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Health and Aging in the Alameda County Study

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INTRODUCTION

It is only relatively recently that the aging process and its relationship to health has attracted the interest of epidemiologists. The impact of age on the health outcomes that have become so prevalent during the last half century is so strong, that it became common to simply include age in all analyses as an adjustment variable. Although this strategy permitted public health researchers to get on with many important tasks, including the development of the preventive approaches that have been so successful, it led to a pervasive lack of knowledge concerning the relationships between aging and health.

The increasingly important changes in the age structure of the United States, and most industrialized countries have, fortunately, led to a revaluation of this perspective, and an explosion of research in the epidemiology of aging. Based on the new evidence, there are several evolving view points that need to be emphasized. First, there is now a general recognition that the elderly of today are different from those of the past. In addition to occupying a substantially greater proportion of the population, today's elderly differ on a wide variety of demographic, social, and behavioral dimensions from those of earlier generations (Riley, 1981). Critical comparative issues concerning the health of the elderly, the discussion of the compression of morbidity, are being hotly debated (Fries, 1980, 1983, 1984; Manton, 1982; Schneider & Brody, 1983; Schneider & Guralnik, 1987). Second, a growing literature documents the importance of not confusing disease with aging. Chronic, degenerative diseases are now being seen as separate from aging, and not a necessary result of aging (Rowe & Kahn, 1987). Third, the wide variations, with aging, in health trajectories

and outcomes suggest that there may be distinctly different pathways of aging, and there is an increasing recognition of the need to acknowledge this enormous variability (Manton & Soldo, 1985; Rowe & Kahn, 1987). Finally, at the same time as there is increasing interest in the physiology and molecular biology of aging, there is a growing appreciation of the need to study aging within a broad perspective that includes behavioral, social, demographic, psychological, and other factors (Kaplan & Haan, 1989; Kaplan, Seeman, Cohen, Knudsen, & Guralnik, 1987; Lazarus, Kaplan, Cohen, & Leu, 1989; Rowe & Kahn, 1987; Seeman, Kaplan, Knudsen, Cohen, & Guralnik, 1987).

It is important not to lose sight of the steep increases with age in the prevalence and toll from many diseases. For example, Fig. 3.1 shows the exponential increases in death rates that occur with increasing age (National Center for Health Statistics, 1988). Similar increases are seen for most of the morbidities that exact the biggest population burden. Given the rapid rise in morbidity that is coincident with increasing age, and the large increases in life expectancy at the older ages (Brody, Dwight, & Williams, 1987), it is of great importance to know if preventive efforts might be efficacious for older persons (Kaplan & Haan, 1989).

Epidemiologic approaches to prevention have, generally, started with the identification of associations between risk factors and health outcomes, leading ultimately to interventions directed at preventing, removing, or lowering the levels of these risk factors. However, the examination of such associations in older persons has been influenced by several beliefs. It has long been believed that persons who survive to older ages represent a select group of the

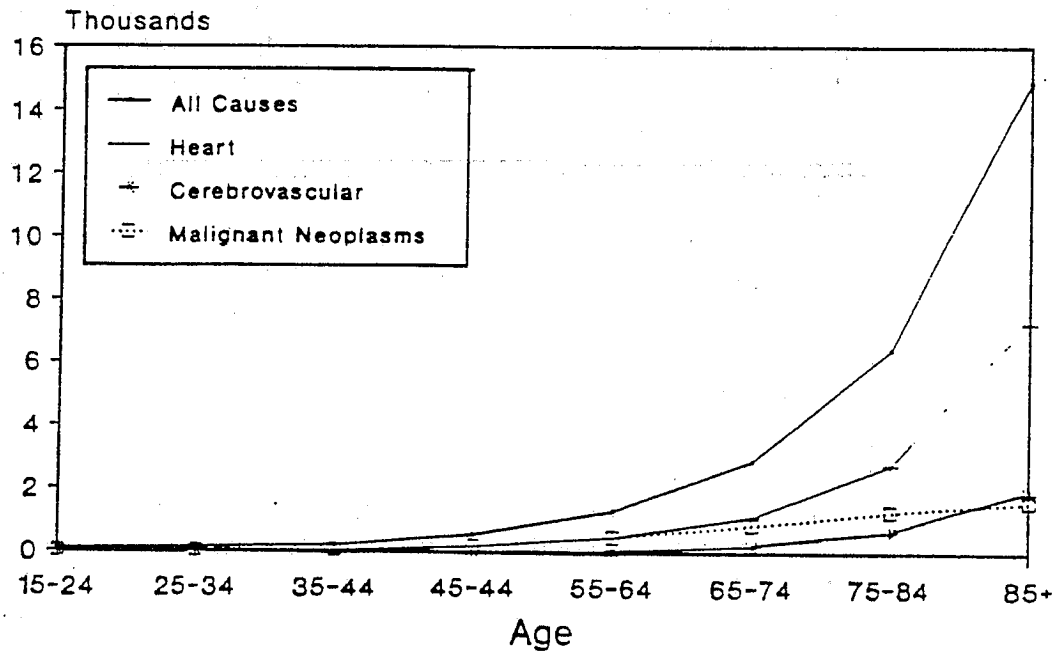

FIG. 3.1. Annual mortality rates (per 100,000) for all causes and selected causes and selected causes by age, United States, 1984.

population for whom a specific risk factor might have been relatively unimportant. For example, from this perspective tobacco exposure should not matter for a person aged 70 or older because those who were truly susceptible to the impact of tobacco exposure would already have suffered premature deaths from heart disease or lung cancer. Also, given the cumulative effects of exposure to risk factors, it was felt that changes late in life could not reverse the damage that had already been caused by smoking or other risk factors. Early studies indicating that risk factor effects declined at the older ages generally supported such views (Kannel & Gordon, 1980).

Although those who survive to older ages undoubtedly reflect a selected population, the impact of this selection is complex (Vaupel & Yashin, 1985), and does not guarantee that risk factor effects will be negligible at older ages. The impact of these selection factors is real, however, it needs to be emphasized that most chronic diseases are multifactorial in nature, with no one risk factor accounting for the bulk of the disease experience. Furthermore, even if the association between a risk factor and a health outcome decreases somewhat among older persons, the greatly increased risk of the outcome in that group means that the risk factor can still have a significant population burden of compromised health. Finally, for reasons that are not entirely clear, the majority of recent studies differ from the earlier studies in that they have indicated a substantial role for behavioral, social, demographic, and, to a limited extent, psychological risk factors in the health of older persons.

In what follows, we examine this latter point in some detail using data collected as part of the Alameda County Study, a large-scale prospective study of adult residents of a typical urban county that was initiated in 1965 by the Human Population Laboratory of the California Department of Health Services (Berkman & Breslow, 1983; Hochstim, 1970). Unlike many of the population-based studies initiated around that time, the 1965 Alameda County Study had no upward restrictions on age. The result was a baseline sample that numbered almost 7,000, with an age range of 16–94 years. These respondents have been followed up on two occasions, 1974 and 1983, and their mortality and cancer morbidity experience has been monitored continuously since the study's inception.

DETERMINANTS OF MORTALITY FROM ALL CAUSES

Health Status

Because most of the causes of death among older persons represent the consequences of cumulative disease processes, it is not surprising that chronic conditions and symptoms reported by Alameda County Study respondents are strongly associated with subsequent risk of death. For those who were 60–94

years old in 1965, the self-reports of heart trouble, high blood pressure, diabetes, chest pain, or shortness of breath were associated with a 45%–60% increased risk of death, compared to those without the particular conditions, over the next 19 years. Those 45% who reported all five conditions and symptoms were at a three-fold risk of death (Relative Hazard = 3.00, 95% Confidence Interval, 2.68-3.35) compared to the 55% who reported none. In other analyses, those with 3 or more conditions and symptoms out of a list of 22, were at 1.24-fold increased risk of death (95% Confidence Interval, 1.03-1.49) compared to those who reported none (Seeman, Guralnik, Kaplan, Knudsen, & Cohen, 1989). Global perception of health status, perceived health, was also strongly associated with risk of death. Over a 9-year follow-up period, men and women over 60 years old who reported that their health was "poor" were at 1.52 and 2.82-fold increased risk of death, respectively, compared to those who reported their health "excellent" (Kaplan & Camacho, 1983). This increased risk was independent of other measures of physical health status, health practices, social network participation, and other covariables.

Behavioral Factors

A number of behaviorally-related factors have been identified as strong determinants of mortality risk in older Alameda County Study participants. Figure 3.2 presents the results of these analyses for those 70 years or more old who were followed for mortality over a 17-year period (Kaplan et al., 1987). Even among those who had survived until age 70, smoking continues to exact a significant toll. With adjustment for age, sex, baseline health status, and other significant predictors, those who were current smokers had 1.43 times (95% Confidence Interval, 1.08-1.89) the risk of death of those who were never smokers. Past smokers did not differ significantly from never smokers (Relative Risk = 1.01, 95% Confidence Interval, 0.76-1.33). In additional analyses, quitting smoking was shown to have a significant protective effect on subsequent mortality (Kaplan & Haan, 1989). Among those 50–94 years old in 1965, the risk of subsequent death for those who quit smoking between the 1965 baseline interview and a follow-up interview in 1974 was considerably different from those who continued smoking. Compared to never smokers, 1965–1974 quitters were at 33% increased risk (Relative Hazard = 1.33, 95% Confidence Interval, 0.98-1.82), whereas those who continued smoking were at 76% increased risk (Relative Hazard = 1.76, 95% Confidence Interval, 1.35-2.31). Those who quit before the baseline interview did not differ from those who never smoked (Relative Hazard = 1.06, 95% Confidence Interval, 0.79-1.42).

Physical activity and changes in level of physical activity were importantly associated with mortality risk among older respondents in the Alameda County Study. In analyses examining the 17-year mortality risk of respondents 70–94

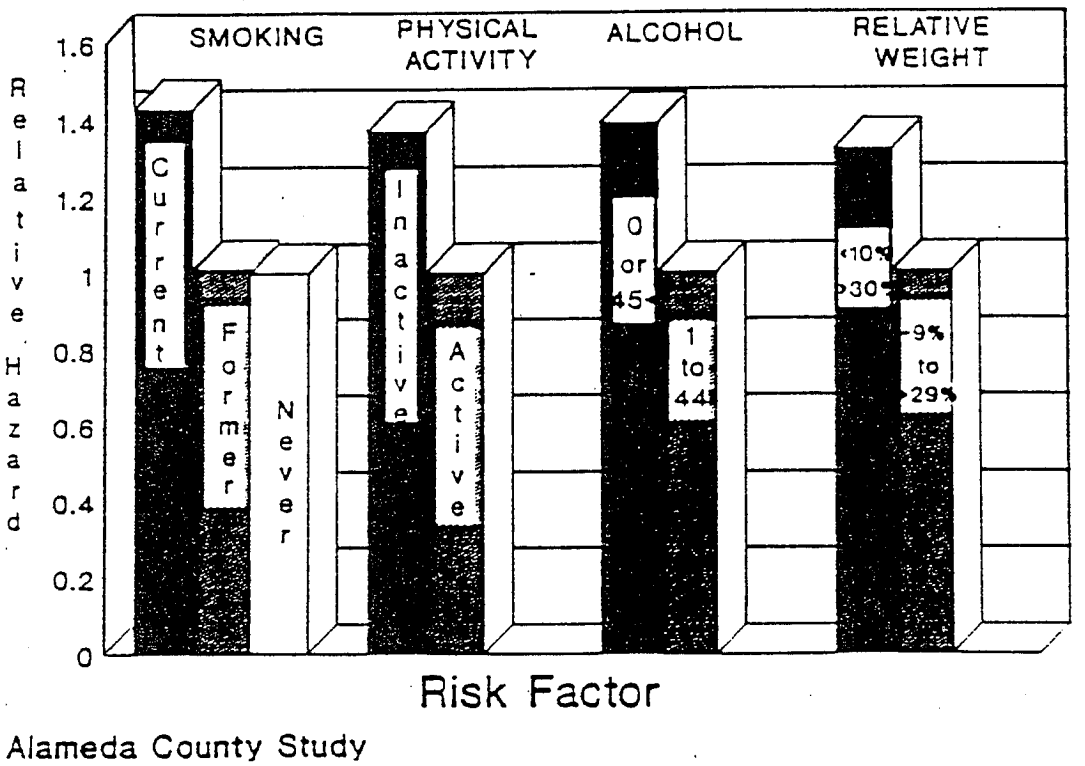

FIG. 3.2. Association between behavioral risk factors and 17-year risk of death in those 70–94 years.

years old, physical inactivity was associated with a 37% increased risk of death (Relative Hazard = 1.37, 95% Confidence Interval, 1.09-1.72), with adjustment for age, physical health status, smoking, and relative weight (Kaplan et al., 1987). Interestingly, this increased risk associated with physical inactivity varied very little from that for the younger respondents. Changes in level of physical activity were also importantly related to subsequent risk of death (Kaplan & Haan, 1989). Respondents aged 50–94 who increased their level of physical activity were at significantly decreased risk compared to those who maintained the same level, and those who decreased their level of activity were at significantly increased risk. This impact of change in physical activity level on subsequent risk of death was maintained in analyses restricted to those who were healthy at baseline, and were independent of incident chronic conditions, alcohol consumption, smoking changes, weight changes, and body mass index.

Alcohol consumption is also related to risk among the older members of the Alameda County Study, with those who abstained or consumed more than 45 drinks per month at increased risk compared to those who consumed 1–25 drinks per month (Kaplan et al., 1987). In this case the increased risk was 39% for the first two groups compared to the moderate drinkers (Relative Hazard = 1.39, 95% Confidence Interval, 0.94-2.05). Analyses of the association between changes in alcohol consumption and subsequent risk of death,

currently underway, suggest that the increased risk among abstainers is due primarily to those who are former drinkers but who stopped drinking. The presumption being that the change in drinking habits was associated with health status changes (Lazarus, Kaplan, & Cohen, 1991).

Relative weight, which is partially influenced by behavioral factors, was also related to risk of death. For those 70-94, being more than 10% underweight or 30% overweight was associated with a 32% increased risk (Relative Hazard = 1.32, 95% Confidence Interval, 1.05-1.67) compared to those of moderate weight (Kaplan et al., 1987). Changes in weight, for those 50-94 years old, were also associated with risk of death (Kaplan & Haan, 1989). The main increased risk was associated with decreases in weight, with a 14-pound decline over a 9-year period resulting in a 48% increased risk of death compared to those who maintained the same weight (Relative Hazard = 1.48, 95% Confidence Interval, 1.18-1.85). These results, which have been confirmed in other studies, suggest that unintentional weight loss among the elderly is cause for concern.

Social Factors

Figure 3.3 illustrates the association between a number of measures of social connections and mortality risk in Alameda County Study respondents 70-94 years old in 1965 (Seeman et al., 1987). Being unmarried, which at younger ages is associated with increased risk in this cohort, is no longer so associated in those over 70 years old (Relative Hazard = 1.15, 95% Confidence Interval, 0.93-1.43). On the other hand, those who reported fewer than five close friends or relatives seen at least once per month, labeled socially isolated, were at 31% higher risk (Relative Hazard = 1.31, 95% Confidence Interval, 1.05-1.62) than those who reported a greater number of contacts. Nonmembership in church groups and in other types of groups were both associated with increased risk (Relative Hazard = 1.32, 95% Confidence Interval, 1.08-1.62 and Relative Hazard = 1.20, 95% Confidence Interval, 0.99-1.46, respectively). A summary measure of social network participation, the Social Network Index (Berkman & Breslow, 1983), was also strongly associated with risk of death in those over 70 years old. Those who were in the lowest category of the index had a mortality risk that was 1.69 times higher (95% Confidence Interval, 1.24-2.29) compared to those in the highest category.

Changes in social contacts are also important predictors of mortality risk in this cohort. Nine-year declines in numbers of close friends, close relatives, number of close friends and relatives seen at least once per month, and total numbers of contacts were all associated with increased risk of death compared to those who did not experience such declines (Kaplan & Haan, 1989), the increased risk ranging from 22% to 77%. These results were independent of

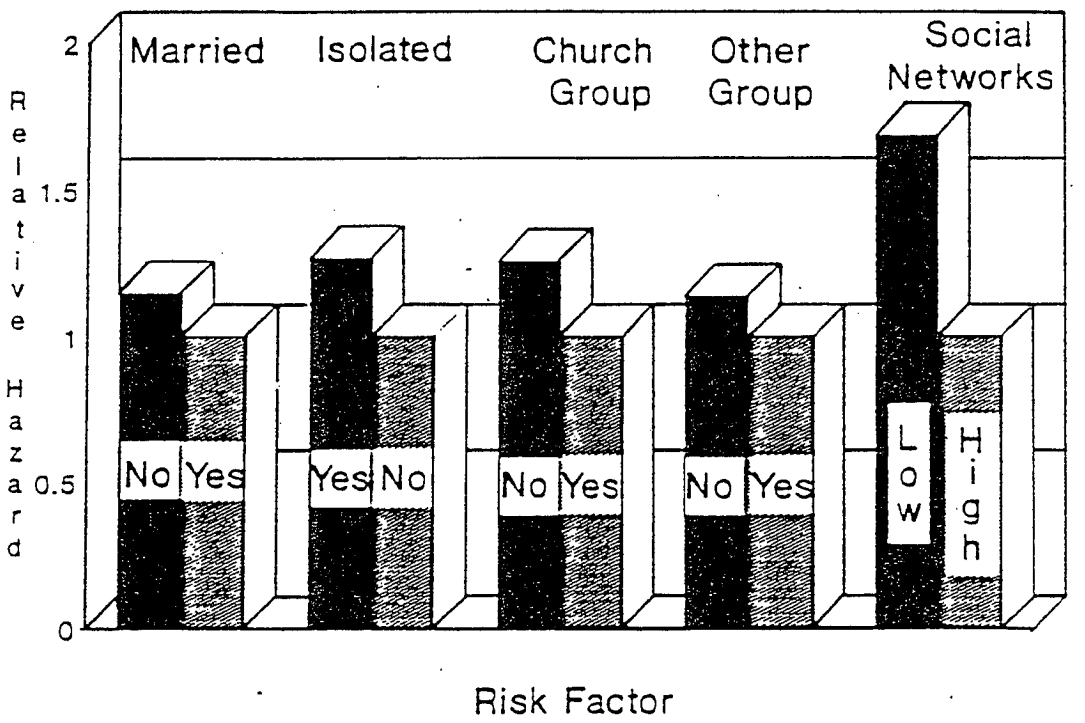

FIG. 3.3. Association between social risk factors and 17-year risk of death in those 70–94 years.

the presence of chronic conditions and symptoms at baseline, incident conditions and symptoms, and other covariables.

Demographic Factors

Figure 3.4 illustrates the relationship between a variety of demographic factors and 17-year risk of death among older participants in the Alameda County Study. The sex difference in mortality, observed in many studies, persists among those 60 years or older and is virtually identical when the analyses involve only those 70 years or older (Kaplan et al., 1987). There is, however, some diminution of the male excess with increasing age, largely due to female rates of cardiovascular disease increasing faster than male rates from age 50 on (Wingard, Cohn, Kaplan, Cirillo, & Cohen, 1989).

A comparison of Black and White mortality rates at this age shows that the Black disadvantage at earlier ages has been eliminated and, perhaps, even reversed (Kaplan et al., 1987). For those who were 60 years old or more in 1965, Blacks were at slightly lower risk over the next 17 years (Relative Hazard = 0.93, 95% Confidence Interval, 0.70-1.22). This "crossover" effect, which has been found in other analyses is not well understood, and may reflect

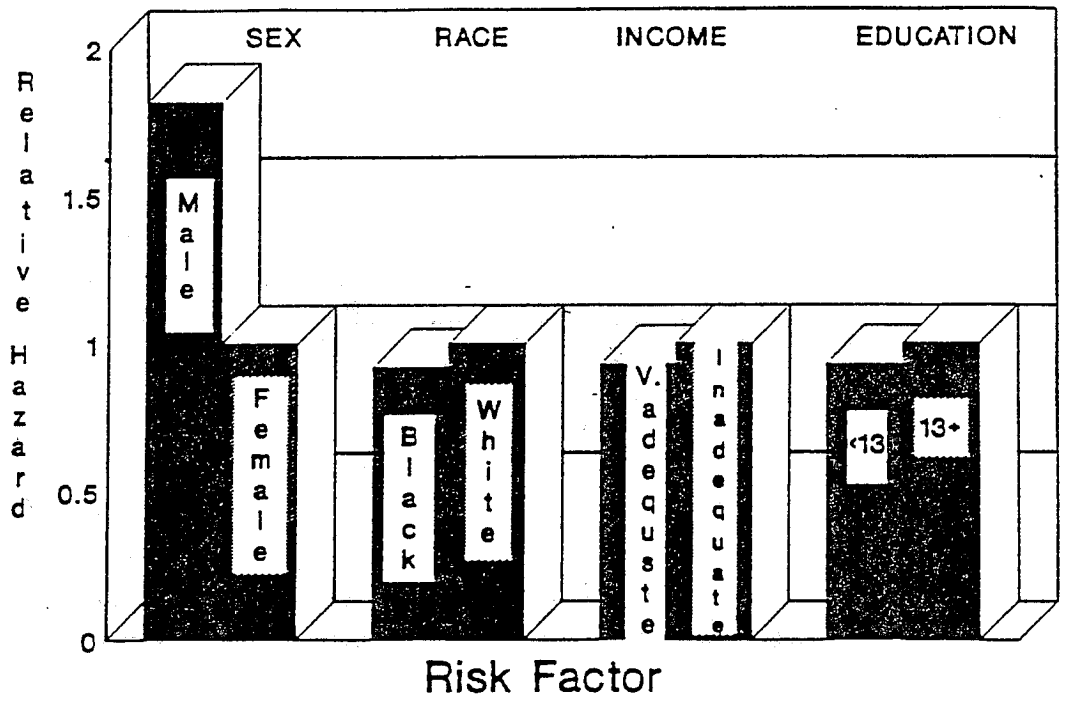

FIG. 3.4. Association between demographic risk factors and 17-year risk of death in those 70–94 years.

the combined effect of differential survivorship and risk factor exposure, cohort effects, and misreporting of age.

Measures of socioeconomic position, education and income, are no longer associated with mortality risk in older persons in the Alameda County Study. When the association between income and 17-year mortality was examined for those 60 years or older, those in the bottom quintile of the distribution of family income adjusted for family size were not at increased risk compared to those in the top quintile (Relative Hazard = 0.90, 95% Confidence Interval, 0.71-1.14). This was in contrast with a much stronger association for those 38–59 years old (Relative Hazard = 1.73, 95% Confidence Interval, 1.29-2.31). Similar results were found when the association between level of education and 17-year risk of death was examined. Those who were over 60 years old in 1965 and had more than a high school education were actually at somewhat higher, but not significant, risk compared to those with less education (Relative Hazard = 1.14, 95% Confidence Interval, 0.91-1.43). For those who were 38–59 years old, there was a considerably elevated risk associated with lower education (Relative Hazard = 1.34, 95% Confidence Interval, 0.96-1.87). The lack of an association between level of income and risk of death probably reflects the fact that it is not a good measure of the economic resources of older persons, whereas the absence of an association with education may reflect cohort differences.

Socioenvironmental factors are also related to mortality risk among older respondents in the Alameda County Study. In an analysis of the cohort members who lived in Oakland, California, the largest city in Alameda County, the association between residence in federally designated poverty areas and mortality was examined (Haan, Kaplan, & Camacho, 1987). For those who were 55 years old or more, residence in such areas was associated with 26% higher 9-year mortality risk when compared to those who did not live in such areas (95% Confidence Interval, 0.96-1.67). What's more, this increased risk persisted when there was adjustment for age, race, gender, income, employment status, access to medical care, health insurance coverage, smoking, physical activity, body mass index, and other risk factors. The analyses were expanded to all of Alameda County, however, instead of using residence in a poverty area as the predictor, a series of scales were developed based on demographic and socioenvironmental characteristics of Alameda County census tracts. Several of these scales were strongly associated with subsequent risk of death among older persons. For example, those 60-year-olds who lived in census tracts that had high proportions of separated or divorced persons, deteriorating housing units, blue-collar workers, and Blacks were at 1.67-fold risk of death over 9 years (95% Confidence Interval, 1.17-2.39) compared to those who lived in census tracts that had low proportions. For another scale that measured the proportion of males older than 65 years, housing units with no bath or shared bath and with no heat, and widowed males, there was also increased risk (Relative Hazard = 1.37, 95% Confidence Interval, 1.06-1.77). These increased risks were maintained even when there was adjustment for the long list of potential confounders used in the poverty area analyses. Thus, there is an indication that socioenvironmental characteristics of the areas in which older people live may be independent predictors of their subsequent health.

Psychological Factors

A number of psychological factors have been shown to be associated with mortality risk in the Alameda County Study (Kaplan, 1985). For example, those who report high levels of depressive symptoms are at higher risk of death compared to those who do not. For those over 60 years of age, high levels of depressive symptoms are associated with a 1.4-fold (95% Confidence Interval, 1.15-1.75) increase in 9-year mortality risk. However, when there is adjustment for the presence of chronic conditions, symptoms, and disability, there is no association (Relative Hazard = 1.08, 95% Confidence Interval, 0.85-1.36). Thus, the relationship between depressive symptoms and all cause mortality among older persons seems to reflect the higher rates of depression among those who are sick (Kaplan & Reynolds, 1988; Roberts, Kaplan, & Camacho, 1990).

Life satisfaction and personal uncertainty, a measure of helplessness (Berkman & Breslow, 1983), are also associated with mortality risk among older persons in the Alameda County Study. Those over 60 years of age who were dissatisfied, were at 1.65 times the 9-year risk of death when compared to those who were not (95% Confidence Interval, 1.24-2.20). Again, however, a good deal of the association appears to be due to higher rates of illness among those who are dissatisfied. With adjustment for chronic conditions, symptoms, and disabilities, the association is considerably weakened (Relative Hazard = 1.32, 95% Confidence Interval, 0.98-1.78). Those who indicated high levels of personal uncertainty were also at increased risk (Relative Hazard = 1.35, 95% Confidence Interval, 1.04-1.75), but this association was not appreciably weakened by adjustment for prevalent illness and disability (Relative Hazard = 1.23, 95% Confidence Interval, 0.94-1.61).

DETERMINANTS OF FUNCTIONAL HEALTH

Death, of course, is not the only outcome of interest in epidemiologic studies of aging and health. The increasing numbers of persons who are surviving to older ages has led many to be concerned with the assessment of functional status. This focus views physical, psychological, and social functioning as critical and interacting dimensions of the health of older persons. A number of analyses have been completed using the Alameda County Study that bear upon this approach. Long-range predictors of physical functioning were studied in a sample of study participants who were at least 65 years old (Guralnik, 1985). In this study, a broad measure of physical functioning was used that enabled respondents to be ordered on a scale ranging from having difficulties with basic activities of daily living to participating in active sports. Predictors were taken from the interview 19 years earlier in 1965 when the respondents were at least 48 years old. Table 3.1 shows the variables that, in multiple regression models,

TABLE 3.1
1965 Predictors of 1984 Functional Health Status
(from Guralnik, 1985)

Variable	*Beta*	*p ( )*
Age	−0.34	.0001
Race	−4.26	.0005
Health	−1.82	.04
Disability	−2.78	.008
Smoking	−2.22	.006
Weight/height	2.37	.014
Income	1.49	.004
Marital status	3.00	.0014
Physical activity	2.68	.008

TABLE 3.2
Association Between Incident Health Problems and Incident ADL Problems

	Odds Ratio (95% C.I.) ADL	
	Feeding, dressing, or moving	*Climbing stairs or getting outdoors*
Stroke	6.61 (3.52,12.39)	6.78 (3.78,12.17)
Heart trouble	2.82 (1.66,4.80)	5.12 (3.40,7.70)
Arthritis	2.14 (1.11,4.10)	2.13 (1.35,3.36)
Diabetes	1.84 (0.76,4.46)	3.23 (1.72,6.04)
Chest pain	2.88 (1.55,5.35)	4.36 (2.71,7.02)
Shortness of breath	4.06 (2.32,7.11)	4.50 (2.85,7.09)
Back pain	2.21 (1.18,4.13)	2.34 (1.50,3.64)
Joint stiffness	4.02 (2.16,7.51)	4.99 (3.28,7.60)

were significantly associated with higher levels of physical functioning 19 years later, when the respondents were 65–89 years old. These predictors cover a broad range, ranging from earlier levels of physical activity and health status to demographic, behavioral, social and psychological domains. Similar results were found when the analyses focused on predictors of high levels of functioning, an aspect of healthy aging (Guralnik & Kaplan, 1989).

In other analyses, in which attention was focused on limitations in the ability to perform activities of daily living, there were similar findings. For example, among those who were 55–94 years of age in 1965, 9-year incidence of limitations in climbing stairs or getting outdoors were higher among those who were current smokers (Odds Ratio = 1.93, 95% Confidence Interval, 1.24-3.01), depressed (Odds Ratio = 2.24, 95% Confidence Interval, 1.36-3.68), or who had inadequate versus very adequate incomes (Odds Ratio = 2.13, 95% Confidence Interval, 1.11-4.12).

The major predictors of difficulties in performing activities of daily living are, of course, related to health problems. Table 3.2 presents the results of analyses that examine the association, in those 50 years old or more, between 1965–1974 incidence of chronic conditions and symptoms and incidence of limitations in activities of daily living in the same period. As can be seen, the associations are very strong. However, above and beyond the influence of chronic conditions and symptoms, there is an impact of behavioral, social, psychological, and demographic factors. Among those who were incident cases of heart trouble, stroke, diabetes, or arthritis, the rates of mobility limitations were higher in those who smoked (Odds Ratio = 2.02, 95% Confidence Interval, 1.21-3.38), who were depressed (Odds Ratio = 1.76, 95% Confidence Interval, 0.95-3.27), who were socially isolated (Odds Ratio = 1.95, 95% Confidence Interval, 0.97-3.91), and who had inadequate incomes (Odds Ratio = 3.54, 95% Confidence Interval, 1.50-8.36).

This pattern of results, in which there are important predictors representing health status, behavioral, social, psychological, and demographic factors is repeated when psychological functioning is considered. Factors predictive of high levels of depressive symptoms have been examined in the Alameda County Study, using a symptom check list similar to the CES-D and the other measures of depressive symptoms that have been used in epidemiologic studies (Kaplan, Roberts, Camacho, & Coyne, 1987). For example, for those over 60 years old in 1965 a number of factors were importantly associated with level of depressive symptoms in 1974, with adjustment for age and level of symptoms at baseline: less than high school education (Odds Ratio = 3.16, 95% Confidence Interval, 1.79-5.61), inadequate income (Odds Ratio = 2.29, 95% Confidence Interval, 1.28-4.10), ADL limitations (Odds Ratio = 3.33, 95% Confidence Interval, 1.42-7.81), chronic conditions (Odds Ratio = 2.11, 95% Confidence Interval, 0.92-4.88), poor versus excellent perceived health (Odds Ratio = 2.96, 95% Confidence Interval, 2.08-4.20), personal uncertainty (Odds Ratio = 1.88, 95% Confidence Interval, 1.07-3.30), loss of a spouse (Odds Ratio = 2.18, Confidence Interval, 1.17-4.07), money stress (Odds Ratio = 2.31, 95% Confidence Interval, 0.95-5.54), and social isolation (Odds Ratio = 1.91, Confidence Interval, 0.88-4.14). Thus, many of the factors that are associated with mortality risk or with levels of physical functioning are also associated with depression.

DETERMINANTS OF RISK FACTOR CHANGE

Older persons, just like younger persons, are not static. Their behaviors, social relationships, feelings, and other characteristics change over time. However, there has been remarkably little attention paid to the patterns of risk factor change over time in older persons, or the factors that contribute to those changes. Because the Alameda County Study interviewed respondents on several occasions it was possible to examine, in a preliminary way, the natural history of risk factor change.

Figure 3.5 presents information on baseline physical activity by age, and the percent change in physical activity level between 1965 and 1974 (Lazarus et al., 1989). A simple measure of leisure-time physical activity, which is related to subsequent mortality risk, based on reports of the frequency of participation in active sports, swimming or taking long walks, working in the garden, and doing physical exercises was used. Generally speaking, levels of physical activity decline with age, more so in women than in men, with a major change occurring after age 60. This age-related decline, however, is not automatic, as there is considerable variability. When the reasons for this variability were examined, a number of behavioral, social, psychological, and health status variables were found to be important predictors of change in physical activity level. At age 70, men and women who smoked showed a 1.63 and 1.65-fold, respectively, greater decline in physical activity compared to never smokers, with

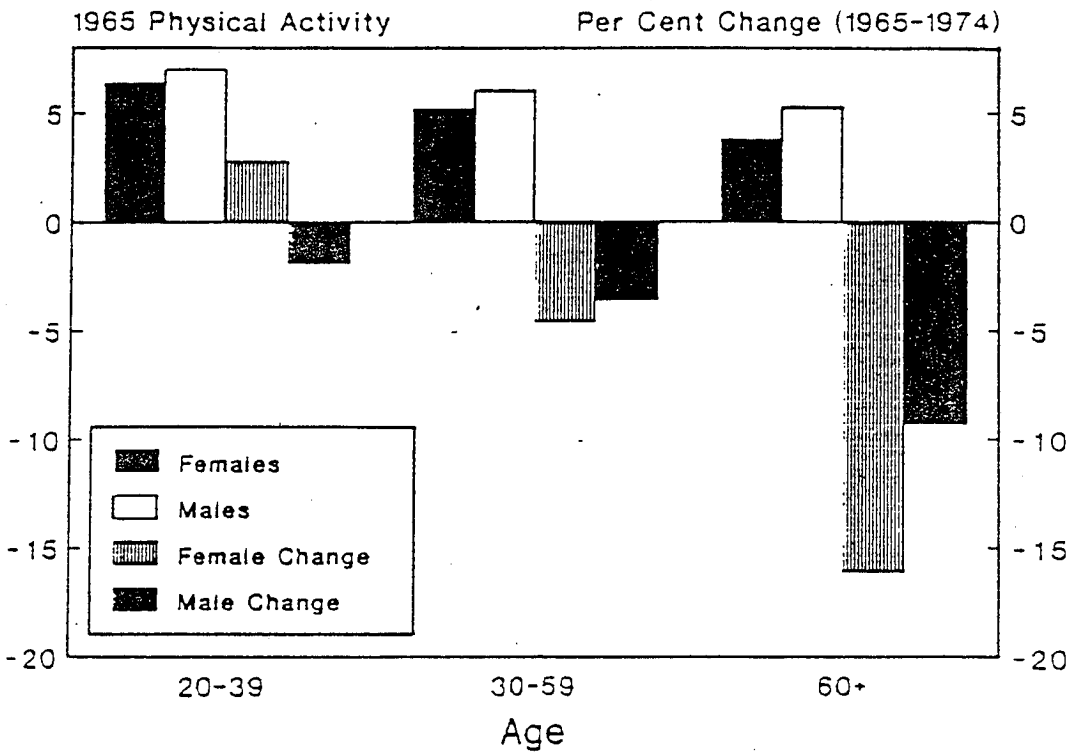

FIG. 3.5. Baseline level of leisure-time physical activity and 1965–1974 change in leisure-time physical activity by age and sex.

adjustment for body mass index and baseline level of physical activity. Body mass index was also related to declines in physical activity; among those 60 years old or more, thin men showing especially large declines. Not surprisingly, incidence of cardiovascular conditions during the follow-up was also associated with greater declines in physical activity. Those over 70 who were socially isolated showed greater declines than those who were not isolated with 2.3-fold and 4.4-fold greater declines in isolated men and women, respectively. Men and women who were not married had approximately 30% greater declines over 9 years, as did those with less than a high school education (1.3-fold and 1.6-fold women and men, respectively). Depression, low life satisfaction, and being Black versus White were also associated with greater declines at age 70.

In a similar manner, the natural history of social isolation has also been studied (Kaplan, Lazarus, Cohen, & Leu, 1991). Among those who were not socially isolated in 1965, the 9-year risk of becoming socially isolated varied by age and sex (Fig. 3.6). Men generally had higher risks, and the risk of becoming socially isolated declined with increasing age. For women, the highest risks were among the youngest and declined until age 60, at which point they increased. Closer inspection indicated that at age 70 and above, the risks for women exceeded those for men. In general, the results indicate, consistent with

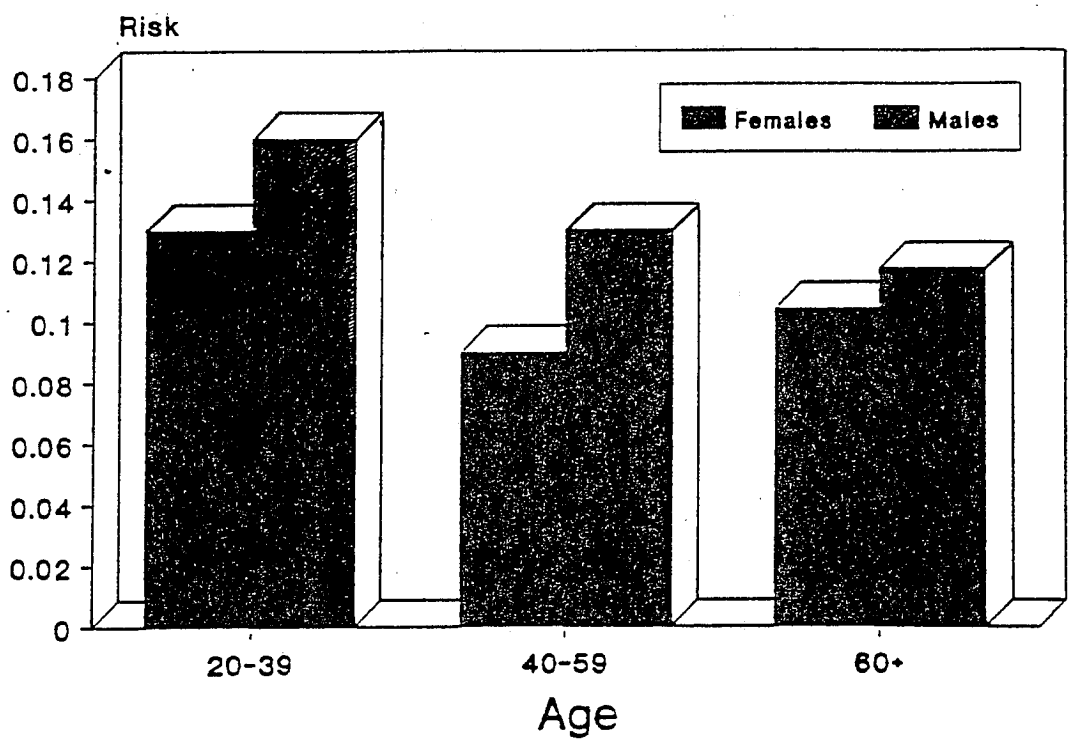

FIG. 3.6. Risk of social isolation (1965–1974) by age and sex.

other studies, that the stereotype of the elderly becoming progressively isolated is not correct. As in the case of changes in physical activity it was possible to examine what factors were associated with increasing risk of social isolation. Again, there was a wide array of behavioral, social, psychological, health status, and demographic factors that were related to risk of social isolation in 1965. Being disabled, or becoming disabled, were both associated with increased risk. For example, in women, difficulties in performing ADLs in 1965 were associated with a 2.3-fold increased risk of being socially isolated in 1974 (95% Confidence Interval, 1.38-3.92). Low levels of physical activity were also associated with increased risk of social isolation, with a greater effect for women than for men. Psychological factors such as depression and low life satisfaction were also associated with increased risk of social isolation. Finally, there was an almost linear relationship between the number of negative life events experienced between 1965-1974 and the risk of social isolation (Fig. 3.7).

OVERALL PATTERN OF RESULTS

Figure 3.8 summarizes the results seen in the analyses reported here, and in others not reported here. A " + " indicates that a significant association has been seen, a "0" indicates that no association was found, and a blank indicates

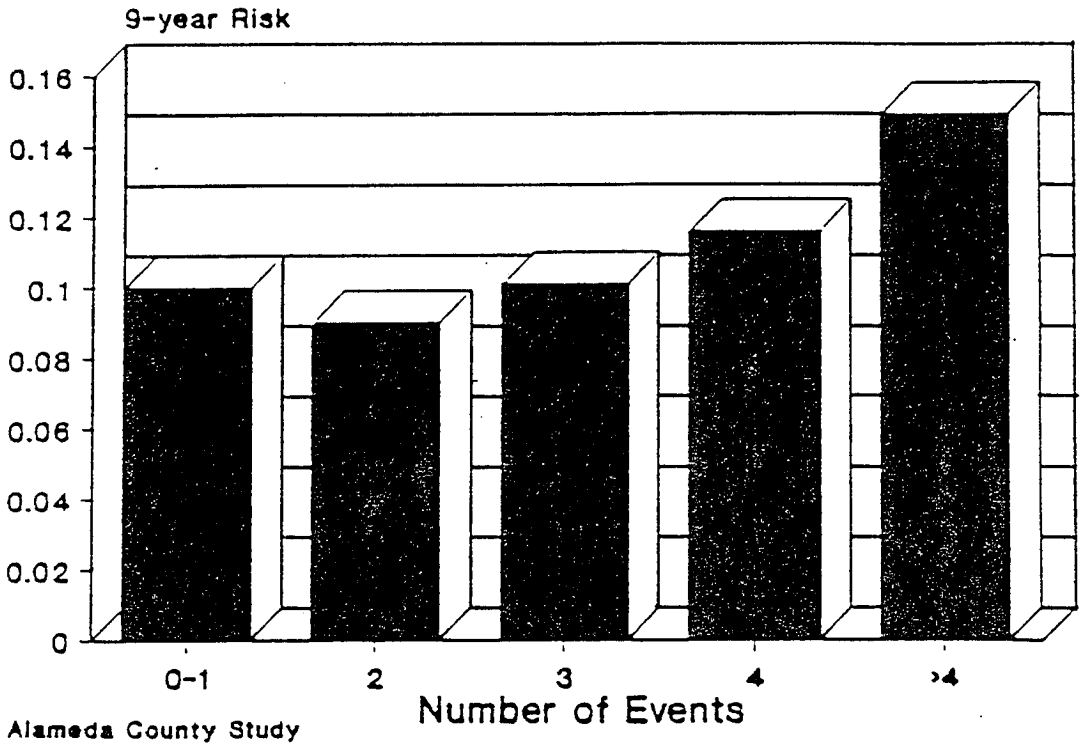

FIG. 3.7. Risk of social isolation (1965–1974) by negative life events (1965–1974) for those 60+ years.

	Death	ADL's	Physical Function	Physical Activity	Depression	Isolation
Health Status	+	+	+	+	+	+
Perceived Health	+	+	0	+	+	+
Physical Activity	+	+	+		+	+
Smoking	+	+	+	+	0	0
Relative Weight	+	+	+	0	0	
Alcohol	+	0	+	0	0	
Marital Status	0	+	+	+	0	+
Group Member	+	0	+	+	+	+
Isolation	+	+		+	+	
Social Networks	+	+		+	+	+
Race	0	+	+	+	0	+
Education	0	+	+	+	+	0
Income	0	+	+	+	0	0
Area Properties	+	+			0	
Depression	+	+	+	+		+
Life Satisfaction	+	+		+	+	+
Personal Uncer.	+	+		+	+	0
Life Events	+	+			+	+

+ = significant association 0 = not significant blank = not studied

FIG. 3.8. Summary of predictors and outcomes for those 60+ years.

that the association has not been examined. As can be seen, a given variable may be related to multiple outcomes, and some variables serve as both predictors and outcomes. The predominant pattern is one of mutual determination, with little evidence of any simple causal pathways. The complexity of the results are seen even when we consider only a few outcomes and predictors (Fig. 3.9). Depression, social isolation, physical activity, and problems in performing activities of daily living, are all interconnected. Levels of depression are predictive of subsequent levels of physical activity, social isolation, or ADLs. Similarly, social isolation predicts subsequent levels of depression, physical activity, and ADLs. To complete the circle, levels of ADLs are predictive of subsequent levels of physical activity, depression, and social isolation. The impact of depression on risk of death appears to be largely through these variables and others related to health status, whereas the three other variables are independent predictors of mortality risk. Of course, the situation is much more complex when the impact of other variables is added. In fact a major need is the development of models that allow the full complexity of these relationships and their causal connections to be explicated.

It is not really surprising that the health and functioning of older persons should be affected by a wide range of variables. What remains to be more fully understood are the dynamics of this process, and the physiologic pathways that

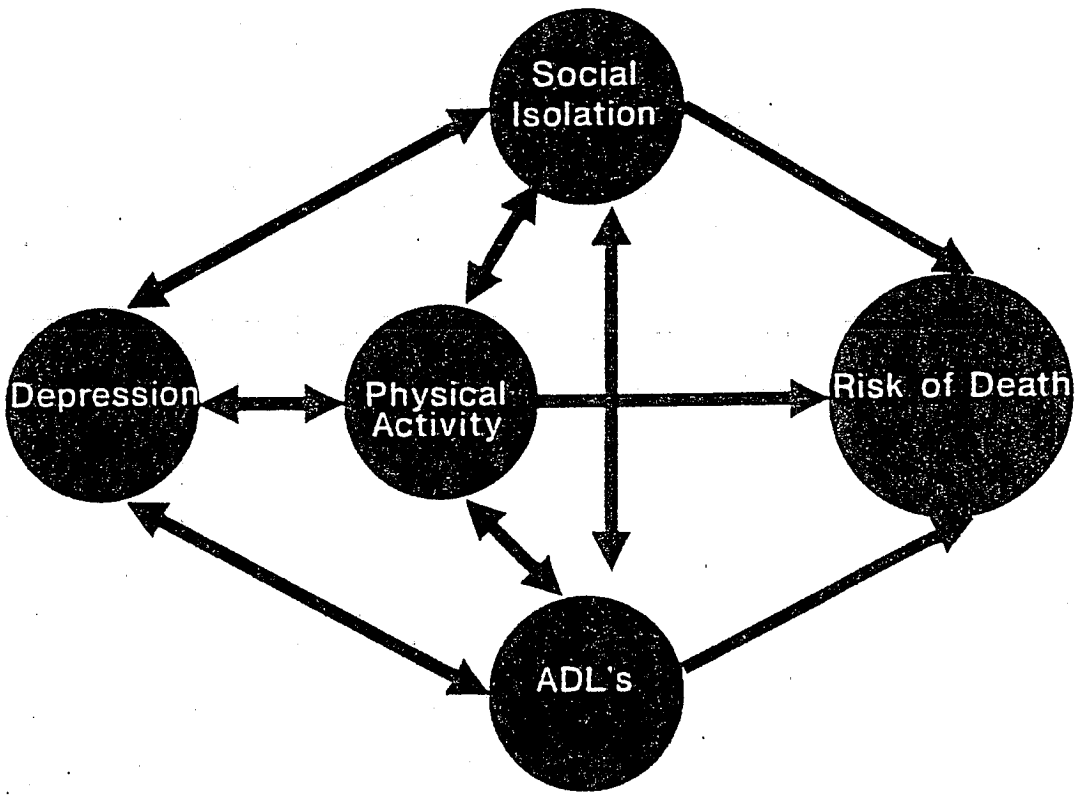

FIG. 3.9. Interrelationships between social isolation, physical activity, depression, functional health, and risk of death.

mediate these associations. It is clear that the understanding of these relationships and processes will require studies that assess a broad range of behavioral, social, demographic, psychological, and physiologic variables—far broader, even, than those studied in the Alameda County Study. In addition, a full understanding of the dynamic patterns of interaction between all these variables will require studies that carry out multiple assessments over time.

THE MEANING OF AGING IN EPIDEMIOLOGIC RESEARCH

A full appreciation of the pathways by which health, in all its manifestations, is determined for older persons, will also require some continued thinking about the interpretation of "age" in epidemiologic research. Although it is clear that researchers have moved away from simply dealing with age as a nuisance or adjustment variable, there still needs to be further consideration of what age represents and how it affects health. The importance of distinguishing age, period, and cohort effects continues to be an important agenda, and one that has not been adequately addressed in health-related research. Given the paucity of databases that would allow these factors to be properly studied, we need to continue to keep in mind that age differences observed in a longitudinal study may carry with them important behavioral, social, and demographic differences that are cohort-related.

It is clear that conclusions reached about the aging process from the observation of cross-sectional age differences are likely to misinform us. But even conclusions that derive from longitudinal studies may not be without problems in interpretation. Leaving the issues of age-period-cohort analysis aside, it is not clear that conclusions reached from prospective studies will necessarily yield information about the aging process, per se. The reason for this is that aging does not take place in a vacuum. Instead, there are exposures, challenges, and problems that occur in an age-related way. The clearest examples relate to events such as retirement and bereavement, but there are others. Unless studies of aging take into account these socioenvironmental events, and the behavioral, cognitive, and psychological responses to these events, then the conclusions about "aging" will be importantly confounded. To give a more specific example, consider possible age-dependent changes in pulmonary function and in exercise capacity. These changes, which vary greatly from individual to individual, reflect a combination of the physiological aging of individuals, and, perhaps to an even greater extent, represent the consequences of exposures to various factors such as tobacco and physical exercise. Tobacco exposure and participating in exercise are of course individual decisions, but these decisions are greatly influenced by societal attitudes, environmental controls (tobacco) or opportunities (exercise), and by societal expectations about what is appro-

priate at a given age. Thus, when patterns of change with age of pulmonary function and exercise capacity are studied, even longitudinally, we are looking at a process which involves far more than just aging. In the same sense that geneticists study the interaction of genotype and environment, students of aging, by necessity, must study the interaction of age and environment.

With these issues in mind, there needs to be a continued epidemiologic emphasis on a number of key questions which have not been addressed in most studies. Among these are the following:

1. Are there changes in the associations between risk factors and morbidity and mortality with increasing age? Do these changes represent selection effects; cumulative effects of exposures over a lifetime; changes in the social, behavioral, and psychological environment; or other factors?
2. Do the predictors of change in risk factors vary by age? If so, can an understanding of the ways in which environments, demands, and resources change with age advance our ability to construct efficacious interventions?
3. Can an emphasis on the behavioral, social, psychological, demographic, and environmental situations that are unique to particular ages help us to understand the development of age-dependent diseases (Brody & Schneider, 1986)?
4. Does lifetime exposure to behavioral, social, and other risk factors influence the impact of age-dependent risk factors such as bereavement?
5. Can the contribution of behavioral, social, psychological, demographic, and environmental factors to both incidence and progression of age-dependent diseases be understood? This is an issue of critical importance to the controversy concerning the compression of morbidity.

CONCLUSIONS

These results from the Alameda County Study, and other analyses, underscore the importance of a broad approach to the study of aging and health. There appears to be dense, reciprocal determination of a broad range of behavioral, social, psychological, and demographic risk factors. The proper study of systems of this complexity will require study designs and analytic techniques which strain our current resources and knowledge. From a public health perspective, however, such studies will be necessary to provide a firm basis for a new disease prevention/health promotion approach that can reduce the burden of disease, illness, and disability in an aging population.

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