Chapter

3

Behavioral, Social, and Socioenvironmental Factors Adding Years to Life and Life to Years

George A. Kaplan, Ph.D.

Though it has been recognized for some time that the U.S. population is aging, responses by many public health agencies have been muted by competing new threats to public health, by inadequate resources, by a lack of appreciation of the magnitude of the demographic changes, and by the specter of intergenerational warfare over diminishing resources. Indeed, there is even considerable controversy about what these population changes portend, ranging from optimistic forecasts of increasing numbers of hale and hearty older Americans to dire projections of pandemics of disease, disability, and dementia.

Our knowledge base concerning the potential role for primary and secondary prevention with aged people is still relatively small, and numerous conceptual and methodological problems beset those who study health promotion and disease prevention (Kaplan, Haan, and Cohen, 1992; Wallace and Woolson, 1992). Nevertheless, a rapidly increasing literature in public health disciplines points to the importance of such preventive efforts. Behavioral, social, psychological, and socioenvironmental factors appear to play an important role in the health of aged persons; indeed, they may become increasingly important in older age, and may represent critical areas of intervention in public health practice.

Before reviewing the evidence that buttresses this strong claim, it is important to highlight the plasticity of the relationship between age and health. Between 1950 and 1991 there were large declines in age-specific mortality rates from all causes among older populations (National Center for Health Statistics, 1994). For example, for those between 65 and 74 years of age, death rates fell by 35.6 percent during those four decades. For those 75 to 84 years of age the decrease was 36.9 percent, and for those 85 or older it was 25.5 percent. Thus, while being older conveys increased risk and death, the magnitude of this increased risk associated with a particular age varies over time. It has been noted that, in recent years, much of this decline in risk and death has been due to declines in risk of cardiovascular mortality (Kochanek, Maurer, and Rosenberg, 1994). The impact of these declines in mortality rates is, of course, reflected in increased life expectancy. During the same period, life expectancy at age 65 increased 3.6 years, or 26 percent. This increase of 3.6 years in life expectancy at age 65 represents 49 percent of the increase in life expectancy at birth between 1950 and 1991. These declines in age-specific mortality, the resultant increases in life expectancy at the older ages, and declines in birth rates since the "baby boom" have led to the aging of the population.

Primary and Secondary Prevention in Older Populations

What is to be prevented in older populations? In many respects the agenda is no different from that in younger populations. However, the increasing burden of subclinical and diagnosed disease and comorbidity which often, but not always, accompany aging, and the increased potential for impaired function, loss of independence, and decreased quality of life lead to a somewhat broader approach to prevention among the aged.

Figure 3.1 schematically presents some of the key points of intervention in preventive efforts in the aged. Clearly, the imperative to prevent the development of disease and to lengthen the healthy period (Part A) does not disappear when applying preventive approaches to the aged. It is well to remember that coronary heart disease used to be considered a disease of senescence, but we now have a considerable armamentarium for its prevention and no longer see it as irrevocably tied to aging. As subclinical disease begins to develop (Part B), preventive approaches can be applied to slowing the rate of deterioration, thus decreasing the slope of the line and delaying the next transition. The threshold at which subclinical disease is detected will be dependent on screening, technology, and other nondisease factors. It is significant primarily because early detection will often trigger focused approaches, both clinical and behavioral, to slowing down the rate of disease progression. Slowing down the rate of disease progression (Part C) will help to delay any number of com-

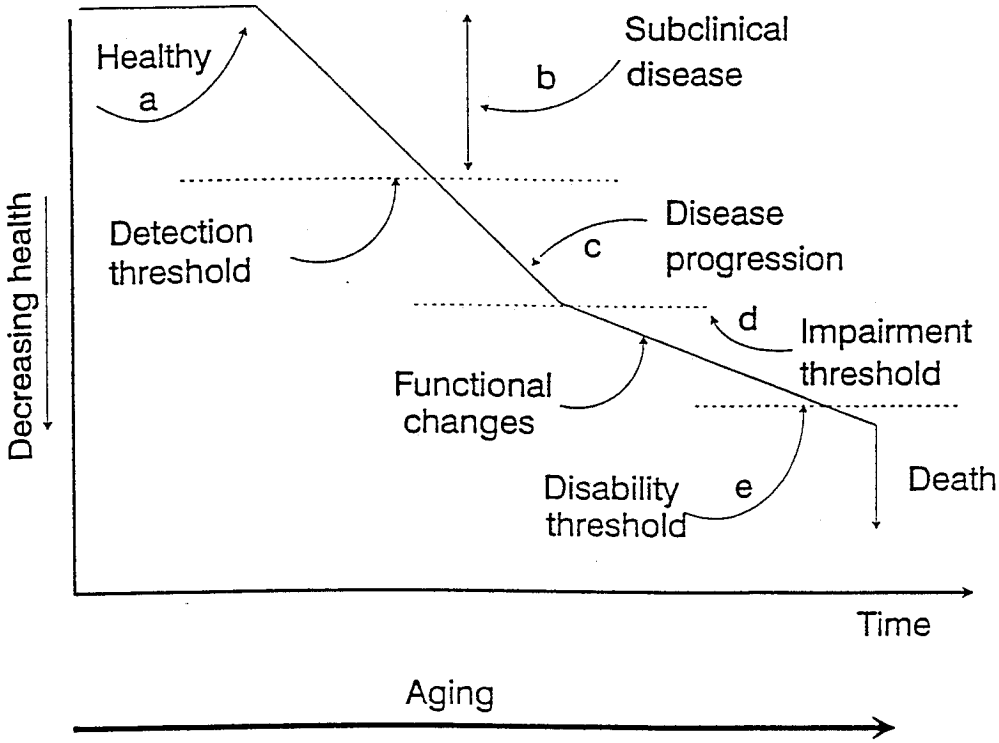

FIGURE 3.1 Opportunities for prevention.

plications, the most important of which, in the present discussion, is the development of declines in function—physical, cognitive, social, or psychological. If the transition to functional impairment is crossed (Part D), the next target for prevention is to slow down the rate of decline in impairment, to prevent or delay the development of disability (Part E). Finally, attempts can be made to slow the progression of disability.

Thus, there is a broad spectrum across which both primary and secondary prevention efforts can be applied in older populations. Following is some of the evidence that behavioral, social, and socioenvironmental factors could be effective in influencing the stages and transitions in Figure 3.1. While many other examples could be chosen, the intent is to present illustrative examples of the association between these factors and longevity and disability.

Behavioral Factors

Current evidence suggests that smoking and physical activity are strongly tied to health status and quality of life among aged persons. While other factors are important, the strength of the evidence and the potential for public health intervention justify a focus on these two.

Smoking. A number of studies have indicated an increased risk of death associated with smoking in aged populations (Barrett-Connor et al., 1984; Kaplan et al., 1987; LaCroix et al., 1991; U.S. Department of Health and Human Services, 1990; Schoenfeld et al., 1994). A typical example of such findings comes from a seventeen-year follow-up of current, former, and never smokers in the Alameda County Study (Kaplan et al., 1987). For those who were 60 to 90 years of age, current smokers had almost 50 percent higher rates of death (RR = 1.46, 95% C.I. = 1.21-1.78) than those who never smoked. When only those over 70 years of age were considered, there was still a 1.4-fold increased risk (RR = 1.43, 95% C.I. = 1.08-1.89). Similar results from three studies of aged persons are reported by LaCroix and associates (1991). Among those 65 years of age or more, current smokers were consistently at higher risk of death than never smokers, with former smokers at intermediate risk. Again, there is a substantial impact of current smoking on mortality.

While it is undoubtedly true that smoking exerts its impact on mortality via the development of numerous pathophysiological changes affecting multiple systems, there is an impact of smoking on mortality even in healthy, high-functioning older Americans. In a study of 70- to 79-year-old people who had no disabilities, no cognitive defects, and one or no chronic conditions, comprising the top 30 percent of those in this age group, current versus never smoking was associated with a twofold increased 3-year risk of death (Schoenfeld et al., 1994).

In most of these studies, former smokers have considerably lower mortality risk than current smokers. This suggests that smoking cessation, even at older ages, may be protective. There is some evidence that this is true. For example, Kaplan and Haan (1989), using the Alameda County Study, examined mortality risks as a function of nine-year smoking histories. Those who continued to smoke, compared to those who never smoked, had a 76 percent increased risk of death (RR = 1.76, 95% C.I. = 1.33-2.31), while those who quit smoking during this nine-year period had only a 33 percent increased risk (RR = 1.33, 95% C.I. = 0.98-1.82). A reduction in all cause mortality risk associated with quitting smoking was also found by Hermanson, Omenn, Kronmal, and Gersh (1988) in their study of the survival of patients with angiographically documented coronary artery disease. This latter finding is particularly interesting because it suggests considerable benefit from smoking cessation in this high-risk group.

Evidence is also accumulating that suggests that smoking may exact a considerable burden with respect to level of physical functioning (Guralnik and Kaplan, 1989; Mor et al., 1989; Pinsky, Leaverton, and Stokes, 1987; Branch, 1985; Kaplan, 1992; Kaplan et al., 1993; LaCroix et al., 1993). For example, Guralnik and Kaplan (1989), in a nineteen-year follow-up of the participants in the Alameda County Study, found that those who were current smokers in 1965, and who survived to 1984, were twice as likely to show reduced levels of physical functioning and ability to complete basic and instrumental activities of daily living (IDL and

IADLs) as were those who never smoked. LaCroix et al. (1993) examined loss of mobility over four years in the three cohorts from the Established Populations for Epidemiologic Studies of the Elderly. Loss of mobility was defined as becoming unable to walk half a mile or walk up and down stairs without help. Figure 3.2 shows the relationship between smoking status and four-year loss of mobility for men and women in these three community studies. In all groups who were mobile at baseline, those who were current smokers at baseline had the highest rate of losing mobility. Former smokers were intermediate, and never smokers were at lowest risk. Using a more comprehensive measure of physical functioning, Kaplan et al. (1993) found that six-year changes in physical function were related to smoking status, with current smokers showing greater declines in functioning than former and never smokers.

Although it has not been well studied, there is also some indication that those who smoke show higher rates of functional problems related to chronic conditions. For example, Kaplan (1992) found twice the risk of incident mobility problems among smokers, compared to nonsmokers, who reported incident stroke, arthritis, or heart trouble. Clearly this is an area where more work is necessary in order to tease out the causal pathways. For example, patients who smoke may have poorer functional outcomes because they suffer more severe disease, because they have more comorbidities that exert an impact on function, or for other reasons.

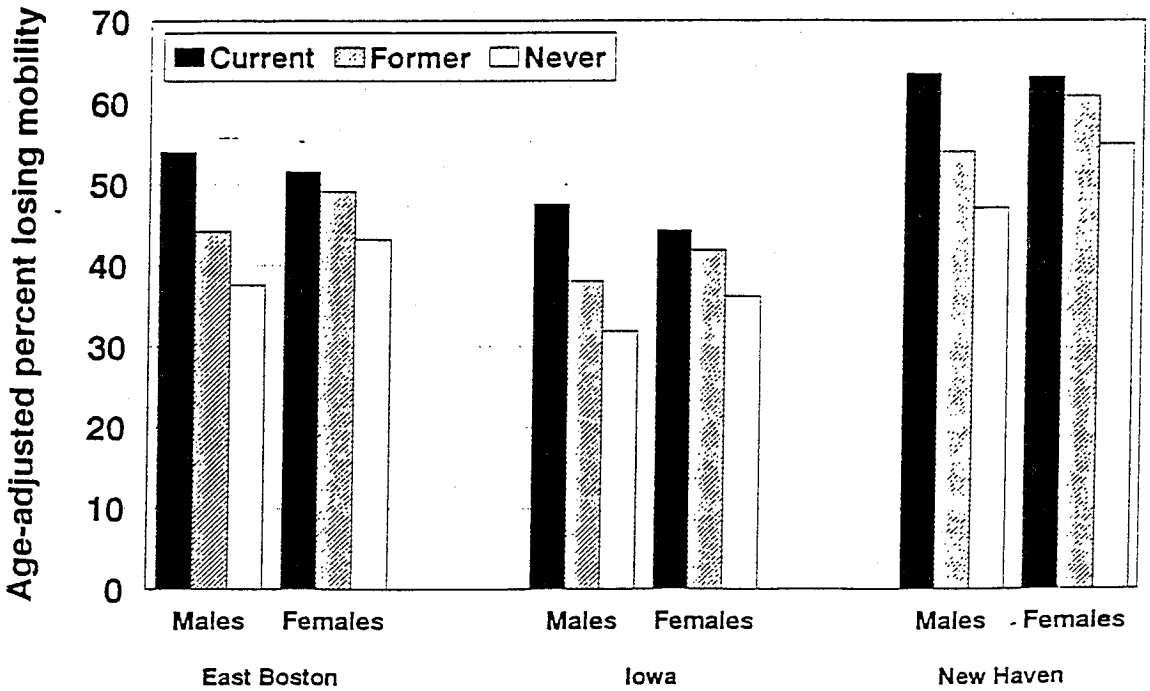

FIGURE 3.2 Four-year loss of mobility by smoking status in persons 65+ years of age: Three communities in Established Populations for Epidemiologic Studies of the Elderly.
Source: Data from LaCroix et al., 1993.

Physical activity. Considerable evidence also indicates that being physically active may prolong life, even at older ages (Kaplan et al., 1987; Foley et al., 1990; Blair et al., 1989; Paffenbarger et al., 1993; Boult et al., 1994). For example, the impact of a sedentary lifestyle on seventeen-year mortality risk among older persons was found in the Alameda County Study (Kaplan et al., 1987). A physical activity score based on the frequency with which a variety of leisure-time physical activities were performed was strongly associated with mortality risk. Among those who were 60 years of age or older, those who reported low levels of leisure-time physical activity had 40 percent higher mortality risk than those who reported higher levels of activity (RR = 1.41, 95% C.I. = 1.20-1.66). This pattern was found even when there was adjustment for other behavioral risk factors, and for presence of chronic conditions, symptoms, and disabilities. When the results were examined for different age groups, there was little change in the magnitude of the association after age 50. Indeed, those who were 70 years of age or older who were sedentary were at 37 percent increased risk of death over the next seventeen years.

Studies with more precise measurement of physical activity and fitness also show similar results. Paffenbarger et al. (1993) found in a 12- to 16-year follow-up of men 60 to 74 years of age that energy expenditure from walking, climbing stairs, and sports was monotonically related to risk of death. Among those 60 to 69 years of age, those with weekly energy expenditures less than 500 kcal had approximately twice the risk of death of those expending at least 2000 kcal. Similarly, Blair et al. (1989) found a linear relationship between fitness quintile, based on exercise test findings, and risk of death among those age 60 or older. Interestingly, the impact of fitness on risk of death was greater for those above 60 years of age than for those below.

Increases in physical activity also seem to benefit older populations. Kaplan and Haan (1989) found that those who increased their levels of physical activity over a nine-year period had subsequently decreased mortality risk compared to those who stayed the same or to those who decreased. These results persisted even when the analyses were restricted to those who were healthy at baseline, or when there was extensive adjustment for risk factors and for prevalent and incident chronic conditions and disabilities. Similarly, analyses by Paffenbarger et al. (1993) indicate that older men who began moderately vigorous sports activities had decreased mortality risk compared to those who remained less active.

An increasing number of studies indicate that low levels of physical activity are involved in the development of problems in physical functioning (Mor et al., 1989; LaCroix et al., 1993; Kaplan, 1992; Kaplan et al., 1993; Camacho et al., 1993). Analyzing the Longitudinal Study on Aging two- and four-year follow-up data, both Mor et al. (1989) and Boult et al. (1994) found associations between no activity and development of problems in functioning. In the Boult et al. (1994) analyses, having no regular exercise was associated with a 37 percent increased risk of developing a

functional limitation over four years. In the analyses of factors associated with loss of mobility by LaCroix et al. (1993), a summary index of physical activity based on the frequency of walking, gardening, and performing vigorous exercise was strongly associated with loss of function. Those who engaged in such activities three or more times per week had 60 percent the risk of losing mobility of those who did not so engage. Some of the largest effects were seen by Kaplan (1992) in examining nine-year incidence of self-care and mobility problems in the Alameda County Study. Those who were sedentary were at 5.2-fold and 3.0-fold risk of developing self-care or mobility problems, respectively.

Levels of physical activity also seem to be associated with overall declines in physical functioning. A scale based on the frequency with which five leisure-time physical activities were performed was inversely associated with changes in six-year physical functioning—lower levels of physical activity predicted greater declines in function, even after adjustment for baseline level of physical functioning and chronic conditions related to changes in function (Kaplan et al., 1993). Finally, in one of the first studies to look at long-term patterns of physical activity and physical functioning, Camacho et al. (1993) examined the relationship between levels of physical activity assessed on three occasions over almost 20 years and level of physical functioning in a group who had reached age 80 or older. Their findings showed a strong relationship between the number of previous waves of data collection in which they reported some physical activity and level of functioning. Level of physical functioning rose monotonically with the practice of physical activity over the previous two decades, even though the participants were 61 years of age or older at baseline and had survived two to three decades longer than their life expectancy at birth.

While we do not know precisely what it is about physical activity that is important, a growing number of studies suggest that conditioning and strengthening interventions might improve the functioning of older persons, particularly those who already have compromised function (Buchner et al., 1992; Fiatarone et al., 1994). Exercise interventions may have broad effects in community populations, influencing overall health, role functioning, and physical functioning (Stewart, King, and Haskell, 1993). Extrapolating from one small study (Hu and Woollacott, 1994), increased physical functioning may even improve postural stability, thereby decreasing falls and fractures. Finally, there are some indications that exercise interventions may improve some aspects of cognitive function (Stones and Dawe, 1993).

Social Factors

Over the last fifteen years, a substantial literature has appeared linking mortality risk to aspects of social functioning reflected in measures of social networks and social support (House, Landis, and Umberson, 1988). A number of these studies indicate that the increased risk of death associated with social isolation is also found

among the aged (Seeman et al., 1987; Orth-Gomer and Johnson, 1987; Welin et al., 1985; Steinbach, 1992; Blazer, 1979; Boult et al., 1994; Sugisawa, Liang, and Liu, 1994; Seeman et al., 1993). Seeman et al. (1987), analyzing the experience of the Alameda County Study cohort, found a strong relationship between social network participation, as indexed by the Berkman and Syme (1979) social network index and risk of death. The social network index is a composite measure of social network participation that combines information about marital status, numbers of close friends and relatives, frequency of seeing close friends and relatives, and group participation. Low compared to high levels of this index were associated with a 50 to 70 percent increased risk of death in various age groups over 50 years of age. Examining the component items of the index, in those age 70 or older, marital status and membership in nonreligious groups has only weak, and marginally statistically significant, association with seventeen-year risk of death, but both low contacts with friends and relatives and nonmembership in religious groups were associated with approximately 30 percent increased risk of death. Analyzing mortality experience of participants in the Longitudinal Study on Aging, both Steinbach (1992) and Boult et al. (1994) found that low levels of contacts with others were associated with increased risk of death. In the Boult et al. (1994) study, the report of no social contacts was associated with a 2.3-fold increased risk of death over the next four years. In a national sample of elderly persons in Japan, Sugisawa, Liang, and Liu (1994) found that those who reported no social participation were at 1.5-fold increased three-year risk of death.

The extent of social networks and support also appears to be related to levels of functional status, although there are fewer studies than those examining social functioning and mortality. Several of these studies are based on analyses of the Alameda County Study cohort. For example, being socially isolated was associated with 1.7-fold increased nine-year risk of developing self-care problems (Kaplan, 1992). Examining the functional status of those 80 years of age or older, Camacho et al. (1993) found that those who were consistently involved with others over the previous two decades had higher levels of functioning. Also using data from the Alameda County Study, Kaplan et al. (1993) observed an association between low social network participation and decreases in physical functioning over a six-year period. Similar findings were reported by Boult et al. (1994) in participants in the Longitudinal Study on Aging. Those who reported no recent social contacts were at 2.3-fold increased risk of developing impaired physical function.

A larger number of studies report an important effect of social functioning on the health of persons diagnosed with specific conditions (Cummings et al., 1988; Verbrugge, Gates, and Ike, 1991; Nickel and Chirikos, 1990; Kaplan, 1992; Magaziner et al., 1990; Marottoli, Berkman, and Cooney, 1992; Berkman, Leo-Summers, and Horwitz, 1992; Ruberman et al., 1984; Williams et al., 1992; Colantonio et al., 1993). In the Cummings et al. (1988) study of recovery of function in hip fracture patients,

greater numbers of social supports were associated with increased probability of regaining the ability to walk unaided six months after the fracture. Magaziner et al. (1990), also studying recovery of function in hip fracture patients, found that greater contact with social networks was associated with better walking ability, less physical dependence, and less instrumental dependence at one year post stroke. Higher social network participation is also associated with better survival in patients with angiographically documented coronary artery diseases (Williams et al., 1992). Among stroke patients, Colantonio et al. (1993) found that larger social networks prior to the stroke were associated with fewer limitations in physical functioning and lower risk of institutionalization.

Socioeconomic Factors

Low socioeconomic level has been found to be associated with increased risk of death in numerous studies of older persons (Lew and Garfinkel, 1990; Branch and Ku, 1989; Sugisawa, Liang, and Liu, 1994; Schoenfeld et al., 1994; Feldman et al., 1989). While the increased risks associated with lower socioeconomic level are often not as great as those found in younger groups, it is important to keep in mind that measures like assets and home ownership may be better indices of current economic resources in older populations than income or education. Nevertheless, socioeconomic level does appear to be related to mortality risk among older persons. For example, in analyses that were based on almost 50,000 persons over age 75 years who participated in the Cancer Prevention Study-I (Lew and Garfinkel, 1990) there was an inverse association between level of education and death rates.

Socioeconomic level is also strongly associated with level of physical functioning and disability in the elderly (Guralnik and Kaplan, 1989; Lammi et al., 1989; Mor et al., 1989; Pinsky, Leaverton, and Stokes, 1987; Kaplan, 1992; Harris et al., 1989; Kaplan et al., 1993; Camacho et al., 1993; Maddox and Clark, 1992; Guralnik et al., 1993; Rogers, Rogers, and Belanger, 1992; Clark and Maddox, 1992; Keil et al., 1989; Seeman et al., 1994; Boult et al., 1994). Examining seventeen-year predictors of mortality and physical function in individuals ages 65 to 89, Guralnik and Kaplan (1989) found that those at low levels of income, who survived, were one-third as likely to have high levels of function as those who had high levels of income. Also in the Alameda County Study, low income was associated with an almost threefold elevation in the nine-year risk of developing mobility limitations (Kaplan, 1992), and with six-year declines in physical functioning (Kaplan et al., 1993). The fact that different measures of socioeconomic level may show different associations in different groups is highlighted in the Guralnik, LaCroix et al. (1993) study of factors associated with loss of mobility. For men and women, low income was associated with a 50 percent increased risk of losing mobility. However, low education was only associated with increased risk for men.

Finally, Guralnik, Land et al. (1993), putting together the impact of education on mortality and mobility by calculating active life expectancy at age 65, found differences in active life expectancy at age 65 related to education level. Black and white men and women who had less than a high school education, compared to those with at least that level of education, had 2.4 to 3.9 years less of life expectancy.

Socioenvironmental Factors

It is intuitively obvious that properties of the physical environment should have some impact on the health of aged persons, but there have been few attempts to examine such efforts. What little evidence there is provides some support. Figure 3.3 schematically presents the dilemma that faces many older pedestrians when they attempt to cross a street. According to data from the EPESE (J. Guralnik, personal communication) and allowing a one-second interval from light change to the beginning of crossing, most older pedestrians would not be able to cross the street. Hoxie and Rubenstein (1994) studied this problem at one intersection in an area of Los Angeles with a high density of older persons. They found that while all pedestrians estimated to be under 65 years of age were able to cross in the allocated time,

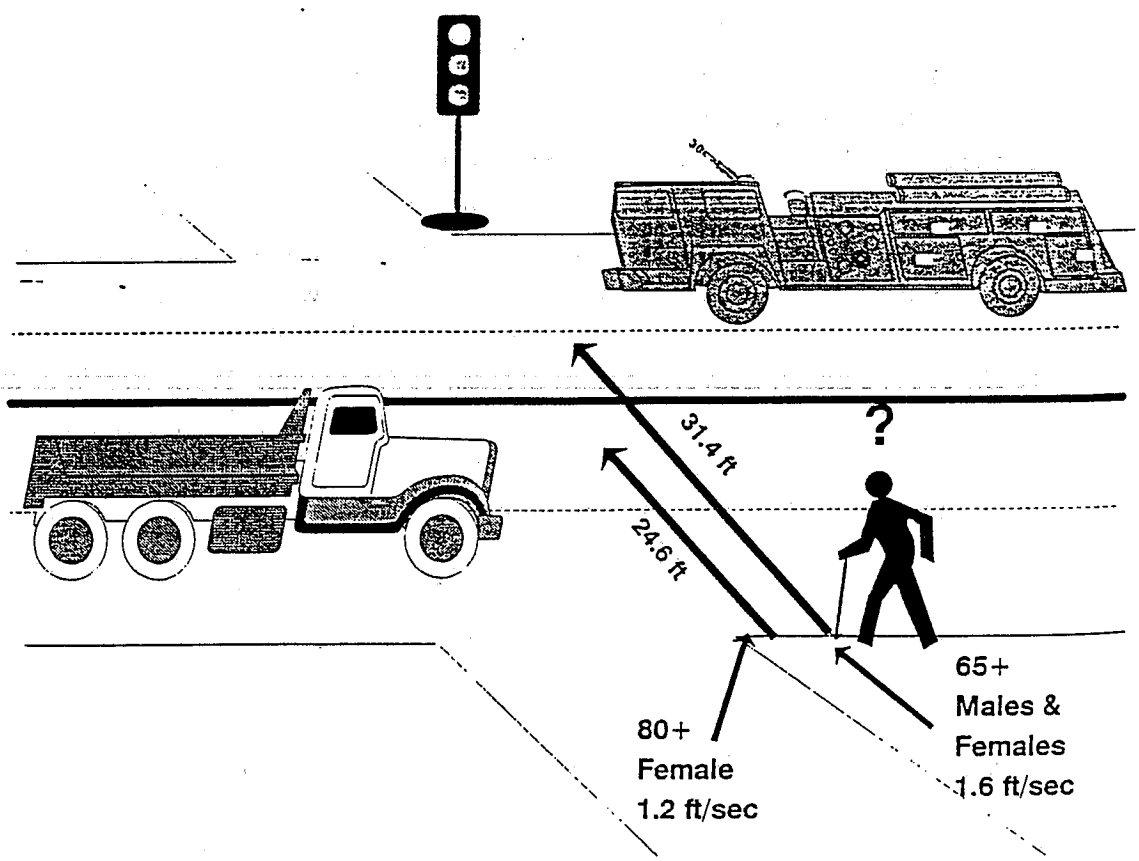

FIGURE 3.3 Problems in crossing streets for elderly persons.
Source: Kaplan and Strawbridge, 1994. Reprinted with permission.

27 percent of all pedestrians judged to be 65 years of age or older were unable to do so. As they point out, this surely underestimates the problem, for many older persons probably do not attempt to cross a street if they feel they cannot cross in the time available. One attempt to intervene in order to increase the safety of older pedestrians was successful in lowering traffic-related mortality (MMWR, 1989). The intervention involved several environmental adjustments including lengthening crossing times, placing signals on median strips, and other modifications, in addition to increased traffic law enforcement and an educational campaign. Because of insufficient study, one can only speculate as to the impact of such environmental barriers on the health of aged persons.

Environmental factors can also have an indirect effect on health through their influence on health promotion behaviors. It is not too speculative to assume that the perception of a neighborhood as unsafe leads to a reduction of physical activity and resultant decreased fitness, as well as an increase in social isolation, depression, and other factors that would result in poorer health and function. Reductions in physical activity may then lead to poorer balance, further mobility problems, and a downward cascade.

The impact of environmental hazards on risk of falls in older persons has been examined in a number of studies. It has been estimated that environmental hazards, in the context of intrinsic limitations, play a role in one-third to one-half of all home falls (Hornbrook et al., 1994). For example, Studenski et al. (1994) conducted an audit of homes and calculated an environmental hazard score based on their observations. The probability of recurrent falls was significantly related to this index of environmental hazards in the home. Given that 60 percent of aged home owners have lived in the same house for twenty years or longer, and the relatively higher costs of housing for the aged (Newman, Zais, and Struyk, 1984), it would not be surprising to determine that many older persons live in houses with features that could be environmental hazards. One attempt to intervene regarding rates of accidental falls in the aged actually provided technical and financial assistance to correct hazards in the home (Hornbrook et al., 1994). This intervention, which also included education and modification of behavioral and physical risk factors, resulted in a 16 percent reduction in total falls in the intervention group compared to a normal group. While there were no significant declines in the average number of falls, fractures, or fall-related hospitalizations, the decline in total falls provides some initial support for this type of intervention.

There are many other socioenvironmental factors that might be important in prolonging life and maintaining function, but they have not been studied. For example, the design of housing and neighborhoods, outdoor lighting and safety, the age-mix of areas, and many other factors could easily affect levels of physical activity, social networks and social support, and depression. Each of these might then influence the slope and transitions present in Figure 3.1.

Implications

While the evidence cited in this chapter suggests an important role for behavioral, social, and socioeconomic factors in prolonging both life and independent functioning, this area is in need of considerable additional study. We know little of the natural history of risk factors, risk factor change, morbidity, functional problems, and health transitions in the aged. The relative role of long-term patterns of exposure to risk factors versus changes in them at older ages has been virtually unstudied; the specific ways in which behavioral, social, and socioenvironmental factors interact with diagnosed and preclinical disease in the determination of functional health status is only beginning to be studied. Likewise, issues related to comorbidities and their synergistic effect on longevity and quality of life need to be further examined within the context of the biology of disease and function. Despite the plausibility of socioenvironmental effects on the health of the aged, there is little information. Finally, we need much more information on the complex, recursive interactions between health status and behavioral, social, psychological and socioenvironmental factors in the aged (Kaplan and Strawbridge, 1994).

With all these gaps in our knowledge, what are the implications for public health practice? It is clear that preventive activities related to the health of the aged are relatively underrepresented in most state and local health departments. In addition, there is a virtual absence of data at the state and local level on morbidity and disability levels among the aged. Such information is critical for the efficient targeting of preventive interventions for the aged. But, the information reviewed in this chapter does have implications for public health practice, even in the presence of unfilled research needs and lack of local data. With an aging population and increased demands on limited resources, prevention—ranging from primary to tertiary—looms more and more important. Based on the available evidence, preventive activities hold great promise in retarding the downward transitions represented in Figure 3.1. This evidence suggests that such activities may well be important in promoting independent functioning in the aged and reducing costly institutionalization. A growing body of evidence indicates that interventions to reduce smoking and increase physical activity in the aged are feasible, but we know little of the impact of interventions directed at social isolation, poverty, or socioenvironmental hazards on the health of the aged. It is reasonable to think that such interventions could have a major public health impact, and the time is ripe for public health professionals to take on such efforts. Together with an active cadre of researchers investigating the role of preventive factors in the aged, public health professionals can—and should—increase their efforts not only to add years to life, but also to add life to years.

References

Barrett-Connor, E., Suarez, L., Khaw, K., Criqui, M., and Wingard, D. 1984. Ischemic heart disease risk factors after age 50. *Journal of Chronic Diseases* 37:903–8.

Berkman, L., and Syme, S. 1979. Social networks, host residence, and mortality: A nine-year follow-up study of Alameda County residents. *American Journal of Epidemiology* 109:186–204.

Berkman, L., Leo-Summers, L., and Horwitz, R. 1992. Emotional support and survival after myocardial infarction: A prospective, population-based study of the elderly. *Annals of Internal Medicine* 117:1003–9.

Blair, S., Kohl, H. I., Paffenbarger, R., Clark, D., Cooper, K., and Gibbons, L. 1989. Physical fitness and all-cause mortality: A prospective study of healthy men and women. *Journal of the American Medical Association* 262:2395–2401.

Blazer, D. 1979. Social support and mortality in an elderly community population. *American Journal of Epidemiology* 115:684–94.

Boult, C., Kane, R., Louis, T., Boult, L., and McCaffrey, D. 1994. Chronic conditions that lead to functional limitations in the elderly. *Journals of Gerontology* 49(1):M28–36.

Branch, L. 1985. Health practices and incident disability among the elderly. *American Journal of Public Health* 75:1436–9.

Branch, L., and Ku, L. 1989. Transition probabilities to dependency, institutionalization, and death among the elderly over a decade. *Journal of Aging and Health*, 1:370–408.

Buchner, D., Beresford, S., Larson, E., LaCroix, A., and Wagner, E. 1992. Effects of physical activity on health status in older adults. II. Intervention studies. *Annual Review of Public Health* 13:469–88.

Camacho, T., Strawbridge, W., Cohen, R., and Kaplan, G. 1993. Functional ability in the oldest old: Cumulative impact of risk factors from the preceding two decades. *Journal of Aging and Health* 5(4):439–54.

Clark, D., and Maddox, G. 1992. Racial and social correlates of age-related changes in functioning. *Journals of Gerontology* 47:S222–32.

Colantonio, A., Kasl, S., Ostfeld, A., and Berkman, L. 1993. Psychosocial predictors of stroke outcomes in an elderly population. *Journals of Gerontology* 48:S261–8.

Cummings, S., Phillips, S., Wheat, M., Black, D., Goosby, E., Wlodarczyk, D., Trafton, P., Jergesen, H., Winograd, C., and Hulley, S. 1988. Recovery of function after hip fracture: The role of social supports. *Journal of the American Geriatrics Society* 36:801–6.

Feldman, J., Makuc, D., Kleinman, J., and Cornoni-Huntley, J. 1989. National trends in educational differentials in mortality. *American Journal of Epidemiology* 129:919–33.

Fiatarone, M., O'Neill, E., Ryan, N., Clements, K., Solares, G., Nelson, M., Roberts, S., Kehayias, J., Lipsitz, L., and Evans, W. 1994. Exercise training and nutritional supplementation for physical frailty in very elderly people. *New England Journal of Medicine* 330(25):1769–75.

Foley, D., Branch, L., Madans, J., Brock, D., Guralnik, J., and Williams, T. 1990. Physical function. In J. Cornoni-Huntley, R. Huntley, and J. Feldman, eds., *Health Status and Well-Being of the Elderly: National Health and Nutrition Examination Survey—I Epidemiologic Follow-up Study.* 221–36. New York: Oxford University Press.

Guralnik, J., and Kaplan, G. 1989. Predictors of healthy aging: Prospective evidence from the Alameda County Study. *American Journal of Public Health* 79:703–8.

Guralnik, J., LaCroix, A., Abbott, R., Berkman, L., Satterfield, S., Evans, D., and Wallace, R.

1993. Maintaining mobility in late life: Part I. *American Journal of Epidemiology* 137:845–57.

Guralnik, J., Land, K., Blazer, D., Fillenbaum, G., and Branch, L. 1993. Educational status and active life expectancy among older blacks and whites. *New England Journal of Medicine* 329(2):110–16.

Harris, T., Kovar, M., Suzman, R., Kleinman, J., and Feldman, J. 1989. Longitudinal study of physical ability in the oldest-old. *American Journal of Public Health* 79:698–702.

Hermanson, B., Omenn, G., Kronmal, R., and Gersh, B. (Participants in the Coronary Artery Surgical Study). 1988. Beneficial six-year outcome of smoking cessation in older men and women with coronary artery disease. *New England Journal of Medicine* 319:1365–69.

Hornbrook, M., Stevens, V., Wingfield, D., Hollis, J., Greenlick, M., and Ory, M. 1994. Preventing falls among community-dwelling older persons: Results from a randomized trial. *The Gerontological Society of America* 34(1):16–23.

House, J., Landis, K., and Umberson, D. 1988. Social relationships and health. *Science* 241:540–45.

Hoxie, R., and Rubenstein, L. 1994. Are older pedestrians allowed enough time to cross intersections safely? *Journal of the American Geriatrics Society* 42:241–44.

Hu, M-H., and Woollacott, M. H. 1994. Multisensory training of standing balance in older adults: I. Postural stability and one-leg stance balance. *Journals of Gerontology* 49:M53–61.

Kaplan, G. 1992. Maintenance of functioning in the elderly. *Annals of Epidemiology* 2:823–34.

Kaplan, G., and Haan, M. 1989. Is there a role for prevention among the elderly? Epidemiological evidence from the Alameda County Study. In M. Ory and K. Bond, eds., *Aging and Health Care: Social Science and Policy Perspectives*, 27–51. London: Routledge.

Kaplan, G., and Strawbridge, W. 1994. Behavioral and social factors in healthy aging. In R. Abeles, H. Gift, and M. Ory, eds., *Aging and Quality of Life*, 57–78. New York: Springer Publishing Company.

Kaplan, G., Haan, M., and Cohen, R. 1992. Risk factors and the study of prevention in the elderly: Methodological issues. In R. Wallace and R. Woolson, eds., *The Epidemiologic Study of the Elderly*, 20–36. New York: Oxford University Press.

Kaplan, G., Seeman, T., Cohen, R., Knudsen, L., and Guralnik, J. 1987. Mortality among the elderly in the Alameda County Study: Behavioral and demographic risk factors. *American Journal of Public Health* 77:307–12.

Kaplan, G., Strawbridge, W., Camacho, T., and Cohen, R. 1993. Factors associated with change in physical functioning in the elderly: A six-year prospective study. *Journal of Aging and Health* 5:140–53.

Keil, J., Gazes, P., Sutherland, S., Rust, P., Branch, L., and Tyroler, H. 1989. Predictors of physical disability in elderly blacks and whites of the Charleston Heart Study. *Journal of Clinical Epidemiology* 42:521–29.

Kochanek, K., Maurer, J., and Rosenberg, H. 1994. Causes of death contributing to changes in life expectancy: United States, 1984–89. National Center for Health Statistics. Vital Health Stat 20(23).

LaCroix, A., Lang, J., Scherr, P., Wallace, R., Cornoni-Huntley, J., Berkman, L., Curb, J., Evans, D., and Hennekens, C. 1991. Smoking and mortality among older men and women in three communities. *New England Journal of Medicine* 324:1619–25.

LaCroix, A., Guralnik, J., Berkman, L., Wallace, R., and Satterfield, S. 1993. Maintaining mobility in late life. II. Smoking, alcohol consumption, physical activity, and body mass index. *American Journal of Epidemiology* 137:858–69.

Lammi, U., Kivela, S., Nissinen, A., Punsar, S., Puska, P., and Karvonen, M. 1989. Predictors

of disability in elderly Finnish men: A longitudinal study. *Journal of Clinical Epidemiology* 42:1215–25.

Lew, E., and Garfinkel, L. 1990. Mortality at ages 75 and older in the Cancer Prevention Study (CPS-I). *CA: A Cancer Journal for Clinicians* 40:210–24.

Maddox, G., and Clark, D. 1992. Trajectories of functional impairment in later life. *Journal of Health and Social Behavior* 33:114–25.

Magaziner, J., Simonsick, E., Kashner, T., Hebel, J., and Kenzora, J. 1990. Predictors of functional recovery one year following hospital discharge for hip fracture: A prospective study. *Journals of Gerontology* 45:M101–7.

Marottoli, R., Berkman, L., and Cooney, L. 1992. Decline in physical function following hip fracture. *Journal of the American Geriatrics Society* 40:861–66.

MMWR 61–64. 1989. Queens Boulevard pedestrian safety project, New York City.

Mor, V., Murphy, J., Masterson-Allen, S., Willey, C., Razmpour, A., Jackson, M., Greer, D., Katz, S. 1989. Risk of functional decline among well elders. *Journal of Clinical Epidemiology* 42:895–904.

National Center for Health Statistics. 1994. *Health, United States, 1993.* Hyattsville, MD: Public Health Service.

Newman, S., Zais, J., and Struyk, R. 1984. Housing older America. In I. Altman, M. Powell Lawton, and J. Wohlwill, eds., *Elderly People and the Environment,* 17–55. New York: Plenum Press.

Nickel, J., and Chirikos, T. 1990. Functional disability of elderly patients with long-term coronary heart disease: A sex-stratified analysis. *Journals of Gerontology* 45:S60–8.

Orth-Gomer, K., and Johnson, J. 1987. Social network interaction and mortality: A six year follow-up study of a random sample of the Swedish population. *Journal of Chronic Diseases* 40:949–58.

Paffenbarger, R. Jr., Hyde, R., Wing, A., Lee, I., Jung, D., and Kampert, J. 1993. The association of changes in physical-activity level and other lifestyle characteristics with mortality among men. *New England Journal of Medicine* 328:538–45.

Pinsky, J., Leaverton, P., and Stokes, J. III. 1987. Predictors of good function: The Framingham Study. *Journal of Chronic Diseases* 40 (Suppl. 1):15S–67S.

Rogers, R., Rogers, A., and Belanger, A. 1992. Disability-free life among the elderly in the United States. *Journal of Aging and Health* 4:19–42.

Ruberman, W., Weinblatt, E., Goldberg, J., and Chaudhary, B. 1984. Psychosocial influences on mortality after myocardial infarction. *New England Journal of Medicine* 311:552–59.

Schoenfeld, D., Malmrose, L., Blazer, D., Gold, D., and Seeman, T. 1994. Self-rated health and mortality in the high-functioning elderly—A closer look at healthy individuals: MacArthur field study of successful aging. *Journals of Gerontology* 49:M109–15.

Seeman, T., Kaplan, G., Knudsen, L., Cohen, R., and Guralnik, J. 1987. Social network ties and mortality among the elderly in the Alameda County Study. *American Journal of Epidemiology* 126:714–23.

Seeman, T., Berkman, L., Kohout, F., LaCroix, A., Glynn, R., and Blazer, D. 1993. Intercommunity variations in the association between social ties and mortality in the elderly: A comparative analysis of three communities. *Annals of Epidemiology* 3:325–35.

Seeman, T., Charpentier, P., Berkman, L., Tinetti, M., Guralnik, J., Albert, M., Blazer, D., and Rowe, J. 1994. Predicting changes in physical performance in a high-functioning elderly cohort: MacArthur studies of successful aging. *Journals of Gerontology* 49:M97–108.

Steinbach, U. 1992. Social networks, institutionalization, and mortality among elderly people in the United States. *Journals of Gerontology* 47:S183–90.

Stewart, A., King, A., and Haskell, W. 1993. Endurance exercise and health-related quality of life in 50–65-year-old adults. *The Gerontological Society of America* 33(6):782–89.

Stones, M., and Dawe, D. 1993. Acute exercise facilitates semantically cued memory in nursing home residents. *American Geriatrics Society* 41:531–34.

Studenski, S., Duncan, P., Chandler, J., Samsa, G., Prescott, B., Hogue, C., and Bearon, L. 1994. Predicting falls: The role of mobility and nonphysical factors. *Journal of the American Geriatrics Society* 42(3):297–302.

Sugisawa, H., Liang, J., and Liu, X. 1994. Social networks, social support, and mortality among older people in Japan. *Journals of Gerontology* 49:S3–13.

U.S. Department of Health and Human Services. 1990. The health benefits of smoking cessation. Rockville, MD: USDHHS, Public Health Service, Centers for Disease Control, Office on Smoking and Health.

Verbrugge, L., Gates, D., and Ike, R. 1991. Risk factors for disability among U.S. adults with arthritis. *Journal of Clinical Epidemiology* 44:167–82.

Vogt, T., Mullooly, J., Ernst, D., Pope, C., and Hollis, J. 1992. Social networks as predictors of ischemic heart disease, cancer, stroke, and hypertension: Incidence, survival and mortality. *Journal of Clinical Epidemiology* 45:659–66.

Wallace, R., and Woolson, R., eds. 1992. *The Epidemiologic Study of the Elderly*. New York: Oxford University Press.

Welin, L., Tibblin, G., Tibblin, B., Svardsudd, K., Ander-Peciva, S., Larsson, B., and Wilhelmsen, L. 1985. Prospective study of social influences on mortality. *Lancet* 1:915–18.

Williams, R., Barefoot, J., Califf, R., Haney, T. L., Saunders, W. B., Pryor, D. B., Hlatkey, M. A., Siegler, I. C., Mark, D. B. 1992. Prognostic importance of social and economic resources among medically treated patients with angiographically documented coronary heart disease. *Journal of the American Medical Association* 267:520–24.