Recent Perspectives on Active Life Expectancy for Older Women

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SUMMARY. This article provides a critical review of recent active life expectancy literature, describing trends of special interest to women. We review findings from leading perspectives used to study life expectancy and active life expectancy, including gender, racial and socioeconomic differences, disease-specific effects, and biodemography. We examine three competing theories of population health that frame active life expectancy research—compression of morbidity, expansion of morbidity, and dynamic equilibrium—concluding there is support for both the compression of morbidity and dynamic equilibrium theories. Policy implications for women include a greater understanding of the role of education and racial and ethnic diversity in active life trends, and an increased public policy emphasis on preven—
tion and treatment of chronic disease, together with adoption of more healthy lifestyles.

INTRODUCTION

Global aging will play a prominent role in shaping the 21st century (Kinsella & Gist, 1998). Many countries, both developed and developing, enjoyed dramatic life expectancy gains over the last century (U.S. Census Bureau, 2000; Vaupel et al., 1998). However, declining mortality raises new questions about life quality, especially at older ages. Do individuals who escape death from once-fatal diseases develop substantial disability from chronic diseases? Do population subgroups fare differently in life expectancy, or in the proportion of life without significant disability? Questions such as these define the study of active life expectancy, also commonly referred to as healthy life expectancy. The latter phrase can be limited to describe only years lived without serious health problems. It is possible for an individual with health problems to remain free of serious physical or cognitive impairments when evaluated using common disability measures. It is similarly possible for a disabled individual to be free of significant health problems. Nonetheless, given the close relationship between health and physical abilities, the two phrases are often used interchangeably. Similarly, for the purposes of this review, we use the terms impairment, functional limitation, and disability interchangeably. Researchers distinguish among these terms, emphasizing that disability is in part determined by socially constructed limitations.

Policy makers and health care planners increasingly use estimates of active life expectancy to monitor changes in population health, develop health care and social policies, and forecast service costs and use. It is particularly important that women, gerontologists, and people interested in international aging understand trends in health and disability. Women make up a large majority of most older populations (U.S. Census Bureau,
Retirement and health policies for older persons affect women disproportionately, and these policies are driven, in part, by demographic trends. Aging populations also affect family caregiving, with important implications for both older women and their daughters. Women have dramatically increased their educational attainment, a factor that has been strongly associated both theoretically and in empirical studies of earlier generations with increasing longevity and increasing active life expectancy (Freedman & Martin, 1999; Preston, 1992). Is more education for the current generation of older women associated with longer life and a greater proportion of life spent free of disability? Or will more education simply bring more years of disability? These are particularly pressing questions addressed by recent demographic research. Individuals and their families, governments, and other social institutions all have an interest in the answers.

We present a critical review of recent active life expectancy literature. Ours is not an exhaustive review, but is intended to present general trends and leading-edge research. Our purpose is to review and critique representative theoretical articles, empirical studies, and review articles published during the past decade, with a focus on issues of special interest to women. Our spotlight is on applied work, which emphasizes findings most relevant to older individuals and their families, and to policy makers. Most methods for studying active life expectancy require accurate and detailed data about health and mortality, either for a large number of representative individuals or an entire population. Such data have generally been available only for developed countries, and the literature has largely been restricted to this focus. Although we address research on less developed countries, our review is for the most part similarly bounded. We begin, in the following section, by summarizing the most important approaches to the study of both total and active life expectancy. Here, we also describe major findings of recent empirical studies conducted using each approach. We then discuss several competing theories of population health that frame the active life expectancy literature. These theories are commonly referred to as the “compression of morbidity,” the “expansion of morbidity,” and “dynamic equilibrium.” Briefly, the compression of morbidity theory suggests that people are living a greater proportion of life free of disease and disability. In contrast, proponents of the expansion of morbidity suggest that the percentage of life lived with disability is growing. Dynamic equilibrium offers the view that the disabled proportion of the population will increase as mortality rates fall, but that this increase will be accompanied by a reduction in the rate at which chronic diseases progress. We review active life expectancy findings from the perspective of
each theory. Finally, we discuss policy implications of these collective findings, with particular emphasis on implications for women.

**LEADING PERSPECTIVES AND FINDINGS**

**Gender Differences**

Almost all studies have found that life expectancy is notably longer for women than for men, but that women spend a greater proportion of their longer lives with significant disability (Robine, Romieu, & Cambois, 1997). This is the case for women living in European countries such as France, The Netherlands, England, and Wales, as well as Canada (Belanger, Martel, Berthelot, & Wilkins, 2002; Robine & Ritchie, 1991) and Japan (Sauvaget, Tsuji, Aonuma, & Hisamichi, 1999; Tsuji, Sauvaget, & Hisamichi, 2002). This has also been the finding of numerous studies conducted using data from the United States (e.g., Branch et al., 1991; Crimmins, Hayward, & Saito, 1996; Laditka & Wolf, 1998; Manton, Corder, & Stallard, 1993). Recent findings highlight gender differences in developing and developed counties throughout the world as well as in relatively homogeneous European countries (Mathers, Murray, Lopez, Sadana, & Salomon, 2002; Robine, Jagger, & Cambois, 2002). Several reasons are cited for these substantial gender differences in life expectancy and active life expectancy. Some researchers find that women have more favorable survival histories than men at all ages. Thus, women’s advantage at later ages merely continues trends of earlier life stages (Deeg, 2001). Women are more likely to experience a decline in functional status, and are less likely to recover than men (Becket et al., 1996). Others conclude that the somewhat higher incidence of disability among women at all ages accounts for substantial gender differences in disability prevalence at older ages (Leveille, Penninx, Melzer, Izmirlian, & Guralnik, 2000). Women may simply accumulate more disability throughout the life course.

**Socioeconomic Differences**

Researchers calculating active life expectancy have often used two broad measures to capture differences in socioeconomic status, income, and education. For the measure of income, reviewing studies using data from Canada, The Netherlands, Finland and Belgium, Bone, Bebbington, and Nicolaas (1998), and Robine and Ritchie (1991) conclude that more affluent people live substantially longer and healthier lives than the less afflu-
These income differences in life expectancy and active life expectancy are greater than gender differences. Education has a similar relationship to health. It seems clear, at least from studies using United States’ data, that older women and men with more education live longer, healthier lives than people with less education (Crimmins et al., 1996; Crimmins & Saito, 2001; Freedman & Martin, 1999; Laditka & Wolf, 1998; Land, Guralnik, & Blazer, 1994). Using data from Fiji, Panapasa (2002) also found that more education was positively associated with longer, healthier lives for women and men. Researchers have suggested several ways that education may confer protective effects relating to specific functional limitations and major diseases. Education may alter one’s ability to understand risks to health, or the propensity to accept or reduce known risks. For example, taking vitamin supplements and not smoking may protect against macular degeneration and cataracts, and thereby reduce visual impairment at older ages (e.g., Christen, Glynn, & Hennekens, 1996). Increased physical activity, improved diet, and weight control have also been linked to more education. These lifestyle advantages are further linked to reduced levels of some chronic conditions, such as arthritis and osteoporosis (Wister, 1996). There is evidence that women with less education have substantially more behavioral and biological risks associated with coronary artery disease. For example, they are more likely to smoke cigarettes, exercise less, and have lower high-density lipoprotein levels than women with more education (Matthews, Kelsey, Meilahn, Kuller, & Wing, 1989). When both income and education are included in the research design, women and men living in Belgium, Canada, Finland, The Netherlands, and Sweden who are poorer and have less education live shorter, more disabled lives than those who are more affluent and have more education (Robine et al., 1997).

**Racial Differences**

Most studies of racial differences in active life expectancy have been restricted to data from the United States, most often comparing active life expectancies of whites and blacks. These life expectancy comparisons invariably report that death rates for blacks exceed those of whites at younger ages. In some studies, curves plotting life expectancy at each age for blacks and whites cross at older ages (80 and over). In these studies, death rate estimates for whites exceed those for blacks at these older ages. Demographers intensely debate the existence of a black-white mortality crossover. Some argue that any evidence of a crossover reflects inaccurate age reporting by older people. Several studies have corrected for age misstate-
ment by survey respondents. In these studies, the black-white crossover disappeared (Elo & Preston, 1997; Preston, Elo, Rosenwaike, & Hill, 1996). Manton and Stallard (1997), however, found evidence of a mortality crossover even after correcting for age misstatement. They found that, among those having reached old age, blacks live longer, more disabled lives than whites. Consistent with gender differences for whites, researchers generally find that black women live substantially longer than black men. In a study that corrected for age misstatement and examined longevity trends from the late 1930s until 1990, Elo (2001) found life expectancy gains of almost 20 years for black women and 14 years for black men. During the latter half of the twentieth century, Elo found black women achieved notably larger gains in life expectancy than black men.

There is also evidence of morbidity differences between blacks and whites. Several researchers have found that, compared with whites, blacks at older ages are less likely to be disabled, and have longer life expectancies. For example, Clark, Maddox, and Steinhauser (1993) found that blacks age 85 or older are only about 50% as likely to experience a decline in functional status as whites. Land et al. (1994) found that black women and men age 75 or older had both active and impaired life expectancies noticeably exceeding those of white women and men. However, a growing number of researchers have found that white women and men have both total and active life expectancies longer than those of black women and men (Crimmins et al., 1996; Geronimus, Bound, Waidmann, Colen, & Steffick, 2001; Hayward & Heron, 1999). In addition, most researchers conclude that black women live a notably greater percentage of their lives with disability than black men (e.g., Crimmins et al., 1996; Crimmins & Saito, 2001; Geronimus et al., 2001; Hayward & Heron, 1999). A small number of studies has examined life expectancy and disability patterns for other racial and ethnic groups. These studies have found that blacks and native Americans live notably shorter and more disabled lives than whites, Asian Americans, or Hispanics (Hayward & Heron, 1999; Waidmann & Liu, 2000). Researchers emphasize disparate distributions of advantages and disadvantages over the life span, and socioeconomic and cultural factors as likely causes of racial and ethnic disparities in mortality and morbidity (Blackwell, Hayward, & Crimmins, 2001; Hayward, Crimmins, Miles, & Yang, 2000).

Additional Health Status Indicators

Health encompasses multiple dimensions. Researchers therefore stress the importance of incorporating multiple dimensions of health in
studies examining life expectancy and active life expectancy (Crimmins, 1996). Panapasa (2002) describes the complexity of defining disability in developing countries, where disability is influenced by factors beyond those generally found in social and medical support systems of developed countries. Many studies have used one or both of two standard measures to represent functional status: Activities of Daily Living (ADLs) such as eating, dressing, and bathing, and Instrumental Activities of Daily Living (IADLs) such as marketing and preparing meals (Branch et al., 1991; Crimmins, Hayward, & Saito, 1994, 1996; Laditka & Wolf, 1998; Manton, Corder, & Stallard, 1993; Manton & Gu, 2001). Wolf, Laditka, and Laditka (2002) provide a new perspective on ADL disability by reporting the full distribution of remaining total, active, and inactive years for women sharing a set of important characteristics. Wolf et al. (2002) found that years of total, active, and inactive life are broadly distributed within each group of women with the same characteristics. They also found that the shapes of these distributions vary considerably across groups, highlighting the heterogeneity of disability in older populations.

Recently, sensory and cognitive impairments have been added to the set of functional status measures included in definitions of active and impaired life. Jagger, Raymond, and Morgan (1998) found that women live a greater proportion of life with impaired vision than men. Vision impairment is a particularly interesting indicator of functional status when the research focus is on changing disability patterns. Treatments for vision impairments have improved markedly in recent years, as exemplified by treatments for cataracts and diabetic retinopathy. These improvements are likely to have substantial positive effects on the ability of older people to live independently. Jagger and Matthews (2002) included cognitive status as a disability measure, and found that women live a substantially longer proportion of remaining life with a cognitive impairment than men. Cognitive deterioration is of increasing interest, because extended longevity has been accompanied by predictions of more dementia, especially for women (e.g., Brookmeyer, Gray, & Kawas, 1998).

Some researchers suggest that ADLs and IADLs are strongly influenced by individuals’ socially defined roles and physical environments. An individual may be less likely to report disability if she can compensate for an impairment with assistive devices, or by upgrading her home to aid functioning. A woman who might otherwise be disabled in bathing by some measures, for example, might regain her ability to perform this activity with a walk-in shower or tub. Changes in functioning found by recent research could reflect changes in individuals’ expectations of disability and use of equipment, rather than changes in their underlying
physiological functioning (Crimmins, 1996; Freedman & Martin, 1998). An increasing number of studies have used measures such as seeing, lifting, carrying, and climbing stairs, instead of—or in addition to—ADL and/or IADL scales, to capture more information about underlying physiological functioning (Freedman & Martin, 1998, 1999, 2000; Jagger et al., 1998; Leveille et al., 2000; Waidmann & Liu, 2000). In another area, studies have also used self-reported health, often in conjunction with other health indicators (Spiers, Jagger, & Clarke, 1996). However, there is evidence of gender differences in the ways in which women and men evaluate and report their own health status. For example, Helmer, Barberger-Gateau, Letenneur, and Dartigues (1999) found that self-reported health was more closely associated with medical conditions and disability for women than for men. Thus, the predictive power of subjective health reports from women and men may differ.

“Health profiles” identified with the Grade of Membership (GoM) method offer another measure of health status for active life expectancy research. This method groups individuals based on the types and extent of health problems they experience (Manton, Woodbury, Stallard, & Corder, 1992). The GoM method often incorporates information about co-morbidity as well as degree of disability. Deeg, Portrait, and Lindeboom (2002) identified six health profiles for women and men in The Netherlands. They found that women are more likely than men to be frail, to have cancer, or to be cognitively impaired.

**Disease Specific Effects**

An additional dimension of disability is captured by examining cause-specific mortality and/or morbidity rates, and their effects on active life expectancy. Research in this area is often restricted by the limited availability of sufficiently detailed data. For example, analyses generally do not account for co-morbidities, which could provide a measure of underlying health status, and other risk factors. Where appropriate data are available, however, this approach allows researchers to rank diseases by their importance in contributing to mortality and morbidity. Findings in this area are particularly useful for policy makers, because they provide information that can be used to select among alternative strategies targeted toward specific diseases. By quantifying hypothetical gains to total life and active life, these methods provide a basis for ranking research funding options for acute and chronic diseases.

Cause-specific mortality and morbidity calculations have been made using data from Australia, Canada, The Netherlands, the United King-
dom, and the United States (Bélanger et al., 2002; Robine et al., 1997). Reviewing results from Australia, Britain, and The Netherlands, and focusing on three major disease categories—cancer, circulatory disease, and musculoskeletal conditions—Bone et al. (1998) found that eliminating circulatory diseases had the largest positive effect on longevity. Eliminating chronic nonfatal diseases, such as musculoskeletal conditions, had almost no effect on life expectancy, but brought the largest gain in the proportion of active life for most people studied (Bone et al., 1998; Nusselder, van der Velden, van Sonsbeek, Lenior, & van den Bos, 1996). Estimating models in which a major cause of death was eliminated separately for women and men, Hayward, Crimmins, and Saito (1998) found substantial gender differences in disease-specific effects. For both women and men, eliminating heart disease brought the greatest life expectancy gains. For men, additional years from the elimination of heart disease were primarily active ones (Hayward et al., 1998). For women, however, these years gained were inactive years. Providing another perspective on disease-specific effects, Crimmins, Kim, and Hagedorn (2002) compared life with and without major diseases between women and men. They found that women live longer with and without diseases than men. Interestingly, they found that women live longer with heart disease than men, despite notably later disease onset. They also found that men live longer with arthritis than they do with heart disease.

**Biodemography**

Biodemography is one of the most recent approaches to active life expectancy. Biodemography integrates demographic methods with applications from the biological sciences, and examines the role of biological factors in life expectancy. Biodemography allows researchers to address questions about the influence of genes and the environment on the course of aging and survival. Biodemography addresses questions about the nature of processes that underlie demographic trends, and population aging and health. How might genetic components of differential aging rates affect gender differences in mortality? What are the reasons for observed mortality decline? How long will this trend continue? What are the biological limits of human longevity? Why do some individuals die shortly after birth, while others live to old age? Questions such as these stimulate new approaches to longstanding demographic mysteries, such the gender gap in longevity. Wachter (1997) provides a useful review of biodemography perspectives, stressing that, in contrast to focusing on limits to life expec-
tancy and built-in senescence, more recent views emphasize the plasticity of the life span.

Two empirical studies illustrate recent analyses in biodemography, and highlight research important for women. Using historical data for European aristocratic families, Gavrilov and Gavrilova (2001) examined health and longevity trends for daughters and sons born to parents of various ages. Their unusual study population offered the distinct advantage of relatively uniform lifestyles, and thus implicitly controlled for many factors that otherwise challenge the interpretability of demographic research. Their primary question was: Does parental age affect health and longevity differently for daughters and sons? They found that parental age influences the life span for daughters but not for sons: daughters born to older fathers (45 to 55 years) had significantly shorter lives than daughters born to younger fathers. The age of the mother was not significantly associated with longevity for daughters or sons. Reasoning from the perspective of biodemography, Gavrilov and Gavrilova observe that only daughters inherit the paternal X chromosome. Given their findings, they speculate that the X chromosome may concentrate genes that affect longevity and are sensitive to mutation. If confirmed by further research, this finding would have important implications for women, because there has been a dramatic increase in childbearing at older ages in many countries.

In another study examining the degree to which daughters and sons might inherit genes that affect their life spans, Cournil (2001) used data from a historical population registry, analyzing people from a small homogeneous rural farming community. Since members of this community shared similar lifestyles and education levels, wealth, and so forth, the population choice controlled for socioeconomic status and lifestyle. Sons’ longevity was not influenced by their mothers’ or fathers’ length of life. Mothers’ longevity was also not significantly related to either daughters’ or sons’ longevity. But Cournil found that daughters of short-lived fathers had notably shorter life spans than daughters of longer lived fathers. Similar to Gavrilov and Gavrilova (2001), Cournil suggests that this result indicates an important role for the X chromosome in women’s longevity.

**MORBIDITY COMPRESSION, EXPANSION, OR DYNAMIC EQUILIBRIUM?**

The active life expectancy literature is framed by three competing theories of trends in population health. Fries (1980) proposed that the onset of illness and disability could be postponed to a brief period at the end of life.
Fries’ theory is often referred to as the compression of morbidity. In contrast, representing the expansion of morbidity theory, Gruenberg (1977) and Kramer (1983) argued that longer lives will be accompanied by more chronic disease and disability. The theory of dynamic equilibrium, proposed by Manton (1982), assumes a more complex dynamic for population health. As mortality rates fall, it suggests, the prevalence of chronic disease will increase. At the same time, the rate at which chronic diseases progress will slow. In sum, more people will be disabled, and they will be disabled through more years. But through many of this increased number of years, they will experience less intense forms of disability. When examining evidence for these theories, researchers have studied trends in both incidence and prevalence. Incidence refers to the onset of new cases of health problems, such as disability or disease. Prevalence refers to the percentage of the population experiencing the disease or disability at a given time. We describe approaches used to address these theories, review findings of empirical work, and consider how these findings tend to support or refute the three theories.

**Observed Changes in Population Health**

Research using data from the 1960s and 1970s found that older Americans were then living longer, but in poorer health (Colvez & Blanchet, 1981; Crimmins, Saito, & Ingegneri, 1989; Verbrugge, 1984). More recently, most studies from the early 1980s to the late 1990s indicate improving health for older women and men. Using data from the National Long-Term Care Survey (NLTCS), Manton and colleagues found that the prevalence of disability decreased from the early 1980s to the late 1980s (Manton, Corder, & Stallard, 1993). Another study found evidence of both increased life expectancy and small increases in healthy life expectancy (Crimmins, Saito, & Ingegneri, 1997). One study found no clear trends in disability prevalence (Crimmins, Saito, & Reynolds, 1997). Reviewing evidence from the 1982 to 1989 NLTCS and 1984 to 1990 Longitudinal Study of Aging, Freedman and Soldo (1994) concluded there was evidence of reductions in the prevalence of IADL disability and in the incidence of ADL and IADL disability.

Studies using more recent data have also found significant disability declines. Using data from 1982 to 1994 and adjusting for age, Manton, Corder, and Stallard (1997) found there was a 1.1% annual relative decline in the proportion of people who were chronically disabled (having an ADL disability that had lasted, or that was expected to last, 90 or more days at the time of interview). Using different functional status measures,
Freedman and Martin (1998) analyzed data from 1983 and 1994, also finding significant limitation reductions. These reductions amounted to 0.9% to 2.3% annually, depending on the measure of functional status examined. The biggest limitation reductions were among the oldest old, people age 80 or over, suggesting the plasticity of age-related diseases even at older ages. Using data from 1983 to 1993 and four measures of functional ability (seeing, lifting and carrying, climbing stairs, and walking a quarter mile), Freedman and Martin (1999) found significant reductions in all measures of functional limitation. They also found that increased educational attainment for the cohort reaching older ages during this period accounted for the largest share of the improvement. Waidmann and Liu (2000) used Medicare Current Beneficiary Survey data from 1992 to 1996, and found that the largest decreases were in IADL disability, reductions of 2.3% per year, after controlling for age and sex. Studying trends from 1978 through 1998 for the Austrian population, Doblhammer and Kytir (2001) found the proportion of life lived in good health increased throughout the period for women and men, and that mortality rates declined throughout the period. Examining trends in several U.S. studies, Schoeni, Freedman, and Wallace (2001) conclude that improvements in health were concentrated in the 1982 to 1986 period, and more modest declines were evident from 1992 through 1996. Decreases in disability during these periods occurred for women and men, and were concentrated in individuals with higher education (Schoeni et al., 2001). Using data from the NLTCS that included surveys from 1982 through 1999, Manton and Gu (2001) reach a different conclusion. They found that the rate of decrease in the prevalence of chronic disability was greater in the 1990s than the 1980s; the standardized annual rate of decrease in the prevalence of disability was 0.26% from 1982 to 1989, 0.38% from 1989 to 1994, and 0.56% from 1994 to 1999 (Manton & Gu, 2001). These researchers also found that blacks experienced a larger percentage decline in disability prevalence than nonblacks (Manton & Gu, 2001). Collectively, these studies offer support for the compression of morbidity theory, and suggest that the older population was healthier in the 1980s and 1990s than it was in the 1960s and 1970s.

Two recent studies focus on links between disability prevalence and reports of major chronic diseases. Using data from 1981 and 1991 in France, Robine, Mormiche, and Sermet (1998) found a notable decrease in the prevalence of disability among middle aged and older people. However, they also found that the prevalence of thirteen major chronic diseases (e.g., cancer, heart disease) increased during this period. They suggest that the most frequent chronic diseases, cardiovascular disease and arthritis,
appear to be less disabling in 1991 than in 1981. Freedman and Martin (2000) also examined the link between chronic disease and functioning, using samples of older Americans from 1984 and 1994. They developed two scales of functional status: one for upper body limitation, one for lower body limitation. They also examined prevalence for nine major chronic diseases and injuries (e.g., hip fracture, cancer, heart disease, and arthritis). Lower body limitations declined significantly, about 1.4% annually. If disability reductions of this magnitude were to continue over an extended period, the change would alter the face of aging importantly, both for individuals and their families, and in terms of costs to the nation. Despite declining functional limitations, however, reports of all chronic diseases and injuries increased in the Freedman and Martin study, with the exception of hypertension. Similar to Robine et al. (1998), Freedman and Martin (2000) found that several major diseases, particularly arthritis, appeared to be less debilitating for more recent cohorts of older individuals. These researchers suggest their findings may arise from earlier disease detection, advances in treatment, and reductions in behavioral risks, such as poor diet or lack of exercise. These two studies offer support for the dynamic equilibrium theory.

Also supporting the theory of dynamic equilibrium is a study by Spiers et al. (1996), who used 1981 and 1988 data from the United Kingdom to examine trends in both functional status, measured by ADLs, and self-reported health. They found a significant reduction in the proportion of older people who were dependent in at least one of five ADLs. However, respondents surveyed in 1988 were less likely to report good health than those surveyed in 1981. This seemingly contradictory finding of improved ADL functioning and reduced self perceived health status underscores the multidimensional nature of population health, and highlights the importance of including disability measures spanning severe and mild impairments. It also has important policy implications. As Spiers et al. (1996) emphasize, the way people perceive their own health status may be influenced by both the absolute and relative prevalence of severe and mild chronic conditions in their society. In the scenario painted by their research findings, the population makes headway against severe disability while experiencing more mild disability. Here, the threshold at which individuals perceive “disability” may be lowered for everyone. As individuals approach that lowered threshold, they may seek treatment or other services for conditions or impairment levels that would not have prompted concern for many individuals of earlier cohorts. To the extent that heightened expectations spur improved medical management, technological developments, and healthier lifestyles, they may lead to further
improvements in population health. However, these improvements may entail increased costs. Paradoxically, these improvements can also increase reported rates of disability.

**Demographic Models of Population Health**

Scholars have also used data from a number of countries, and various demographic methods, to simulate effects of mortality and/or morbidity changes on life expectancy and active life expectancy. Reviewing findings in this area, Bone et al. (1998) conclude that the most likely way we might bring about morbidity compression would be to delay the onset of chronic disease, increase remission rates, and focus on chronic diseases that seldom cause death but produce a large proportion of morbidity and disability. Crimmins et al. (1994) illustrate separate and combined effects of changing assumptions about mortality and morbidity. Crimmins and her colleagues conclude that increasing the age at which individuals become disabled or decreasing the incidence of disability are the most effective ways to reduce the number of people with a functional limitation. Do various population subgroups fare differently with generally improving health? Laditka and Laditka (2001) addressed this question by examining effects of reducing morbidity on expectancies for total and active life for several subgroups of older individuals. Women experienced greater proportional gains in both total and active life expectancy than men in their simulations. Nonwhites experienced larger proportional gains in both total and active life expectancy than whites. Women and men with less education had greater proportional gains in both total and active life expectancy than those with more education. Thus, women and traditionally disadvantaged population subgroups had the most to gain, in terms of active life expectancy, by reducing functional decline and increasing recovery from illness or injury.

Several simulation studies have explicitly modeled effects of improved education. Waidmann and Liu (2000) estimated projections of older people through 2040 under several scenarios. For the baseline projection, they assumed the current prevalence of disability stayed constant. When they assumed that improvements observed between 1992 and 1996 continue to accumulate at the same rate indefinitely, there was about a 62% reduction in IADL disability and a 50% decrease in ADL disability. In addition, Waidmann and Liu suggest that we already may have achieved most of the gains in functional status obtainable from more education. Using data from 1984 to 1993 and a different modeling approach, Freedman and Martin (1999) reach a similar conclusion about smaller disability im-
provements attributed to future gains in education. Freedman and Martin (1999) project functional status through 2030 under several assumptions of changes in education, holding all other factors constant. Over the period of their projection, changes in education decreased functional difficulty by 1.3% to 3.2%, depending on the disability measure selected. These researchers suggest that future disability reductions will be small, compared with improvements of the recent past.

**CONCLUSIONS AND POLICY IMPLICATIONS**

Our review of the active life expectancy literature suggests several important policy implications. Socioeconomic factors, particularly education, are significantly associated with expectancies for longevity and active life. Results from several recent studies suggest that most of the benefits attributed to more education have already been achieved. But there may be differential effects of education for women. Women coming of age in recent decades have achieved greater educational gains than men. In developing countries, women are still often disadvantaged in educational opportunity; yet here, too, women are beginning to experience relative education gains.

Better data and emerging methodologies will continue to improve our understanding of longevity and the dynamics of population health. Further research is particularly likely to shed light on trends in population health and inform policy making in three areas: total and active life differences for at-risk populations such as those defined by race, ethnicity, or income, active life expectancy estimates for developing countries, and biodemography. Based on current trends, by the year 2025 over two thirds of older women will live in developing countries (Kinsella & Gist, 1998). Thus, a better understanding of population health trends in developing countries, where population growth is great and resources are much harder to come by, is important (Panapasa, 2002). Biodemography is another area in which more research is needed. Biodemography has already shed new light on possible reasons for longevity differences between women and men. Future work in this area will likely help us better understand processes underlying active life expectancy differences, too. Advances in genetics, like mapping the human genome, should spur this work. Biodemographers can now expect to learn more about causal impacts of specific genes on medical conditions involved in longevity and active life.
Also useful for setting policy priorities is information about relative effects of various lethal and chronic diseases on longevity and active life expectancy. Results from cause-specific studies of major diseases suggest that eliminating lethal diseases, such as heart disease, increases the proportion of disabled life for women. Eliminating nonfatal disabling diseases, such as arthritis and osteoporosis, increases the percentage of active life, and thereby quality of life. A substantially higher percentage of women than men suffer from chronic diseases, so women have a special interest in policies that help find ways to prevent, delay, or treat nonfatal or chronic diseases.

Findings for the three theories of population health, compression of morbidity, expansion of morbidity, and dynamic equilibrium, are complex—and remain inconclusive. A growing number of studies offer evidence of improving population health over the past decade, supporting the compression of morbidity theory (e.g., Freedman & Martin, 1998; Manton et al., 1997; Manton & Gu, 2001). Collectively, however, studies in this area also tend to support the theory of dynamic equilibrium described by Manton (1982) (Crimmins, Saito, & Reynolds, 1997; Freedman & Martin, 2000; Robine et al., 1998; Spiers et al., 1996).

Despite mixed findings about population health trends, two results of active life expectancy research are clear. First, women are more likely than men to become disabled. When women experience disability, they are also less likely to recover. Thus, women have higher disability incidence and prevalence at all ages (e.g., Becket et al., 1996; Leveille et al., 2000). Second, studies using demographic models to examine population health demonstrate that the greatest gains in longevity and active life expectancy come by decreasing the rate of functional status decline (e.g., Crimmins et al., 1994; Laditka & Laditka, 2001). Regardless of which of the three competing theories of population health might come closest to actual population processes in the coming decades, many researchers familiar with these issues agree that more public resources should be devoted to preventing or delaying the onset of disabling diseases (e.g., Crimmins, Saito, & Reynolds, 1997; Laditka & Laditka, 2000, 2001).

This view is supported by a growing body of research that shows women and men who adopt healthy lifestyles—controlling blood pressure, maintaining appropriate weight, abstaining from smoking, and being physically active—have a significantly lower prevalence of illness and impairment than those who do not follow healthy lifestyles (e.g., Reed et al., 1998; Vita Terry, Hubert, & Fries, 1998). These findings suggest that policy makers and practitioners serving older people should become more proactive in promoting exercise and generally healthier lifestyles. En-
hancing public investment in healthy lifestyles will reward women dispro-
portionately, given their longer lives, their greater incidence of both
chronic illness and disability, and their greater use of long-term care. If
healthy lifestyles are associated with morbidity compression and their
adoption is promoted successfully, women’s long-term care needs would
be substantially reduced. The care women commonly provide for their
parents and husbands would be reduced as well.

Research on disability processes often overlooks the fact that the great
majority of individuals at all but the very oldest ages live relatively active
lives. They may have minor impairments that limit one activity or an-
other, and these limitations can eventually become sufficiently restric-
tive that life becomes inactive, disabled, by common health status
measures. Even an individual living a joyous, productive, and otherwise
active life might find herself responding “yes” to the phrasing of a survey
question asking about a particular impairment. The reality of life for us all
is that the distinction between “active” life and “inactive” life disguises a
continuum of functional ability. Recognizing this continuum only adds to
the complexity of active life expectancy research, already illustrated in
our review.

Regardless of the thresholds we may set defining disability, however,
long-term care will exert pressing demands on our society’s resources in
the coming decades. We face these increasing pressures no matter what
actions we may take to ameliorate the impact of population aging. The
large baby boom cohort will require more formal and informal care, in the
aggregate, regardless of lifestyle changes, or research successes, or mor-
bidity compression we may enjoy. Nonetheless, our review suggests, as
nations and individuals, we can still do more to limit decline, enhance re-
covery, and extend active life.

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