crisis has been studied extensively. The economic viability of a rural community is an important determinant of its ability to attract physicians. Rural hospitals face a variety of economic disadvantages, including a much higher rate of charity care due to high rates of uninsured patients (9). Also, the rural poor often do not request (or receive) public assistance such as housing, food stamps, and Medicaid (4). Lack of health insurance not only serves as a barrier to their seeking care but also decreases their ability to reimburse providers and hospitals for care received. Health Census '89 identified low rates of preventive services such as cholesterol screening for those without insurance or with Medicaid (11). Thus, a chain of causality can be hypothesized in which rural poverty leads to reduced access to primary care and hospital services, which in turn leads to reduced ability to prevent and treat CVD and its sequelae.

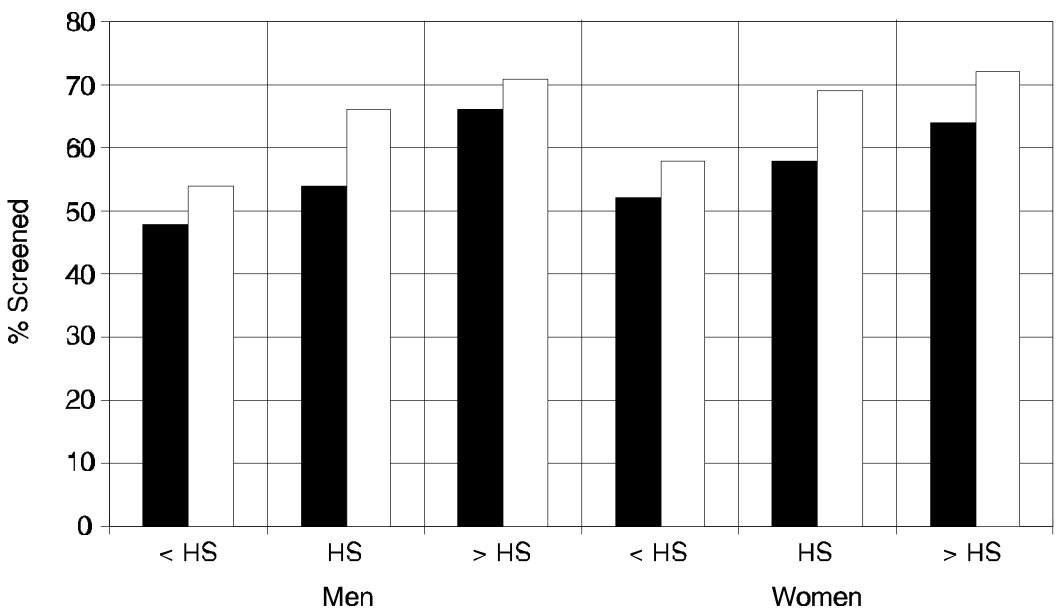

Figure 3.—*Prevalence of Blood Cholesterol Screening in Men and Women, Ages 45 to 64, in Otsego County, New York, 1989.* *Data are stratified by education level and residence in a town of 13,900 (open bars) or in the countryside (closed bars).*

The importance of early identification of symptoms and prompt transport to a medical facility and intervention (e.g., defibrillation, thrombolysis) to improve the natural history of acute CHD has been well described. The closure of rural hospitals increases the distance to an acute care facility for many residents and can add significantly to delays in intervention. Possible additional barriers to prompt treatment include lower awareness of symptoms in rural populations, the lack of emergency (911) telephone systems, poor roads, and frequently hostile weather conditions (12). Moreover, emergency personnel in rural areas are often volunteers with minimal training in cardiac care and infrequent opportunities to use their skills. Community hospital emergency personnel likewise may have minimal training for the management of acute cardiac emergencies. Little is known about strategies to improve the promptness of emergency treatment in rural areas.

Conclusions

Rurality can be seen as a CVD risk factor independent of SES and race/ethnicity. First, the association between rural residence and low SES is established and shown to be additive to the association between race/ethnicity and SES. The large number of rural poor underscores their importance as a high-risk subgroup. Second, there has been a dramatic reversal in the association between rural residence and CHD between the 1950s and the 1980s. Third, the most obvious pathway through which rurality may be related to CHD is its association with low SES; that is, the increasing poverty of rural areas leads to increasing rates of CHD. Detrimental trends in health behaviors, a lack of health promotion messages, a crisis in access to rural primary health care, and limitations in rural emergency medical systems are all potential causes of the recent excess of CHD mortality in rural areas.

Clearly, a great deal needs to be learned before this excess in CHD in the rural poor can be fully understood. Potentially fruitful areas of research include the following:

- Population-based studies in which both urban and rural populations are surveyed for CVD incidence and mortality. It may be necessary to design such studies to include sizeable groups of minorities living in rural areas.

- Targeted surveys to compare prevalence, knowledge, attitudes, and beliefs about CVD and its risk factors in urban and rural populations with variable SES.

- Community intervention programs to evaluate health education strategies or develop new ones specifically for the rural poor.

- Identification of alternate care systems to provide preventive care to the rural poor.

- Studies on programs to reduce delays in emergency cardiac care in rural communities characterized by high CVD mortality and high levels of poverty.

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Socioeconomic Status, Cardiovascular Risk Factors, and Cardiovascular Disease: Findings on U.S. Working Populations

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Few papers in the literature address the relationship of socioeconomic status (SES) to the major cardiovascular diseases (CVD) and CVD risk factors in U.S. employed populations. In 1985, the Dupont Study reported a differential in the decline in incident myocardial infarction (MI) between wage and salaried male employees between 1957 to 1959 and 1981 to 1983 (1). Although average annual rates for MI incidence were similar in 1957 to 1959 for these two sectors of the labor force (3.13 and 3.30 per 1,000, respectively), by 1981 to 1983 they were 2.56 and 2.06; that is, rates for wage employees were 18 percent lower but those for salaried employees were 38 percent lower, a decline more than twice as great. The study of California male physicians reported a similar SES-related trend (2). Between 1950 and 1954, the standardized mortality ratio (SMR) for coronary heart disease (CHD) was 115 for California physicians compared with age-matched U.S. white men. In the next decades, this ratio fell progressively. For the periods from 1965 to 1969, 1970 to 1974, and 1975 to 1979, the SMRs for California physicians compared with all U.S. white men were 80, 74, and 69, respectively. That is, CHD declined 40 percent more for California physicians than for all U.S. white men, for whom a decline in CHD mortality began in the 1960s. Thus, during the years of the general decline in the U.S. CHD death rate, California physicians experienced a 14 percent greater decline. The trend for all-cause mortality was similar, so that for California physicians life expectancy at age 25 increased by 5 years from 1950 to 1979, compared with 3 years for all U.S. white men.

CHICAGO STUDIES

Since 1957, our research group has been involved in long-term prospective epidemiologic investigations of workplace-based Chicago population samples (3–6). These include the People's Gas (PG), Western Electric (WE), and Chicago Heart Association Detection Project in Industry (CHA) studies. Nine cohorts of employed men and women have been under study, totalling almost 44,000 persons:

- PG men ages 25 to 39 and 40 to 59 years at baseline;
- WE men ages 40 to 54;
- CHA men ages 18 to 39, 40 to 59, and 60 to 74; and
- CHA women ages 18 to 39, 40 to 59, and 60 to 74.

Baseline surveys of the PG and WE middle-aged men were done in 1957 to 1959; those for PG younger men, in 1959 to 1963; and those for the CHA cohorts, in 1967 to 1973 at 84 Chicago area companies and organizations (6).

SES and Risk Factors at Baseline

PG Men Ages 25 to 39 and 40 to 59

There was a graded inverse relationship between education and blood pressure (BP), both systolic and diastolic (SBP, DBP). Also, the greater the education level, the lower the prevalence of cigarette smoking. Height was directly related to education; especially for men ages 25 to 39, average height was progressively greater with greater education. In contrast to these significant associations, body mass index (BMI)—weight (kg) divided by height (m) squared—did not differ significantly across education strata, nor was there clear evidence of a graded relationship between education and serum cholesterol.

CHA Men

For all three cohorts of CHA men, as for the PG cohorts, the higher the education, the lower the average SBP and DBP, the lower the prevalence of smoking, and the greater the mean height (Table 1). Education was inversely related to BMI, with mean BMI slightly but consistently lower in college graduates. For serum cholesterol, differences among education groups were small and there was no indication of a linear trend.

CHA Women

Again, education was inversely related to SBP, DBP, prevalence of smoking, and BMI, and directly related to height (Table 1). There was no significant relationship of serum cholesterol to education.

WE Men

Findings for the above parameters were generally concordant with those for other cohorts. In the WE Study, typical eating and drinking patterns were assessed by in-depth interview at both baseline and first annual examination in 1957 to 1958 and 1958 to 1959 (6,7). Differences across SES strata—small but statistically significant and tending to be graded—were found for several macro- and micronutrients and for alcohol. Mean levels of dietary total protein, animal protein, total fat, saturated fatty acids, polyunsaturated fatty acids, dietary cholesterol, calcium, vitamin C, riboflavin, vitamin A, and vitamin D (8), and beta-carotene (9) were all directly related to education level. Intake of vegetable protein, alcohol consumption, and dietary kilocalories were inversely related to education. For five WE SES strata, Keys dietary lipid scores (10) were uniformly high and virtually identical (range, 61.6–63.1), concordant with the almost identical mean serum cholesterol levels of these strata.

The inverse relationship of SES to BMI and to alcohol intake in WE men probably relates to the inverse relationship of SES to blood pressure. In the INTERSALT Study, which also recorded an inverse relationship of education to BP in more than 10,000 participants ages 20 to 59, four dietary variables—higher BMI, excess alcohol intake, higher 24-hour sodium excretion, and lower 24-hour potassium excretion—accounted significantly for the inverse SES–BP relationship (11).

In the WE Study, there was a significant independent inverse relationship between education and rise of SBP/DBP over 8 years of followup.

SES and Mortality with Long-Term Followup

PG Men

For the PG cohort ages 25 to 39 at baseline, with followup of 29 years, age-adjusted mortality from CHD, CVD, and all causes increased with lower education. The relationship was graded, and differences across education strata were substantial—relative risks (RRs) were 3-fold and greater for those with only

Table 1.—Education and Risk Factors at Baseline,[o] Chicago Heart Association Detection Project in Industry Study

Cohort	Education (years)	*N*	Blood Pressure (mmHg) SBP	DBP	Serum Cholesterol (mg/dL)	Percent Smokers	Cigarettes/ Day^	BMI (kg/m^2)	Height (in.)
Men, 18-39 years (total *n*, 11,141)	< HS graduate	1361	137.1	79.7	189.9	66.9	19.4	26.1	68.5
	HS graduate	3317	135.7	78.7	191.5	56.9	22.0	26.2	69.3
	Some college	2409	134.2	78.4	189.9	46.8	21.6	26.1	69.7
	College graduate +	4054	133.0	77.2	189.1	33.4	20.0	25.8	70.3
		*p**	<0.001	<0.001	<0.05	<0.001	<0.001	<0.001	<0.001
Men, 40-59 years (total *n*, 9,350)	< HS graduate	2327	144.4	85.3	211.1	54.7	22.9	27.5	68.0
	HS graduate	3053	143.1	84.9	213.1	44.1	23.8	27.3	68.8
	Some college	1568	141.0	84.3	215.4	38.2	23.9	27.2	69.1
	College graduate +	2402	137.8	82.5	211.7	26.9	23.9	26.7	69.5
		p	<0.001	<0.001	<0.001	<0.001	NS	<0.001	<0.001
Men, 60-74 years (total *n*, 1,622)	< HS graduate	673	153.8	87.1	211.7	33.2	20.4	27.6	67.4
	HS graduate	384	153.4	87.2	210.2	32.9	20.4	27.0	67.9
	Some college	235	151.9	86.8	208.3	26.8	21.8	27.2	68.1
	College graduate +	330	148.1	85.2	211.4	20.2	23.2	26.8	68.3
		p	<0.01	NS	NS	<0.001	NS	<0.01	<0.001
Women, 18-39 years (total *n*, 7,744)	< HS graduate	748	125.2	74.3	184.0	53.2	16.1	24.4	63.8
	HS graduate	4074	124.8	73.9	182.7	47.6	17.3	23.0	64.8
	Some college	1658	123.5	73.0	183.9	43.4	17.0	22.9	65.2
	College graduate +	1264	121.5	72.1	183.3	33.6	16.7	22.0	65.5
		p	<0.001	<0.001	NS	<0.001	NS	<0.001	<0.001
Women, 40-59 years (total *n*, 7,714)	< HS graduate	2170	138.9	81.4	221.1	37.2	17.4	26.4	63.3
	HS graduate	3826	137.1	80.8	219.4	35.9	18.0	24.9	64.1
	Some college	1069	134.3	79.2	218.1	38.6	17.7	24.9	64.4
	College graduate +	649	132.3	78.7	216.6	30.7	17.5	23.7	64.7
		p	<0.001	<0.001	<0.10	<0.001	NS	<0.001	<0.001
Women, 60-74 years (total *n*, 1,302)	< HS graduate	574	150.1	83.8	233.0	21.9	16.2	26.2	62.9
	HS graduate	439	149.3	83.7	237.4	25.7	17.4	25.3	63.3
	Some college	163	146.9	82.2	228.3	30.5	17.8	25.3	63.7
	College graduate +	126	147.9	82.3	228.8	17.7	14.5	25.2	63.7
		p	NS	NS	<0.10	<0.10	NS	<0.001	<0.001

[o] Age-adjusted mean or percent. ^ For smokers only. * For F test HS = High school

elementary or some high school education than for college graduates. In Cox proportional hazards regression analyses, with adjustment for age only and for multiple risk factors, estimated RRs for men with 4 years less education were 1.59 age-adjusted and 1.50 multivariate-adjusted for CHD (Z = 2.34 and 1.97); 1.87 and 1.77 for CVD (Z = 3.44 and 3.03); and 1.81 and 1.69 for all causes (Z = 4.61 and 3.98).
From Cox analyses for PG men ages 40 to 59 at baseline, with 31 years of followup, 4 years less education was associated with RRs of 1.15–1.17 for CHD, CVD, and all-cause mortality, with control both for age only and for multiple risk factors (Z = 1.81 and 1.84 for CHD; 2.06 and 2.06 for CVD; 2.92 and 2.63 for all causes).

CHA Men

For all three cohorts, with 22-year followup, less education was associated with higher age-adjusted mortality rates for CHD, CVD, and all causes (Table 2). Both age-adjusted and multivariate-adjusted RRs with 4 years less education were highest in younger men and lowest in older men (Table 3). RRs decreased slightly in size with control for major CVD risk factors.

CHA Women Ages 40 to 59 and 60 to 74

For women ages 40 to 59 at baseline, age-adjusted data indicated an inverse relationship of education to risk of CHD, CVD, and all-cause mortality (Tables 2 and 3). With multivariate adjustment, compared to age adjustment only, RRs decreased by about one-third for CHD and CVD and by one-fourth for all causes, but Z scores remained greater than 2.00 for CVD and all causes. For women ages 60 to 74, there was no evidence of a consistent relationship between education and the three mortality end points.

WE Men

With 32-year followup, age-adjusted mortality rates from CHD, CVD, and all causes tended to be inversely related to education in the WE men ages 40 to 55 at baseline. In particular, the strata with less education

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Table 2.—Education and 22-Year Age-Adjusted Mortality by Cause, Gender, and Age at Baseline, Chicago Heart Association Detection Project in Industry Study

Gender and Age at Baseline	Education (years)	*N*	CHD		CVD		All Causes	
			Deaths	Rate/ 1000	Deaths	Rate/ 1000	Deaths	Rate/ 1000
Men, 18-39 years	< HS graduate	1361	34	24.3	43	31.2	135	97.2
	HS graduate	3317	60	18.4	75	22.9	199	60.5
	Some college	2409	27	12.4	32	14.9	115	51.5
	College graduate +	4054	39	8.8	52	12.0	136	31.6
Men , 40-59 years	< HS graduate	2327	323	129.4	416	165.6	846	336.5
	HS graduate	3053	308	99.4	405	130.6	888	286.9
	Some college	1568	135	86.8	191	123.2	401	259.0
	College graduate +	2402	123	59.0	160	76.7	385	182.4
Men, 60-74 years	< HS graduate	673	166	243.3	220	324.3	442	653.9
	HS graduate	384	78	204.3	122	319.1	231	605.3
	Some college	235	54	233.8	77	332.4	132	568.8
	College graduate +	330	69	208.2	86	258.9	179	538.0
Women, 18-39 years*	< HS graduate	748					37	44.6
	HS graduate	4074	—	—	—	—	85	21.4
	Some college	1658					46	30.1
	College graduate +	1264					26	19.8
Women, 40-59 years	< HS graduate	2170	117	49.7	175	72.9	422	176.5
	HS graduate	3826	118	32.6	181	50.1	565	153.5
	Some college	1069	40	40.0	55	55.5	163	161.0
	College graduate +	649	16	25.9	23	37.1	69	110.0
Women, 60-74 years	< HS graduate	574	81	140.3	130	223.2	242	418.0
	HS graduate	439	58	133.1	89	205.0	184	423.7
	Some college	163	26	152.5	37	232.4	74	465.2
	College graduate +	126	13	100.7	27	224.2	54	420.8

*Only 9 deaths from CHD and 18 from major CVD occurred in this cohort overall. HS = High school

Table 3.—Relationship of 4 Years Less Education to Relative Risk of Mortality in 22 Years, by Cause, Gender, and Age at Baseline, Chicago Heart Association Detection Project in Industry

Gender and Age at Baseline	***N***	CHD			CVD			All Causes		
		Deaths	Age-Adjusted RR Z-score	Multivariate-Adjusted* RR (Z)	Deaths	Age-Adjusted RR (Z)	Multivariate-Adjusted RR (Z)	Deaths	Age-Adjusted RR (Z)	Multivariate-Adjusted RR (Z)
Men										
18-39	11,141	160	1.77 (4.79)	1.64 (3.81)	202	1.74 (5.18)	1.55 (3.84)	585	1.80 (9.31)	1.52 (6.28)
40-59	9,350	889	1.55 (8.55)	1.39 (6.23)	1,172	1.53 (9.55)	1.37 (6.78)	2,520	1.45 (12.35)	1.30 (8.44)
60-74	1,622	367	1.13 (1.85)	1.05 (0.67)	505	1.16 (2.57)	1.09 (1.38)	984	1.18 (3.87)	1.11 (2.45)
Women										
18-39	7,744	9	**	**	18	**	**	194	1.27 (1.68)	1.22 (1.36)
40-59	7,714	291	1.30 (2.39)	1.18 (1.46)	434	1.33 (3.19)	1.22 (2.10)	1,219	1.20 (3.49)	1.15 (2.56)
60-74	1,302	178	1.01 (0.07)	1.04 (0.26)	283	1.00 (0.00)	1.02 (0.21)	554	1.04 (0.59)	1.03 (0.38)

*Adjusted for baseline age, cigarettes/day, SBP, serum cholesterol., BMI, BMI^2, race, CHD.
**Too few deaths for estimation by Cox analysis.

had higher death rates than college graduates. For the least educated men, compared with college graduates, RRs were 1.67 for CHD, 1.54 for CVD, and 1.27 for all causes. From Cox analyses, men with 4 years less education had age-adjusted and multivariate-adjusted RRs of 1.16 and 1.09 for CHD (Z = 1.91 and 1.09); 1.10 and 1.03 for CVD (Z = 1.45 and 0.43); 1.11 and 1.04 for all causes (Z = 2.00 and 0.70).

THE MULTIPLE RISK FACTOR INTERVENTION TRIAL (MRFIT) COHORT

Between 1973 and 1975, 361,662 men ages 35 to 57 were screened in 18 U.S. cities for recruitment for the MRFIT. The initial screening included standardized measurement of serum total cholesterol, SBP and DBP, and current cigarette use as well as two medical history questions about drug treatment for diabetes and hospitalization for heart attack. No SES data were collected on the individual screenees, but 1980 U.S. Census data were obtained later for race-specific median family income by zip code of residence (12).

Income and CV Risk Factors

For both white and black men, there was a graded inverse relationship of income to baseline SBP, DBP, and prevalence of cigarette smoking, but mean serum cholesterol was similar across income strata (12).

Income and 16-Year Mortality

With 16 years of followup, there was a graded inverse relationship of income to age-adjusted mortality from CHD, CVD, and all causes (Table 4) (12). For comparison between white men in the lowest and highest income strata, Cox analyses with age adjustment only and multivariate adjustment yielded RRs of 1.62 and 1.39 for CHD death; 1.63 and 1.40 for CVD death; and 1.59 and 1.41 for all-cause death ($p < 0.01$ for all). A $10,000 difference in annual income was associated with age-adjusted RR (95 percent confidence intervals in parentheses) for each of the three mortality end points of 1.25 (1.21–1.30), 1.26 (1.22–1.30), and 1.26 (1.23–1.28), and multivariate-adjusted RR of 1.16 (1.12–1.21), 1.17 (1.13–1.21),

Table 4.—Age-Adjusted Mortality by Income and Cause, 16-Year Followup of White and Black Men Ages 35 to 57 at Baseline, Multiple Risk Factor Intervention Trial

Cohort	Annual Income*	*N*	No. of Deaths and Age-Adjusted Death Rate/10,000 person-years					
			CHD		CVD		All Causes	
White Men (total *n*, 300,685)	< $18,571	29,701	1325	28.1	1831	38.9	4120	87.5
	$18,571-$21,585	58,832	2381	26.1	3190	34.9	7121	78.0
	$21,586-$24,057	60,932	2221	24.0	2941	31.7	6680	72.1
	$24,058-$27,372	60,834	2026	22.2	2688	29.4	6038	66.0
	$27,373-$31,952	59,993	1814	20.5	2366	26.8	5290	59.7
	> $31,952	30,393	812	17.7	1086	23.7	2488	54.1
Black Men (total *n*, 20,224)	< $12,333	6,741	282	29.1	474	48.8	1161	119.2
	$12,333-$16,300	6,741	226	23.8	378	39.7	1003	104.7
	> $16,300	6,742	216	23.6	336	36.8	773	84.1

*Family income for whites and blacks, from median family income of zip code of residence, 1980 U.S. Census.
Source: Smith et al (12), reprinted with permission.

and 1.18 (1.16–1.21). For black men, $10,000 less income per year was associated with age-adjusted RRs of 1.32 for CHD, 1.31 for CVD, and 1.35 for all-cause mortality, and multivariate-adjusted RRs of 1.26, 1.25, and 1.29, respectively.

Low-Risk MRFIT Men, Income, and 16-Year Mortality

The large size of the MRFIT cohort made it possible—for the first time in epidemiological research on CVD—to identify a stratum with favorable levels for all major risk factors (6). Criteria for this low-risk designation here are: baseline serum total cholesterol less than 200 mg/dL, SBP/DBP 120/80 mmHg or lower, no smoking, no history of treatment for diabetes, and no history of hospitalization for heart attack. Men with all these favorable traits were a small subset of MRFIT screenees—7.9 percent of higher-income whites, 5.9 percent of lower-income whites, 4.7 percent of higher-income blacks, and 3.7 percent of lower-income blacks. With prevailing American lifestyles, maintenance of low-risk status into middle age is unlikely for all four income–ethnic groups.

Stratification based on status for all major risk factors defines groups markedly different for average SBP/DBP and mean serum cholesterol, as well as for prevalence of cigarette smoking, diabetes history, and MI history (Table 5). Thus, it was possible to go beyond analyses of the type presented above and to explore the following questions: What is the comparative impact of combined major risk factor status and of SES on mortality from CHD, CVD, and all causes? What is the comparative impact of SES on these mortality end points for low-risk men and for those not at low risk? As to the first question, at both higher and lower income and for both whites and blacks, CHD and CVD mortality rates were much higher for men with one or more risk factors than for low-risk men. RR for 16-year CHD mortality was 5.38 for white men of higher income and 5.18 for white men of lower income. Clearly, status with respect to established major CVD risk factors considered together has a quantitatively similar strong effect on long-term risk of CHD, CVD, and all-cause mortality for both higher- and lower-income men, white and black.

The CHD data for white men give the essence of the interaction between lower SES and combined major risk factors. Low-risk higher-income men had the lowest death rates. In comparison with this group, the RR for low-risk lower-income men was 1.31; for all other higher-income men, RR was 5.56; for all other

Table 5.—CHD Risk Factors and Mortality, 16-Year Followup by Income and Baseline Risk, MRFIT Men

Variable	Higher Income,[+] Low Risk[^]		Lower Income, Low Risk		Higher Income Not Low Risk[x]		Lower Income, Not Low Risk	
No. of Men, Total	12,794		9,722		152,249		157,782	
White	12,330		9,341		142,861		147,792	
Black (% of total)	464 (3.6)		381 (3.9)		9,388 (6.2)		9,990 (6.3)	
SBP (mmHg)	112.2		112.5		130.3		132.0	
DBP (mmHg)	72.8		72.9		84.1		84.8	
Serum Cholesterol (mg/dL)	174.8		174.1		217.9		216.4	
Smokers (%)	0.0		0.0		35.5		41.6	
Cigarettes/day (smokers)	0.0		0.0		25.6		25.8	
Diabetic (%)	0.0		0.0		1.5		1.9	
MI History (%)	0.0		0.0		1.4		1.8	
Cause of Death	**No. of Deaths and Mortality Rate/10,000 person-years**							
White Men								
CHD	59	3.9	62	5.1	4,667	21.0	6,051	26.4
CVD	81	5.3	92	7.6	6,160	28.7	8,138	35.5
All Causes	433	26.6	440	34.7	13,635	63.4	18,108	79.1
Black Men								
CHD	4	6.2	2	4.3	313	24.1	405	28.3
CVD	11	20.5	7	15.0	496	38.2	674	47.0
All Causes	29	50.6	33	70.8	1,196	91.2	1,679	116.8

*Cut points for income: median family income, zip code of residence, 1980 U.S. Census; Whites—$24,058/year, Blacks—$14,300/year.
[+]Baseline SBP/DBP < 121/< 81 mmHg, serum cholesterol < 200 mg/dL, nonsmoker, nondiabetic, no history of hospitalization for heart attack (MI).
[x]One or more of the following conditions: baseline SBP > 120 mmHg, DBP > 80 mmHg, serum cholesterol ≥ 200 mg/dL, smoker, treated for diabetes, hospitalized for heart attack.

lower-income men, RR was 6.77. Clearly, the factor that influences relative risk (and absolute excess risk) most is unfavorable risk factor status; lower SES (income) has a moderate synergistic effect. For low-risk men, CHD and CVD risk are low for both lower-income and higher-income men.

DISCUSSION

The main findings reported here for SES and risk factors at baseline are the following: graded inverse relationships of SES to SBP and DBP and to prevalence of cigarette smoking; little evidence of a graded relationship of SES to serum cholesterol; a graded inverse relationship of SES to BMI in most of the Chicago cohorts; and a graded direct relationship of SES to height in all nine Chicago cohorts (height and weight were not measured at first visit of the men screened for MRFIT).

For baseline SES and long-term age-adjusted mortality from CVD, the main findings are the following: significant inverse relationships of education to mortality for the PG and CHA young adult male cohorts (age-adjusted RRs for 4 years less education of 1.74 and 1.87); smaller age-adjusted RRs (1.15–1.53) for five of six middle-aged cohorts (CHA men and women, PG men, and MRFIT white and black men); and an RR of 1.16 for older CHA men. With multivariate adjustment for risk factors, most of these RRs were still significant, but were smaller than with age adjustment only.

These findings on working cohorts are consistent with similar data sets for other U.S. population samples, as is evident from findings displayed at this conference. The U.S. population is generally exposed from early childhood on to adverse primary lifestyles (poor eating habits, drinking, smoking, inactivity), resulting in high average levels of body mass, blood pressure, and serum cholesterol in adults. Societally engendered differential conditioning of lifestyle behaviors leads to even worse risk factor patterns for lower- than for higher-SES populations. That is, worse risk factor patterns for lower-SES strata are an exaggerated special case of a population-wide phenomenon—hence, the population-wide CHD and CVD epidemic is aggravated for lower-SES strata.

Low SES "adds insult to injury" not only by generating particularly adverse primary lifestyle-related established major risk factors, from childhood on, but also—probably—by resulting in excess exposures to other unfavorable influences (e.g., adverse psychosocial influences at work, home, and in the community). Only limited data are available on the interplay among these two sets of factors, and valid quantification of their relative contributions is virtually nonexistent—and difficult to accomplish.

In this regard, it is necessary to examine one component of the data presented here. With multivariate adjustment for major risk factors, RRs of CHD and CVD mortality for lower- vs. higher-SES strata were only moderately reduced and remained significantly greater than 1.00 (RRs 1.17–1.37) for 7 of 10 cohorts. Such data have been interpreted as indicating important influences of traits other than established major risk factors in accounting for SES–CVD relationships. They have also been interpreted as indicating that established major risk factors account only to a modest degree for these relationships.

Both these interpretations are questionable. All multivariate adjustments for major risk factors presented here, and in nearly all other such analyses, are *underadjustments*, for several reasons. First, they are all based on only one measurement per person of each major risk factor. Methods for measuring key risk factors such as blood pressure and serum cholesterol may have limited reliability and reproducibility, resulting in misclassification, the regression dilution bias problem (13), with consequent underadjustment. Second, multivariate adjustment gives only a limited one-time picture of exposures that operate from childhood on to produce their effects over decades, varying over time for different people. Again, the result is regression dilution bias and underadjustment for influences of these major factors on relative risks.

In this regard, the consistent direct relationship of height to SES in all of the Chicago cohorts may be relevant, given recent research indicating that undernourishment in middle to late gestation, leading to disproportionate fetal growth, can influence adult patterns of major risk factors and of CHD in middle age (14). Nutrition in utero and in early postnatal life may also influence adult height, which therefore may be a marker of more adverse gestational and neonatal exposures for lower- than higher-SES strata, affecting their CHD and CVD risk in addition to, and independent of, the adverse lifestyles prevalent among lower-SES strata. Furthermore, these multivariate-adjusted RRs do not include dietary composition, itself an independent major risk factor (15), nor do they include physical inactivity at work and leisure. Again, the result is underadjustment for major risk factors.

The analyses made possible by the extraordinarily large size of the MRFIT cohort are unequivocal and reveal the importance of the established major risk factors in the etiology of epidemic CHD and CVD in the adult population overall, in both lower- and higher-SES strata. For the small proportion (less than 10 percent) of men with favorable baseline status for all risk factors, regardless of SES level, CHD and CVD death rates are very low and do not account for a high proportion of total deaths. This is in marked contrast to the situation for men with one or more of the major risk factors at baseline. Among these men, who make up the great majority—over 90 percent of the population—and have several-fold greater risk (whether lower or higher SES, white or black), components of lower SES apparently synergize significantly with adverse major CVD risk factors to increase CVD risk further by about 25 percent. Whatever the specific pathways for this further aggravation of risk, the key point on the etiology of epidemic CHD and CVD is the lesson of the MRFIT low-risk men: Absent all major risk factors, there is no epidemic CHD or CVD.

This overwhelming message from the MRFIT data has strong practical implications for health promotion for Americans of all SES levels and all ethnic backgrounds: Primary prevention of the major adverse lifestyles and lifestyle-related risk factors beginning early in childhood—along with their effective sustained control when primary prevention has not been achieved—is the key to ensuring further declines in CHD and CVD rates and ending the CHD and CVD epidemic (16). For lower-SES strata of all ethnicities, strategic emphasis and sustained effective action to achieve this goal—and to overcome special obstacles in the way—are a particular challenge that must be met if overall declines in CHD and CVD rates are to be maintained and accelerated.

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PSYCHOSOCIAL PATHWAYS LINKING SES AND CVD

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A strong association between socioeconomic status (SES) and cardiovascular disease (CVD) has been established in both cross-sectional and prospective studies. There are suggestions of gender and racial/ethnic variation in SES differences in CVD, and strong evidence exists that while lower-SES groups have been characterized by higher morbidity and mortality from all causes in most populations for at least a century, the currently observed excess of CVD morbidity and mortality at lower SES levels is a relatively new phenomenon. In the early 20th century, CVD morbidity and mortality in the economically most developed nations were more prevalent at higher SES, but in the past 30–50 years, low-SES groups in these countries have borne the greater CVD burden. This secular trend is important for understanding the pathways through which SES leads to CVD.

Significant SES differences in access to preventive and therapeutic medical care for CVD and other diseases clearly continue to exist in the United States—and perhaps even, to a lesser degree, in countries with programs of national health insurance or health services. However, a variety of evidence indicates that access to medical care explains only a small portion (perhaps less than 10 percent) of the currently observable SES differences in CVD, just as changes in medical care have accounted for only a minor part of the dramatic declines in CVD morbidity and mortality of the past 25 years (1,2). Examples include the changing SES gradient in CVD and the relative imperviousness of the current SES gradient in CVD to the introduction of national health care (e.g., in the United Kingdom) and insurance (e.g., in Canada).

Increasing evidence shows that all or most of the major physiological variables (e.g., diabetes, blood pressure, blood lipids, blood glucose) and behavioral or lifestyle factors (e.g., smoking, alcohol consumption, diet, body mass, and physical activity) for CVD are differentially distributed by SES. Low-SES groups tend to have higher levels of each of these risk factors, especially the psychosocial ones. These variables appear to play a larger role than medical care in explaining both recent declines in CVD and SES differences in CVD, but controlling for them still accounts for only a moderate portion (about 25 percent) of observed SES differences in CVD (3).

Thus, access to medical care and almost all of the conventional CVD risk factors relate to SES in a way that is consistent with the observed excess of CVD in lower SES strata. However, multivariate analysis indicates that they may in combination account for or explain only about one-third of the observed SES differences in CVD morbidity and mortality. A growing body of research over the past 25 years suggests that a range of other psychosocial variables may explain the remaining two-thirds of the relationship between SES and CVD. In order to determine the contribution of these variables to the SES–CVD relationship, it is important to consider what evidence is necessary, how much evidence we now have, what future research is needed, and the implications of these considerations for research and public health policy.

Psychosocial Variables as Pathways Between SES and CVD

To establish that any psychosocial variable is a pathway explaining the impact of SES on CVD requires four kinds of evidence:

- Evidence, especially from prospective studies, that the variable is a risk factor for CVD morbidity and mortality;

- Evidence that the variable varies by SES in a manner that may account for or explain the relationship of SES to CVD (i.e., higher levels of risk should characterize lower-SES groups);

- Evidence that controlling for the variable reduces the relationship between SES and CVD;

- Logical or empirical evidence that the variable is caused or determined by SES, not by some third factor that produces a spurious association between the variable and CVD. The psychosocial variable, in turn, must cause or determine CVD through plausible biobehavioral mechanisms.

Psychosocial Factors as Potential Pathways Between SES and CVD

A variety of psychosocial variables have been proposed as potential additional pathways between SES and CVD. For all those reviewed here, evidence exists that they relate to SES in a manner that might account for the SES–CVD relationship. However, the extent to which each has been already established as a risk factor for CVD varies and the extent to which they have been clearly shown to account for some portion of the SES–CVD relationship varies even more. In most cases, plausible confounding factors that might produce a spurious association between the psychosocial variable and either CVD or SES have been appropriately controlled, and the necessary causal ordering and mechanisms among the variables are plausible. However, as in any nonexperimental research, the search for variables that produce spurious relationships is never complete, and must be evaluated largely in terms of how plausible the existence of currently unmeasured, unevaluated, or unknown confounding factors is.

Evidence for CVD Risk Factor Status

As in the case for more conventional risk factors, the key evidence in establishing these psychosocial variables as CVD risk factors comes from prospective studies. Such studies are either ongoing community and national studies that measured indicators of psychosocial risk factors even before they were identified as putative risk factors, or newly initiated studies that tend to be more limited in scope or duration.

Type A behavior and anger/hostility. Type A behavior was the first major psychosocial variable to be established as a risk factor for CVD (4). Subsequent research, however, suggests that the key aspect of Type A responsible for its impact on CVD is a chronic disposition toward anger or hostility, and this disposition has been quite compellingly established as a risk factor for CVD (5).

Lack of social relationships and supports. In the past 20 years, the relative lack of social relationships or supports in circumstances such as social isolation has consistently been found to constitute a significant risk factor for all-cause mortality (6). In all studies where CVD deaths could be isolated, social relationships were as predictive of CVD as they were of other major causes of death and all-cause mortality.

Lack of personal efficacy/control. A variety of evidence suggests that the lack of a sense of personal efficacy/control is associated with poor general and cardiovascular health and is predictive of all-cause and CVD mortality (7). However, broad community or national prospective studies such as those available for Type A/anger/hostility and social supports are scarce for this variable and constitute a major research need.

Depression/negative affect. Findings from the past 10 years increasingly suggest that depression or negative affect is a risk factor for CVD and probably for other diseases as well. This prospective research is probably at least as abundant as that for personal efficacy/control, but has largely been limited to very selective samples, often of patients with coronary heart disease (5). Again, broader community or national prospective studies are needed to study the impact of depression and negative affect on CVD and other diseases. Initial results in this regard support the risk factor status of depression (8).

Acute and chronic stress. The study of "life events" was a major impetus for research on the relationships of stress and psychosocial factors to health. Early studies linked the occurrence of life events to increased risk of physical and mental disorders, albeit often relatively mild or transient disorders. Later work showed that major negative events are the ones responsible for these associations, and also demonstrated that such events can be predictive of CVD and other forms of morbidity and mortality (9). Again, evidence from broader community and national prospective studies is still lacking and should be a major direction for future research.

Conceptual and empirical analysis clearly suggest that chronic stress or deprivation caused by lack of income or chronic problems in work, marriage, or parenting may be at least as important a determinant of health as acute or life event stressors. Recent developments in stress measurement highlight the need to broaden the assessment of stress beyond life events and chronic stressors. This research indicates that, independent of the effects of recent life events and chronic stressors, other sources of stress such as childhood traumas, earlier adult life events, daily hassles, and even nonevents (desired events that fail to occur) can affect physical and mental health. Moreover, this comprehensive measurement of stress accounts for substantially more variability in health status than previous studies of stress have suggested (10). This full range of stress variables needs to be incorporated into research on the relationship between SES and CVD.

Finally, there is new interest in characterizing the stressfulness or deprivation of areas as well as individuals and evaluating their impact on all forms of health. This is another direction for future CVD research (8).

Evidence for SES Determination of Psychosocial Risk

Although the evidence linking putative psychosocial risk factors to CVD and other forms of morbidity and mortality is somewhat variable, relationships of these psychosocial risk factors to SES are remarkably consistent. As with more conventional CVD risk factors, it is almost always the case that lower-SES groups are exposed to more psychosocial risk. This holds for education and other SES indicators that are clearly antecedent to the psychosocial risk factors, and for income and other SES variables that are more proximal to the psychosocial risk variables, yet probably also antecedent to them.

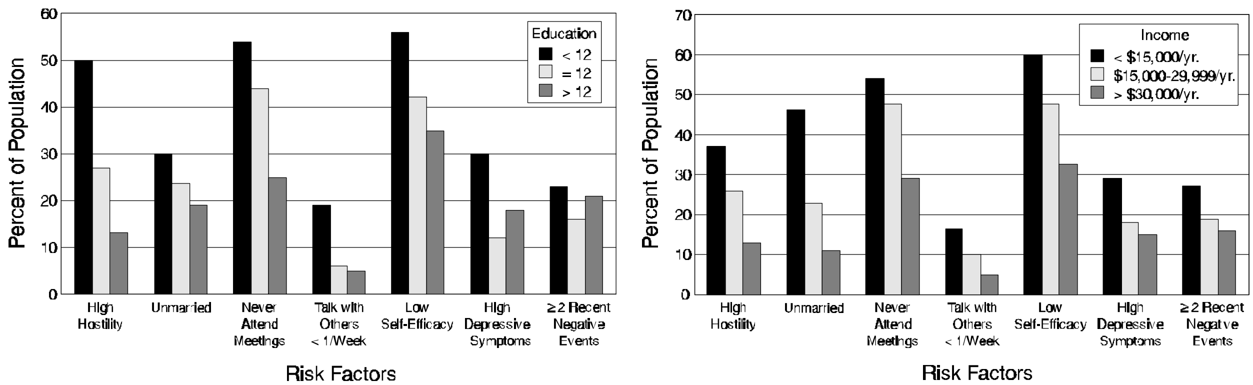

Figure 1.—*Psychosocial Risk Factor Status in U.S. Residents, Ages 45 to 64, by Education and Income*. *Hostility data are taken from the l984-86 MMPI-II Restandardization Study. Data for other variables come from the l986 Americans' Changing Lives Study, a national probability sample survey conducted by the University of Michigan.*

Figure 1 shows that indicators of each of the major psychosocial variables just discussed vary almost exactly as expected by both education and income among the U.S. population, 45 to 64 years of age. Results tend to be similar for other age groups, but weaker for some variables at older ages (11).

The prevalence of each of the putative psychosocial risk factors in Figure 1 is always greatest among those with the lowest level of education or income and almost always least among those with the highest level of education and income. The rate ratios of the lowest education and income level to the highest levels range from a low of 1.1 to a high of 3.8, and average around 2.0. Thus, as with the more conventional biomedical and lifestyle/behavioral risk factors, the putative psychosocial risk factors tend to be more prevalent in lower-SES groups.

Evidence That Psychosocial Risk Factors Help Explain SES-CVD Relationship

Too few studies, especially prospective ones, have evaluated the ability of these various psychosocial risk factors, taken singly or together, to explain the relationship of SES to CVD or other health outcomes. Several studies, however, find that controlling for a broad range of these variables along with physical environmental exposures and more conventional risk factors can explain a substantial portion of the relation of SES to CVD or other health outcomes (11,12). These results should be considered quite preliminary, though promising and consistent with Redford Williams' model for explaining the relationship of SES to CVD (13). More prospective studies of large community populations are necessary to measure the individual and combined contributions of a broad array of psychosocial, physiological, and behavioral risk factors to the relationships between SES and the incidence and course of CVD.

Spurious Associations

It is plausible that SES shapes or determines exposure to almost all risk factors for CVD. This is especially true for education, which in most adult populations is completed well before the assessment of risk factors. Greater potential for reciprocal causality exists between more contemporaneous measures of SES such as income and adult health or risk factor measures, but a variety of evidence suggests that causality generally flows from SES to risk factors to morbidity and mortality (3).

Perhaps the main challenge to this model of causal pathways lies in the argument that genetic factors, environment, or their interactions early in life determine the later life trajectory of both socioeconomic attainment and health. Only long-term longitudinal studies can resolve these concerns. At this point it appears that although genes and environmental conditions in early life can and do affect SES and health in later life, these effects tend to be smaller and diminishing over the life course compared to more proximal or contemporaneous SES, psychosocial, or biomedical influences. Moreover, there is relatively little evidence to suggest that such genetic or early life variables can account for the observed relationships of SES to psychosocial risk factors and CVD or other health outcomes in middle or later life (3,12). The need remains, however, for more and better research on these issues, especially on gene–environment interactions over the life course and the ways in which early life deprivations or trauma may affect SES, risk factors, and CVD in later life.

Implications

The psychosocial risk factors discussed here, and others that remain to be identified, are critical to understanding the pathways linking SES to CVD and other health outcomes. For all of these psychosocial variables, plausible biobehavioral mechanisms have been posited to explain their effects on CVD or other health outcomes (3,5,6). However, it is important to recognize that with or without full understanding of these biological pathways, SES and associated psychosocial risk factors remain important determinants of CVD and other health outcomes, and hence are important potential avenues for efforts at CVD prevention and control. For example, we do not yet fully understand the biological mechanisms by which cigarette smoking produces CVD morbidity and mortality, but we have been able to reduce smoking and hence have a significant preventive effect on CVD and other health problems.

Most important, SES is a kind of "master status" that influences exposure to almost all major physiological, behavioral, and psychosocial risk factors for CVD. Thus, we need to examine the role of SES as a "fundamental cause" of CVD (14). As such, changes in the SES of individuals or larger subgroups of the population could result in the simultaneous reduction of a broad array of risk factors and hence diseases, as general improvements in nutrition and public sanitation have done. Addressing these broad and fundamental or "upstream" determinants of health has the likely advantage of affecting not only current or known risk factors but unknown or future ones as well. Thus, for example, as CVD has become a more important cause of morbidity and mortality and its risk factors better understood, persons of higher SES have been increasingly able and likely to reduce their exposure to these risk factors and hence to CVD.

The SES of individuals and groups can and does change in response to unplanned or natural SES cycles or events and as a result of social policy. The greater success of many other industrialized countries, relative to the United States, in reducing SES deprivation and inequality has been posited as a major reason that population health and life expectancy in those countries has come over the last several decades to improve more rapidly and reach higher absolute levels than in this country, despite the fact that none of the other countries approach the United States in either spending for or advances in medical care and biomedical research (15). Thus, SES policy may increasingly be a major instrument of health policy. Both researchers and public health policy makers must pay increasing attention to understanding the pathways by which SES, or changes in SES at the level of both individuals and populations, affects CVD. This knowledge will serve as the basis of preventive efforts to reduce not only risk factor pathways but also SES deprivation and inequality.

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STRESS, WORK, SOCIAL SUPPORTS, AND GENDER IN RELATION TO CARDIOVASCULAR DISEASE

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Because traditional risk factors explain only a portion of coronary heart disease (CHD) risk, other less well established CHD risk factors, including social, psychological, and behavioral factors, are under investigation. Stressors in work and in social life, for example, are important psychosocial contributors to CHD risk (1,2). The combination of high demand and low control at work is particularly harmful. Lack of social support and deficiencies in the social network seem to be strong risk factors for new CHD events and for mortality after a heart attack (2).

The roles of psychosocial risk factors have been investigated more extensively in men than in women (3). The purpose of this paper is to address the relative importance of psychosocial and traditional CHD risk factors and explore their relationship to socioeconomic status (SES) and gender.

Psychosocial Work Strain

Karasek originally defined job strain according to a model that combined psychological demands with decision latitude at work (1). According to his hypothesis, the worst possible combination for adverse health effects was high job demand with low job decision latitude, whereas the best combination was low demand with high decision latitude. The other two combinations in this model were assigned intermediate levels of risk.

A large number of cross-sectional, case–control, and cohort studies have examined the validity of this hypothesis for CHD outcome variables. Most of these studies show definite effects of job strain on all-cause mortality, CHD mortality, and incidence of myocardial infarction (MI). Schnall and Landsbergis have found effects of similar magnitude and consistency across outcome variables among male and female working populations in response to job strain (4). However, most studies have focused on northern European populations. The role of ethnic and cultural influences on the relationship is relatively unknown.

Similarly, the role of low SES in these associations remains controversial. The idea that high job strain equals low SES is often expressed. According to Karasek's hypothesis, however, low-status jobs as assessed by occupational grade can be either high demand/low decision latitude or low demand/low decision latitude occupations, also referred to as high-strain active work and low-strain passive work, respectively (1).

In an ongoing large-scale population study, comprising over 11,000 men and women living in Malmo, South Sweden, high-strain jobs were found among 10 percent of white collar men and 35 percent of blue collar men. Corresponding differences between white and blue collar women were almost equally strong, 17 percent versus 38 percent. A similar social class gradient was evident for low-strain, passive jobs: 12 percent of white collar men had such jobs as compared with 30 percent of blue collar men. A social gradient in passive work was also found in women: 18 percent of white collar women as compared to 35 percent of blue collar women had such jobs. Thus it seems that SES is mainly associated with lack of decision latitude and control over work, whereas the work strain associated with increased CHD risk is characterized by both high demand and low control. In fact, many studies that have controlled for SES through such factors as educational level have still shown a significant effect of job strain on CHD risk (4). Part of the risk, in particular in relation to lack of control, is dependent on low SES.

Social Supports in Men

Lack of social support is defined primarily as a lack of, or possession of relatively few, social contacts among family, friends, coworkers, and neighbors. Several studies from the United States and Scandinavia have shown, using quantitative measures, that men with few social contacts are prone to die earlier than men with an extended network. Some of the studies have found lack of social support to be almost as strong a predictor of CHD mortality as of all-cause mortality (5).

In the Swedish Survey of Living Conditions, 17,400 men and women were interviewed about quantitative aspects of their social networks and then followed for 6 years. For both men and women, those with few social contacts experienced excess mortality risk from cardiovascular disease (CVD). After age, smoking, lack of exercise, low education, unemployment, and presence of hypertension or CVD at entry were taken into account, subjects in the lowest third of the social network index had an excess CHD mortality risk of 50 percent. Thus it seems that both men and women benefit from having a certain crucial number of social contacts (6). However, the effects of social network on outcome measures were modest and nonspecific.

In our attempt to understand these relationships, we asked whether the quality and function of the contacts are more important than the number of available persons in the network or the frequency of interaction with network members. We wanted to know whether these contacts are actually supportive or whether they are perhaps also demanding and stressful. Few studies have linked functional measures of social support and prospective prediction of CVD end points.

We examined the following dimensions of social support:

- emotional support or attachment, usually provided by close friends or family members;
- tangible support (practical help);
- appraisal support (good advice and help for proper recognition and estimation of problems and difficulties); and
- the need to belong to groups of people with whom one shares interests and values.

The last three functions are usually provided by the extended social network, whereas emotional support is typically found within the family and among close friends (7).

The studies of 50-year-old men born in Gothenburg are well known and respected for their representativity, methodological accuracy, and conclusiveness. Therefore, it is particularly useful to examine this study group in terms of socially supportive functions to determine whether they predict the incidence of MI in previously healthy middle-aged men. Lack of social integration—the extended network functions that provide guidance, advice, practical help, and sense of belonging—had the strongest effect on MI risk and was associated with a 3-fold higher incidence of MI.

It is perhaps not surprising that these functions were highly correlated with social class. Men at higher occupational levels had more support and were better socially integrated. Only 12 percent of men with higher-level nonmanual occupations had poor social integration, as compared with 34 percent of unskilled manual laborers.

By contrast, emotional support and attachment—the very close emotional relationships that provide comfort, trust, love and self-esteem—were only marginally predictive of MI in these men. The social gradient for attachment was small and nonsignificant. However, a smaller group of men (23 percent) really lacked this kind of support and had a moderate increase in MI risk (2).

Social Supports in Women

The relationships between social support and CHD risk derived from large-scale population studies are more ambiguous for women than for men (5). In the Swedish Survey of Living Conditions, women were as much in need as men of a basic number of contacts for their survival (6). The same was found in the Alameda County Study in California, where women who lacked social ties had an excess mortality risk that was slightly higher than that of men (8). Most of the participants in these studies were from urban or cosmopolitan areas. In contrast, rural women in the North Karelia Study in eastern Finland and the Evans County Study in Georgia did not seem to be endangered if they had smaller networks and fewer contacts. Both of these populations are characterized by stable living conditions and well-defined female roles in society (9,10). It may be that women who lead a more unstable life and who are subjected to more changes and contradictory demands from multiple social roles are in greater need of social networks. Therefore it seems necessary to try to disentangle the roles of strain and support in women's lives and their significance for cardiovascular health. Furthermore, these aspects should be examined in relation to SES as well as to occupational status.

The Framingham Heart Study and other population studies have shown that low SES and relative social deprivation are risk factors in women as well as in men. Framingham women who had too little leisure time and too few of their own resources to take a single vacation in 6 years had an increased risk of MI. Furthermore, employed Framingham women had a lower MI risk than homemakers. Loneliness, anxieties, and sleep disturbances increased the risk of MI for homemakers. In employed Framingham women, economic difficulties were the main factor that increased MI risk (11). Possible mechanisms for the difference include a social gradient and a healthy worker effect. Women who were able to work outside the home may have been socially and economically better equipped from the beginning. Many women also benefited from increased economical resources as a consequence of their employment.

In Sweden the situation is different. Since the end of the 1970s, nearly all Swedish women are employed outside the home. There is even formal legislation requiring every citizen, man or woman, to work and to provide an income for himself or herself. Under these circumstances it is not surprising that we found only two homemakers among 600 women in the greater Stockholm area.

Employment outside the home means an additional workload for most Swedish women, as Frankenhäuser and coworkers have demonstrated (12). In their studies of male and female employees in large companies, they have estimated the total number of hours per week spent on paid work and on work at home for the service of the family. Childless men and women employed full-time both work an average of 60 hours per week. Women with three small children increase their total workload to 90 hours per week, but men in the same situation increase their total workload only to 70 hours per week.

The Swedish Study of Female Coronary Risk Factors (Fem Cor Risk Study)

The health effects of chronically increased workload in women are not yet known. In the Fem Cor Risk Study in Stockholm, one objective was to investigate the circumstances and the form in which multiple roles and a double burden of employment and homemaking may be detrimental to health.

All female residents in the greater Stockholm area who were admitted to a hospital for an acute CHD event between February 1991 and February 1994 were asked to participate in the study. The study group was restricted to Swedish-speaking patients age 65 or younger. The Swedish health care system provides care to all residents regardless of income, SES, or insurance status. Thus we were certain to reach all patients who needed and sought acute hospital care for a CHD event in this time period. Control subjects were selected from the census register of greater Stockholm. For each case, a healthy woman born the same day as or as close as possible to the birthdate of the patient and living in the same hospital catchment area was chosen as a control. "Healthy" was defined as being free from symptoms of heart disease and without hospitalization for any illness during the past 5 years. Participation in the study was 87 percent among cases and 83 percent among controls.

The methods used to study social support and major risk factors for CHD were identical with those for the Gothenburg Study. The only difference was the longitudinal design in the Gothenburg Study. The Gothenburg men were 50 years old at the beginning of the study and were followed for CHD incidence for 6 years. To study women in this age group prospectively would require a sample at least 3 times that of men. We therefore used a population-based case–control design for the Fem Cor Risk Study. The mean age of the Stockholm women with CHD was 56 years (± 7.0) at examination.

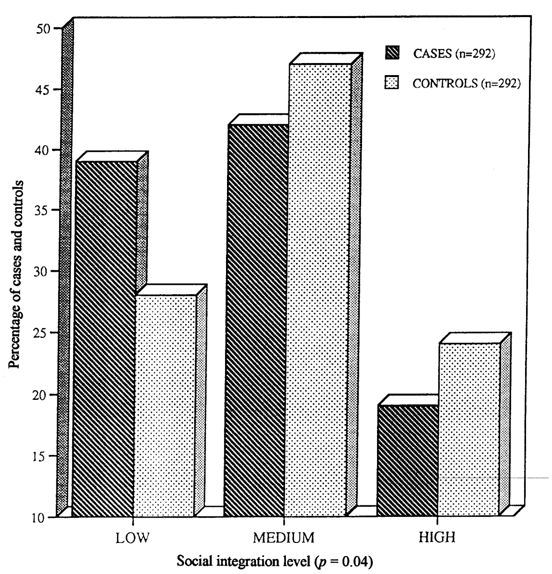


Figure 1.—*Social Integration and CHD in Women from the Fem Cor Risk Study.* *Reported data are for 292 cases with age- and sex-matched controls. The odds ratio for CHD in women with low social integration is 1.65 (95 percent confidence levels: 1.16, 2.35).*

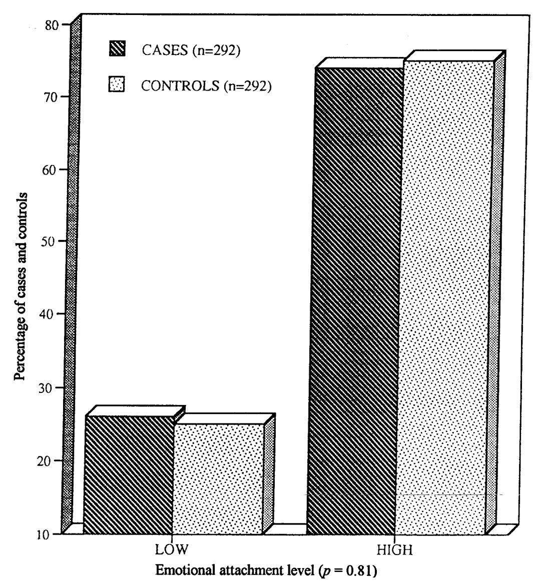


Figure 2.—*Emotional Attachment and CHD in Women from the Fem Cor Risk Study*. *Reported data are for 292 cases with age- and sex-matched controls. The odds ratio for CHD in women with low levels of emotional attachment is 1.06 (95 percent confidence levels: 0.72, 1.55).*

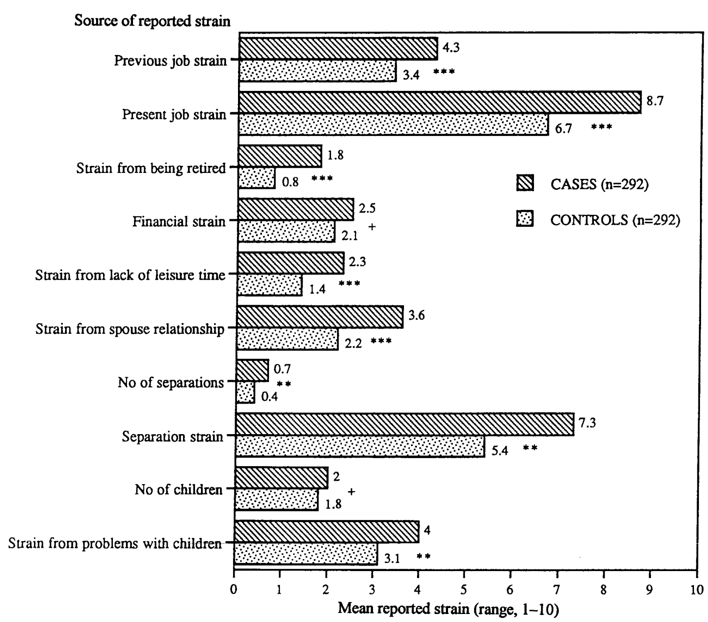
The effects of social support were generally weaker for women than for men. Only the scale describing social integration, which for men was the best predictor of MI, showed a small but significant difference between cases and controls (Fig. 1). The scale describing lack of emotional attachment, which was a marginal predictor of CHD in men, showed absolutely no difference between women with and without CHD (Fig. 2). Furthermore, when results in women were adjusted for standard risk factors including education level, the net effect of lack of social integration was no longer significant. However, after controlling for standard risk factors in Gothenburg men, the effect of lack of social integration remained significant.

Social Networks and Social Strain

Because of the contradictory patterns of social network structure and function, an interview procedure was used to explore not just the level and kind of social support, but also the presence of strain from the social sphere. The general goal of the interview was to describe all possible sources of strain. The concept of family strain was similar to those used by Karasek et al. for work strain, and included dimensions of demand and control.

The interview was structured to describe work and family life in terms of concrete and "objective" issues that were relatively unsusceptible to retrospective reinterpretation. It specifically addressed employment; marriages, divorces, and separations; births and childrearing; and caretaking responsibilities for elderly and other relatives.

Most pronounced in women with CHD were the excess strain scores for current occupation and insufficient leisure time (Fig. 3) Women with CHD had more children (cases/controls = 1.11; $p \leq 0.10$) and experienced more spousal separations (cases/controls = 1.75; $p \leq 0.01$) than healthy controls. They



*** $p \leq 0.001$ ** $p \leq 0.01$ $^{+}$ $p \leq 0.10$

Figure 3.—*Psychosocial Strain and CHD in Women from the Fem Cor Risk Study*. *Reported data are for 292 cases with age- and sex-matched controls.*

also reported more strain from problems with children and much more strain from problems associated with their spousal relationships, particularly from separations. Because these women already had CHD at the time of interview, it is possible that their perception of family strain was compromised by the knowledge that they had heart disease, but it is unlikely that these women would consciously blame their heart disease on family problems. When asked directly, most blamed their heart disease on their own unhealthy lifestyle behaviors (e.g., smoking, lack of exercise). It is also unlikely that for many of the women, their disease could have had a directly contaminating effect on family life. Most of the women had their first symptoms of heart disease only a few years before the interview. Their mean age at interview was 56 years, so most of them had already passed reproductive age and had finished rearing their children.

Lack of social support from the extended network and from close family has been strongly associated with CVD risk in Swedish men. Among both men and women, lack of social support was found to be more prevalent in low SES. For men, lack of social integration is a stronger risk factor for MI and more prevalent in low SES than lack of emotional support. In Swedish women, however, these associations are weak and confounded by standard risk factors. Instead, women perceive many of their social contacts as stressful.

Taken together, lack of control in the workplace and lack of social integration and social anchorage in society seem to explain an important part of the social gradient in CVD. The fact that these effects persist even after controlling for lifestyle and standard risk factors suggests new possibilities for preventive measures. Progress in interdisciplinary research on the modification of behavioral and psychosocial factors is giving rise to new intervention methods that appear to be effective but need to be implemented and tested in large-scale epidemiological studies (2).

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MEDICAL CARE: ACCESS, UTILIZATION, AND COST

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The observation that low socioeconomic status (SES), as reflected by various measures, is associated with increased total and cardiovascular disease (CVD) mortality has been made repeatedly (1–3), but the explanation for this relationship remains incomplete. Proposed mediators fall into several classes. One of those cited most often is reduced access to medical care. This includes preventive care, disease management, and emergency care. Both financial and nonfinancial considerations may be important when examining the role of access to care, since the effect of low SES on health is seen even in countries with universal access (4). Harmful behaviors related to development of clinically manifest disease and to its prognosis constitute another class of potential mediators. These behaviors or risk factors fall into biological (e.g., poor management of hypertension, diabetes, or hypercholesterolemia) and lifestyle (e.g., smoking, exercise, diet) categories (5). A third class of potential mediators involves compliance with prescribed medical regimens.

Most investigations of the relationship between SES markers and coronary heart disease (CHD) outcomes have involved large populations and lacked detailed measures of disease stage or severity. For example, relatively few studies have controlled for left ventricular function and extent of atherosclerotic coronary obstructive disease in their examinations of the adverse health effects of low SES. For this report, the SES–outcome relationship has been examined with careful control for disease severity using two different populations from the Duke Cardiovascular Disease Database.

Prognostic Importance of SES in the Duke Database

Initial Investigations

Between October 1974 and February 1980, we administered a battery of questions concerning psychosocial, economic, and functional status to 1,368 symptomatic patients undergoing coronary angiography at Duke University (6). All patients had significant CHD, defined at angiography as at least 75 percent stenosis of at least one major coronary artery. As part of the routine for the Duke Cardiovascular Disease Database, all patients were followed at 6 and 12 months after their angiogram and annually thereafter. At the time of data analysis, the median followup was 9 years. The major SES measures available in this data set were years of education, family income, employment status, and number of people dependent on the income. A previously derived hazard score with the Cox proportional hazards regression model allowed control for confounding by disease severity. The hazard score is calculated by summing the products of the value of each of the prognostically important characteristics identified in this population and their corresponding Cox model regression coefficients. This hazard score has been validated as a predictor of prognosis in several populations and serves as an efficient means of "leveling the playing field."

Table 1.—SES Profile of Study Population, Duke Cardiovascular Disease Database

Family Income	
Range	**Percent**
< $10,000	23
$10,000-$19,999	35
$20,000-$29,999	20
$30,000-$39,999	13
≥ $40,000	9
Other Variables	
Employed (%)	68
Number of people dependent on income	2 (2–4)*
Basic needs are met (%)	86
Enough money left after basic needs met (%)	70
Years of education	12 (10–14)*

*Continuous variables displayed as median (25th to 75th percentile).
Source: Adapted from Williams RB, et al (6) with permission.

The study population consisted of 245 women and 1,123 men (99 percent white) with a median age of 52 years (6). The distribution of major economic characteristics for this group is shown in Table 1. In Cox regression analysis controlling for disease severity, patients with higher household income had better survival than those with lower incomes (adjusted $\chi^2 = 10.9$, $p = 0.001$). Patients with annual household incomes of $40,000 or more had an average 5-year survival rate of 0.91, whereas patients with incomes below $10,000 had a 5-year survival rate of 0.76 (Fig. 1). In relative terms, those with the lowest incomes were almost twice as likely to die within 5 years of enrollment in this study as those in the highest income class (Cox model adjusted hazard ratio, 1.9; 95 percent confidence interval, 1.57–2.32). Additionally, survival was inversely related to the number of individuals dependent on the household income (adjusted $\chi^2 = 5.6$, $p = 0.018$).

None of the other economic variables or the prespecified interactions were statistically significant. Gender was not a significant predictor either alone or in interactions with income or number of dependents. Thus in this study SES measures identified a significant population (23 percent) who were at substantially increased risk after taking into account all standard measures of disease severity. In this early study, we were not able to evaluate issues about mechanism or to identify potentially modifiable correlates of low SES.

Ongoing Investigations

More recently we have initiated a detailed prospective psychosocial evaluation, the Mediators of Social Support (MOSS) Study, in our angiographic patient population. The main purpose of this investigation is to confirm and elaborate on previous observations about the relationship between psychosocial factors and CVD outcomes, after adjusting for standard measures of disease severity. A strong secondary goal is to identify putative mediators that may lead to the elucidation of mechanisms or point to effective interventions. Although the study is still enrolling and following patients, results of preliminary data analysis from the initial 2,360 patients (30 percent women, 13 percent black) are available. All patients had angiographically documented CHD. The population had a mean age of 62 years and a mean education level of 11.4 years. The mean income class was $20,000–$30,000 per year.

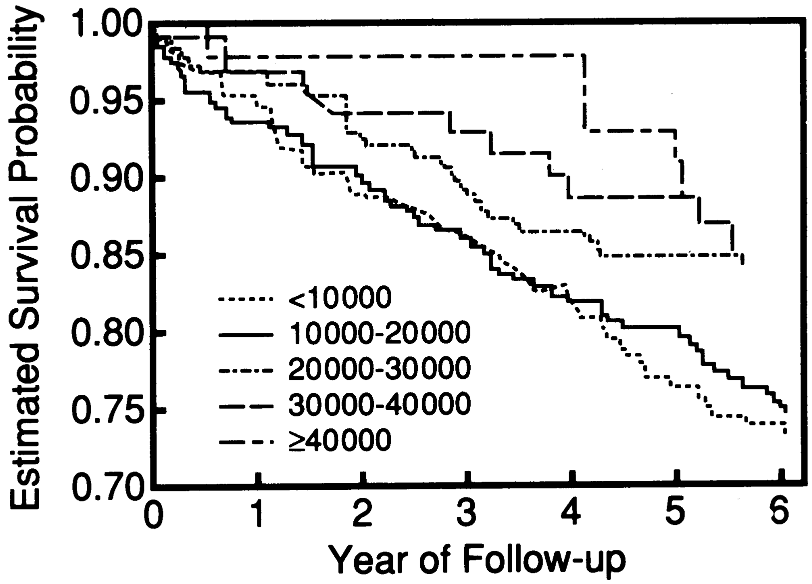

Figure 1.—*Survival and Family Income*. Source: *(6) with permission.*

Because education and income have been proposed as markers of SES, these variables were studied in the MOSS population (Fig. 2). As expected, there was a monotonically increasing relationship between income class and years of education. Each income class was associated with an increment of approximately 1–2 years in mean education level relative to the next lower income class (r = 0.58).

To understand the implications of SES, we examined its correlation with a spectrum of demographic, clinical, and health status measures assessed at the time of enrollment. In general, evident correlations were significantly stronger with income than with education. Baseline correlations of more than 0.3 with higher income were seen for patients with higher functional status (measured using either the Duke Activity Status Index [DASI] or the SF-36 Physical Functioning Scale), patients with higher general health perceptions (measured using the SF-36 scale), and married patients. Weaker correlates included lower hostility levels (using the Cook–Medley scale), younger age, male sex, more regular exercise, more favorable psychological status (using the SF-36 scale), increased optimism, and decreased perceived stress. In general, the major medical prognostic factors were either very weakly correlated with SES (e.g., ejection fraction) or were not correlated at all (e.g., number of diseased vessels).

MOSS also examines patients' perceived access to various aspects of medical care. In a subset of patients undergoing medical treatment, several measures of access were lower in patients with lower SES. For example, patients who said the cost of medical care kept them from going to the doctor as often as they should had lower education and income levels than the patients who did not view cost as a barrier to seeing their doctor (Fig. 3). The same trend was seen for cost as a prohibitive factor for seeking necessary emergency room or hospital care, with the lower-SES patients indicating lower perceived access to care (Fig. 4).

At the 1-year followup, we examined the frequency of physician visits that patients reported within the previous 6 weeks as an approximate measure of the relationship between SES and actual medical care utilization. Low-SES patients had more physician visits than their higher-SES counterparts. This modest

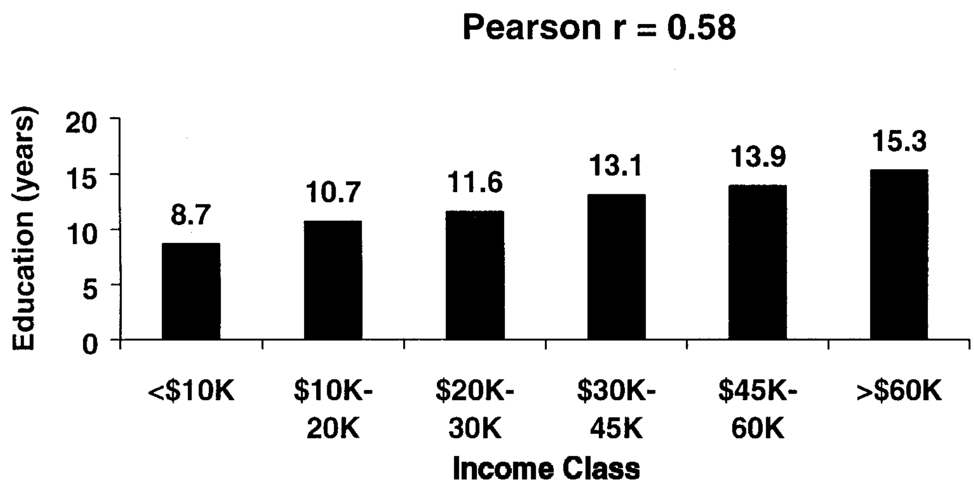

Figure 2.—*Measures of Socioeconomic Status: Relationship between Education and Income.* *Education vs. income class in patients from the Duke MOSS Study.*

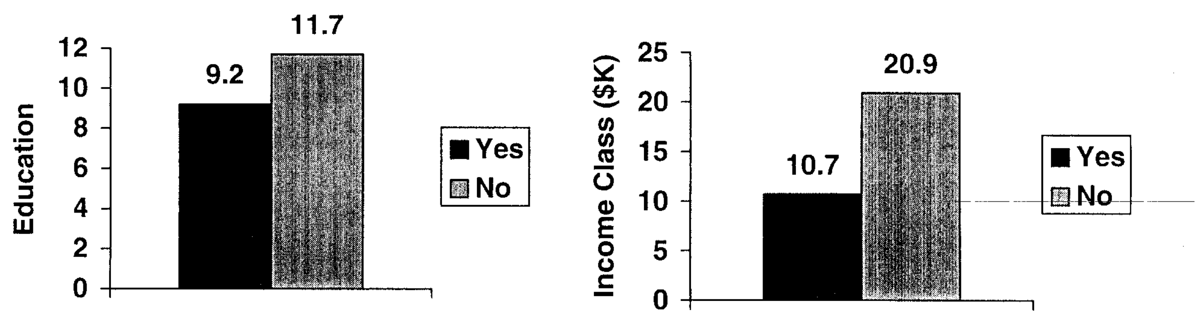

Figure 3.—*Effect of Cost of Medical Care on Perceived Access to Physician Care by SES Level.* *Yes = patients who perceived cost as a barrier to physician care; no = patients who said cost did not prevent them from visiting a doctor.*

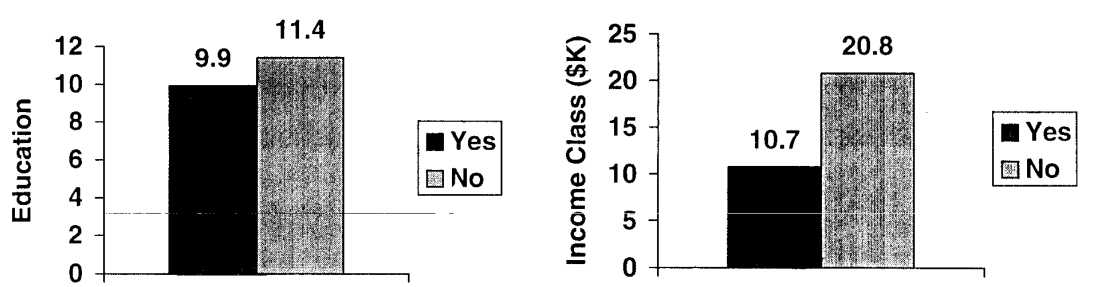

Figure 4.—*Effect of Cost of Medical Care on Perceived Access to Emergency or Hospital Care by SES Level.* *Yes = patients who said cost prevented them from seeking necessary hospital or emergency care; no = patients who did not perceive cost as a barrier to receiving emergency or hospital care.*

but definite trend was based on both education and income levels. Ongoing investigations are examining the nature of these visits (e.g., primary care, specialty care, emergency department).

Relationships between SES and several potential mediators of CVD are also being examined in this population. SES had no effect on the quit rate of patients who were smoking at the time of enrollment (Fig. 5). In contrast, comparison of patients' self-reported frequency of exercise at baseline and at 1 year showed that patients with higher SES (particularly higher income) were significantly more likely to increase their physical activity during the year after their angiography than lower-SES patients (Fig. 6).

Finally, we examined the relationship between the two SES markers and 1-year survival in this population. The unadjusted relationship between years of education and survival was highly significant ($p = 0.0004$) with a hazard ratio of 0.78 for a 4-year difference in education. After adjustment for baseline measures that included disease severity, age, functional status (using DASI) and general health perceptions (using the SF-36 scale), education was no longer a significant predictor of 1-year survival ($p = 0.95$). Income class was also a strong predictor of 1-year survival in the unadjusted Cox model ($p < 0.0001$), with a hazard ratio of 0.73 for a one-income class difference. After adjusting for the four covariates above, income remained marginally significant in the Cox model ($p = 0.04$) and the hazard ratio increased to 0.89, indicating a reduced prognostic effect of the residual income term in the model.

In general, these findings are in agreement with our previous analyses (6). Income was an independent predictor of outcome in the CHD population after adjustment for disease severity, but education was not. In our new analyses, much of the prognostic importance of income appears to be accounted for by other variables, including functional status and general health perceptions. These variables may in turn be dependent on other elements of disease severity or general physical and psychological disability (7). Other analyses indicate that patients who engage in cardiac rehabilitation improve their DASI scores. This may provide an important clue about at least one of the needs of lower-SES patients who, according to our data, do not appear to respond to CHD diagnosis by increasing exercise levels on their own (8).

Conclusions

Analyses from the Duke Cardiovascular Diseases Database confirm larger population-based studies in showing that measures of SES are important prognostic factors. In addition, income appears to be a

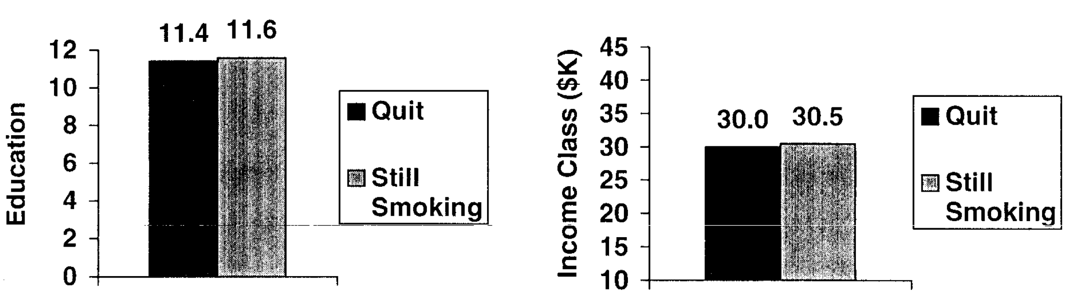

Figure 5.—*Effect of SES on Smoking Cessation Rates in CHD Patients Over 1 Year of Followup.*

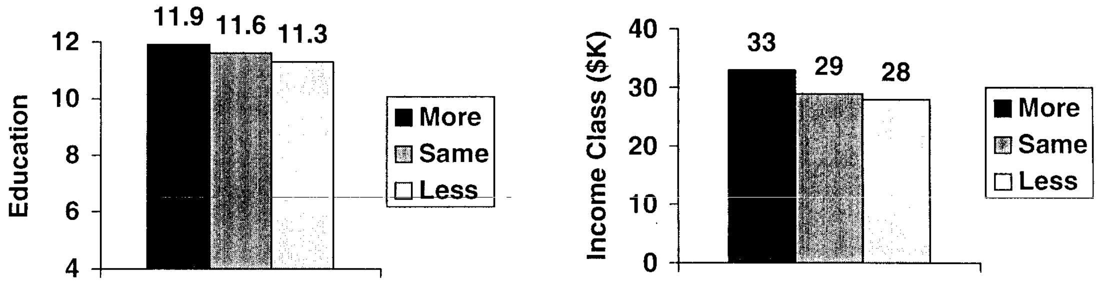

Figure 6.—*Effect of SES on Exercise Behavior in CHD Patients Over 1 Year of Followup.*

significantly stronger predictor of outcome than education in patients with established CHD, but may be confounded by the effect of disease on the patient's income prior to presentation. Lower SES does appear to be a marker for reduced perceived access to medical care, although some preliminary data suggest that utilization rates of outpatient care may actually be higher among low-SES patients. New prognostic analyses suggest that differences in patient functional status and health perceptions account for at least part of the relationship between lower SES and poorer survival in CHD and may reflect unmeasured aspects of disease severity or resultant disability.

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SESSION III:

Experiences in Educational and Preventive Interventions Across SES Groups

SESSION III OVERVIEW

L. Julian Haywood, M.D., Chair

The goal of this session was to examine the effectiveness of educational and preventive interventions for control of cardiovascular disease (CVD) across socioeconomic groups and, in the process, to determine whether common problems and opportunities exist for intervention design and implementation. The interventions discussed here, which include programs for smoking cessation, reduction of dietary fats, and increased physical activity, have been or are currently being tested in a variety of clinical and community settings. A striking finding in many studies is that individuals in all socioeconomic status (SES) groups appear to respond similarly to effective interventions when the interventions use solid experimental and clinical investigative methods. The challenge is to apply these interventions effectively in real-life settings so that their potential for improving public health can be realized among all SES groups throughout the whole population.

Speakers and discussion participants pointed to the growing need for appropriately designed CVD interventions and assessment tools for all SES groups, particularly for low-SES communities. Clustering of interrelated behavioral and environmental risk factors makes determining specific influences of SES factors extremely difficult in these communities. For instance, among inner-city populations in high-crime neighborhoods, access to heart-healthy foods is limited and simple exercise activities such as walking around the block can be prohibitively dangerous. Lower literacy rates among adults in low-SES communities complicate communication efforts. These factors require special consideration in the design of CVD interventions, but they are not insurmountable.

Studies of CVD risk generally show a gradient between the lowest and highest SES levels rather than specific SES thresholds for risk. These trends suggest that public interventions should not be targeted solely at the lowest-SES populations but at all SES levels to provide the maximum public health benefit. The participants stressed the need to develop culturally appropriate intervention tools for individuals and communities at each SES level using appropriate measures.

The conferees also noted that the real mark of efficacy for a given intervention lies in the ability to sustain its promotion of healthy behaviors and reduction of CVD events after the study or demonstration project concludes. To that end, public outreach programs should include representatives from the study communities as partners in project design and implementation. Many programs do so already.

The participants in this session urged the implementation of public health policies and intervention methods with proven efficacy. They recommended directing resources and efforts toward hypothesis-driven research in new areas of interest as well as on issues that have received inadequate attention in the past. Many of the observations and recommendations presented at this conference parallel recently reported findings of an NHLBI Task Force on Epidemiology and Prevention (1). Specific observations included the following:

Smoking. Cessation is a long-term process. About 75 percent of quitters are light or infrequent smokers and stop "on their own." Less-educated smokers, however, are less likely to quit. More needs to be learned about the quitting process for these smokers.

Weight Loss. Obesity is closely related to the combined effects of excessive calories and sedentary lifestyle, both of which are highly prevalent in low-SES groups. Cultural and individual beliefs about the value of large body size are also important factors. Many studies have shown that self-help groups are often as successful at losing weight as groups that receive special interventions. Self-help models require further study.

Physical Activity. Obesity is increasing despite decreasing fat intake and flat caloric intake; therefore, decreasing energy expenditure (the result of a sedentary lifestyle) must be a cause. Just as efforts to give smoking a "bad" public image through the mass media have been effective at changing smoking behavior, efforts to give exercise a "good" image may be successful in boosting physical activity levels. A campaign is needed to encourage moderate exercise, with the minimal goal of increasing average physical activity to walking at least 30 minutes per day for at least 5 days per week.

Culture. The influence of culture is poorly recognized and is especially important for some ethnic and racial groups. Smoking, for example, may have religious significance (e.g., for Native Americans). Food is often symbolic of welcome and acceptance, and obesity may be considered physically attractive. Interventions must recognize local community factors.

Clinical Trials. Much has been learned from large clinical trials regarding effectiveness of specific interventions such as treatment of high blood pressure and lipid lowering across populations. However, low-SES groups have been underrepresented in most trials, as have minority groups. Existing databases are underutilized and should be examined more closely to explore findings by ethnicity/race and SES.

Interventions in Worksites, Communities, and Schools. Experience to date indicates that each of these locales may be an effective forum for intervention. Low-SES and minority groups can be actively involved in these programs and can achieve similar or even greater benefits than majority groups. More attention is needed in interventions at all these sites to achieve primary and secondary prevention with regard to adverse lifestyles and related risk factors (1).

National Education Programs. These programs, such as the National High Blood Pressure Education Program (NHBPEP) and the National Cholesterol Education Program (NCEP), have contributed to a reduction in morbidity and mortality through effective physician and public education and can serve as models for beneficial risk factor reduction in many segments of the population. A similar physical activity advocacy program is needed.

Research Recommendations

- Efforts should be directed at developing better definitions of SES that will facilitate model development and data analysis. An interdisciplinary effort involving physicians, economists, health educators, epidemiologists, psychologists, and sociologists is needed to conceptualize SES in greater depth and formulate hypotheses related to CVD, outcomes, and intervention success. Family and generational influences should be considered in this process.

- Research should be directed at improving self-help and intervention models. Appropriate models should be developed and tested for different SES groups. Program effectiveness may be improved by applying the lessons learned in this process.

- Cost analysis should be incorporated into major clinical trials and other intervention studies, in addition to SES-related data, to facilitate estimation of the cost and benefits of broad applications, including those for disadvantaged populations.

- Continued collaboration between researchers from physical and mental health fields should be encouraged for investigations of SES effects on health.

- Communities with high risk factor indices should be targeted for in-depth study and should be the focus of efforts for improving availability of and access to resources. Factors such as knowledge, attitudes, and behaviors should be studied in low-SES populations, rural and urban. These populations should be targeted for studying interventions that address obesity, nutrition, physical activity, and smoking.

- Studies should examine and identify barriers to adoption of heart-healthy lifestyles and behaviors within high-strain employment settings and poor communities. Cultural and broad community factors and institutions should be included, and unemployment must be addressed as a factor in intervention design.

- Studies should be designed with the goal of developing interventions that will foster sustained behavior and risk factor changes once the research project has ended. Analysis of outcomes should be carried out over extended periods, and time trend analysis should be included in study designs. Community members must be included as active participants in developing and carrying out intervention programs that they can sustain.

Opportunities for Practical Application

- Concise smoking prevention, cessation, and relapse prevention interventions should be provided through community health centers, Federal Women, Infants, and Children (WIC) clinics, public hospitals, and other health care providers for children, adolescents, and adults of lower SES.

- For adolescents of lower SES who remain in school, school-based smoking prevention, cessation, and relapse prevention programs that emphasize the immediate benefits of not smoking are appropriate. For adolescents who have left school, such interventions should be community-, media-, and worksite-based.

- Linkage of mass media antismoking messages to smoking cessation hotlines and to sources of self-help materials tailored to different SES and racial groups may be particularly cost-effective.

- Interventions should recognize existing resources in the community. Dietary education and intervention programs should be designed with consideration of foods available through WIC and commodity programs as well as a knowledge of culturally important foods.

- The Institute's national CVD education programs and initiatives offer an effective and rapid means of translating research results into practical applications for health care. Examples include the Coronary Heart Disease in Blacks Initiative and the Latino Community Cardiovascular Disease Prevention and Outreach Initiative. New interventions to improve the health of target populations should take advantage of Institute expertise and resources in developing and utilizing information dissemination networks.

- The well-documented intervention methods for changing smoking habits, dietary behavior, and physical activity used in the Multiple Risk Factor Intervention Trial (MRFIT), the Treatment of Mild Hypertension Study (TOMHS), and similar clinical trials should be made more widely available. It may be necessary to modify these methods for use in specific low-SES groups.

- The effectiveness of diuretic-based stepped care for blood pressure control in all SES groups should receive continued and enhanced emphasis through the NHBPEP.

- If results from the NHLBI-supported projects on nutritional intervention for low-literacy populations are found to be positive, the intervention methods and information on their effectiveness should be disseminated through the NHBPEP and NCEP.

- School health education should be encouraged at lower grade levels and with all SES groups in attendance.

- Partnerships should be encouraged between Federal, voluntary, and local agencies that have similar goals.

- Work in encouragement of healthy food choices at institutional cafeterias should be supported.

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What Have We Learned About Socioeconomic Status and Cardiovascular Disease From Large Clinical Trials?

Jeffrey A. Cutler, M.D., M.P.H.
Greg Grandits, M.S.

Little published information is available about the influence of socioeconomic status (SES) of participants on the findings of large clinical trials. The main exception is the Hypertension Detection and Followup Program (HDFP) (1,2). This and other NHLBI-supported primary prevention trials arguably have the greatest relevance to differential rates and outcomes of cardiovascular disease (CVD) in the general population.

Key questions addressed are the following:

- Since findings are always conditioned by the population studied, how does <u>recruitment</u> affect SES distribution of trial participants?
- How does SES affect <u>adherence</u> to interventions tested in clinical trials?
- Are <u>morbidity and mortality benefits</u> the same across different levels of SES?

Highest educational attainment is used, for the most part, as the main indicator of SES.

Recruitment

The three large primary prevention trials initiated by NHLBI in the early 1970s present contrasts in recruitment methods and results. The HDFP recruited men and women, 45 percent of whom were black, from enumerated residential and worksite populations using home visits for initial screening, an approach that contributed to a broad SES distribution (40 percent with less than high school education, 22 percent with some post-secondary education) (2). The Multiple Risk Factor Intervention Trial (MRFIT) and the Lipid Research Clinics Coronary Primary Prevention Trial (CPPT) recruited during the same period, but targeted men only and generally utilized a volunteer approach. This approach yielded study groups of which only 16 percent and 12 percent had less than high school education, while 27 percent and 38 percent were college graduates in MRFIT and CPPT respectively (3,4).

Internal evidence from the CPPT indicates that the educational distribution of randomized participants depended on screening source: among those from medical sources (e.g., clinical labs, medical referrals), 32 to 36 percent were college graduates and 12 to18 percent had 7th to 11th grade education; while among those identified from mass mailings and media, 40 to 44 percent were college graduates and only 10 to 11 percent had 7th to 11th grade education (4). Evidence that coming into a trial through a medical care source exerts less selection by SES is further illustrated by data from a secondary prevention trial, the Beta-blocker Heart Attack Trial (BHAT). The BHAT sample, largely men and from a birth cohort similar to that of the MRFIT, had 37 percent with post-secondary education as compared with 63 percent in MRFIT (3,5).

Age, or more precisely birth cohort, is probably the strongest influence on educational levels of trial participants. Although the Systolic Hypertension in the Elderly Program (SHEP) recruited a sample about 15 years older than that of the HDFP, because SHEP was begun almost 15 years later, participants were drawn from approximately the same birth cohort, and a similar proportion had post-secondary education (31 percent in SHEP, 22 percent in HDFP) (6). The slightly higher education distribution of SHEP probably reflects recruitment of volunteers and smaller numbers of blacks. In contrast, two primary prevention trials involving young adults that recruited during the same period as SHEP—the Trials of Hypertension Prevention Phase II (7) and the Dietary Intervention Study in Children, which recruited parents of 8- to 10-year-old children (8)—drew participants more than 85 percent of whom had post-secondary education. The fact that these protocols promised to be quite demanding probably had an influence as well.

Adherence to Interventions

We could find no results published from large trials on adherence according to SES. Therefore, we further analyzed data from two large primary prevention trials involving both pharmacologic and behavioral interventions: the MRFIT and the Treatment of Mild Hypertension Study (TOMHS).

According to the MRFIT design, the primary targets of the Special Intervention (SI) were reduction of diastolic blood pressure (DBP) using largely diuretic-based stepped-care drug treatment, cessation of cigarette smoking through behavior modification methods, and reduction of total serum cholesterol by dietary means (9). Changes in these risk factors after 6 years of followup are shown in Table 1 according to education level, race, and randomized group (SI *vs*. Usual Care, or UC). It is evident that for nonblack men (98 percent of whom were white) changes in DBP were very similar across education levels within both SI and UC groups, and thus yielded constant SI-UC differences. For black men, however, SI-UC differences were larger at lower education levels ($p=0.002$ by ANOVA), mainly due to larger reductions within the SI group. Results were similar for systolic blood pressure (SBP, data not shown).

For smoking cessation, results for nonblack men were again quite uniform across education levels, especially for SI-UC differences, although quit rates tended to be largest among college graduates in both SI and UC. Similarly, although among blacks the lowest quit rates were seen for the least educated, especially in the SI group, the SI-UC differences did not vary significantly across education levels. Overall, the intervention effect (SI vs. UC) was larger in black than nonblack men, due to greater cessation in SI and less quitting in UC participants for black men.

Changes in LDL cholesterol among nonblack men were similar by education. A trend was seen among black men for greater intervention effects for the less-educated groups, but this was not statistically significant. For all races combined, SI-UC differences for changes (baseline to year 6) in intake of saturated fatty acids and dietary cholesterol, measured by single 24-hour recalls, were also similar across education levels (data not shown).

Table 1.—Risk Factor Changes in MRFIT by Education Level, Race, and Randomized Group

Educational Level	Black Men				Non-Black Men			
	N	SI	UC	SI-UC	N	SI	UC	SI-UC
Diastolic Blood Pressure (mmHg), BL-Year 6								
<HS	236	15.7	6.0	9.7	1530	9.9	7.1	2.8
HS	147	13.0	8.7	4.3	2224	10.2	7.0	3.2
Some Coll	300	11.5	8.0	3.5	2744	10.0	7.1	2.9
Coll Grad	134	9.4	6.0	3.4	3025	10.1	6.8	3.3
Reported Smoking Cessation Rate (%), Year 6								
<HS	157	50.0	20.0	30.0	1031	47.9	29.1	18.8
HS	99	59.2	28.0	31.2	1418	46.7	25.5	21.2
Some Coll	204	54.2	25.0	29.2	2357	47.4	29.5	17.9
Coll Grad	87	59.6	22.5	37.1	1707	51.5	32.5	19.9
LDL-Cholesterol* (mg/dl), BL-Year 6								
<HS	236	10.7	3.2	7.5	1530	12.1	8.0	4.1
HS	147	14.2	7.2	7.0	2224	10.7	6.5	4.2
Some Coll	300	12.0	10.0	2.0	3744	11.3	9.1	2.2
Coll Grad	134	6.0	1.7	4.3	3025	10.9	6.4	4.5

MRFIT = Multiple Risk Factor Intervention Trial, SI = Special Intervention, UC = Usual Care, BL = Baseline, HS = High School, Coll = College, LDL = Low-density lipoprotein
* As the main atherogenic lipoprotein, plasma LDL cholesterol is tabulated instead of total cholesterol.

Table 2.—Risk Factor Changes and Medication Adherence Over 4 Years in TOMHS, by Education Level, Race, and Gender

	Black Men			**Black Women**			**Non-Black Men**			**Non-Black Women**		
	N	Mean	SE	N	Mean	SE	N	Mean	SE	N	Mean	SE
Phys Activ (points/wk)												
<Coll Grad	41	104.2	27.2	90	72.8	13.3	265	134.8	12.2	160	84.2	13.3
Coll Grad	22	144.5	42.8	20	-48.7	51.8	210	83.9	12.4	70	34.3	29.2
Weight (lb)												
<Coll Grad	41	-4.3	1.2	91	-3.9	0.7	271	-10.7	0.5	161	-6.5	0.6
Coll Grad	22	-4.7	1.5	20	-2.1	1.8	214	-9.0	0.6	71	-6.4	1.0
Urinary Na (mmol/8h)												
<Coll Grad	40	-9.9	5.0	87	-13.5	2.9	264	-12.8	1.6	156	-6.7	1.4
Coll Grad	21	-1.9	4.5	19	-5.2	4.9	209	-9.9	1.6	69	-8.7	2.1
DBP (mmHg)												
<Coll Grad	41	-10.8	1.0	91	-10.7	0.6	271	-11.7	0.3	161	-11.3	0.4
Coll Grad	22	-11.0	0.9	20	-8.5	1.6	214	-11.4	0.4	71	-11.7	0.7
% On Step 1 Med Only (Active Treatment)	N	12 mo.	48 mo.	N	12 mo.	48 mo.	N	12 mo.	48 mo.	N	12 mo.	48 mo.
<Coll Grad	32	75.0	65.6	67	89.6	61.2	210	76.2	66.0	125	59.2	75.2
Coll Grad	16	62.6	56.3	13	69.2	46.2	153	85.0	72.8	49	69.2	79.6

TOMHS = Treatment of Mild Hypertension Study, DBP = diastolic blood pressure, Coll Grad = college graduate, Na = sodium, Phys Activ = physical activity, Med = medication

Thus, the overall conclusion from MRFIT is that net improvements in risk factors (SI vs. UC) were at least as great for participants with lower education levels as for those with higher levels for the major racial groups, separately and combined. It is of further interest to note that SI-UC differences in CVD mortality over 16 years were also similar across the same education levels: these differences in CVD deaths per 1,000 participants were, from lowest to highest education, respectively: -5.3, -6.7, +2.9, and -6.8.

The TOMHS randomized 902 men and women, 45 to 69 years of age with Stage 1 diastolic hypertension, to placebo or to one of five antihypertensive drugs, each from a different drug class. All participants also received multifactor lifestyle intervention aimed at weight control, increased physical activity, and reduction of sodium and alcohol intake. Average followup was 4.5 years. Twenty percent of participants were black. The main results have been published (10).

We examined medication compliance (percent remaining on randomized drug assignment at 12 and 48 months in the five active drug groups) and measures of change in each lifestyle component, with followup measures averaged over all visits, by education level. When participants' education was dichotomized into college graduation compared with lower levels, increased physical activity (in all subgroups except black men), weight loss (in nonblack men), change in DBP (in black women), and medication compliance (at 12 months in blacks) were significantly greater in the group with a lesser education level (Table 2). Otherwise for these measures, and for overnight sodium excretion, differences by educational attainment were generally not observed.

With years of education used as a continuous variable, physical activity demonstrated consistent trends. These are illustrated according to five categories of education, analyzed separately for each of four race–sex subgroups (Fig. 1). At baseline, education was directly associated with reported level of physical activity in three of the four subgroups (all except the small sample of black men). However, changes from baseline to followup were inversely associated with education in the same three subgroups. In each of these race–sex subgroups, the participants with less than high school or with high school education made the largest changes. Thus, although this pattern could be explained in terms of the groups with the most room for improvement making the largest changes, modest educational achievement was clearly not a barrier to responding to this lifestyle intervention program.

Mortality and Morbidity Outcomes

We focus here on the treatment of hypertension, because the population burden of this condition was shown 20 years ago to be inversely related to SES among individuals screened for the HDFP; moreover, its association with race is well known. (1). Data in the NHLBI *Chartbook* from NHANES III show that this is still the case. In the 45- to 64-year-old stratum, SBP was consistently higher in those with less than 12 years of education than those with more than high school education for each of the major race–sex groups (i.e., by 7, 8, 3, and 4 mmHg, for black men and women and white men and women, respectively). Similar trends were evident in comparisons by income.

In further analyses from the HDFP, it was shown that all-cause mortality among participants in the Referred Care (RC) group was inversely and significantly related to education level. In both black and white hypertensive persons exposed to customary care in the community, there was approximately a 2-fold gradient in risk of death among those with less than high school compared with those with more than high school education. In contrast, among both blacks and whites these gradients were essentially nonexistent in the Stepped Care (SC) group, who received systematic, blood pressure (BP) goal-directed drug treatment (2). When 5-year mortality rates in those with less than high school education were directly compared, the SC and RC rates were 6.9 and 9.0 percent respectively, for an absolute difference of -2.1 percent (95 percent confidence interval, -0.6, -3.6). However, a direct statistical test of whether the mortality benefit (SC vs. RC) differed across educational levels found no significant interaction, a result supporting the conclusion that the 16.9 percent overall relative reduction in mortality in the HDFP SC group was applicable to the subgroup with lower education as well. Because the HDFP was an unblinded trial, and questions are occasionally raised whether nonspecific aspects of care received by the SC group could have contributed to the mortality benefit, the HDFP investigators conducted further analyses. They constructed regression models to try to account for the mortality reduction with variables related to the hypertension treatment protocol, and concluded that SC "explained" 44 percent of the benefit in the least educated subgroup (2).

The most compelling evidence to confirm the efficacy of antihypertensive treatment per se in reducing adverse outcomes in a lower-SES hypertensive population would come from a double-blind randomized trial. The SHEP was such a trial, and some relevant analyses have recently been conducted (11). The differences between randomized groups for rates of major end points generally parallel the HDFP mortality findings. Specifically, in the subgroup with less than high school education, the relative risks (active treatment *vs.* placebo) for nonfatal plus fatal stroke, nonfatal myocardial infarction plus fatal coronary heart disease (CHD), all major CHD events, and all major CVD events were in the range of 0.62 to 0.65, all with 95 percent confidence intervals that did not overlap 1.0. Moreover, in every case the relative risks were smaller (but not significantly so) in those with less than high school education than in those with greater than high

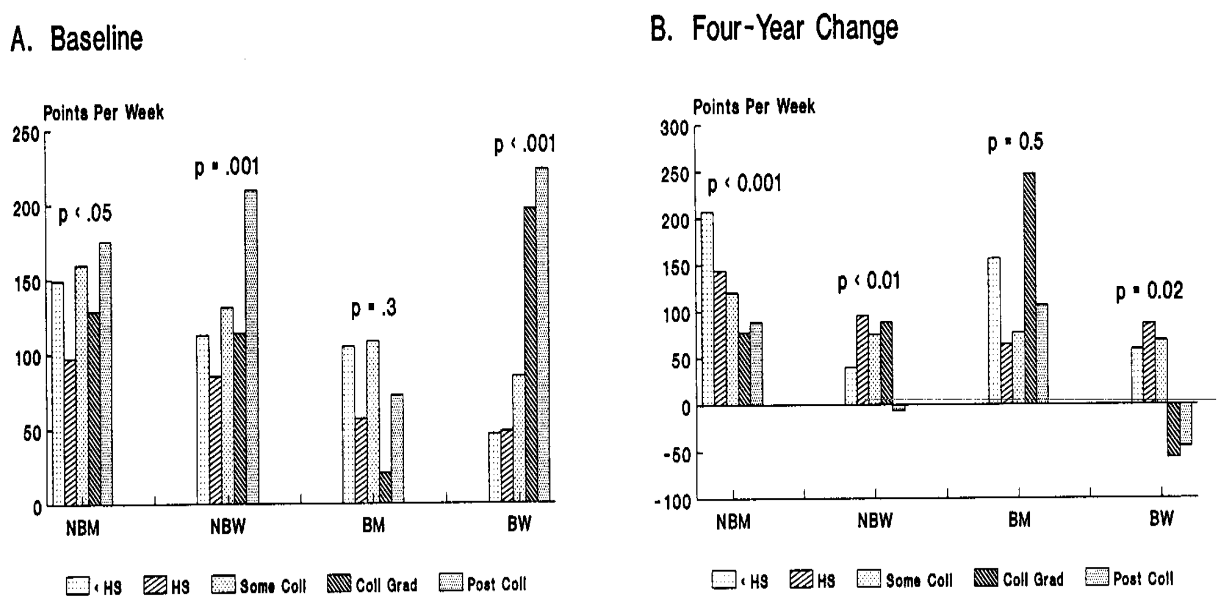

Figure 1.—*Physical Activity Level in TOMHS by Educational Level, Race, and Sex*. *NBM = non-black men, NBW = non-black women, BM = black men, BW = black women.*

school education, (i.e., the data suggest that the active treatment was more effective in reducing adverse outcomes in the lower-SES hypertensive participants). A similar trend across education levels was present for all-cause mortality, but as for the overall SHEP data, subgroups lacked statistical power to show significant effects.

Conclusions

Large clinical trials seek to enroll broadly representative study populations, but their protocols and management teams have traditionally emphasized recruiting adequate numbers of participants overall in order to answer the main study question. Primary prevention trials usually target broad segments of the community to elicit volunteers, an approach that tends to result in underrepresentation of low-SES persons. Participants recruited from medical care sources, especially hospitals, are likely to have a broader SES distribution. The population-based approach used by the HDFP—unique among large U.S. trials—along with targeting of the black population, led to a broad SES distribution. This composition of the screened and randomized study groups facilitated the several SES-related analyses in the HDFP. While other trial data sets may not be as well suited for such analyses, investigators should nonetheless consider using them for this purpose.

The MRFIT Research Group has previously published findings for black and white subgroups showing similar responses to the SI program regarding risk factor changes (3). Data presented in this paper extend these conclusions to subgroups defined by educational attainment. The only significant variation by education was seen for BP change in black men, largest among the least educated. In a study of a broader array of treatments for hypertension than in MRFIT, the TOMHS also tended to find greater adherence in the less educated, especially for change in physical activity. A limitation in these conclusions is the absence of a parallel control group for lifestyle change in TOMHS. Nevertheless, these findings strengthen the broad conclusion, based on the MRFIT, that modest educational attainment does not necessarily represent a major impediment to intervention success. In addition (and most important), the findings from HDFP and SHEP indicate that successful intervention on BP translates into morbidity and mortality reduction in the less educated that is at least as great as in the more educated. The results also suggest that systematic treatment produces some attenuation of the risk gradient associated with SES.

Limitations in generalizability of the foregoing conclusions include the possibility that self-selection into trials operates more strongly in lower-SES strata, leading to a study subgroup with more coping and social support resources than individuals not enrolled, and thus better adherence. In addition, there are gaps in our knowledge base about interventions to reduce disparities in CVD among SES strata, some of which are being addressed by ongoing NHLBI intervention research. With regard to classical risk factors and their behavioral determinants, five NHLBI grantees are studying strategies to improve hypertension control in inner-city populations. Another six groups of investigators are funded to develop and test methods of nutrition education for low-literacy populations to improve blood lipid and blood pressure levels. Finally, to address the apparent role of such psychosocial risk determinants as social isolation and depression, a multicenter NHLBI-sponsored clinical trial, Enhancing Recovery In Coronary Heart Disease, has recently begun. These efforts will expand our knowledge and should lead to more effective ways to influence risk favorably in lower-SES groups.

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SMOKING CESSATION, SOCIOECONOMIC STATUS, AND ETHNICITY

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Our ultimate goal is to contribute to the cardiovascular health of the nation by highlighting the scientific information on smoking intervention that is ready for transfer to health care professionals and the public. To achieve this goal, the relationship of smoking to socioeconomic status (SES) and the outcomes of clinical and community interventions for smoking cessation, with a focus on SES and ethnicity, will be reviewed. The utilization of "assisted methods" for smoking cessation by various SES and ethnic groups will be considered, as will barriers to utilization of smoking interventions for low-income and culturally diverse populations. In addition, research opportunities and smoking intervention needs for low-SES and culturally diverse individuals will be identified.

Smoking, SES, and Ethnicity

The prevalence of cigarette smoking varies among ethnic groups, and within each ethnic group and special population (e.g., pregnant smokers) it varies by education. In 1993, the prevalence of cigarette smoking among U.S. adults was highest for American Indians and Alaska Natives (39 percent), intermediate for blacks (26 percent) and whites (25 percent), and lowest for Hispanics (20 percent) and Asian Americans and Pacific Islanders (18 percent) (1). For adolescents, the prevalence of current cigarette smoking was also highest for American Indians and Alaska Natives, intermediate for white adolescents, and lowest for Hispanic and black adolescents.

The strong predictive relationship of education to smoking applies to all racial and ethnic groups, all special populations, and all age groups. For example, in 1993, for 25- to 44-year-olds who had gone beyond a high school education the smoking rates for blacks, whites, and Hispanics were very close (approximately 20 percent). For persons with 9 to 11 years of education and those with at least 16 years of education, 37 percent and 14 percent were smokers, respectively.

Among adolescents, those doing well in school and planning to complete college are much less likely to smoke than are their counterparts (2). In recent years, the prevalence of cigarette smoking decreased more rapidly among American Indian and Alaska Native adolescents than among white adolescents. Among black adolescents it has declined sharply since the 1970s, while for white adolescents it has increased slightly. This difference is maintained after adjustment for parents' education, number of parents in the household, college plans, employment, and degree of religious observance.

For adolescents who have left school, black adolescents are significantly less likely than white adolescents to report current smoking. Black youths initiate smoking at slightly later ages than white youths, and an accelerated rate of decline in smoking has been observed for black youths aged 18 through 24 years, suggesting a cohort effect (3).

Twenty to 35 percent of the general population of pregnant women smoke (4), and rates vary by ethnicity and education. Of low-income pregnant women enrolled in urban Women, Infants, and Children (WIC) programs, 42 percent smoked (5) and, among pregnant smokers, unmarried women with fewer than 12 years of education were least likely to quit smoking spontaneously during pregnancy (4). Over time, the prevalence of smoking has had a 5-fold greater decline for the more educated than the less educated, clearly making it an issue defined by education.

Smoking Treatment Outcome, SES, and Ethnicity

Most small-scale clinical studies have not assessed the efficacy of their smoking interventions across SES and ethnic groups. Therefore, information regarding the efficacy of interventions across SES and ethnic groups is derived from large studies of heterogeneous populations and smaller studies of relatively homogeneous populations of interest. Differing methodologies make comparisons of the latter difficult.

Smoking intervention studies can be grouped by type of intervention or channel (sector) through which the intervention is delivered or both. There is overlap between the groupings, since a channel may have several types of interventions delivered through it. For example, a worksite can have available any of the interventions listed under type. The following intervention groupings are discussed here:

Channel/Sector	Type
• Community Intervention	• Intensive (group or individual)
• Media	• Physician/Dentist based
• Worksite	• Telephone Counseling
• Self-help	

Two large collaborative trials using intensive group and individual interventions delivered over an extended period of time are the Multiple Risk Factor Intervention Trial (MRFIT) and the Lung Health Study. In both trials, education level had a significant effect on smoking cessation, with more-educated smokers being more likely to stop smoking (6, 7). However, even less-educated smokers were more likely to stop smoking with special intensive intervention than in the usual-care conditions. Thus, intensive interventions can have a positive effect on smokers with less education. Unfortunately, utilization of intensive interventions is low among all education groups, and this problem and attrition are perhaps greater for ethnic minorities than in the general population (8). Hispanics and Asian Americans, for example, rarely participate in smoking cessation groups (8). Telephone and face-to-face consultation may be an appropriate alternative, especially among Hispanics whose culture traditionally values personal attention.

Using 11 matched community pairs, the Community Intervention Trial for Heavy Smokers (COMMIT) tested the effect of a community organizational intervention approach on smoking cessation rates across different education and ethnic groups (9). Communities were randomized to intervention and comparison conditions. There was no significant intervention effect on the heavy smokers, with quit rates of 17.9 percent and 18.6 percent in the intervention and comparison conditions, respectively. For the light-to-moderate smokers, the greatest effect on cessation was for those individuals who had a high school education or less, demonstrating a 5.5 percentage point difference in cessation between the intervention and comparison conditions. It is encouraging that a community-wide intervention had a significant effect for less-educated smokers, making it important to use what we can learn from this study and to build on it.

Mass media smoking interventions are potentially cost-effective and can provide a structured program within the privacy of the home. Mass media also can create a social milieu supportive of behavioral change and may increase knowledge, awareness, and motivation. In addition, television and radio can provide demonstrations of behavioral skills not possible in written self-help materials, and resulting behavioral change can be attributed to one's own efforts. Many smokers who might not otherwise receive assistance can be reached through the media. Thus, even small program effects can have a very large public health impact (10). However, mass media programs alone have not been found to be particularly effective. The mass media may be most effective for disseminating information and providing access to quit lines and self-help materials.

In Massachusetts, calls to the Massachusetts Tobacco Control Program quit line, funded by the Massachusetts Tobacco Tax Initiative, increased when the Food and Drug Administration (FDA) indicated that it might regulate tobacco and when a television advertising campaign began. This suggests that coordination of media presentations with other interventions can have a substantial effect.

Televised media programs and the distribution of self-help materials have been combined, since self-help is the method of choice of more than 90 percent of smokers (11) . Flay demonstrated that self-help materials introduced through a media format can be twice as effective as self-help materials alone (10). The studies reviewed by Flay support the conclusion that televised self-help programs can improve the effectiveness of self-help manuals and have the potential for a large public health impact. However, research must isolate the elements required for successful mass media intervention, especially if programs are to target minority, lower-SES, or less-educated smokers.

The National Cancer Institute-funded Programa Latino Para Dejar de Fumar (Hispanic Program to Quit Smoking) has used radio and television public service announcements and the distribution of self-help smoking cessation materials. Through public education, the program has promoted participation in smoking cessation interventions and significantly decreased the prevalence of smoking among the target group of less acculturated Hispanic smokers in San Francisco (12).

Physician-delivered interventions targeted at minority, low-SES, or less-educated smokers have not been well developed and investigated. Much of what is known about health care provider-based intervention with these groups comes from studies of smoking among pregnant women. Smoking among pregnant women is of concern due to smoking's impact on the fetus, the mother, and young children. There have been 15 randomized clinical trials testing interventions with pregnant women, eight of them with women in the low-SES strata. Interventions with pregnant smokers are generally effective, but postpartum relapse is high. One study of women receiving public prenatal care (13) reported prenatal quit rates of 8.5 percent among controls compared with 14.3 percent among women receiving counseling and a self-help guide with supplemental mailings. Black women had higher prenatal quit rates than white women. Unfortunately, at 6 months postpartum, cessation rates were the same in both conditions due to postpartum relapse, making the postpartum period an important time for intervention.

In summary, smoking intervention studies support the conclusions that intensive interventions have a greater impact on more-educated smokers, however, they do have an effect on less-educated smokers; community interventions can have a positive impact on less-educated smokers, but must be tailored to the needs of the target population; self-help interventions and media campaigns, when used together, have demonstrated potential; self-help may be the intervention of choice in some ethnic groups and may be effective when combined with other interventions; interventions targeting pregnant women have promise, but must include the continuation of intervention postpartum; and physician-delivered interventions targeted at low-SES or less-educated populations have demonstrated potential, but they have not been well developed and investigated.

Use of "Assisted Methods" in Smoking Cessation, SES, and Ethnicity

To be efficacious, interventions must be available to, tailored to, and utilized by smokers. Although a variety of intensive interventions have proven efficacy, they are not well utilized by the smokers who need them. Using data from the 1986 Adult Use of Tobacco Survey, Fiore and colleagues (11) found that about 90 percent of successful quitters and 80 percent of unsuccessful quitters used individual methods rather than organized programs. Female, middle-aged, and more-educated smokers with more quit attempts and heavier smokers were most likely to use a program. Among smokers who had attempted cessation within the previous 10 years, 47.5 percent who tried on their own and 23.6 percent who used programs succeeded. This reflects the fact that heavier smokers are more likely to use programs.

When smokers are counseled by physicians or dentists, their likelihood of stopping smoking significantly increases. Such advice is as cost-effective per year of life saved as other preventive medical practices. Unfortunately, smokers often report that advice to quit has not been provided to them by a physician. The 1991 National Health Interview Survey (NHIS) collected self-report information from a representative sample of U.S. adults regarding smoking status and visits to and receipt of advice to quit from health care professionals (14). An estimated 70.2 percent (95 percent confidence interval [CI] = ±1.0 percent) of the 51 million persons who smoke had at least one outpatient visit to a healthcare professional during the preceding 12 months. However, about 20 million of these smokers reported that they did not receive advice to quit smoking. Among persons with four or more visits, 45.5 percent (CI = ±2.0 percent) reported being counseled to quit compared with 28.1 percent (CI = ±1.9 percent) of those with one visit. Counseling rates were slightly lower for Hispanics than for white non-Hispanics, but otherwise did not vary by race–ethnicity, education, or SES (Tables 1 and 2).

Health care professionals also have an important role in adolescent smoking intervention. The 1993 Teenage Attitudes and Practices Survey (TAPS II) collected data from a weighted sample of adolescents to

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Table 1.—Percentage of Adult Smokers[a] Receiving Advice to Quit from a Health Care Professional in a 12-Month Period, by Number of Visits and Income

Income[c]	**Number of Health Care Professional Visits** (%, 95% CI)			
	1	2-3	≥4	Any visit
Poverty level or above	29.0 (±2.2)	36.9 (±2.4)	45.6 (±2.3)	37.5 (±1.4)
Below poverty level	26.3 (±5.5)	33.5 (±5.9)	45.5 (±4.5)	37.7 (±3.2)
Unknown	20.4 (±6.1)	31.4 (±7.9)	42.3 (±7.9)	32.5 (±4.5)
Total	28.1 (±1.9)	36.2 (±2.2)	45.5 (±2.0)	37.2 (±1.3)

[a] Persons aged ≥18 years who reported they had smoked during the preceeding 12 months.
[b] Confidence Interval.
[c] Poverty statistics are based on definitions developed by the Social Security Administration that include a set of income thresholds that vary by family size and composition.
[d] Sample size = 8778; excludes 369 respondents with an unknown number of physician visits.
Source: National Health Interview Survey—Health Promotion and Disease Prevention Supplement, 1991.[d]

Table 2.—Percentage of Adult Smokers[a] Who Received Advice to Quit from a Health Care Professional in a 12-Month Period, by Number of Visits and Education

Education	Number of Health Care Professional Visits (%, 95% CI)			
	1	2-3	≥4	Any visit
Less than high school	27.8 (±4.7)	32.6 (±4.4)	47.8 (±3.9)	37.9 (±2.7)
High school graduate	28.5 (±2.9)	36.2 (±3.4)	46.5 (±3.0)	37.6 (±1.9)
Some college	29.2 (±4.2)	37.1 (±4.4)	42.4 (±4.2)	36.3 (±2.5)
College graduate	25.4 (±4.8)	40.9 (±6.1)	41.2 (±5.5)	36.1 (±3.3)
Total[c]	28.1 (±1.9)	36.2 (±2.2)	45.5 (±2.0)	37.2 (±1.3)

[a] Persons aged ≥18 years who reported they had smoked during the preceeding 12 months.
[b] Confidence Interval.
[c] Sample size = 8778; excludes 369 respondents with an unknown number of physician visits.
Source: National Health Interview Survey—Health Promotion and Disease Prevention Supplement, 1991.

derive national estimates of tobacco use knowledge, attitudes, and practices, and of health care providers discussing tobacco use with young people (ages 10 to 22) (15). Only 25.1 percent of respondents reported that a health care professional had mentioned cigarette smoking, and 11.8 percent said the same about smokeless tobacco (SLT). The strongest correlate of an affirmative response was having a history of tobacco use. Still, only 24 percent of respondents who had tried a cigarette and only 13.2 percent of those who had tried SLT recalled being advised about tobacco use. No significant differences were found by race–ethnicity, poverty status, or region of the county. Therefore, it appears that more can be done to provide information to adolescents of all SES and ethnic backgrounds before they begin to experiment with tobacco. To date, there have been no reported studies testing the efficacy of pediatricians' office-based smoking interventions.

Telephone quit lines are another important vehicle for intervention. Data from the Massachusetts quit line indicate that smokers with less than high school education are less likely to access it than smokers with high school, some college, or a completed college education. As quit lines are free, the barriers to use are not likely economic. Therefore, it is important to investigate the barriers to the use of quit lines and develop interventions to enhance such use.

Barriers to Smoking Interventions, SES, and Ethnicity

In low-income and culturally diverse populations, smoking is often one of several disease-related lifestyle behaviors. Through available, accessible, and appropriate health education about lifestyle issues and adherence to clinical preventive services guidelines and medical regimens, the number of excess deaths and illnesses among low-income culturally diverse populations can be substantially reduced. However, the co-occurrence of smoking with other risk factors makes effective intervention more difficult.

An optimal public health approach could improve delivery of services and access for all consumers. Such an approach includes five major components. First, education for smokers and providers about smoking treatment, the most important aspect of the public health approach, must be delivered in a mode that is acceptable to the target population. Second, the development of social norms and an environment that supports change is also necessary since individual change, for smokers and health care providers, does not occur in a vacuum. Several studies that utilized focus groups have found an unsupportive environment to be a barrier to cessation (16).

A third important component of a public health approach requires efforts in worksites, health care settings, voluntary organizations, and the media to be coordinated and integrated so that services and programs can be optimized. More research is needed to study the efficacy of integrated services delivered through multiple channels. The creation of an infrastructure, the fourth important component, makes possible the delivery of information and services to health care providers and smokers. Without the infrastructure, efficacious interventions cannot be implemented. One way to provide an infrastructure is to earmark tobacco tax funds, as was done for the Massachusetts Tobacco Control Program. Finally, regulations mandating services and standards of performance are needed to provide incentives for the delivery of high-quality interventions to economically and ethnically diverse smokers. Without the incentives and the infrastructure to deliver services, interventions will not be delivered.

Conclusions

Differences between more- and less-educated people in smoking prevalence, quitting, and initiation have increased over time, and education is now the best demographic predictor of smoking patterns. Approximately 60 percent of adult smokers, and 50 percent of young (10 to 22 years old) smokers report ever having been advised by a physician to stop smoking. This rate does not vary by race–ethnicity, education or SES. Although every smoker should be advised by his or her physician to quit or not to start and offered assistance to quit, more research is needed to examine the impact of such interventions in the low-SES strata and various ethic groups. In addition, coordinated intervention programs, such as media campaigns combined with self-help materials, may assist smokers to quit, but more research is needed to investigate the effect of tailoring interventions for low-SES groups.

The fact that only 15 percent of smokers use programs to quit and that program users are more often white, highly educated, and female must be recognized. Assisted methods need to be tailored to and made available to smokers of lower SES and educational attainment. Barriers to intervention, including lack of social support for cessation, low perceived health risks of smoking, social norms that support smoking, and limited usable information on smoking, need to be kept in mind (16). Broader social support efforts and educational materials should be tailored for smokers of low educational attainment and combined with other interventions. Smoking must be seen as a long-term problem requiring long-term solutions.

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NUTRITION INTERVENTION STUDIES

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Limited literacy skills affect over 50 percent of adults in the United States, are strongly associated with low socioeconomic status (SES), and undoubtedly contribute to the increased health risks of low-SES individuals (1,2). In addition to the general association of low literacy with variables such as education level, earning potential, and the ability to pay for health care, low literacy skills specifically limit access to nutrition and health information, most of which is written at a tenth grade or even college level (3–6). Literacy may be particularly relevant to SES differentials between minority and majority populations because the marginalization associated with literacy problems may be additive with or even synergistic with problems related to racial and ethnic discrimination or cultural alienation.

The National Heart, Lung, and Blood Institute (NHLBI) has funded several projects that address the need for cardiovascular nutrition education materials suitable for English-speaking adults with limited literacy skills (7). These projects have developed and tested strategies for reaching racial–ethnic minority or multiethnic populations in various settings across the United States with education to foster healthy eating; reduce dietary intakes of fat, saturated fat, cholesterol, and sodium; or improve weight management. These educational strategies utilize interactive computer technology, video, audiocassettes, compact disks, and a variety of printed media:

- **CARDES**—Cardiovascular Dietary Education System (Hershey, Pennsylvania, and Washington, D.C.) is a self-help program consisting of a motivational video, food picture cards and accompanying workbook, and a 12-program audiocassette series designed for use in the outpatient management of high blood pressure and high cholesterol.

- **HEALTHTALK** (Chapel Hill, North Carolina) is a user-friendly, interactive computer-assisted video instructional program that allows individualized counseling of individuals with high cholesterol in an outpatient clinic setting.

- **IDEA**—Innovative Dietary Education Approaches (Minneapolis, Minnesota), is designed to be incorporated into the U.S. Department of Agriculture (USDA) Expanded Food and Nutrition Education Program (EFNEP), which reaches low-income persons (primarily women) responsible for food preparation.

- **SNAP—**Stanford Nutrition Action Program (Stanford, California) was designed primarily for women, ages 20 to 35, from diverse ethnic and economic backgrounds. SNAP recruited participants from EFNEP.

- **Language for Health** (San Diego, California) is a nutrition curriculum for low-literate adults designed for integration into adult English-as-a-Second-Language (ESL) classes.

- **The Lightway**—Living in God's Healthy Temple (Baltimore, Maryland) is a community-based cardiovascular disease (CVD) nutrition intervention program designed and implemented in cooperation with a network of inner-city black churches.

- **Minimal Contact Education for Cholesterol Change** (Pawtucket, Rhode Island), involves several interventions designed for use in worksites, public sites, religious organizations, medical facilities, or other community settings and utilizing printed materials, a compact disk audio intervention, or brief face-to-face counseling.

- **Computer-Assisted Instruction for Weight Management** (Amherst, New York) offers an approach to nutrition education for weight management for use with adults in various inner-city settings.

Some of the learning (e.g., Language for Health in the ESL classes) is provided in the context of performing life skills functions such as using money or requesting job information. HEALTHTALK uses the popular talk-show format to increase familiarity and appeal of the learning encounter. CARDES maintains a narrative story line, initially introduced in the motivational video, involving members of an extended family, through a series of short, instructionally oriented vignettes on the 12-program audioseries.

All programs have incorporated the guidance of experts in adult education and literacy skills training (some of whom are project coinvestigators) as to how best to work around functional literacy problems (3). In brief, this advice involves:

- keeping the presentation of information direct and conceptually simple;
- providing for extensive opportunities for interaction between the learner and the instructor or instructional medium;
- judicious use of illustrations that enhance recognition and comprehension;
- formatting printed materials with sufficient white space, color, and guidance to make the reading order clear;
- where useful, incorporation of a story line to facilitate interest in and retention of the information; and
- making the information relevant to the cultural perspectives of the client group(s).

Most projects have used multiple media. All have emphasized the systematic development of educational materials and evaluation strategies that include assessment of the impact of using the educational materials in one or more ways on objectively measured risk factors such as serum cholesterol.

Each project also includes an assessment of literacy levels using either standardized tests or validated proxy measures. This enables characterization of intervention processes and outcome results according to the reading levels of those involved. Some programs used existing literacy tests while others developed specially designed instruments to assess CVD nutrition literacy. For example, CARDES developed a 20-item word recognition test (in this type of test the respondent's ability to pronounce words correctly correlates with reading comprehension) (8). The 20 words were selected systematically, by reference to scores on the standardized Tests of Adult Basic Education (TABE) for the same set of individuals, from a pool of 200 words commonly found in CVD nutrition education materials. When the word recognition test was administered to 339 black adults enrolling the CARDES evaluation trial, 164 (48 percent) scored at or below the 8th grade reading level, including 37 who had completed more than 12 years of school and 117 with 8 to 12 years of schooling. This finding emphasizes that, although literacy levels are generally associated with education level, schooling cannot be equated with having attained basic literacy skills (9).

Selected Findings

Preliminary findings from these projects illustrate the general impression that the effort spent in developing these client-centered instructional approaches is yielding success in enrolling and counseling individuals with limited literacy skills in CVD risk reduction programs. Not only is this success contrary to the common perception that such populations are hard to reach (9), but it also offers concrete potential for working around a functional aspect of lower SES that may hinder improvements in health.

- SNAP reached a multiethnic population of EFNEP participants in 24 different settings. Sixty percent had literacy levels below the 8th grade level, as ascertained with the Wide Range Achievement Test (WRAT-R). The interactive SNAP CVD nutrition curriculum involved discussions, group problem-solving activities, experiential learning, food tastings and demonstrations and utilized various printed and audiovisual materials. SNAP was compared with a standard nutrition education program.

- The Minimal Contact Education for Cholesterol Change Project is reaching a population of more than 10,000 individuals across a wide distribution of educational levels, including a substantial number of persons of Hispanic or Portuguese descent as well as some blacks, Asian Americans, and Native Americans. Preliminary data on 4,000 individuals indicate that return rates for the 3-month followup visits were highest (89 to 91 percent) among those with a high school education or more, but were almost as high (85 percent) among those with an 8th grade education or less. Three-month followup rates were above 75 percent for every ethnic subgroup.

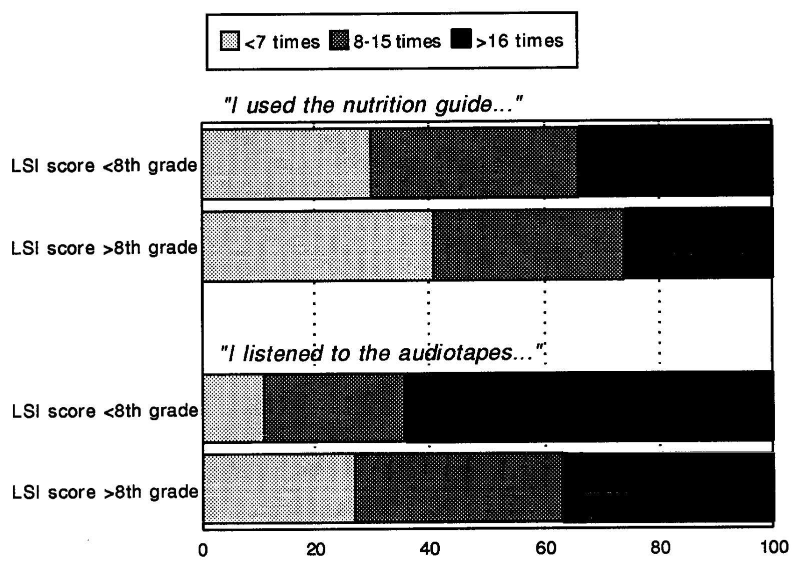

Figure 1.—*Reported Use of CARDES Materials at 4-Month Followup by Literacy Screening Instrument (LSI) Score (n=238).* *Participants are 40- to 70-year-old black men and women in Washington, DC.*
Source: *Cardiovascular Dietary Education System*

- The CARDES evaluation trial is comparing two formats for using the take-home educational package designed to facilitate dietary change in an entertaining, nonquantitative, self-help format. It enrolled men and women, ages 40 to 70, with hypertension or elevated cholesterol (*n* = 339), recruited primarily through community-based screening in local supermarkets in the Washington, D.C., community. Participants are followed at intervals over a 12-month period. Risk factors are monitored and brief nutrition counseling is given to all participants at a community-based clinic site. All CARDES participants receive a deck of 100 full-color food picture cards coded with symbols to indicate whether the food is low, medium, or high in fat, sodium, and cholesterol, with an accompanying booklet that includes replicas of the cards and additional nutrition information. Half also attend four initial monthly nutrition education classes where they watch and discuss a motivational video and receive instructional audiocassettes for home learning.

  Based on preliminary 4-month followup data as shown in Figure 1, CARDES participants reported a high frequency of using the provided materials during the first 4 months, with *greater* use reported by the subset with lower scores on the literacy screening instrument. Figure 2 shows preliminary data on risk factor changes in the overall CARDES sample. The improvements in total cholesterol and low-density lipoprotein cholesterol (LDL) and the lack of adverse changes in either high-density lipoprotein cholesterol (HDL) or triglyceride levels are noteworthy. Also noteworthy is the apparent gradual progress in risk factor change over time. This is an encouraging departure from the frequently observed pattern of a large initial change followed by a gradual loss of effect and return to baseline at followup.

Conclusions

The projects conducted under the low-literacy initiative can serve as a model for focused research that addresses *modifiable* aspects of SES-related CVD risk. These projects are illustrating effective ways to

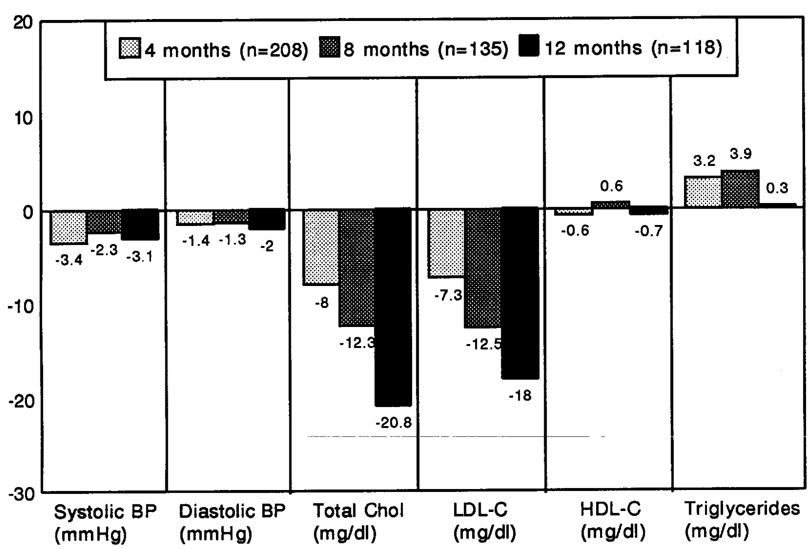

Figure 2.—*Total Sample Data for Risk Factor Changes in CARDES Participants; Preliminary Data (10/95).*
Participants are 40- to 70-year-old black men and women in Washington, DC.
Source: *Cardiovascular Dietary Education System*

reach individuals who are typically characterized as hard to reach (10). The known limitations in literacy in these study populations have forced investigators to address systematically the need to adhere to established principles of adult education as a part of these nutrition interventions. This may lead to particularly favorable or long-lasting results. In addition, the methodological aspects of the projects and the descriptive data collected on these diverse populations in conjunction with literacy assessments provide a beginning data base for specifying SES-related differentials according to literacy skills—a functional variable that is directly related to the potential for benefiting from lifestyle risk reduction programs.

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PHYSICAL ACTIVITY INTERVENTION STUDIES AND SOCIOECONOMIC STATUS

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Sedentary living is a major modifiable contributor to disease morbidity and mortality, including coronary heart disease (CHD) (1). This observation is supported by both epidemiological data and controlled clinical trials. A recent meta-analysis of more than 40 studies indicates that CHD is nearly twice as likely to develop in sedentary individuals as in active persons independent of other risk factors (2).

Furthermore, when one considers that the population-attributable risks for unfit individuals are equal to or greater than that for other traditional cardiovascular disease risk factors (e.g., hypertension, obesity, hypercholesterolemia), it follows that physical inactivity represents a considerable public health burden. From the perspective of physical activity intervention, it is encouraging to realize the major health and economic impact that can be achieved by increasing participation in regular physical activity.

Several recent epidemiological studies illustrate this point. Recent findings from the Aerobics Center Longitudinal Study (ACLS) indicate that men who changed from unfit to fit between two physical examinations (approximately 5 years apart) had a 44 percent reduction in mortality compared with unfit men who did not improve (3). This finding is particularly promising considering the men only needed to achieve a moderate level of fitness to be placed into the “fit” category. Therefore, the degree of fitness and hence physical activity required for substantial health benefits appears to be modest. Likewise, increased physical activity has been reported to produce a CHD risk reduction equal to that identified with favorable changes in smoking, weight, and blood pressure (4). Given the potential of physical activity to influence health, it is evident that programs to increase physical activity should be treated with the same urgency as the problems of hypertension, hypercholesterolemia, and cigarette smoking.

Patterns of physical activity vary among population segments with different sociodemographic characteristics (1). However, few intervention studies examine the relation between socioeconomic status (SES) and physical activity. Moreover, the overall picture is obscured by the variety of SES indicators in physical activity research and the inconsistent measurement of physical activity across research studies.

SES indicators within the physical activity literature include education level, income, occupation, and race–ethnicity. Although minority status and lower SES often co-vary, differences in physical activity associated with race (as with other health behaviors) can largely be accounted for by differences in education, income, and occupation (5). This is not to minimize the importance of targeting minority groups in physical activity research. Minority populations are generally underserved in the area of health promotion (6), and a better understanding of the relation between physical activity and race–ethnicity is necessary to maximize the effectiveness of physical activity programs for these population segments. The complex relation between race–ethnicity and SES may require special considerations in physical activity promotion.

The use of various definitions and measurement techniques for physical activity across studies is also problematic because different SES groups tend to participate in different forms of physical activity. As noted by King et al, the classification of certain population subgroups as sedentary may be a function of the type of physical activity being measured. For instance, research studies indicate that higher-SES men tend to do more leisure-time physical activity, and lower-SES men spend more time walking and doing household chores (1). How the activities are classified will affect the degree of activity ascribed to different populations. It also should be acknowledged that commonly used measures of physical activity may lack the precision and reliability to detect true differences across sociodemographic variables such as SES.

Despite the aforementioned problems in physical activity research, several trends are apparent in the literature on SES and physical activity (1):

- Lower education is associated with a more sedentary lifestyle;
- Lower income is associated with a more sedentary lifestyle;
- Blue collar occupations are associated with a more sedentary lifestyle; and
- Ethnic minorities (e.g., blacks, American Indians) appear to be less active than whites.

By virtue of their physical inactivity and given the demonstrated dose–response relation between physical activity and health benefits (1), lower-SES individuals have much to gain from becoming physically active. Nevertheless, lower-SES individuals are less likely to attend the types of programs usually offered in communities throughout the United States, and interventions designed specifically to meet the unique demands and preferences of lower-SES groups are rare. The pressing need for effective physical activity interventions in lower-income populations is highlighted by specific national objectives for increasing physical activity and decreasing inactivity in lower-income people outlined in Healthy People 2000 (6).

Data from the few programs that explicitly targeted poor, unemployed, or disadvantaged population segments demonstrate the appropriateness of such interventions despite concern from some members of the health community that there are more pressing problems, such as poverty or violence (5). The promotion of physical activity within lower-SES groups can be approached with less skepticism and more optimism. Although blue collar workers are less physically active in leisure-time, physical activity programs for blue collar workers can be successful if structured creatively to overcome certain unique barriers. For instance, lower-income environments replete with crime, unemployment, and violence may limit the opportunities for the economically or educationally disadvantaged to engage in some forms of physical activity. However, few research projects examine how changes in the community environment influence physical activity participation, despite evidence suggesting that such changes can increase health behaviors (7). Few programs target lower-SES individuals, partly because of inconvenience (i.e., difficulty recruiting and accessing lower-SES groups), partly due to differential attrition, and perhaps because of public policy.

The study of physical activity models and determinants is based in part on the understanding that physical activity interventions can be tailored (type, format, intensity, location) to meet the needs and overcome the unique barriers (i.e., special programs) of different population segments (5). Moreover, the complexity of physical activity behavior and the difficulty of producing and maintaining changes necessitate a conceptual formulation and a detailed knowledge of mediators of behavioral change. Over the past 20 years several health behavior models have been applied to physical activity (e.g., Social Cognitive Theory, Transtheoretical Model of Stages of Change [5]). Although no single model has proven superior to others, much has been learned about the operation of particular physical activity determinants that could not have been achieved through a nonconceptual approach.

Current understanding suggests that physical activity determinants vary in strength in different population segments; however, there is an unfortunate dearth of studies that specifically investigate the possible differential influence of various determinants, including SES, among diverse subgroups. This is particularly true for youth (8). Self-efficacy for physical activity, perceived barriers (e.g., lack of time), and enjoyment are important predictors of involvement in physical activity; low- to moderate-intensity activities are more likely to be adhered to than high-intensity activities; and self-regulatory skills contribute to maintenance across all age groups (1).

Individualized approaches to promote physical activity are insufficient given the breadth and complexity of the physical activity problem (5). Here we review selected physical activity studies from two basic sites of intervention: the community and the worksite.

Community Approaches

Until recently, most physical activity studies applied unidimensional interventions to physical activity with select groups rather than following a public health approach (5). Community interventions based on behavior change theories gained popularity because they can most effectively target diverse and difficult-to-access population segments by including organizational, environmental, and social components. However, physical activity was not the centerpiece of community-based interventions, and these studies did not produce sizeable increases in physical activity behavior.

To understand the unfavorable outcomes and the untapped potential of community-based physical activity interventions, it is helpful to examine two recent NHLBI community-wide multifactorial cardiovascular risk reduction projects that involved a physical activity component: the Stanford Five-City Project (SFCP) (9) and the Minnesota Heart Health Program (MHHP) (10). Each of these projects incorporated a broad range of strategies and theories aimed at multiple levels (e.g., individual, group, societal).

Despite a population-based approach and a primary prevention focus, programs for risk factor reduction in the SFCP were relatively intensive. Nevertheless, 6 years of community-wide health education demonstrated only small increases in physical activity (9). Based on these findings, Young et al cited the need to develop more effective approaches to increase physical activity than can be provided by a broad-based, community-wide health education program. This may be possible by segmenting the community into demographically homogenous subgroups (e.g., neighborhoods) that can be specifically targeted. The results of the SFCP suggest that adults may be more receptive to adopting moderately intense activities rather than vigorous activities.

Similar to the SFCP, the MHHP was a 13-year, population-wide, community-based program to prevent and reduce CHD. Consistent with the population-based approach, exposure data from the MHHP suggest that the project successfully reached multiple sociodemographic groups (10). Although the MHHP had only a moderate impact on physical activity (i.e., a small increase in kilocalories per day expended in leisure-time physical activity was noted in the early years of the study), the process data from the study are important. For instance, exercise campaign events that occurred in pre-existing community structures or were associated with traditional community events had the greatest participation (11). This underscores the importance of utilizing existing settings (e.g., worksites) and recognized events for community-based exercise promotion.

Segments of the population that were more specifically targeted through tailored strategies demonstrated better outcomes (12). In light of the MHHP goal of increasing “active lifestyles,” the message “to engage in [physical activity] at least three times per week, for 30 minutes, at an intensity sufficient to cause increased breathing and/or induce sweating” (11) was probably not the most appropriate one for this trial. Although few ethnic or low-income communities currently receive tailored programs to increase physical activity, some interventions demonstrate promising outcomes with these population segments. The Community Health Assessment and Promotion Project (CHAPP) (13) was a multifaceted intervention for women in a predominantly black community in Atlanta. To meet specific needs of this population segment, the CHAPP provided multiple offerings of moderate-intensity physical activity and related health topics. At 4-month followup, 60 to 70 percent of the participants were still active.

Worksite Approaches

The worksite continues to be an important location for reaching a large portion of the adult population with health promotion programs (6). There is a notable increase in the number of work sites offering physical activity programs over the past 15 years in the United States. The outcomes of physical activity research in the worksite are positive. Two selected studies demonstrate the applicability of worksite interventions for various SES groups.

Brill and colleagues (14) examined the recruitment, retention, and success among various demographic groups in a large clinical worksite health promotion program. Overall, participants improved in physical fitness and, perhaps most important, changes were consistent across SES groups. The Johnson & Johnson *Live for Life* program (15) took a public health approach to increase formal and informal physical activity for the entire work force. At 24-month followup, employees in companies offering *Live for Life* more than doubled their physical activity. As in the Brill study, changes were distributed across SES groups—demonstrating that clinically significant changes can be achieved through worksite interventions in both lower- and higher-SES groups.

The limitations of worksite physical activity promotion programs include lower enrollment of blue collar and less-educated workers (5). In the Brill study, recruitment rates were significantly lower for nondegree (20 percent) and bachelor's degree (31 percent) employees as compared with employees with advanced degrees (41 percent). Significantly fewer blacks than whites enrolled in the program. More baseline social marketing research and segmentation on SES to tailor worksite programs to at-risk groups are likely to yield better results.

Conclusions

- A need exists for additional physical activity research in various SES groups. This research should utilize measures with demonstrated reliability and sensitivity in different demographic groups in a manner that allows for comparison across studies. In particular, the mechanisms that produce differences in physical activity across SES indicators must be identified to develop greater understanding and improved interventions.

- Some progress has been made since the 1992 NHLBI-sponsored workshop, *Physical Activity and Cardiovascular Health: Special Emphasis on Women and Youth* (16), but there remains a need to develop theoretically based interventions that are effective for specific population subgroups. Special emphasis should be placed on lower-SES groups and minorities, because these are the groups with the highest absolute and relative risk for inactivity, and we know relatively little about physical activity interventions for them.

- Although recent research suggests that positive experiences with health behavior change in one area might favorably influence commitment to changing other risk behaviors, it is not clear whether physical activity is more successfully promoted by itself or as part of a multiple risk factor program (5). Furthermore, because physical activity has the potential to facilitate the lowering of other risk factors, there is a need to further examine physical activity within a comprehensive approach to health promotion and CHD risk reduction.

- Development, implementation, and testing of various physical activity interventions for specific SES groups is strongly indicated. Issues such as ethnicity, income, education, gender, and the possible interaction of these variables should be investigated.

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WORKSITE, COMMUNITY-BASED, AND SCHOOL-BASED INTERVENTION

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Increased cardiovascular disease (CVD) risk and poor disease outcomes in lower socioeconomic status (SES) groups have been observed for many years. However, the difficulty in engaging and improving the health of low-SES populations is also well known. Few programs are seen as effective, resulting in discouragement in the ability to narrow the health gap between high- and low-SES groups. The community, worksite, and school experience with reaching and changing the CVD risk profiles of low-SES groups is presented and reviewed here. The examples presented are population strategies that focus on educating all groups in society simultaneously, many with particular attention to the needs of the high-risk, low-SES segment. Information in this area is extensive and arguably overwhelming.

COMMUNITY TRIALS

Stanford Three-Community Study

The Stanford Three-Community Study was one of the earliest interventions to focus on improving CVD risk characteristics in whole communities. It involved three northern California towns studied in the early 1970s. The main results have been presented. This study emphasized mass media methods in the intervention towns and demonstrated a reduction in CVD risk factors. It recognized the importance of low SES and minority groups (1). The towns had a high percentage of Spanish-speaking citizens, principally of Mexican origin. The Stanford group tailored their program specifically to target these Mexican Americans, using native Spanish-speaking experts as part of the intervention team. Baseline data collection in the community found that the Spanish-speaking radio stations were the primary source of information for this population group. Thus, educational advertising in Spanish used radio heavily.

Table 1 presents data for cholesterol intake from the study. It is apparent from this table that the highest consumption of cholesterol is among lower-SES, Spanish-speaking individuals. At the end of the 2-year program, the decline in cholesterol intake was similar across all groups in the population. There is even some suggestion of an increased response among the low-SES Spanish-speaking group. Although not shown here, there are similar baseline and outcome results for diet, weight, and plasma cholesterol. The Stanford authors conclude that a mass media program that recognizes SES and minority issues can be effective at changing behaviors and CVD risk.

Stanford Five-City Project (SFCP)

The SFCP was an extension of the Three-Community Study to larger and more complex urban areas. It involved two intervention and three control communities over 8 years in the 1980s (2). The main results were published recently (2,3). Again, the Stanford group recognized the need to develop messages and communication channels that involve low-SES and minority groups in these northern California communities. The results of this effort are shown in Table 2. For men, comparison is made between the

Table 1.—Dietary Cholesterol (mg/day) at Baseline and 2 Years, by SES and Language Group, Stanford Three-Community Study

	SES Group (1 = highest SES, 5 = lowest SES)					
	1	2	3	4	5	all
Baseline						
English	451	453	442	471	480	460
Bilingual	—	—	508	526	509	515
Spanish	—	—	—	672	631	637
All	450	451	446	479	522	473
2-Year Change (5%)						
English	-20.6	-29.7	-27.6	-32.8	-33.8	-30.3
Bilingual	—	—	-50.8	-33.6	-40.5	-39.7
Spanish	—	—	—	-43.7	-39.3	-39.8
All	-20.6	-30.0	-28.9	-33.2	-37.6	-32.0

Source: Adapted from Fortmann, et al. (1), with permission. © 1982, American Heart Association.

least educated and most educated. Declines are noted in smoking, blood pressure, and blood cholesterol in both intervention and comparison communities. They are greater, on average, in the intervention communities. Both high- and low-SES groups lowered their risk factors. For men, it appears that the less-educated groups did moderately better than the more-educated groups. For women, the results were generally similar except for cholesterol, which actually rose in the intervention group. The Stanford authors conclude that one of the outcomes of a broad-based multimedia program is that all segments of society are reached and make changes.

The Pawtucket Heart Health Program (PHHP)

The PHHP was a community intervention study in Rhode Island begun in 1980. The results were published recently (4). The populations of both intervention and control communities in this study have a high concentration of low-SES groups, recent immigrants, and unemployed persons. High school graduation rates in these communities among adults are less than 50 percent. The proportion of foreign-born residents ranges from 16 to 24 percent, and unemployment ranges from 14 to 18 percent. The PHHP intervention group recognized that this population has unique characteristics, and that interventions would need to be tailored accordingly.

The PHHP reported positive differences in the intervention community at midpoint, but these disappeared later in the setting of strong and beneficial secular trends in the control town. However, evaluation by SES—with education as a measure—demonstrated increased effects in the less-educated groups. Less-educated women had a greater cholesterol decrease and less-educated men had lower systolic blood pressure and less weight gain. These group differences, however, were not significant. Contrary to these positive findings, the less-educated had smaller declines in smoking. Nonetheless, a combined risk score for CVD showed that the less-educated benefitted significantly more from this program, (risk ratio 0.63, confidence interval 0.41–0.98).

The PHHP investigators also concluded that community programs that recognize and target low-SES and minority groups in the setting of a broad community effort can produce beneficial changes.

Table 2.—Change in Risk Factors by Education Level, Stanford Five-City Project

	Intervention Communities			Control Communities		
	1979-80 (Baseline)	1985-86	Difference	1979-80 (Baseline)	1985-86	Difference
Men						
Smokers (%)						
<12 years	34.4	26.7	-7.7	46.7	44.0	-2.7
≥ 16 years	21.8	15.9	-5.9	20.3	12.9	-7.4
Mean SBP (mmHg)						
< 12 years	136.8	125.3	-11.5	136.5	128.1	-8.4
≥ 16 years	129.2	127.2	-2.0	126.0	123.8	-3.2
Plasma Cholesterol (mg/dL)						
< 12 years	207.9	198.6	-9.3	202.7	199.5	-3.2
≥ 16 years	201.9	194.1	-7.8	190.1	190.0	-0.1
Women						
Smokers (%)						
<12 years	39.8	29.3	-10.5	25.9	32.7	+6.8
≥ 16 years	23.2	14.3	-8.9	18.0	10.6	-7.4
Mean SBP (mmHg)						
< 12 years	127.9	120.5	-7.4	128.6	118.7	-9.9
≥ 16 years	122.7	115.8	-6.9	116.1	114.1	-2.0
Plasma Cholesterol (mg/dL)						
< 12 years	199.3	204.8	+5.5	211.5	204.3	-7.2
≥ 16 years	190.1	184.7	-5.4	187.9	181.4	-6.5

Source: Adapted from Winkleby, et al. (3), with permission.

The Minnesota Heart Health Program (MHHP)

The MHHP was a six-community, three-pair study involving 500,000 people, beginning in 1980. The main results have been published (5).

A particular attempt was made to involve low-SES individuals in the Minnesota program. Although there is considerable population homogeneity in the upper midwest, SES differences in CVD risks and outcomes are reported to be similar to other populations.

The MHHP produced modest changes in risk in the setting of strong and beneficial secular trends. The greatest differences were at midpoint in the program. Physical activity, blood cholesterol, systolic blood pressure, and cigarette smoking all showed modest but favorable changes. Evaluation of these changes by education and income levels indicated no independent effects and no interactions. It appeared as if lower-SES individuals received the same benefits as high-SES individuals. The MHHP also concluded that community programs that target and involve low-SES groups can effectively reach them.

COMMIT

The COMMIT involved 11 pairs of communities across the United States. Its goal was to reduce heavy smoking in intervention communities compared with control communities (6). The trial showed an 18 percent decrease in heavy smoking between baseline and 4-year followup. However, these results did not differ between intervention and control communities. The COMMIT investigators concluded that their primary goal was not met. Nonetheless, light-to-moderate smoking did fall significantly, more in the intervention towns compared with the controls. This difference in smoking was concentrated in the lower-education groups (6). Apparently, the more-educated groups did not significantly benefit from this community intervention program, but less-educated groups did.

WORKSITE PROGRAMS

There is a large literature on worksite risk reduction programs with varying results. Most have been tested in large, stable companies. Unfortunately, many low-SES, high-risk people are transient, part-time workers who lack benefits or live in rural settings. These are not included in traditional worksite programs and may constitute an important portion of the problem.

Healthy Worker Project

The Healthy Worker Project involved 32 randomized sites in the Minneapolis–St. Paul metropolitan area (7). These sites had a significant blue collar population. On-site classes and a payroll incentive program were part of a 2-year intervention aimed at cigarette smoking and weight reduction.

As shown in Table 3, significant effects were found for reduction in cigarette smoking. However, no significant changes were observed in weight as represented by body mass index. This occurred despite the fact that weight control programs were very popular. The authors concluded that smoking cessation programs can have an effect in the traditional factory setting but that weight control programs are unlikely to be as successful.

MHHP—Bloomington Project

Eight factories in Bloomington, Minnesota, with 38 percent blue collar workers, were targeted for a smoking intervention or control status (8). The intervention included on-site smoking cessation classes, nonsmoker helper classes, and smoking restriction consultation. The authors observed increased levels of quit attempts and cessation, including among blue collar workers. They concluded that one can engage factories with blue collar workers in a smoking cessation program.

SCHOOL PROGRAMS

School is one place where all segments of society join regardless of minority or SES status. It is rightly viewed as a place where quality health education can occur. Many believe that the school setting has the potential for building lifelong healthy habits.

Table 3.—Healthy Worker Project Outcomes

	Cross-Section Sample			Cohort Sample		
	BL*	2 Years	Difference	BL	2 Years	Difference
Smoking (%)						
Treatment	25.47	22.47	-3.00	24.75	21.71	-3.04
Controls	24.73	25.76	1.02	23.76	22.82	-0.93
Weight (BMI^ kg/m^2)						
Treatment	25.88	25.83	-0.05	25.88	25.86	-0.02
Controls	26.06	26.01	-0.05	26.03	26.11	0.08

*BL = baseline value ^BMI = body mass index

Source: Adapted from Jeffery, et al. (7), with permission. © 1993, American Public Health Association.

Know Your Body (KYB)

The KYB program was a complex and intense program focusing on grades four through eight in the New York schools in the 1980s (9). A unique aspect of the program is a comparison of high-SES Westchester schools with low-SES Bronx schools. Notwithstanding concerns about measurement and analysis of the KYB program, the comparison of the high- and low-SES groups is of considerable interest.

As shown in Table 4, KYB reported blood cholesterol changes favoring the intervention schools over the comparison schools. Of equal importance is the observation that these changes appeared to affect the Bronx schools at a similar magnitude to that observed in the more affluent Westchester schools. Health knowledge paralleled these changes. In addition, dietary intake changes had similar trends between the two types of schools (not shown). Although other risk factors were not significantly altered, this study suggests that programs aimed at low-SES schools can produce changes similar to those in more affluent school districts.

Child and Adolescent Trial for Cardiovascular Health (CATCH)

CATCH involves 96 schools in four sites across the United States (10). The population is ethnically diverse, comprising substantial portions of Hispanic and black students. It also includes many low-SES students, particularly at the Louisiana and Texas sites.

Although CATCH was not allowed to collect definitive SES data in the student populations, other relevant information is available. Students who ate more subsidized meals in the school tended to have higher calorie and fat consumption. Low-SES students are much more likely to have both breakfast and lunch in the schools.

Interim results of the CATCH cafeteria intervention program are shown in Figure 1. A directed cafeteria intervention with food service workers produces significant reduction in the fat calories served and consumed by students. The CATCH Program indicates that schools continue to serve less-than-healthy diets to students, but a focused intervention program can modify this food service environment and provide healthier foods to all students.

Table 4.—Know Your Body Program 5-Year Results*

	Westchester			Bronx		
Factor	Intervention	Control	Difference	Intervention	Control	Difference
Plasma Cholesterol (mg/dL)	-2.1 ± 1.0	-0.4 ± 0.7	-1.7	-2.6 ± 1.5	-1.6 ± 1.8	-1.0
Health Knowledge Score	+0.21 ± 0.08	+0.07 ± 0.07	+0.14	+0.23 ± 0.11	+0.11 ± 0.07	+0.12

*All results are given as changes in factor values between baseline and 5-year followup.
Source: Adapted from Walter, et al. (9), with permission. © 1988, Massachusetts Medical Society.

Class of 1989

The Class of 1989 Program was part of the MHHP (11). All school students in the Fargo–Moorhead (North Dakota and Minnesota) district were involved in a multiyear intervention that focused on major cardiovascular health behaviors.

Sioux Falls, South Dakota, a town of similar population size (100,000) served as the reference. There were striking differences in smoking behaviors through 12th grade. The intervention schools had rates that were less than half of those in the comparison schools. These results were confirmed by a chemical measure of cigarette smoking.

These results are among the most dramatic of any school-based smoking prevention program. The authors conclude that student curriculum plays one important role; however, the integration of the school program with a community-wide program in Fargo–Moorhead may account for a significant portion of the positive results. Fargo–Moorhead was part of the MHHP at the time the Class of 1989 project was initiated, so many elements in society were simultaneously directed toward similar health goals.

SUMMARY AND CONCLUSIONS

This review leads naturally to several conclusions. First, well-designed community or population interventions can produce healthy changes in CVD risk both in high- and low-SES and minority groups. At times, the effect has been even greater in the less educated and less affluent. These groups do, however, start at higher levels of risk.

Several elements are associated with these favorable results. Population studies that recognize differing cultural norms, including language, and target them for particular attention were effective. Studies using

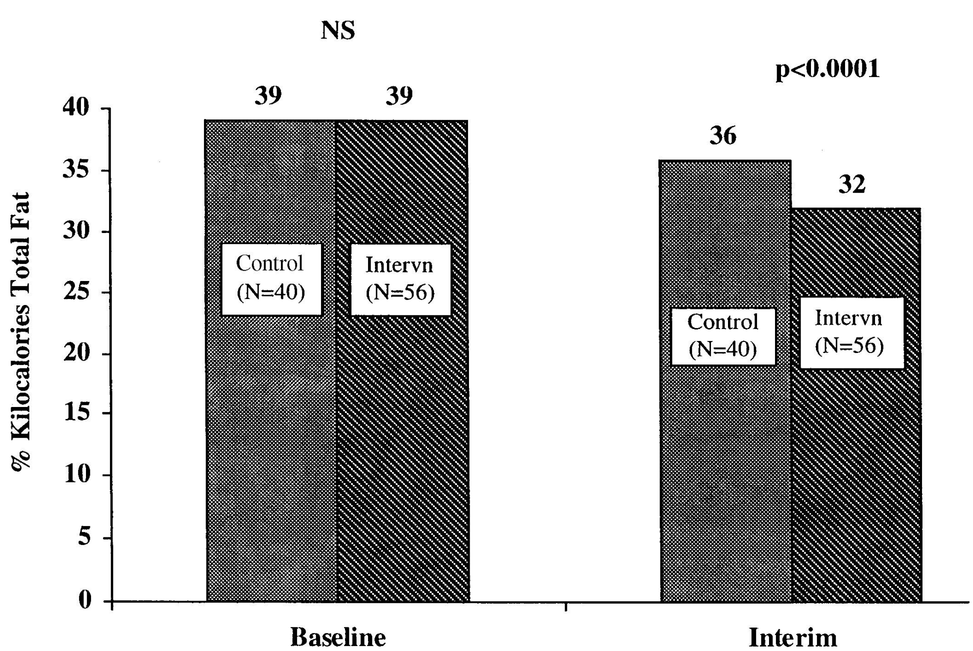

Figure 1. —*Fat Reduction in School Lunch Menus, Child and Adolescent Trial for Cardiovascular Health.*

material written at comprehension levels appropriate to the intended audiences also were more successful. The inclusion in a population study of communication channels appropriate to all SES groups, including those of lower-SES strata, appears to be of particular importance.

Another element is recognition of the need to involve whole communities in these programs. The successful programs were sensitive to the unique needs of low-SES groups, but the message was delivered to all individuals living in that population. CVD is a population-wide epidemic and, although higher rates are observed in low-SES groups, the burden to all society is great. An important observation here is that programs that work best involve all groups in society, not just high-risk, low-SES groups.

Finally, sustained programs that can be accessed by everyone and those that involve environmental alterations such as offering healthier food choices are needed.

In summary, progress has been made in the population control of CVD risk in all societal groups over the past decades. However, low-SES groups remain at higher risk than those in the upper strata. There is a need to reduce this differential. Methods are available at the population level to induce favorable changes; however, they are not widely or effectively applied. One of the important public health missions is to ensure wider application of known knowledge.

RECOMMENDATIONS

- Regular ongoing surveillance of CVD risk and outcomes should be maintained. Patterns are changing and education programs need to be tailored to current, not past, data.

- Research is needed to understand the effects of broad community programs on the cardiovascular health of individuals. This is particularly true of large-scale environmental programs and includes change in citizen access, change in regulations and development of healthy choices for nonsmoking, healthy eating patterns, and physical activity.

- Methods to disseminate current information and successful community efforts need to be maintained and even increased.

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INTERVENTIONS TARGETED TO ETHNIC MINORITIES, ESPECIALLY WOMEN

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Minorities, by definition "less than," are always disadvantaged, numerically or otherwise. Health statistics show a great disparity in health status between the various ethnic groups and the majority population. However, awareness of the magnitude of this disparity provides insufficient motivation for individuals and health professionals to close the gap.

The most accepted explanation for the gap in health status is differences in socioeconomic status (SES). There is a well-recognized relationship between poverty and ill health; moreover, because poverty, unlike genetic factors, may be remedied, universal access to health care with a strong emphasis on prevention would appear to have potential for closing the gap in health status.

Concern for health is universal. However, the pursuit of health, perception of health problems, presentation of symptoms, care-seeking behavior, length of time in care, and evaluation of care are also culturally influenced. Another factor known to contribute to health disparities is difference in health behaviors, shifting the burden toward the individual. Although lifestyle has often been emphasized, one must recognize that, even if minorities implemented all the recommended preventive behaviors, a gap would still appear in health status.

Health of a community is not exclusively an individual affair. Discriminatory attitudes of the white population toward minority groups have contributed to the disparity in health status. Minorities are discouraged not by the magnitude of the difference in health status but by their recognition that they are at a disadvantage, no matter how hard they try. In an aggressively competitive society, those with greater resources will always surpass those with fewer, yet the inherent injustices multiply when the majority criticizes the disadvantaged for not achieving the same results, whether in health status, education level, or employment.

Working for 20 years in an urban American Indian health program, I criticized the young mothers for not being more compliant in bringing their children back for regular well-baby checks or followup visits, until I realized the subsistence-level conditions in which many of these patients lived. It is difficult to prioritize coming to clinic with more than one child and waiting to see the doctor or nurse, when you may not know if you will have a place to sleep that night or where you will find the money to feed your children that day.

But we try. Programs with funding from the foundations and federal agencies now provide not only a set of statistics but resources that will help communities become healthier.

Emerging Patterns of Diabetes and Obesity

A study of the prevalence of diabetes/hyperglycemia and associated cardiovascular disease (CVD) risk factors in blacks and whites began with vital statistics records demonstrating that death rates from CVD are higher among blacks than whites in the United States. Diabetes mellitus is an important CVD risk factor, and death rates from diabetes are higher among blacks than whites. The study reported the prevalence rates of diabetes, asymptomatic hyperglycemia, and CVD risk factors in an employed population of 28,895 whites and 2,607 blacks, ages 25 to 64 years. A divergent pattern of obesity was observed, with black females being by far the most overweight. Preliminary mortality data for males suggest that both blacks and whites with diabetes have sizeably higher death rates than those without diabetes; a black–white differential is not apparent.

Diabetes was rare in Oklahoma Indians before 1940. In the 19th century, they were typically very lean. Most were active in outdoor activities; many were nomadic hunters and meat eaters. In the past several decades, however, Indian lifestyles have changed completely. Outdoor activities have declined drastically, but the Indian diets, concepts of ideal weight, and metabolic system are largely unchanged. Apparently, the consumption of calories is excessive in relation to energy expenditure. This excess is substantially derived from a high-fat diet, which was necessary in the past.

Attitudes toward adiposity also play an important role. It is believed by middle-aged Plains Indian women that they should weigh about 50 pounds more than what would be considered ideal by upper-class white women. This concept may have originated during the era of confinement at the Fort Sill brigade, when most of the Indians living there were very lean, and overweight or abundant women were considered beautiful. It is interesting to find that diabetes rates and obesity levels increase significantly as the degree of "Indianness" increases.

There is no doubt that both genetic and environmental factors contribute to the high prevalence of diabetes in Oklahoma Indians. The diets, opinions, and attitudes toward obesity are essential environmental factors. Thus, in addition to basic research on genetic, metabolic, and biochemical characteristics related to diabetes, the importance of cultural effects cannot be ignored.

Diet and Culture

Nutritional management is the cornerstone of any treatment program for diabetes mellitus, either insulin-dependent (IDDM) or noninsulin-dependent (NIDDM). However, compliance with the diet prescription by American Indians with diabetes is low. A study found that of 90 Cherokee Indians with NIDDM, only 14 percent reported themselves in compliance with the diet order. Nearly one-fifth of the sample had difficulty using the exchange system for meal planning, and 12 percent did not follow the diet because they wanted to use local foods and cooking methods.

All people use food in culturally defined ways. Everyone must eat, but what people eat, how they eat it, and with whom vary from one culture to another. Culturally determined food behaviors include food production, processing, and preservation; consumption; ritual use of foods; food taboos; and sharing food with others.

In many American Indian cultures, food has great religious and social value. Food is an integral part of the numerous celebrations and the main attraction at feast day celebrations, powwows, and religious ceremonies. Hospitality, which includes serving food, is a serious obligation. It is socially and culturally unacceptable for a guest to refuse food offered at these occasions.

Food also has a significant role in traditional medicine. Sioux Indians have a high regard for traditional foods and medicinal plants. Florida Seminole Indians using Indian medicine revealed that they could not follow diets as prescribed by biomedical practitioners because many fruits and vegetables are forbidden while using traditional medicine.

Targeted Interventions

Obesity is a major health concern for most American Indian tribes. The increasing rates of obesity and diabetes may be related to recent changes in lifestyle among many American Indian tribes. Modernization has resulted in three major lifestyle changes: 1) reduced energy expenditure due to sedentary lifestyles; 2) change from a diet high in fiber and unrefined carbohydrates to one high in refined and simple carbohydrates and low in fiber; and 3) stress due to acculturation.

It is important to note the wide use of the commodity program in Indian country. Peanut butter, butter, cheese, canned meats, flour, rice, and canned vegetables and fruit are nutritious if prepared properly and in proper amounts. These foods, along with food from the federal Women, Infants, and Children Program (WIC) vouchers (i.e., milk, cheese, cereal, eggs), are high in fat content. Poverty rates in the Indian community are high and families rely on these food supplement programs to feed their children. It would be beneficial for the nutritionists in these communities to teach cooking techniques and menu preparation using available foods rather than preferred foods.

For many centuries the Zunis and other Pueblo Indians prided themselves on a tradition of fitness; many tribal members were runners of great strength and endurance. During the last century their lifestyle has become sedentary, resulting in obesity and diabetes. In 1976, the diabetes rate for Zuni Indians over age 45 was 25 percent. In an effort to reduce obesity, prevent diabetes, and revitalize cultural values, a fitness program was initiated on the Zuni Indian Reservation in 1983. It includes weight control programs, exercise classes, running clubs, and a variety of other fitness activities. And it began with one woman and the health educator. Persistence and positive results expanded the program, and it has been very successful. Overweight Zuni Indians have lost weight, tribal members with diabetes have stopped taking medications because their fasting blood sugar levels have gone down, and the Zuni tradition of fitness has been rekindled.

Cultural diversity challenges health practitioners and educators. We must become aware of our own health beliefs, attitudes, and values to bridge crosscultural gaps with our clients successfully. Health care providers must recognize and respect clients' cultural heritage and adapt their education and treatment programs appropriately. Some techniques and approaches that address the challenges posed in providing culturally relevant preventative medicine and health education include the following:

- Recognize and respect each client’s health care beliefs;
- Learn about the community's cultural food behaviors;
- Develop culturally relevant education programs to teach self-care skills;
- Develop community and family support; and
- Increase involvement by the minority population.

We must recognize the power of culture to prevent disease and promote health. Cooperation and receptivity increase when the client knows that the health care provider values and respects cultural differences. This respect, along with a genuine interest in each client, can lead to better health outcomes.

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NATIONAL CARDIOVASCULAR DISEASE EDUCATION PROGRAMS

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The National Heart, Lung, and Blood Institute (NHLBI) serves as the lead agency for the Heart Disease and Stroke Priority Area of the Healthy People 2000 national disease prevention and health promotion objectives. Since launching the Healthy People 2000 objectives for the nation, the United States has witnessed noteworthy declines in the death toll of coronary heart disease (CHD) and stroke. Prevention—lifestyle improvements by the American public and better control of the risk factors for cardiovascular disease (CVD)—has been a major factor in these declines. Blood lipid levels, specifically total cholesterol, have been reduced as Americans have adopted heart-healthy eating patterns. Average blood pressure levels have dropped, and blood pressure control in the United States is among the best in any industrialized nation. Cigarette smoking rates—although now appearing to level off—have declined over the years, with fewer people beginning to smoke.

During the past 15 years, these improvements have been associated with a continuing decline in population levels of CHD and stroke. Most of these positive changes, however, still fall short of the national goals set forth in Healthy People 2000. The prevalence of overweight has increased, moving away from rather than toward the Healthy People 2000 target. Prevention efforts have not reached all segments of American society equally: Minorities and persons of low socioeconomic status (SES) have not seen the same degree of improvement in lifestyle and risk factor control. Predictably, these differences also are reflected in death rates for CHD and stroke: The rates are higher, and the decline has not been as substantial for some special populations. If this phenomenon persists, it will jeopardize achievement of the nation's goals for the year 2000.

These challenges are being addressed by a broad-based, twofold strategy for risk reduction that involves a high-risk approach for persons at increased risk for CHD and stroke, as well as population-wide efforts that emphasize primary prevention. The high-risk approach through the medical model seeks to improve identification and treatment of individuals at increased risk for CHD and stroke through development of treatment guidelines for health professionals and patient education materials. The population-based strategy uses the public health approach to reduce the prevalence of risk factors in the population. Both approaches rely on three central principles that have served as a foundation for effective prevention strategies of the past.

The first principle is that prevention programs must rest squarely on a base of scientific evidence ranging from basic science and animal models to epidemiological, clinical, and prevention demonstration studies. Thus the NHLBI—as the lead agency—is strategically linked to the science base. This science base provides the crucial evidence that interventions aimed at lowering CVD risk factors actually will reduce the toll of CHD and stroke in the general population, as well as the risk for those at high risk for CHD and stroke.

The success of these strategies relies on a two-way relationship between prevention education and research. Epidemiologic and other studies have identified CVD risk factors. Clinical trials have assessed new therapies and potential benefits of treatment. Community-wide studies have demonstrated that population-wide strategies of disease prevention and health promotion are feasible and that the environmental change programs in the community are effective. Survey research has assisted the NHLBI in understanding the target audience and evaluating the program progress by documenting changes over time in public and professional knowledge, attitudes, and behaviors. As the science base changes, recommendations for medical practice or population-wide education efforts change to reflect the new knowledge. The research responds by addressing gaps in the knowledge, barriers to reaching particular targets of these education efforts, or barriers to applying this research to practice.

The second principle is that effective prevention strategies must involve a variety of organizations that operate as a partnership. The mission to reduce death and disability from CHD and stroke is larger than all the organizations involved—heart disease is the leading cause of death in the nation, and stroke is the third leading cause of death. To meet this challenge, the NHLBI coordinates the National High Blood Pressure Education Program (NHBPEP) and the National Cholesterol Education Program (NCEP). Both operate by building partnerships with a broad network of organizations to reach a wide audience. The most salient example of partnerships in the national programs is that of the NHBPEP and NCEP Coordinating Committees. These two committees serve as the Healthy People 2000 Working Group for CHD and Stroke. Representatives of more than 40 nonprofit organizations constitute the coordinating committee of each program. The membership includes major medical and health organizations, voluntary health organizations, community programs, and government agencies committed to improving the health of the nation through education, better treatment, and prevention.

Partnerships with these organizations are forged to meet the special needs of specific minority populations, to reach children and young adults to encourage healthy eating and increase physical activity, and to disseminate patient education materials of the NHBPEP and NCEP to the appropriate target audience. The year 2000 objectives address all Americans, and special alliances are joined to reach Americans outside the traditional health care system—children, minorities, and the underserved.

Other examples of partnerships include the state and community alliances to reduce the burden of CVD nationwide. On February 1, 1995, the Association of State and Territorial Health Officials and its state affiliates for chronic disease, health promotion and education, and public health nutrition unveiled an action plan for preventing and controlling CHD and stroke.

The third principle is that public, professional, and patient education relies on the use of effective communication strategies. The programs utilize the efforts of all the coordinating committee organizations to carry out these education activities. All three audiences are important targets for messages about CVD risk factors. In professional education, the programs use materials and kits for physicians, continuing medical education activities, and presentations at professional meetings. Educational materials for patients are distributed both through professionals and directly by the NHLBI Information Center. For the public, the programs develop public service announcements for radio and television, print ads for newspapers and magazines, airport posters, billboards, fact sheets, and other publications.

The remarkable coalescence of scientific evidence on the causes and prevention of CHD and stroke and community studies on the dissemination of prevention messages has resulted in strategies that have changed medical practice, public health policy, and attitudes and lifestyles among large numbers of Americans.

More intensified outreach efforts will be needed, however, to reduce the disparity of disease burden seen in certain minority and lower-SES populations. For example, blacks have the highest risk of developing and dying from a stroke. Blacks also have a higher prevalence of the major modifiable risk factors for stroke—high blood pressure and cigarette smoking. Eleven states (Alabama, Arkansas, Georgia, Indiana, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, and Virginia) have age-adjusted stroke mortality rates that are more than 10 percent higher than the national average. All except Indiana are in the Southeast. The above-average stroke death rate in this “Stroke Belt” exists for each sex–race group (black and white men and black and white women).

The NHLBI designed a Stroke Belt Initiative to assist state health departments in delivering more effective interventions to reduce the overall risk of stroke in the region. The projects fall in one of four general education and intervention categories: (1) intervention in health department clinics and outreach services, (2) church-based risk factor intervention programs, (3) community education and intervention programs, and (4) public education campaigns using the mass media.

Interventions in Health Department Clinics and Outreach Services

The **Alabama** project uses quality assurance audits and patient recruitment strategies to improve and expand existing hypertension detection, treatment, and followup interventions. Quality assurance audits are used to increase the rate of hypertension control among underserved populations by improving the level of care in 42 county health department clinics. An audit team visits the clinics and reviews patient charts for compliance with 27 standards. For any standard that is more than 10 percent deficient, a plan of action to correct it must be developed. Counties with excessive deficiencies receive followup audits to determine whether they have implemented the corrective plan of action. The second strategy is patient recruitment and coordination. A patient coordinator–recruiter works with four selected county health units with low patient loads to increase patient enrollment. Thus, more patients receive an improved level of care.

The **Indiana** State Department of Health has expanded its emphasis beyond hypertension control to include smoking cessation. The project targets low-income and minority populations in two health centers and their adjacent housing projects in Indianapolis. Physicians refer patients with one or both risk factors. Health educators work with patients with high blood pressure to set goals for lifestyle change. They meet with patients during regular office visits with the primary care provider. They also follow up on missed office visits and try to solve adherence problems. Patients with difficulties may receive additional counseling by the health educator and free nicotine patches. The health educators also promote the use of social and family support for all patients.

The **Kentucky** project consists of three components. The first is a training program on the role of the community health nurse in CVD. The nurses receive a 6-hour course on how to give effective smoking cessation advice to patients. The second component is a smoking cessation program that includes smoking cessation classes and support groups for local health department staff, especially the 800 nurses employed by the Kentucky Department of Health Services. The third component provides extended followup to smokers who agree to quit and receive a prescription for nicotine patches from the health department. The program requires all smokers to attend a support group. Public health nurses conduct followup by telephone and mail beginning on the date the patient's prescription expires and continuing for 6 months.

Church-based Risk Factor Intervention Programs

The **Louisiana** Office of Public Health promotes the control of high blood pressure and other risk factors (diet, exercise, and smoking) in churches throughout the state. Health department staff support and maintain 26 church programs in the New Orleans area and subcontract with a medical center to support programs in 60 churches in northern Louisiana. The intervention strategy includes the following: (1) establishing and training volunteer coordinators in each church, (2) certifying lay blood pressure workers in each congregation, (3) conducting focus groups and taste tests to promote dietary changes, and (4) conducting outreach activities to develop community support and encourage collaboration among local churches.

The **Virginia** project is a cooperative effort between the Virginia Department of Health and the Baptist General Convention to promote stroke risk reduction programs in black churches. The project focuses on delivering hypertension control, smoking cessation, and nutrition and weight loss programs to black churches. The project (1) recruits and trains nurses and blood pressure measurement specialists in the Baptist General Convention churches to serve as area coordinators and to train other volunteers in hypertension detection and control, smoking cessation, and nutrition programs, (2) develops, produces, and distributes an easy-to-read manual on high blood pressure, smoking cessation, and nutrition, (3) develops, produces, and distributes with church pastors and members, a health-related brochure for churches, (4) provides incentives for pastoral and congregational participation, and (5) provides training to Baptist General Convention coordinators as well as health department staff members, who often assist in blood pressure screening and referral activities.

Community Education and Intervention Programs

The state of **Arkansas** is applying community organization approaches to help 10 communities in 14 counties to promote stroke prevention activities. Two graduate school interns, a health educator, and a social worker organize planning groups and prepare them to carry out stroke risk reduction activities. They work with area managers and local health unit administrators to identify local leaders and form planning groups. The planning group in each community selects the education program and the methods of delivery.

The **Mississippi** hypertension education and intervention program targets high-risk populations in the state's largest health districts. The project placed blood pressure measurement machines in the six southernmost counties, offering people a way to check their blood pressure for free. The machines display a message instructing persons with elevated blood pressure to see a doctor and advise those without a source of care or resources to pay for care to call a toll-free number. The project nurse helps callers find a source of care, and also arranges for drugs, nutrition counseling, and social services as needed. During 6 months of operation, the machines recorded 22,277 blood pressure readings. The project also has a community education component to support the use of hypertension detection and referral services by arranging or conducting presentations and other education activities at churches, schools, businesses, community agencies, and other appropriate groups.

The **South Carolina** Strike Out Stroke Project is a 3-year effort to improve hypertension awareness, treatment, and control among blacks and increase the number of community-based hypertension control programs serving blacks. Churches, fraternities and sororities, barber shops and beauty shops, and black colleges are the targets for education and intervention programs by local health departments. The project trains local health department staff to identify black institutions and organizations to target, conduct training workshops, and provide technical assistance in carrying out hypertension education and control activities.

In **Tennessee**, smoking reduction efforts are promoted in three major metropolitan communities with large black populations (68.6 percent of all the state's blacks live in the three counties). The role of the Tennessee Department of Health is to coordinate services of three independent but related projects managed by the Chattanooga–Hamilton County Health Department, the Metropolitan–Davidson County Health Department, and the Preventing African American Strokes From the Use of Tobacco (PAAST, Inc.) coalition.

In Chattanooga, the health department incorporated a smoking cessation component into a state-funded hypertension project at a community health center. The project also works with the Tobacco Use Project Task Force to train individuals in housing projects to lead smoking cessation groups for other residents. Working with the Minority Involvement Committee of the American Heart Association, the project offers smoking cessation and hypertension control programs in black churches.

In Nashville, the health department helps black churches establish smoking cessation and weight reduction programs. Members at five churches formed health promotion teams to coordinate project activities. The teams developed a children's letter-writing campaign, a stage play about risk factors, and food-tasting demonstrations. In the letter-writing campaign, children from the churches wrote letters asking a significant adult in their lives to stop smoking. Each child follows up at 3, 6, and 12 months to see if the adult has stopped smoking. A playwright from a participating church agreed to write a play about CVD and stroke risk factors that actors perform during church services. The play, when perfected, will be videotaped for wider distribution.

PAAST, Inc., also located in Tennessee, is a coalition established to educate the black community about the harmful effects of smoking and overweight and to stimulate community-based smoking and weight control programs. The coalition targeted three black churches for health promotion activities. During the first year, the weight control component enrolled 136 members of the congregation, compared with only 14 for the smoking cessation program. The Youth Mentor Program consists of 20 black teenagers who make presentations on risk factors to adult and youth organizations. They encourage smoking cessation and lead support groups for adults who want to quit.

Public Education Campaigns Using the Mass Media

The **Georgia** project encourages persons aware of their high blood pressure to stay on treatment. The Georgia Department of Human Resources subcontracted with a communications firm to assist in developing and promoting a mass media campaign, which involves TV, radio, and print media. The project trains local health department staff to work with local media to promote the campaign, and it also conducts the successful Strike Out Stroke campaign with the Atlanta Braves professional baseball team. This includes public service announcements, live TV coverage, and blood pressure screening and other activities at the stadium during selected games. A working relationship is being developed with smaller TV stations outside Atlanta and with the Black Radio Network of Gospel and Talk Radio Stations. The print campaign includes feature articles, health reports, human interest stories, and letters to the editor for small-town newspapers. Finally, the Georgia Department of Human Resources installed automated blood pressure, pulse rate, and weight monitoring equipment in one of the state office buildings providing service to more than 1,700 state employees.

The **North Carolina** project targets blacks and features a mass media education campaign, distribution of culturally sensitive educational materials, and training for local health department staff members. The project targets the 36 county health departments that receive funds to implement hypertension control programs. The community awareness and mass media activities concentrate on radio and target the four major media markets with large black audiences. The campaign emphasizes the importance of hypertension control as the most important step to reduce the risk of stroke. Local health department staff members also received training on using mass media approaches. The project staff developed and is mass-producing culturally sensitive materials and providing them to local health department clinics, rural health centers, and worksite health promotion programs.

The progress made toward meeting the Healthy People 2000 objectives suggests that CVD prevention programs are having a substantial effect. Of the 17 objectives in the CHD and stroke priority area, data for 14 objectives show progress toward meeting the year 2000 targets, including one objective that has already been met. From 1972 to 1992, the CHD death rate declined about 58 percent. In 1990, 76 percent of the population had their blood pressure measured within the previous 2 years and could state whether it was normal or high. The year 2000 target of 90 percent is attainable. Eighty percent of those who have been told they have high blood pressure are taking action to control their blood pressure; the target for the year 2000 is 90 percent. From 1978 to 1990, the mean serum cholesterol level fell from 213 mg/dL to 205 mg/dL, and the percentage of the population with high blood cholesterol fell from 26 percent to the year 2000 target of 20 percent.

The progress that has been made demonstrates the effectiveness of science-based public health strategies that rely on partnership between government and the private sector in combating the barriers to reducing CHD and stroke in the population. Although the challenges ahead must be addressed to reach the Healthy People 2000 objectives, the progress to date shows what can be accomplished when the different sectors of society join forces to address a common problem.

APPENDIX

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