Disability Burdens among Older Americans Associated with Gender and Race/Ethnicity in Rural and Urban Areas

South Carolina
Rural Health
Research Center

At the Heart of Public Health Policy

Disability Burdens among Older Americans Associated with Gender and Race/Ethnicity in Rural and Urban Areas

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Executive Summary

Background and Overview

Policymakers increasingly use disability indicators to measure population health. One useful indicator of population health is called "health expectancy." To estimate health expectancy, researchers partition total life expectancy into two parts. One part is healthy life expectancy, also often referred to as active life expectancy or disability-free life expectancy. This is a measure of the years an individual can expect to live free of serious disability. The second part measures the years a person can expect to live with disability, also commonly referred to as inactive life expectancy or disabled life expectancy.

No prior research has investigated differences in disability-free and disabled life expectancy associated with rural or urban residence. This project addresses this gap. This project identifies differences in healthy life expectancy that may signal important policy needs. The project:

- Examines total life expectancy, disability-free life expectancy, and disabled life expectancy, comparing people in rural and urban areas.
- Compares these expectancy measures for subgroups of rural and urban areas, distinguished by sex, race (white and African American) and educational attainment.

The data source for this project is the 1982, 1984, 1989, 1994, and 1999 survey waves of the National Long-term Care Survey (NLTCS). The sample selected for this project is a nationally representative cohort of respondents to the NLTCS aged 65 to 69 in 1982. This sample was selected to enable a retrospective study of a defined younger-old cohort, individuals who may have much in common with more recent retirees. Disability is defined as being unable to perform one or more of six Activities of Daily Living (ADLs) without help from other individuals or assistive devices. Respondents were considered to be "Rural" residents if they lived in any of the following area types: "Open country/not farm," "Farm," or "City/Town/Village (Under 50,000)." Residents of all other area types were classified as residents of urban areas.

Separate estimates of total, disability-free, and disabled life were developed for women and men living in rural and urban areas. In both rural and urban areas, a total of eight subgroups were examined: African American women with high and low education; white women with high and low education; African American men with high and low education; white men with high and low education.

Key Findings

Among a cohort of Americans aged 65 to 69 in 1982, in seven of the eight subgroups, individuals in rural areas lived longer lives than those in urban areas. Rural as compared to urban people lived (a) more disability-free years, (b) more disabled years, and (c) a notably greater percentage of their lives with a disability. There were striking differences among the high and low education groups, with individuals with more education living substantially longer, less disabled lives. Women lived longer, more disabled lives than men. For most subgroups, African Americans lived shorter, more disabled lives than Whites.

The key findings for women were:

- African American women with high education in rural areas lived a total of 22.5 years versus 19.5 years for those in urban areas; rural women lived 18.2 years disability-free versus 17.4 years for those in urban areas; rural women lived 4.3 years with a disability versus 2.1 for urban women. Women in rural areas spent a greater percentage of their remaining lives with a disability compared with those in an urban area (19.1% versus 10.7%).

- African American women with low education in rural areas lived a total of 10.6 years versus 8.4 years for those in urban areas; rural women lived 4.2 years disability-free versus 4.3 years for those in urban areas; rural women lived 6.5 years with a disability versus 4.3 for urban women. Women in rural areas spent a greater percentage of their remaining lives with a disability compared with those in an urban area (60.8% versus 49.7%).

- White women with high education in rural areas lived a total of 25.3 years versus 20.7 years for those in urban areas; rural women lived 21.7 years disability-free versus 18.9 years for those in urban areas; rural women lived 3.6 years with a disability versus 1.8 for urban women. Women in rural areas spent a greater percentage of their remaining lives with a disability compared with those in an urban area (14.3% versus 8.5%).

- White women with low education in rural areas lived a total of 9.1 years versus 8.5 years for those in urban areas; rural women lived 6.3 years disability-free versus 4.5 years for those in urban areas. In contrast with the other subgroups, rural women in this group lived fewer years with a disability: 2.8 years versus 4.0 for urban women. Women in rural areas spent a smaller percentage of their remaining lives with a disability compared with those in an urban area (30.7% versus 47.1%).

The key findings for men were:

- African American men with high education in rural areas lived a total of 17.7 years versus 12.8 years for those in urban areas; rural men lived 15.1 years disability-free versus 11.7 years for those in urban areas; rural men lived 2.6 years with a disability versus 1.0 for urban men. Men in rural areas spent a greater percentage of their remaining lives with a disability compared with those in an urban area (14.6% versus 8.1%).

- African American men with low education in rural areas lived a total of 7.4 years versus 5.1 years for those in urban areas; rural men lived 3.6 years disability-free versus 2.9 years for those in urban areas; rural men lived 3.7 years with a disability versus 2.2 for urban men. Men in rural areas spent a greater percentage of their remaining lives with a

disability compared with those in an urban area (50.8% versus 43.57%).

- White men with high education in rural areas lived a total of 20.9 years versus 13.5 years for those in urban areas; rural men lived 18.9 years disability-free versus 12.6 years for those in urban areas; rural men lived 2.0 years with a disability versus 0.9 for urban men. Men in rural areas spent a greater percentage of their remaining lives with a disability compared with those in an urban area (9.5% versus 6.4%).

- White men with low education in rural areas lived a total of 7.5 years versus 4.9 years for those in urban areas; rural men lived 3.8 years disability-free versus 2.5 years for those in urban areas; rural men lived 3.7 years with a disability versus 2.4 for those in urban areas. Men in rural areas spent a slightly greater percentage of their remaining lives with a disability compared with those in an urban area (49.4% versus 48.87%).

Implications (See Discussion in Chapter 4)

Our results suggest the following implications:

Promote Research and Policies Focused on Reducing Disability
- Practitioners should focus on strategies to maintain and even enhance physical activity among the old and near-old. Practitioners should become more pro-active in promoting exercise and healthier lifestyles among the older persons they serve. Lifestyle changes seldom come easily, but education and motivation play an important role in bringing them about.

- There should be an increased emphasis in health research and policymaking on postponing chronic illness and maintaining vigor. The findings support a renewed interest on the part of policymakers in promoting healthy lifestyles and additional research on the prevention and treatment of chronic diseases that affect functional status. The most effective way to accomplish these goals is through health promotion education and personal responsibility.

Chapter 1: Introduction: Healthy Life Expectancy, an Indicator of Public Health

Healthy Life Expectancy

Increasing life expectancy is one of the greatest public health achievements of the twentieth century. Most of the gains came from controlling infectious diseases and improving public health early in the century (Fuchs, 1974; Olshansky et al., 1997). Initially, additional years of good health accompanied increases in life expectancy. Beginning about three decades ago, death rates for fatal diseases often associated with older age fell considerably. This trend particularly affected cardiovascular diseases, such as stroke and heart disease (Davis et al., 1985; McGovern et al., 1992). Reduced mortality from major fatal diseases brought even more years of life for the average individual. However, these longevity gains also brought additional years spent in worse health (Colvez & Blanchet, 1981; Crimmins, Saito, & Ingegneri, 1989). These trends illustrate the importance of monitoring the relationship between total life expectancy and the proportion of life spent in good health. Monitoring this relationship is particularly important because various groups in the population have widely differing expectancies for longevity, and for health at older ages. These differences have major implications for needs for health care and social services, public health priorities, and costs to individuals, families, and governments.

Another major epidemiological shift occurred during the past two decades in the United States and in many other developed countries. There is growing evidence that the proportion of the older population with severe disability has declined (Doblhammer & Kytir, 2001; Freedman & Martin, 1998; Freedman, Martin, & Schoeni, 2002; Manton, Corder, & Stallard, 1993). This decline in the prevalence of disability has been attributed to many factors, including better knowledge of healthy lifestyle choices, advances in medical treatment and technology, and prescription drugs (Fries, 2002; Rowe & Kahn, 1998; Vita, Terry, Hubert, & Fries, 1998).

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Policymakers, practitioners, and researchers agree that the demand for health care resources and expenditures for health care and other services for older people depend on both the number of older people and their health status (Jacobzone, 2000; Lubitz, Beebe, & Baker, 1995). However, the relationship between changing disability levels and use of formal and informal services is complex. Although use and cost outcomes depend on many factors, the large increases in life expectancy, and growth in the number of older Americans, has made disability a linchpin for understanding health care resource needs. As the population ages, planning for the transition from full health to levels of disability is essential to develop services that can help older people live in their communities. Planning for needed services is particularly important for rural areas, which commonly lack many services offered in urban areas and are hampered by long distances and limited transportation alternatives (Coburn, 2002).

Policymakers increasingly use disability indicators to measure population health. One useful indicator of population health is called "health expectancy." This indicator was first proposed by the U.S. Department of Health, Education, and Welfare (1969) more than 35 years ago, and has been widely adopted for use by the World Health Organization. To estimate health expectancy, researchers partition total life expectancy into two parts. One part is healthy life expectancy, also often referred to as active life expectancy or disability-free life expectancy. This component is a measure of the years an individual can expect to live free of disability. The second part measures the years a person can expect to live with disability, also commonly referred to as inactive life expectancy or disabled life expectancy.

A growing number of researchers are studying total, disability-free, and disabled life expectancy. For example, an international group of research scientists, known as the International Network on Health Expectancy, or REVES (Réseau Espérance de Vie en Santé), has developed and compared various measures of health expectancy across countries and time

periods to evaluate changes in health expectancies among populations.   A comprehensive review and synthesis of research conducted by REVES network scientists has been published (Robine et al., 2003).

Although morbidity and mortality have been examined from a geographic perspective, no prior research has investigated disability-free and disabled life expectancy differences associated with rural or urban residence. This project addresses this gap by developing detailed estimates of disability-free, disabled, and total life expectancy among rural and urban populations. Life expectancy and its two component parts differ substantially among subgroups. Thus, this project provides estimates separately for important subgroups, distinguished by sex, race and ethnicity, and education, in rural and urban areas. A greater understanding of differences in the burden of disability among groups defined by these characteristics can help national and local policy makers anticipate needs for services of various types.

Gains in Healthy Life Expectancy Differentially Benefit Rural and Urban Areas

Some researchers stress that rural areas tend to be "forgotten," losing out on resources from governmental and private sector funding to areas with more highly skilled health care personnel and greater political clout (e.g., Probst et al., 2004). Particularly relevant to older populations, higher levels of social support available in urban areas may offer the advantage of more cohesive social networks (Vlahov, Galea, & Freudenberg, 2005). Cities may also offer more access to many necessities of life (Vlahov et al., 2005). Although there are notable exceptions, urban areas tend to enjoy better health care systems than rural areas, and better access to a wide variety of wholesome foods. Cities may also have a health-promoting environment, with greater availability of gymnasiums and pools, and other facilities that promote physical activity. In a series of recent commentaries, Vlahov and Galea, (2002) and Vlahov et al. (2005) consider factors that may result in an urban health penalty or an urban health advantage.

Factors thought to be conducive of an urban health penalty include air pollution, crime, and over-crowding, which can lead to poor sanitary conditions (Freudenberg, Galea, & Vlahov, 2005; Judd et al., 2002; McMichael, 2000). Factors that support the "urban health advantage" include the proximity of wealth and poverty, combining to bring benefits to the poor, affluence that helps sustain social organizations, and political support for social services (Eberhardt & Pamuk, 2004; Lee & Cubbin, 2002; Ross, 2000). Of course, urban and rural areas each have a combination of penalty and advantage factors. It is likely that health status is affected by these advantages and penalties.

Findings for morbidity differences by location of residence are complex. Much of the research in this area has found that more poverty in rural areas than in urban areas results in higher levels of morbidity for rural residents (Auchincloss & Hadden, 2002; Auchincloss, Van Nostrand, & Ronsaville, 2001; Wen, Browning, & Cagney, 2003). However the findings of earlier studies are mixed (see Clayton et al., 1994, Appendix 1, pages 78-87, for a summary of earlier studies). Recently, several studies have provided striking evidence that women and men living in the deep south have substantially higher disability rates than those in other parts of the United States (Elman & Myers, 1999; Lin, 2000; Porell & Miltades, 2002). Using data from the 1990 U.S. Census, Lin (2000) found significantly higher rates of morbidity among those living in the Deep South: the risks of developing a disability were 50% higher for those in the South than in the North. These results were true across race and ethnicity groups. Lin attributed greater risks to the higher incidence of stroke and diabetes in the south; however, the data used for Lin's study did not permit controls for potential confounding factors at the individual level. Further, Lin suggests that the excessive disability in the South might be associated with exposure to risk factors in childhood (Lin 2000). Porell and Miltiades (2002) pooled data from the 1992-1995 Medicare Current Beneficiary Survey, incorporating a large number of individual-level controls.

Controlling for health status and economic factors diminished regional differences in disability, but did not eliminate them. These researchers also suggest that exposing individuals to risk factors early in life may predispose them to disability later in life. Research has yielded evidence to support this theory (Hayward & Gorman, 2004).

Women Live Longer Lives, but Experience More Disability

Almost all studies have found that life expectancy is notably longer for women than for men, but women spend a greater proportion of their longer lives with significant disability (Robine, Romieu, & Cambois, 1997). This has been the finding of many 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). These gender differences are attributed to several causes. Women have more favorable survival histories than men at all ages; thus, women's advantage at later ages continues trends of earlier life stages (Deeg, 2001). Women are more likely than men to experience a decline in functional status, and are less likely to recover (Becket et al., 1996). Most studies 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 et al., 2000; Murtagh & Hubert, 2004). Women may simply accumulate more disability throughout their lives.

African Americans Live Shorter Lives with More Disability

Most studies of racial differences in life expectancy and healthy life expectancy have compared whites and African Americans. Because appropriate data are generally not available, these expectancies have rarely been studied for other minority groups (for a notable exception, see Hayward & Heron, 1999). The life expectancy comparisons consistently report that death rates for African Americans exceed those of whites at younger ages. In some studies, curves plotting life expectancy at each age for African Americans and whites cross at older ages (80 and

over). In these studies, death rate estimates for whites exceed those for African Americans at these older ages. Researchers intensely debate the existence of an African American-white mortality crossover. Some argue that inaccurate age reporting by older people results in the observed crossover effects. After correcting for age misstatement by survey respondents, the African American-white crossover disappeared in several studies (Elo & Preston, 1997; Preston, Elo, Rosenwaike, & Hill, 1996). However, one study found evidence of a mortality crossover even after correcting for age misstatement (Manton & Stallard, 1997). This study found that, among those having reached old age, African Americans live longer, more disabled lives than whites. Researchers generally find that African American women live substantially longer than African American men; this finding is consistent with gender differences for whites.

There is also evidence of morbidity differences between African Americans and whites. Several researchers have found that, compared with whites, African Americans who survive to older ages are less likely to be disabled, and can expect to live more years than whites of the same older ages. In one study, researchers found that African Americans age 85 or older are only about 50% as likely to experience a decline in functional status as whites (Clark, Maddox, & Seinhauser, 1993). Another team of researchers found that African American women and men age 75 or older had both disability-free and disabled life expectancies noticeably exceeding those of white women and men (Land et al., 1994). However, more recently, most studies have found that white women and men have both total and disability-free life expectancies longer than those of African American women and men (Crimmins et al., 1996; Geronimus et al., 2001; Hayward & Heron, 1999). Further, most studies have found that African American women live a notably greater percentage of their lives with disability than African American men (e.g., Crimmins et al., 1996; Crimmins & Saito, 2001; Geronimus et al., 2001; Hayward & Heron, 1999). Researchers point to socioeconomic and cultural factors, and disparate distributions of

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advantages and disadvantages over the life course, as likely causes of racial and ethnic disparities in mortality and morbidity (Blackwell, Hayward, & Crimmins, 2001; Hayward, Crimmins, Miles, & Yang, 2000).

Individuals with Less Education Live Shorter Lives with More Disability

Most research in the U.S. has used education to capture differences in socioeconomic status. These studies have consistently found that older women and men with more education live notably longer, healthier lives than people with less education (Crimmins et al., 1996; Crimmins & Saito, 2001; Freedman & Martin, 1999; Freedman et al., 2002; Laditka & Laditka, 2001; Laditka & Wolf, 1998; Land et al., 1994). There are several pathways by which education may confer protective effects relating to specific functional limitations and major diseases. Education may alter an individual's ability to understand risks to health, or the propensity to accept or reduce known risks (Fries, 2002). For example, not smoking, and taking certain vitamin supplements, may protect against macular degeneration and cataracts, thereby reducing visual impairment at older ages (e.g., Christen, Glynn, & Hennekens, 1996). More education is associated with higher levels of physical activity, better diet, and weight control. These health behaviors are linked to reduced levels of some chronic conditions affecting functional ability, such as arthritis and osteoporosis (Wister, 1996). Some studies have shown that women with less education have notably more behavioral and biological risks associated with coronary artery disease. For example, women with less education are more likely to smoke, exercise less, and have lower high density lipoprotein levels than women with more education (Matthews et al., 1989).

This project is designed to identify differences in healthy life expectancy that may signal important policy needs. This report presents summary estimates of the three most commonly used measures of healthy life expectancy. These include:

- Disability-free life expectancy

- Disabled life expectancy

- Total life expectancy

The summary measures focus primarily on the average number of years an individual can expect to live in each of these categories.

The report also presents the full distribution of remaining total, disability-free, and disabled years for women and men in selected groups sharing a set of important characteristics.

Report Overview

Chapter 2 describes the data source and the characteristics of the sample. In Chapter 2,

the definition of disability and rural is also described. The results are presented in Chapter 3.

Chapter 4 summarizes the conclusions and describes the implications. Appendix A provides

details of the data and methods; detailed results and tables are shown in Appendix B.

Chapter 2: Sample Characteristics: Disability and Health Profiles Among Older Americans

The data source for this project is the 1982, 1984, 1989, 1994, and 1999 survey waves of the nationally representative National Long-term Care Survey (NLTCS), matched with Medicare claims files to obtain accurate dates of death.

National Long-Term Care Survey Sample Characteristics

The NLTCS is nationally representative of older Americans having any level of difficulty performing one or more activities of daily living at the time of the survey. Descriptive information for the weighted sample for people in rural and urban areas is shown in Figure 1. For the purposes of this research, respondents were considered to be "Rural" residents if they lived in any of the following areas types: "Open country/not farm," "Farm," or "City/Town/Village (Under 50,000)." Residents of all other area types were classified as residents of urban areas. Education was defined as more than 12 years, referred to as high (or more) education; and less than or equal to 12 years, referred to as low (or less) education.

Figure 1. SAMPLE CHARACTERISTICS WEIGHTED FOR NATIONAL REPRESENTATIVENESS 1982 NLTCS
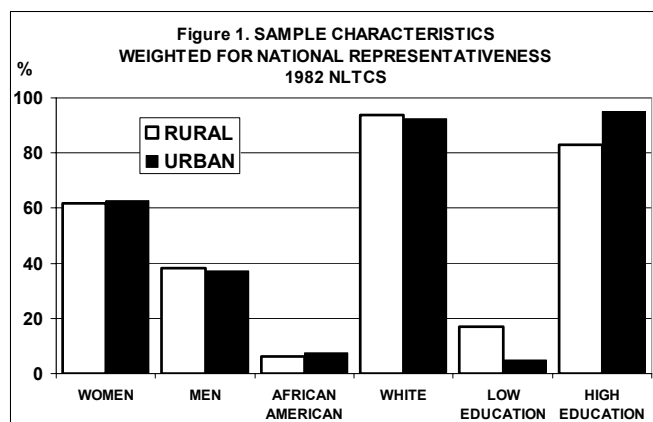
Among rural residents, 6.1% were African Americans; 93.9% were white (Figure 1). Women comprised 61.8% of people living in rural areas, whereas men were 38.2% of the rural sample. 83.1% of those in rural areas had more education, 16.9% had less education. The mean baseline age in the rural sample was 67.1 years (not shown in Figure 1). Among urban residents, 7.6% were African Americans; 92.4% were white.

Women comprised 61.8% of those in urban areas, whereas men were 38.2% of the urban sample. 95.2% of those in urban areas had more education, 4.8% had less education. The mean baseline age in the urban sample was 67.2 years (not shown in Figure 1). Thus, as measured by these characteristics, the urban and rural samples were notably similar, excepting the much greater proportion of the rural sample that had low education. This result suggests the usefulness of adjusting for education when examining differences associated with rural or urban residence when studying the older population. If results were not adjusted for education, it is likely that any rural effect identified by the analysis would be notably biased by the education difference depicted in Figure 1.

NLTCS ADL Disability Prevalence by Age

Disability is defined as being unable to perform any one of six Activities of Daily Living (ADLs) without help from other individuals or assistive devices. Americans at age 65 in 1982 had relatively low rates of ADL disability (Figure 2). For example, about 1% of individuals were disabled in eating at age 65. At age 65, about 6% were disabled in walking (mobility), which can include use of canes, wheelchairs, or other assistive devices or help by others (Figure 2). The prevalence of each type of disability increases as this cohort moves through time. For example, by age 75, about 12% of this cohort is disabled in walking (Figure 2). Measures of ADL disability are important for understanding the likelihood that a given population group at a given age will need help, either informal or formal long-term care services.
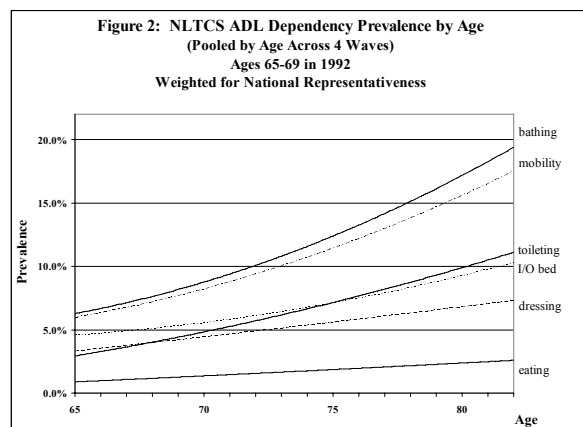
Figure 2: NLTCS ADL Dependency Prevalence by Age (Pooled by Age Across 4 Waves) Ages 65-69 in 1992 Weighted for National Representativeness

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Characteristics of the Sample Used for This Project

To be included in the baseline survey (1982 NLTCS), respondents were required to be at least 65 years old in 1982. The baseline survey, the 1982 NLTCS, collected detailed information from respondents who reported a disability that had lasted, or was expected to last, for at least 90 days. The sample for this project is a cohort of individuals aged 65 to 69 in 1982, individuals born from 1912 to 1917. This sample was selected to enable a retrospective study of a defined younger-old cohort. These younger-old individuals could be expected to have more in common with older individuals alive today, in terms of health expectancies, than would the older-old of 1982. Additional details about the NLTCS and the sample used for this study are provided in Appendix A.

Chapter 3: Individual-Level Health and Disability:Older Life Span Results for Older Americans

~Summary~

Among eight subgroups distinguished by sex, race/ethnicity, and education, there were notable differences in total life expectancy, disability-free life expectancy, and disabled life expectancy comparing subgroups living in rural and urban areas. In all but one instance, those living in rural areas lived longer lives than those in urban areas but lived a greater percentage of these longer lives with a disability. For example, for African American women with high education, those living in rural areas had a total life expectancy at age 65 of 22.5 years compared with 19.5 in urban areas; women in this group in rural areas spent 19.1% of their total lives with a disability compared with 10.7% for those in urban areas.

For all eight subgroups, there were marked differences by education; those with less education lived substantially shorter more disabled lives. For example, African American men with more education living in rural areas had a total life expectancy at age 65 of 17.7 years, and spent 14.6% of their lives after age 65 with a disability. African American men with less education living in rural areas had a total life expectancy of 7.4 years, and spent 50% of their lives after age 65 with a disability. For all groups, the educational differences were larger than the race/ethnicity differences.

For all groups, there was substantial variability around the average estimates of total, disability-free, and disabled life expectancy. That is, there is notable variation in estimates of life expectancy even within subgroups defined by important characteristics.

Summary of Methods Used

Monthly transition probabilities were estimated using multinomial logistic regression. The model allowed individuals to move from a disability-free state to being disabled, from being disabled to being disability-free, and from either a disability-free state or a disabled state to death (Figure 3).

DISABILITY PATHWAYS

Figure 3.

Next, based on the actual lived experience of individuals in the NLTCS, and the disability profile of each of the subgroups at ages 65 to 69

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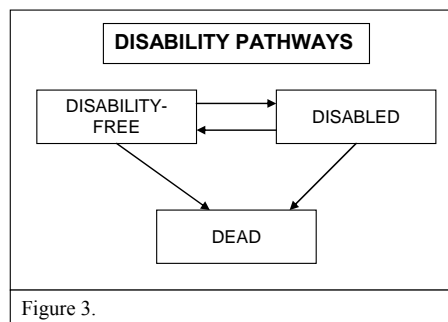
included in the NLTCS, microsimulation methods were used to calculate the life expectancy measures, and full distributions of total life expectancy, disability-free life expectancy, and disabled life expectancy. Separate estimates were developed for women and men living in rural and urban areas. For women and men, given the substantial differences by race/ethnicity and education, we distinguished by race and ethnicity (African American and white) and educational attainment. Individuals with less than 12 years of education are designated as low (or less) education; people with 12 or more years of education are designated as high (or more) education. Thus, total, disability-free, and disabled life expectancy was estimated for eight subgroups living in rural areas and eight living in urban areas, for a total of 16 subgroups. Additional details about the methods are provided in Appendix A.

Older Life Cycle Patterns of Active Life Expectancy

Results are reported in the sections that follow for the subgroups of women, and then men.

Total, Disability-free and Disabled Life for African American Women

Turning to the results for African American women with more education, there were notable differences between women living in rural areas and those in urban areas (Figure 4). At age 65, women living in rural areas had a total remaining life expectancy of 22.5 years compared

Figure 4: Health Expectancies African American Women Education 12 Years or More
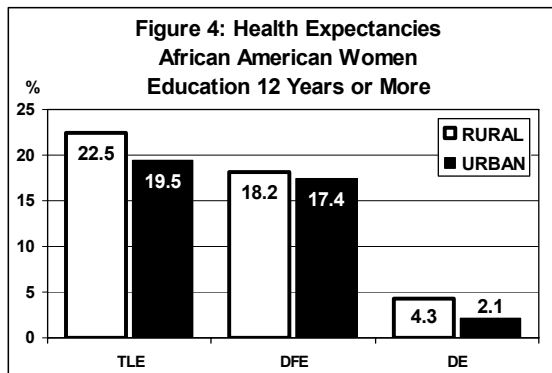
with 19.5 of those living in urban areas (Figure 4). Women in rural areas had more years of life without disability (18.2 versus 17.4) and life with disability (4.3 versus 2.1) as compared to women in urban areas (Figure 4). African American women in rural areas spent a greater percentage of their remaining lives with a disability compared with

those in an urban area (19.1% versus 10.7%; for these figures and other details, see Table B-2).

Figure 5 shows the total life expectancy, disability free life, and disabled life expectancy for African American women with less education. Rural/urban differences are similar to those for African American women with more education; however, in each category of life expectancy, those with less education lived substantially fewer years. At age 65, African American women with less education in rural areas had a total remaining life

Figure 5: Health Expectancies African American Women Education Less Than 12 Years
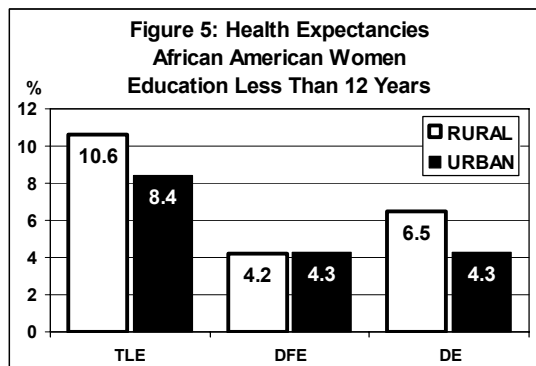
expectancy of 10.6 years compared with 8.4 of those living in urban areas (Figure 5). Those in rural areas had about the same number of years of remaining life without disability (4.2 compared with 4.3, respectively). However, rural women had many more years of disability than did urban women (6.5 compared with 4.3, respectively) (Figure 5). Note: due to rounding, DFE and DE does not sum to TLE in Figures 5, 8, and 9. Among African American women with low education, those in rural areas spent a substantially greater percentage of their remaining lives with a disability than did those in urban areas (60.8% versus 49.0%, see Table B-2).

Total, Disability-free and Disabled Life for White Women

Figure 6: Health Expectancies White Women Education 12 Years or More

Figure 6 reports the results for white women living in rural and urban areas. White women with more education in rural areas had a total remaining life expectancy of 25.3 years compared with 20.7 for those living in urban areas (Figure 6). Compared with those in urban areas, women in rural areas had

greater years of life without disability (21.7 versus 18.9, respectively) and life with disability (3.6 versus 1.8, respectively) (Figure 6). White women in rural areas spent a notably greater

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percentage of their remaining lives with a disability compared with those in urban areas (14.3% versus 8.5%, see Table B-2).

Total life expectancy, disability free life, and disabled life expectancy for white women with less education comparing those in rural and urban areas are shown in Figure 7. For total and disability-free life, rural/urban differences are similar to those for white women with more education; however, in each category of life expectancy, those with less education lived substantially fewer years. At age 65, white women with less education in rural areas had a total remaining life expectancy of 9.1 years compared with 8.5 of those living in urban areas (Figure 7). Compared with those in urban areas, women in rural areas had greater years of life without disability (6.3

Figure 7: Health Expectancies White Women Education Less Than 12 Years
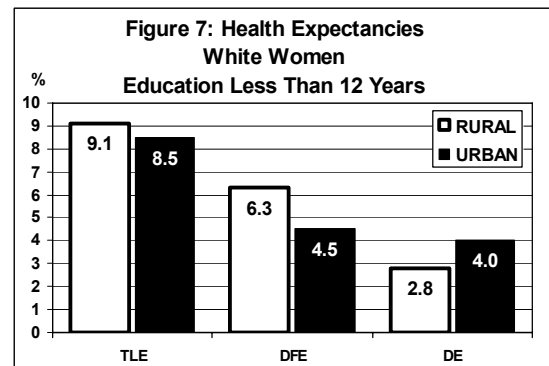
versus 4.5). However, white women with less education in urban areas lived more years with a disability than those in rural areas (4.0 versus 2.8) (Figure 7). Of all groups studied, only in this group of white women with low education did urban residents live more disabled years than comparable rural women. White women in rural areas spent a notably lower percentage of their remaining lives with a disability compared with those in an urban area (30.7% versus 47.1%, see Table B-2).

Comparing results for African American and white women with high education shown in Figures 4 and 6, white women lived more total years than African American women in both rural and urban areas. Comparing analogous results for those with low educational attainment (Figures 5 and 7), however, suggests that African American and white women with low education have similar life expectancies at age 65, with a slight advantage for African American rural residents. However, African American women lived more years disabled than did white

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women in all categories.

Total, Disability-free and Disabled Life for African American Men

Total life expectancy, disability free life, and disabled life expectancy for African

American men with more education, comparing those in rural and urban areas, are displayed in

**Figure 8: Health Expectancies
African American Men
Education 12 Years or More**
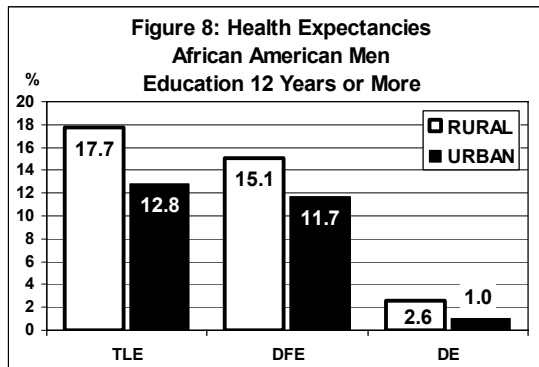
Figure 8. At age 65, men living in rural areas had a

total remaining life expectancy of 17.7 years

compared with 12.8 of those living in urban areas

(Figure 8). Compared with those in urban areas,

men in rural areas had greater years of life without

disability (15.1 versus 11.7, respectively) and life with disability (2.6 versus 1.0, respectively)

(Figure 8). African American men in rural areas spent a greater percentage of their remaining

lives with a disability compared with those in an urban area (14.6% versus 8.1%, see Table B-2).

The total life expectancy, disability free life, and disabled life expectancy for African

American men with less education are shown in Figure 9. Rural urban differences are similar to

those for African American men with more

education; however, in each category of life

expectancy, those with less education lived

substantially fewer years. At age 65, African

American men with less education in rural areas had

**Figure 9: Health Expectancies
African American Men
Education Less Than 12 Years**
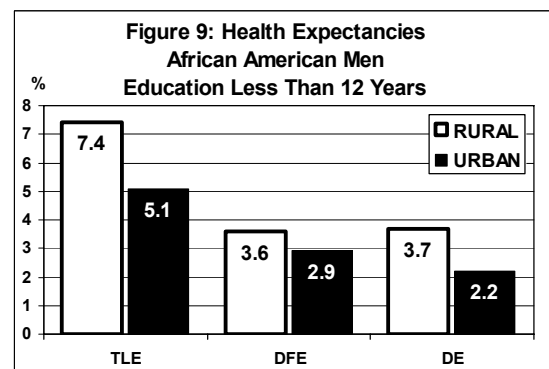
a total remaining life expectancy of 7.4 years compared with 5.1 of those living in urban areas

(Figure 9). Compared with those in urban areas, men in rural areas had greater years of life

without disability (3.6 versus 2.9, respectively) and life with disability (3.7 versus 2.2,

respectively) (Figure 9). African American men in rural areas spent a greater percentage of their

remaining lives with a disability compared with those in urban areas (50.8% versus 43.5%, see

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Table B-2).
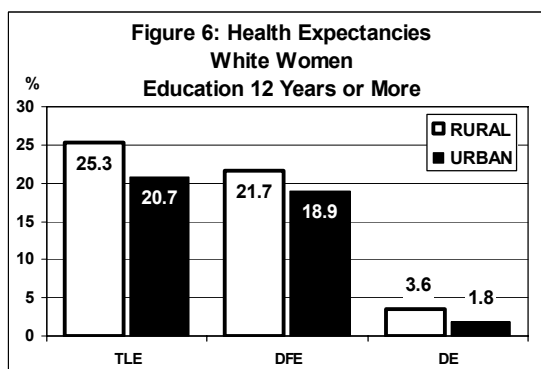
Total, Disability-free and Disabled Life for White Men

Figure 10 reports the results for white men with more education living in rural and urban

areas. White men in rural areas had a total

remaining life expectancy of 20.9 years compared

with 13.5 for those living in urban areas (Figure

10). Compared with those in urban areas, white

men in rural areas had greater years of life without

disability (18.9 versus 12.6, respectively) and life

Figure 10: Health Expectancies
White Men
Education 12 Years or More

[Bar chart showing RURAL and URBAN values: TLE - RURAL 20.9, URBAN 13.5; DFE - RURAL 18.9, URBAN 12.6; DE - RURAL 2.0, URBAN 0.9]

with disability (2.0 versus 0.9, respectively) (Figure 10). White men in rural areas spent a

greater percentage of their remaining lives with a disability compared with those in urban areas

(9.5% versus 6.4%, see Table B-2).

The same expectancy measures for white men with less education for those rural and

Figure 11: Health Expectancies
White Men
Education Less Than 12 Years

[Bar chart showing RURAL and URBAN values: TLE - RURAL 7.5, URBAN 4.9; DFE - RURAL 3.8, URBAN 2.5; DE - RURAL 3.7, URBAN 2.4]

urban areas are shown in Figure 11. For all three

measures, rural/urban differences are similar to

those for white men with more education;

however, in each category of life expectancy,

those with less education lived substantially fewer

years. White men at age 65 with less education in

rural areas had a total remaining life expectancy of 7.5 years compared with 4.9 for those living

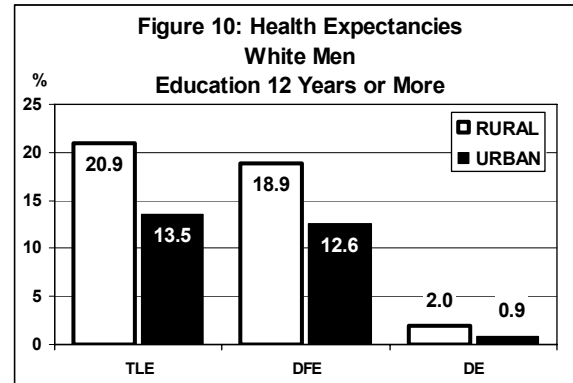in urban areas (Figure 11). Compared with those in urban areas, men in rural areas had greater

years of life without disability (3.8 versus 2.5) and with disability (3.7 years versus 2.4 years)

(Figure 11). White men in rural areas spent a slightly lower percentage of their remaining lives

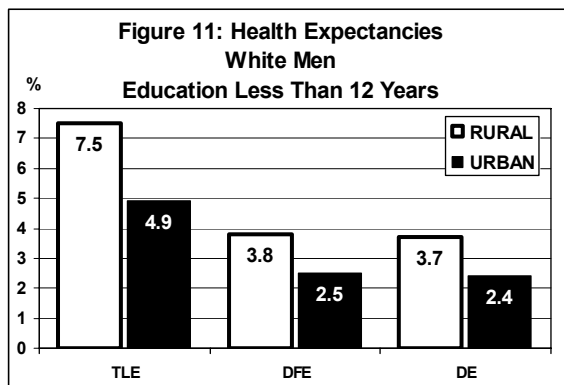with a disability compared with those in urban areas (49.4% versus 48.8%, see Table B-2).

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Comparing results for men with high education in Figures 8 and 10, white men lived longer than African American men in both rural and urban areas. In the analogous groups of men with low education, represented by Figures 9 and 11, differences between African Americans and whites are less pronounced than they were for those with high education, as was the case with women. In all instances except for African American men with less education, African Americans lived a greater percentage of their lives with a disability (see Table B-2).

Full Population Distributions of Life Expectancy Patterns for Women

The microsimulation approach allows an examination of the full distribution of remaining life, in addition to the mean number of years to be lived with and without disability. Figures 12 through 15 illustrate such distributions for selected subgroups of rural and urban residents: results for white women are shown in Figures 12 and 13; results for African American women are displayed in Figures 14 and 15.

Distributions of Life Expectancy for White Women

Figure 12a shows the results for white women with a high level of education living in rural areas at baseline. These women have an average life expectancy at age 65 of 25.3 years. They can expect to live 21.7 of these years without disability, the remainder with disability (results shown in Table B-2). The histograms of Figure 12a show the degree of variability around each of these point estimates for total, disability-free, and disabled life expectancy, and how this variability is distributed. For remaining years of life, the top panel of Figure 12a shows a relatively normal, i.e., bell-shaped, distribution. The histogram for remaining years of disabled life (lower panel of Figure 12a) shows a large spike at zero years, indicating that nearly 40% of white women with more education have zero full years of disability; relatively small percentages of these women live many years disabled. That is, Figure 12a shows that there is a great deal of variability around the average estimates of total, disability-free, and disabled life expectancy.

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This is what we refer to as "within-group" differences. Thus, even among women sharing

similar characteristics, i.e., white women with high education, women in this group vary a great

Figure 12a. Rural Residents
Remaining Years at Age 65 of Total Life Expectancy,
Disability-Free Life Expectancy, and Disabled Life Expectancy
for White Women with Education ≥ 12 Years
Disabled defined as having 1 or more ADL dependencies.

Figure 12b. Urban Residents
Remaining Years at Age 65 of Total Life Expectancy,
Disability-Free Life Expectancy, and Disabled Life Expectancy
for White Women with High Education ≥ 12 Years
Disabled defined as having 1 or more ADL dependencies.

deal in terms of their expectations for total, disability-free, and disabled life expectancy.

Figure 12b shows distributions of the total, active, and inactive life expectancy for a

corresponding simulated population of women living in *urban* areas at baseline. The top panel

of Figure 12b shows that the distribution of total remaining years is unbalanced, toward fewer

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remaining years. The lower panel of Figure 12b shows that 67% of white women with high education who were urban residents can expect *no* full years of disability, compared with about 37% of comparable women in rural areas.

Figure 13 shows analogous information for white women with low education. Of particular note in the middle panel of Figure 13b is the bar indicating no remaining full years free of disability for about 29% of urban white women with less education, compared to about 8% for rural white women with less education. A comparison of corresponding panels of Figures 12 and 13 illustrates striking differences in mortality and morbidity associated with education.

Figure 13a. **Rural Residents**
Total Life Expectancy, Disability-Free Life Expectancy, and Disabled Life Expectancy at Age 65, non-Hispanic white women with education < 12 years. Disabled defined as having 1 or more ADL dependencies.

Figure 13b. **Urban Residents**
Total Life Expectancy, Disability-Free Life Expectancy, and Disabled Life Expectancy at Age 65, non-Hispanic white women with education < 12 years. Disabled defined as having 1 or more ADL dependencies.

Comparing the top panels of Figures 12 and 13 shows those with less education have notably fewer remaining years of life.

Analogous information is shown for African American women in Figures 14 and 15. Figure 14 shows African American women with high education in rural and urban areas. Figure 15 shows the comparison for African American women with low education. Every figure comparing rural and urban health expectancies (e.g., Figure 12a compared with Figure 12b)
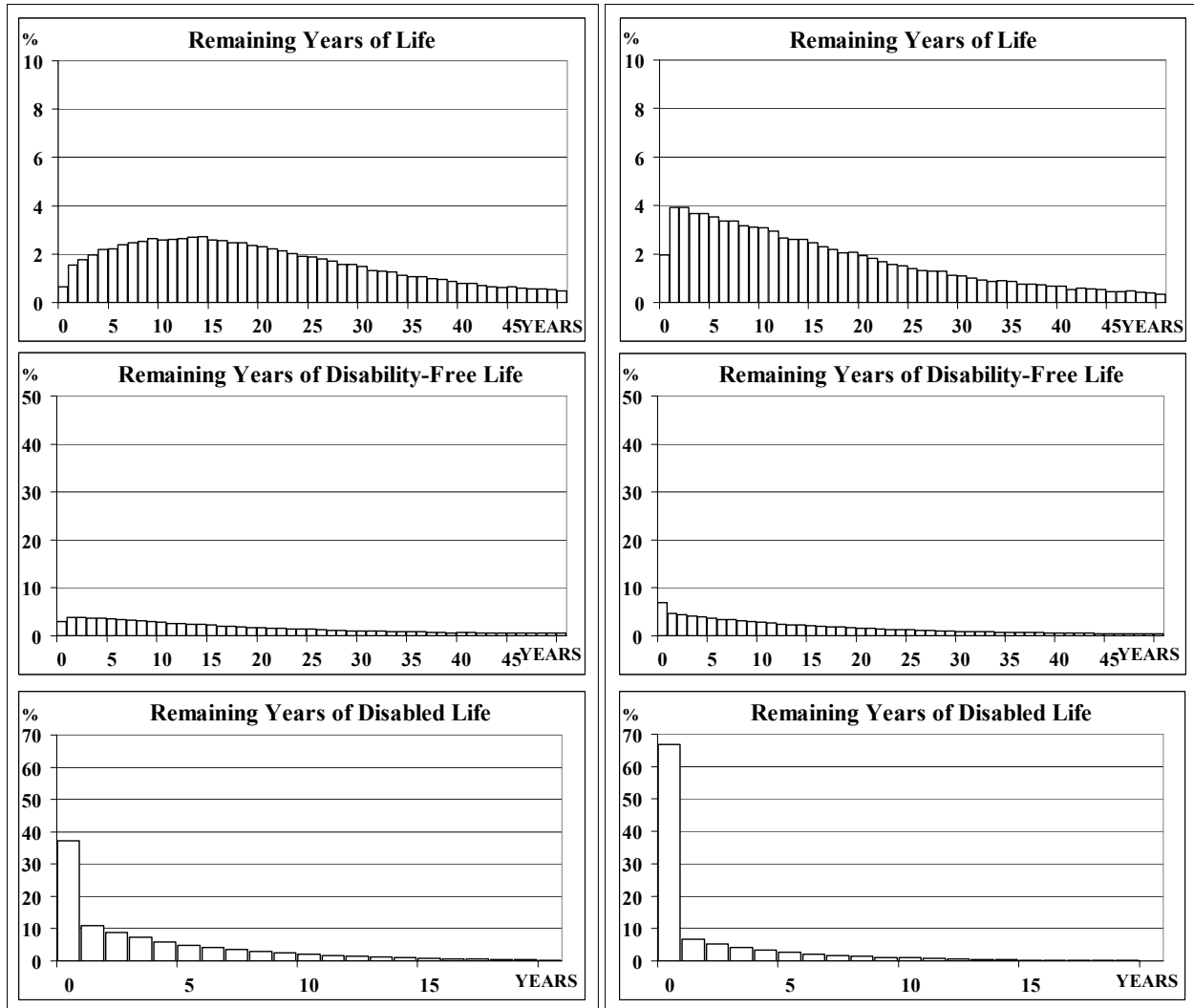
Figure 14a. Rural Residents
Remaining Years at Age 65 of Total Life Expectancy,
Disability-Free Life Expectancy, and Disabled Life Expectancy
for African American Women with Education ≥ 12 Years
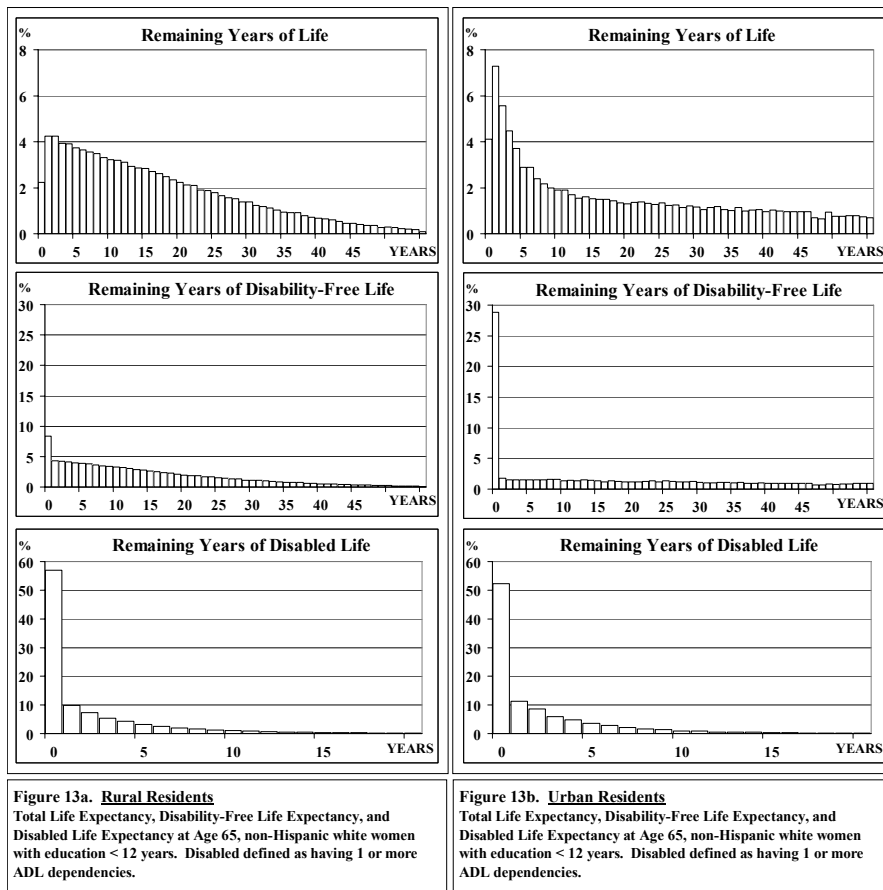Disabled defined as having 1 or more ADL dependencies.

Figure 14b. Urban Residents
Remaining Years at Age 65 of Total Life Expectancy,
Disability-Free Life Expectancy, and Disabled Life Expectancy
for African American Women with Education ≥ 12 Years
Disabled defined as having 1 or more ADL dependencies.

shows that rural expectancies for total life and for disabled life differ greatly from urban expectancies. Comparing the two figures representing women with high education (Figures 12 and 14) to those representing women with low education (Figures 13 and 15) demonstrates that another major determinant of these expectancies is education.

Having accounted for rural/urban residence and educational attainment, however, the results for race differ only modestly.
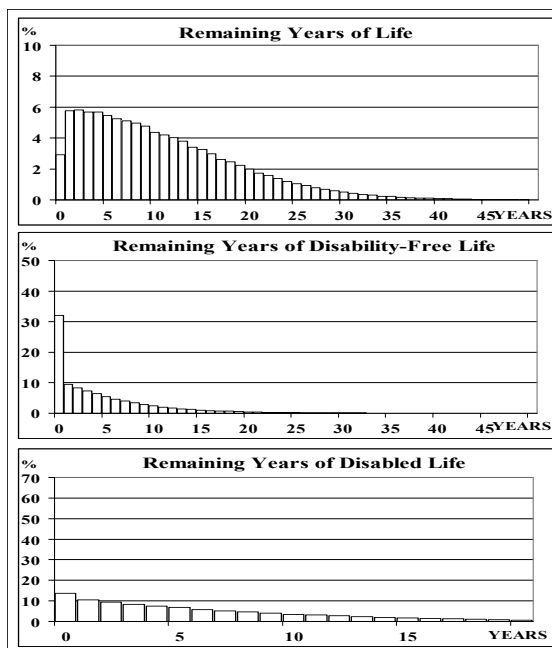
Figure 15a. Rural Residents
Remaining Years at Age 65 of Total Life Expectancy,
Disability-Free Life Expectancy, and Disabled Life Expectancy
for African American Women with Education < 12 Years
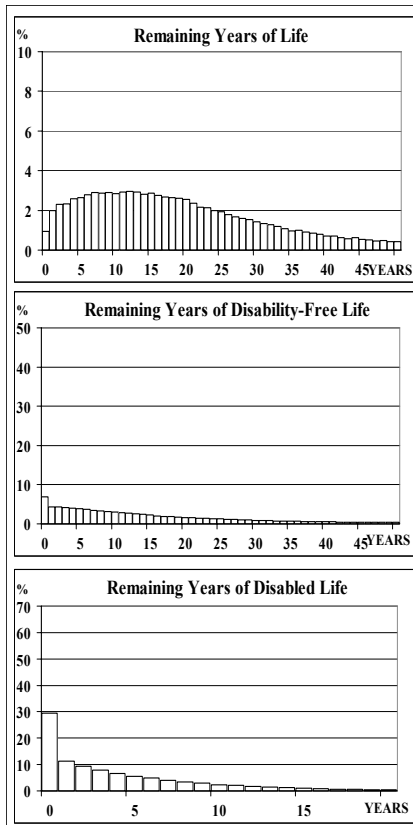Disabled defined as having 1 or more ADL dependencies.
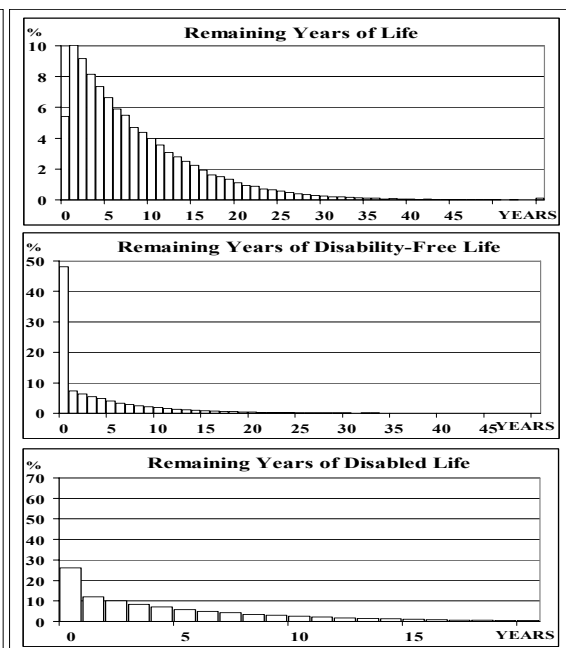
Figure 15b. Urban Residents
Remaining Years at Age 65 of Total Life Expectancy,
Disability-Free Life Expectancy, and Disabled Life Expectancy
for African American Women with Education < 12 Years
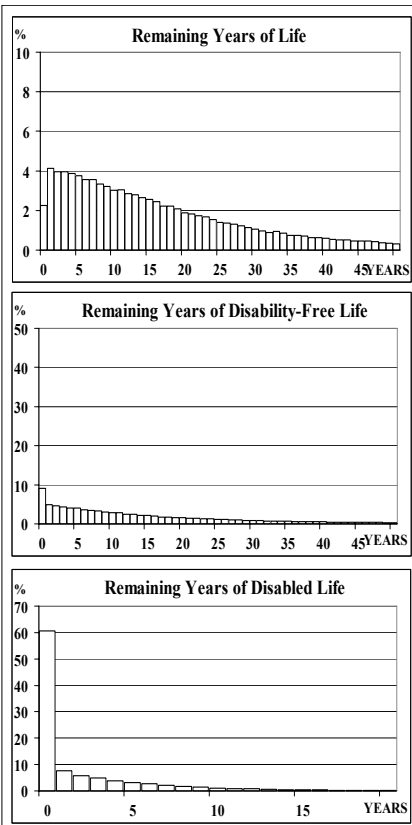Disabled defined as having 1 or more ADL dependencies.

Chapter 4: Conclusions and Implications

Conclusions and Implications

This project used a large nationally representative cohort of older Americans aged 65 to 69 to estimate the older life course impacts of area of residence on total, disability-free, and disabled life expectancy. The findings provide evidence that in almost every population group studied, rural residents live longer lives than urban residents. This amounted to 3 to 5 years of additional life for women, and 2 to 4 years for men. However, rural residents also live a greater proportion of their lives with substantial disability. Among African American women at age 65 with high education, for example, those in rural areas can expect to live 19.1% of their remaining lives with a disability, whereas those in urban areas can expect to live only 10.7% of their remaining lives disabled. This also means that individuals in rural areas live a notably longer total number of years with disability, a result that has important implications for service needs and the total costs of caring for older people in rural areas. The greater burden of disability among rural residents means that many rural communities are doubly disadvantaged, with higher disability among residents and fewer health care and other resources, and additional barriers stemming from isolation and lack of public transportation.

For both women and men, those with less education have substantially shorter lives, and spend a notably higher percentage of their lives with a disability. For example among African American men rural residents at age 65, those with high education can expect to life about 14.6% of their remaining lives with disability, as noted above, whereas those with low education can expect to live 50.8% of their remaining lives disabled. African Americans generally live shorter and more disabled lives that whites. In general, however, effects of education on expectancies for life and health are much greater than those of race.

Our investigation of between- and within-group variability, using information about the full distributions of total, active, and inactive life (Figures 12 through 15), reinforces the heavy health burden of rural residence among all population groups studied. For all population groups, the histograms for remaining years of life and remaining years of disability-free life were markedly more unbalanced for populations in rural areas than for those in urban areas. These patterns illustrate that, in terms of full population distributions as well as averages, people in rural areas live longer lives, and enjoy more years free of substantial disability. Importantly for public policy, however, rural residents also live substantially more years with disability. In addition, the results show that, even within populations characterized by chronic disease and at least some degree of physical impairment (i.e., having some degree of difficulty in performing at least one activity of daily living), there is a great deal of variability around standard summary measures of expectancy.

Collectively, these findings suggest the following implications:

Promote Research and Policies Focused on Reducing Disability

Evidence clearly links many kinds of disability to lifestyles. Many problems associated with behavioral risks are malleable. For example, a review of an extensive number of studies has identified risk factors such as smoking, lack of exercise, obesity, hypertension, saturated fat intake, alcohol intake, low fiber intake, and occupational and environmental toxins that are strongly associated with chronic disease (Fries, 1988). In some instances there is strong evidence that effective interventions are now available for a number of these factors, with strong circumstantial evidence for others. Aging, like chronic disease, is universal, progressive, often presymptomatic for decades, and relatively resistant to treatment. But it is also characterized by risk factors that accelerate or decelerate progression. This suggests that policymakers should emphasize the modifiability or "plasticity" of aging. Studies have provided strong evidence of

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the plasticity of aging: women and men with lower risk (defined in terms of smoking, body mass index, and exercise) experience the onset of disability at older ages (e.g., Vita et al., 1998). They also have less cumulative disability, and lower levels of disability at any given age than do persons with higher levels of health risk.

Investments in human body capital (e.g., exercise, weight control) begun at earlier ages will have greater advantages than those initiated at older ages; however these investments are also useful even at older ages (Rowe & Kahn, 1998). Many members of the baby boom generation have been reluctant to make such choices, despite the fact that this generation is the most highly educated in history. More and better information about the long-term positive benefits of healthy lifestyle choices is clearly in order. In this project, compared with those with less education, people with more education had strikingly longer lives and lived a notably greater percentage of those years without disability. Previous work has demonstrated that people with more education are more likely to adopt healthy behaviors. For example, people 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 disability than those who do not adopt healthy behaviors (e.g., Reed et al., 1998; Vita et al., 1998). Thus, the following recommendations are offered for practitioners and policymakers:

- Practitioners should focus on strategies to maintain and even enhance physical activity among the old and near-old. Resistance training can improve strength, agility, balance, and bone mass, thereby promoting more active lifestyles and reducing risks of injuries commonly associated with declining functional status (Fiatarone et al., 1994; McCartney et al., 1996). The improved health status that results from resistance training and other forms of physical activity has also been shown to reduce levels of acute and chronic disease (Blair et al., 1996; Rowe & Kahn, 1998). Practitioners should become more pro-

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active in promoting exercise and healthier lifestyles among the older persons they serve. Lifestyle changes seldom come easily, but education and motivation play an important role in bringing them about.

- There should be an increased emphasis in health research and policymaking on postponing chronic illness and maintaining health. Policymakers should take renewed interest in promoting both healthy lifestyles and additional research on the prevention and treatment of chronic diseases that affect functional status. A comprehensive analysis in this area requires carefully weighing the likely costs against their potential benefits, the sort of analysis that has already been performed for preventive medicine (Russell, 2001). Although large scale intervention and research programs can have considerable costs, given the magnitude and rapid growth of formal and informal long-term care costs (Arno, Levine, & Memmott, 1999), it seems likely that cost effectiveness analyses would favor programmatic activity above current levels. The most effective way to accomplish these goals is through health promotion, education, and personal responsibility. However, relying on personal responsibility may be of little use in the absence of effective health education and promotion. It may also be useful to address barriers to healthy lifestyles in the built environment, promoting physical activity, for example, by ensuring that people have safe and inviting alternatives for activity.

- Regarding the ethics of social programs to promote lifestyle change, it should be emphasized that potential health gains are greatest among persons with less wealth. Out-of-pocket costs of health care as a fraction of disposable income are greater for poorer persons than those relative costs for persons with more wealth (Holden & Smeeding, 1990). Among older people, the poor and near-poor are predominantly women (Burkhauser & Smeeding, 1994). Promoting more healthy lifestyles among poorer

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persons would help to improve both health and wealth and address income inequality between women and men.

Appendix A: Data and Methods

<u>**Data**</u>

The National Long-Term Care Survey (NLTCS) employs a mixed panel and longitudinal design. The first interview was conducted among a sample of Medicare enrollees age 65 or older in 1982, with follow-up interviews conducted in 1984, 1989, 1994 and 1999. Data collection instruments include a brief screening interview, intended to identify those with disabilities, i.e. experiencing any degree of difficulty in performing one or more Activities of Daily Living (ADLs), such as bathing or walking, or with Instrumental Activities of Daily Living (IADLs), such as managing a checkbook or going shopping, and having that limitation for a period lasting, or expected to last, 3 or more months. Those "screening in" receive a detailed follow-up interview.

Although the NLTCS represents all older persons having any degree of difficulty with at least one ADL, our focus was on disability. Disability was ascertained by asking respondents about their ability to perform each of six ADLs: eating, getting in/out of bed, getting around inside, dressing, bathing, and getting to the bathroom or using the toilet. Separately for each ADL, respondents were asked if they "have any problem" performing the ADL "without help of another person or special equipment." The NLTCS asked the same questions about ADL impairment in each survey wave, using the same language, and conducting the survey using the same organization (the U.S. Census Bureau). Holding instruments and field procedures constant in this way minimizes bias in estimates of disability, and tends to hold any such bias constant. Manton, Coder, and Stallard (1993) provide details about the NLTCS sampling. The NLTCS data were matched with death data from Medicare files, representing all deaths for NLTCS participants through 2001.

Although all respondents to the 1982 NLTCS reported some degree of difficulty in

performing at least one ADL at the time of the survey, many recovered from the initial difficulty. This pattern is characteristic of older individuals. A large proportion of older individuals experience episodes of disability, with many recovering quickly. Such short-term disabilities can arise, for example, from: minor sprains; temporary joint inflammations; a range of illness from minor to major; flare-ups of chronic conditions such as asthma, congestive heart failure, or chronic obstructive pulmonary disease; falls or other accidents; and surgical procedures. It should be emphasized that this project is based on a nationally representative sample of Americans aged 65 to 69 in 1982 having difficulty with performing at least one ADL at the time of the baseline survey. Within this group, a small proportion had "disability" as defined for this research. Most of the younger-old individuals reporting difficulty with performing any of these ADLs were not seriously impaired. For the purposes of this research, disability is defined as being unable to perform the ADL without help from other individuals or assistive devices.

The sample included a notable proportion of generally more disabled individuals who died prior to the 1989 NLTCS survey wave. It also included individuals who were systematically removed from the 1989 survey frame (due to constrained budgets for the NLTCS in that year), all of whom were alive when the 1989 surveys began. Thus, those who died by 1989 were disproportionately represented in the sample, and the longitudinal sample did not fully represent all individuals surveyed in 1982. We addressed this sample feature by re-weighting the data, so that retained individuals represented the U.S. population of individuals age 65 and over in 1982 having difficulty with at least one ADL. Weighted analysis of the re-weighted data produced proportions of women, African Americans, individuals with low education, and so forth, that were equal to those of the full weighted 1982 NLTCS sample. Further, not all individuals represented in the 1982 survey had available data indicating either rural or urban residence. We addressed this feature of the data in the same fashion, again re-weighting the data with the same

result. Details of the weighting procedure have been published (Laditka and Wolf, 2004).

Model of Functional Status Transitions

The study used interpolated Markov modeling techniques. The application of this technique to estimating active life expectancies was pioneered by Laditka and Wolf (1998), and has since been applied widely for this purpose by demographers, epidemiologists, and health services researchers. Monthly transition probabilities were estimated using multinomial logistic regression. The primary final model estimated for this research included six covariates, a Constant (i.e., Intercept), Age, Female, Rural, African American, and Education Less Than 12 Years. There were four transition types explicitly represented in the dependent variable, each representing the transition from a current month to the next: transitions from disability-free to disabled, from disability-free to dead, from disabled to disability-free, and from disabled to dead. The transitions from disability-free to disability-free, and from disabled to disability-free, are represented in the model implicitly, as reference categories, and are normalized to zero. Thus, the model estimated a total of 24 parameters: one constant value for each of the four explicit transition types, and, again for each of the explicit transition types, one parameter for each of the four covariates.

Similar to previous research (e.g., Wolf et al., 2002), the estimates were obtained using specialized software designed for this purpose, written in the SAS IML matrix programming language. The number of covariates in models of these sorts are generally limited, as the estimations involve complex calculations requiring a computing time of several hours for even a single model, even with reasonably accurate starting parameter values and modern computer technology. Moreover, conducting the microsimulations with a large number of covariates is not practical. Nonetheless, the reasonableness of the estimates was confirmed by adding to this basic model a number of other potential confounding characteristics, both individually and in

combination. These included being a parent, being married (with the spouse in the household), and living in the South. None of these covariates notably altered the estimates in our final model, and none altered the levels of significance of covariates in the final model. Moreover, likelihood ratio tests suggested that the addition of these covariates did not significantly improve the model fit. Thus, the final model appears to provide reasonable estimates of the functional status transition probabilities that characterize rural and urban residents.

It should be noted, however, that the addition of each of the control variables included in the final model used for this project did significantly improve the model fit. Indeed, estimates from simpler models, such as a model having only Age, Female, and Rural covariates, showed evidence of substantial omitted variable bias. This suggests that researchers using the interpolated Markov chain method used in this research should carefully assess the possibility of omitted variable bias in related studies, as the sparse models often presented in such research may be affected by this phenomenon.

The estimated parameters of the multinomial logistic regression models were used to conduct microsimulations. The microsimulations calculated the life expectancy measures, and produced full distributions of total life expectancy, healthy life expectancy, and impaired life expectancy. Microsimulation differs from more common simulation methods in that the latter focus on effects of processes at the level of *populations*. Microsimulations, on the other hand, simulate lives of many *individuals*. These simulated individuals are then aggregated for population studies. Thus, microsimulations can adjust estimates much more specifically, than can whole-population simulations, for characteristics of individuals living in rural or urban areas, for other characteristics such as race or ethnicity, and for the disability status of each individual during each month of his or her simulated life.

For this analysis, individual monthly functional status histories were created for 16 simulated populations, each of 100,000 individuals. One such population was simulated for each of 8 groups of women and 8 groups of men, defined by race category, education level, and baseline rural or urban residence. The profile of disability characterizing the starting population for each microsimulation matched the disability profile of actual populations at ages 65-69 living in the community with the same combination of sex, race, education, and rural/urban residence. Actual population profiles were identified through weighted analysis of the 1982 NLTCS. Thus, for example, the older life course experience of disability was simulated for two populations of 100,000 white women with a low level of education. One of these simulations identified life and health expectancies for a population living in a *rural* area. In this instance 14.3% of the simulated population began the simulation disabled, matching the weighted proportion of the corresponding actual population identified from the NLTCS. The second of these two simulations was for a population living in an *urban* area at baseline, 8% of which began the simulation disabled. Analogous simulated populations were created for each group of women and men.

The data produced by the microsimulation procedure were treated as longitudinal survey data, analyzed using standard statistical methods. For example, total life expectancy within the simulated population was simply the average age at death. The degree of variability in the length of active and inactive life was investigated by producing a frequency distribution of the number of years spent in each functional status (Wolf & Laditka 1997; Wolf et al. 2002). This variability was then summarized using conventional summary statistics, such as histograms and standard deviations. Details about the model of functional status, the procedure for estimating transition probabilities, and the microsimulation procedure used in this study have been published (Laditka & Laditka 2001; Laditka & Wolf 1998; Wolf et al. 2002).

Limitations and Areas for Future Research

This research focused on functional status, the ability to perform one or more activities of daily living (ADLs), as an indicator of disability. As others have stressed, cognitive status is another useful indicator of disability (e.g., Robine et al., 2003). It would be useful for future work to include a measure of cognitive status, such as the presence (or absence) of dementia, in the indicator of disability. Although an important contributor to the burdens and costs of long term care, longitudinal studies of disability processes have rarely examined the role of changing cognitive status.

It would similarly be useful to model disability in rural and urban areas accounting for major chronic diseases, such as diabetes. Such an analysis would illustrate the added (or reduced) impact of a major chronic disease in rural and urban areas, a difference that might be influenced by underlying morbidity differences, access to care, and/or qualities of preventive care. Linked with Medicare claims data, the NLTCS provides adequate data to conduct such analyses, including detailed studies of differences in use of generally expected screening and preventive services for individuals with diseases such as diabetes. By also modeling the occurrence of preventable hospitalization for these populations, such a study could provide a comprehensive examination of the occurrence, treatment, and outcomes of diabetes or other major chronic diseases in rural and urban areas.

The percentage of respondents who were disabled in three or more ADLs was small, and those with three or more ADLs rarely return to being free of disability. These features challenged an analysis of disability defined as having 3 or more ADL impairments. Thus, this project focused on disability in 1 or more ADLs. It should be noted again, however, that the definition of disability used in this study, which required an individual to be dependent on others or on equipment to perform an ADL, is a sound measure of serious disability having economic

impacts.

As part of the research conducted for the present study, we were able to model disability as having 3 or more ADL impairments using these data, examining the impact of rural residence while adjusting for age, gender, and race. The adjusted estimated parameters of functional status transition representing rural areas were all highly statistically significant ($p<.001$), and suggested that, compared with urban residents, rural residents were more likely to become impaired. They were also more likely to die when free of disability, less likely to remain impaired, and less likely to die while impaired. In the microsimulations, these preliminary results did not suggest notable differences between rural and urban areas in either total life expectancy, or disabled life expectancy, using this definition of disability. It should be noted, however, that this research has as yet not been able to estimate this model while controlling for education level. The research reported in this report demonstrated that older rural residents were about four times as likely as older urban residents to have low education. Thus, the preliminary results of the modeling discussed in this paragraph should be interpreted with caution, as the results comparing rural and urban areas may be notably subject to omitted variable bias. Further study of modeling disability defined in this fashion is warranted.

The study also investigated the possibility of modeling disability in a four-state model, which would include disability-free, moderately disabled, severely disabled, and dead. Again this modeling was challenged by the fact that the percentage of respondents who were severely disabled (i.e., having three or more ADL dependencies) was small, and those with three or more ADL *dependencies* only very rarely return to being free of disability. Most previous research modeling disability dynamics has defined disability more broadly, as having any degree of difficulty with performing an ADL, as compared with the current study's definition, in which individuals could not perform the ADL at all without the assistance of another person or

equipment. As modeling disability using the broader definition will notably expand the level of variation in the data, including the occurrence of recovery from disability, doing so may enable the successful estimation of the four-state model. This is a promising area for further research, one that would be likely to offer new insight into differences in disability processes between rural and urban areas.

Readers are again reminded that all respondents included in the 1982 NLTCS had some degree of difficulty performing one or more ADLs, at least at the time of the screening interview. The results are nationally representative of such individuals. However, the findings cannot be generalized to all older Americans, many of whom have no notable difficulty in ADL function. Two developments will enable such a study. One is the Second Longitudinal Study of Aging, conducted from 1994 to 2000, which is now becoming available to researchers. The second is more recent waves of the NLTCS, which are nationally representative of the entire population age 65 and older. When data from the 2004 NLTCS survey wave become available, these more recent NLTCS waves should enable further studies of active life expectancy using this representative sample.

Finally, the study presented standard errors for the estimated functional status transition probabilities. However, the study did not calculate standard errors for the microsimulation results, the estimates of total, disability-free, and disabled life expectancy. Doing so remains an area for further work. These estimates may be obtained by conducting each microsimulation n times, where n grows large, taking a random draw from the parameter space as the basis for each of the many simulations. Analysis of the resulting data will provide the desired measures of variability. It should be noted, however, that this proposed research involves substantial challenges. In terms of time and effort, such a study might constitute a separate methods research study. It would be useful to develop the programming that would enable the calculation

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of this type of variation, however. Providing these standard errors for the microsimulation

results would enhance researchers' ability to interpret such results.

Appendix B: Additional Results and Detailed Tables

Estimated Parameters Indicating Active Life Expectancy Probabilities

Table B-1 shows the estimated coefficients for our model of functional status transitions for women and men. Each block of entries displays coefficients associated with covariates in our model, coefficients which together determine probabilities of transitioning from an origin status in a given month to a destination status in the following month. Origin statuses are disability-free and disabled. Destination statuses include disability-free, disabled, and dead. For each possible transition, Table B-1 presents a constant value and four coefficients, one each representing effects of sex, race, education, and rural. Transitions not represented in the table were normalized to zero. Individuals in rural areas were more likely than urban residents to transition from being disability-free to being disabled (*b*=0.694, p<.001).

Appendix Table B-1. Parameters of Multinomial Logit Models of Functional Status Transitions[a]

	Estimate (SE)[c]
Origin = *Disablity-Free*; Destination = *Disabled*[b]	
Constant	-6.356 (0.093) ***
Age	-0.014 (0.007) *
Female	0.055 (0.070)
Rural	0.694 (0.069) ***
African American	0.229 (0.108) *
Education < 12 years	1.210 (0.092) ***
Origin = *Disability-Free*; Destination = *Dead*[b]	
Constant	-5.146 (0.061) ***
Age	-0.012 (0.005) *
Female	-0.621 (0.050) ***
Rural	-1.124 (0.088) ***
African American	0.009 (0.091)
Education < 12 years	0.922 (0.114) ***
Origin = *Disabled*; Destination = *Disabled*[b]	
Constant	4.239 (0.240) ***
Age	0.162 (0.019) ***
Female	-0.124 (0.160)
Rural	-0.085 (0.155)
African American	-0.080 (0.227)
Education < 12 years	-0.060 (0.153)
Origin = *Disabled*; Destination = *Dead*[b]	
Constant	0.083 (0.262)
Age	0.193 (0.020) ***
Female	-0.677 (0.170) ***
Rural	-0.287 (0.167) +
African American	-0.099 (0.245)
Education < 12 years	-0.036 (0.167)

[a]Source: 1982-1999 National Long Term Care Survey.
[+]$p<0.1$; [*]$p < 0.05$; [**]$p < 0.01$; [***]$p < 0.001$

They were also less likely to transition from being disability-free to dead (*b*=-1.124, p<.001), and less likely to transition from being disabled to dead (*b*=-0.287, p<.1). These results all suggest

that rural residents were likely to have both longer lives, and more time with disability.

Detailed Results of Total, Disability-Free, and Disabled Life Expectancy

Appendix Table B-2. Average Remaining Years of Disability-Free, Disabled, and Total Life at Age 65, for Rural and Urban Residents, by Gender, Race, and Education[a]

			Rural							Urban		
Group	Base[b]	TLE(SD)	DFE(SD)	DFE %of TLE	DE(SD)	DE %of TLE	Base[b]	TLE(SD)	DFE(SD)	DFE %of TLE	DE(SD)	DE %of TLE
White Women												
Education ≥ 12 years	14.3	25.3(17.2)	21.7(18.3)	85.8	3.6(4.8)	14.3	8.0	20.7(17.3)	18.9(17.8)	91.5	1.8(3.6)	8.5
Education < 12 years	54.8	9.1(8.0)	6.3(6.9)	69.4	2.8(4.4)	30.7	54.2	8.5(7.9)	4.5(7.1)	53.0	4.0(4.9)	47.1
White Men												
Education ≥ 12 years	15.2	20.9(16.6)	18.9(17.1)	90.5	2.0(3.05)	9.5	7.6	13.5(13.4)	12.6(13.6)	93.6	0.9(2.2)	6.4
Education < 12 years	53.1	7.5(6.9)	3.8(6.1)	50.8	3.7(4.0)	49.4	58.2	4.9(4.9)	2.5(4.4)	48.8	2.4(3.2)	48.8
African American Women												
Education ≥ 12 years	6.9	22.5(16.1)	18.2(16.9)	81.0	4.3(5.2)	19.1	8.9	19.5(16.5)	17.4(16.9)	89.4	2.1(3.9)	10.7
Education < 12 years[c]	50.7	10.6(8.3)	4.2(6.0)	39.4	6.5(6.1)	60.8	50.7	8.4(7.6)	4.3(6.4)	51.1	4.3(6.4)	49.0
African American Men												
Education ≥ 12 years	13.3	17.7(15.3)	15.1(15.8)	85.5	2.6(2.5)	14.6	8.8	12.8(12.8)	11.7(12.9)	91.9	1.0(2.3)	8.1
Education < 12 years[c]	44.4	7.4(6.4)	3.6(5.3)	49.4	3.7(3.9)	50.8	44.4	5.1(4.9)	2.9(4.3)	56.6	2.2(3.2)	43.5

[a]Source: 1982-1999 National Long Term Care Survey. TLE = Total Life Expectancy; DFE = Disability-Free Expectancy; DE = Disabled Expectancy. SD = Standard deviation. DFE and DE may not add to TLE due to rounding. Disability defined as dependency, being unable to perform at least one ADL without help.
[b]Baseline percentage of sub-group at ages 65-69 disabled in 1982 NLTCS (percentage entering microsimulation disabled).
[c]Due to small sample sizes available for the calculation of the baseline disability distribution for this group; rural and urban were assigned the same baseline disability distribution, the mean across rural and urban areas.

Table B-2 shows average years of remaining life (Total Life Expectancy, or TLE), average remaining years of disability-free life (Disability-free Expectancy, or DFE), and average remaining years of disabled life expectancy (Disabled Expectancy, or DE), all at age 65 for the eight groups of women and eight groups of men studied with a dependency in one or more ADLs. Table B-2 also shows the standard deviations of these averages, quantifying within-group differences. This table provides more detailed results, which were summarized in Figures 4 through 15. Note: due to rounding, for several subgroups, DFE and DE does not sum to TLE.

The data column labeled "base" shows the population proportion of each group having an

ADL disability at ages 65-69 in 1982, the simulation baseline, as identified by weighted analysis of the 1982 wave of the NLTCS. For example, among white women with education $\geq$ 12 years, 14.3 percent of rural residents had an ADL disability at baseline, as did 8.0 percent of urban residents. The simulations begin with the baseline population proportion assigned disability. It should be noted that, just as living older individuals commonly recover from disabilities, the disability dynamics of the simulations depend far more on the probabilities of functional status change that are estimated from the empirical data than on the proportion of the population with disability at baseline. The mean life expectancy measures calculated from the microsimulations that are depicted in Table 1 are not highly sensitive to even substantially altered baseline disability profiles. In some instances, however, high proportions of disability in the baseline population will produce notable impacts on the proportion of the simulated population having no full years without disability. This result is consistent with the experience of actual populations.

Turning to within-group differences in life expectancy, we focus on the standard deviations of years remaining in total, disability-free and disabled life displayed in Table B-2. For all groups, the magnitude of standard deviation relative to the mean of TLE and DFE, which indicates relative variability, is considerable. For all groups, the relative variability is larger for disabled life than for total life or disability-free life. In all instances except for African American women with less education, the standard deviation of disabled life is greater than its mean. These results indicate that variability in remaining years of total, disability-free and disabled life is substantial. In other words, the average number of years for any of the expectancy measures does not capture the heterogeneity of life expectancies among these population groups.

Life Expectancy Differences Between Rural and Urban Residents

Table B-3 focuses more specifically on differences in life expectancies between rural and

urban residents. Of particular interest is that, with only two exceptions, women and men living

in rural areas live more years with a disability than do people in urban areas. For example,

among white women with high education the difference between rural and urban residence is 4.6

Appendix Table B-3. Differences in Life Expectancies between Rural and Urban Residents at Age 70, by Expectancy Type, Years, and Percentage[a]

| | Difference in Expectancy by Type | | | | | | |
| | TLE | | DFE | | DE | | Percent Difference In %DE |
	Years	%	Years	%	Years	%	
Women, White, High Education	4.6	22.2	2.8	14.8	1.8	100.0	68.2
Women, White, Low Education	0.6	7.1	1.8	40.0	-1.2	-30.0	-34.8
Women, African American, High Education	7.4	54.8	6.3	50.0	1.1	122.2	48.4
Women, African American, Low Education	2.6	53.1	1.3	52.0	1.3	54.2	1.2
Men, White, High Education	3.0	15.4	0.8	4.6	2.2	104.8	78.5
Men, White, Low Education	2.2	26.2	-0.1	-2.3	2.2	51.2	24.1
Men, African American, High Education	4.9	38.3	3.4	29.1	1.6	160.0	80.2
Men, African American, Low Education	2.3	45.1	0.7	24.1	1.5	68.2	16.8

[a]Source: 1982-1999 National Long Term Care Survey. TLE = Total Life Expectancy;
DFE = Disability-Free Expectancy; DE = Disabled Expectancy.
SD = Standard Deviation.
DFE difference and DE difference may not sum to TLE difference due to rounding.

years for TLE, 2.8 years for DFE, and 1.8 years for DE, with rural residents living longer in each

of these categories. The final column shows the percentage difference in the percentage of life

lived with a disability between rural and urban residents, again for each of the eight groups. For

example, white women with high education can expect to spend 14.3% of their total remaining

lives with a disability (see Table B-2). The analogous figure for urban residents is 8.5% (see

Table B-2). This figure for rural residents is 68.2% higher than that for urban residents,

indicating that the burden of disability as a proportion of remaining life is much greater for rural

residents than it is for urban residents. With the exception of white women with less education,

rural residents in all groups depicted in Table B-3 experience these greater disability burdens.

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