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Summary Measures of Population Health

Report of Findings on Methodologic and Data Issues

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Center for Health Statistics

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Suggested citation

Molla MT, Madans JH, Wagener DK, Crimmins, EM. Summary measures of population health: Report of findings on methodologic and data issues. National Center for Health Statistics. Hyattsville, Maryland. 2003.

For sale by the U.S. Government Printing Office
Superintendent of Documents
Mail Stop: SSOP
Washington, DC 20402-9328
Printed on acid-free paper.

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Hyattsville, Maryland
November 2003
DHHS Publication No. (PHS) 2004–1258

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1. Summary Measures of Population Health

1.1 Introduction

The concept of health expectancy was introduced in the 1960s (1) and further developed in the 1970s (2–4). In more recent years, both policy makers and members of the research community have been increasingly interested in the estimation of healthy life expectancy. This interest arises from the fact that measures of healthy life expectancy potentially offer easily comprehensible measures of both the level of, and change in, the well-being of a population. Because these measures incorporate both mortality and morbidity, they seem highly appropriate as summary measures of health in the older population, where there has been considerable mortality decline, but where there is concern that the extension of life may not be equivalent to the extension of healthy life.

The relationship between changes in mortality and morbidity and the relatively greater burden of morbidity in the older ages gained interest in the 1980s. Debate centered on whether the factors responsible for the reductions in mortality would have a similar effect on morbidity. Some argued that most of the years of life that the elderly gained due to the decline of mortality were ''healthy years'' either because the incidence of chronic conditions was being pushed to the last few years of life, that is, the compression of morbidity (5,6) or because the loss of functioning or disability from chronic conditions had slowed down (7). Others argued that the medical care improvements that saved lives were not accompanied by either disease prevention that would maintain healthy states or health care that would delay functional consequences of disease (8).

Healthy life expectancy is also perceived as a useful tool for health planning and making health-related policy decisions. An indication of the perceived usefulness for policy makers of the concept of healthy life expectancy is the fact that ''years of active life'' are now included among national and international health goals. For the year 2000, the U.S. goal was 65 years of active life expectancy at birth for the total population (9). The two overarching national health goals identified for *Healthy People 2010* are to:

- Increase the quality and years of healthy life and
- Eliminate health disparities (10).

The goals and objectives outlined for the decade in Healthy People have become central to both monitoring the Nation's health and planning an agenda to promote health and prevent ill-health. Monitoring the goals and objectives for the year 2010 will, in part, be achieved through Leading Health Indicators, a small number of measures that address major determinants of health. These Leading Health Indicators provide a way of understanding health in the future, but there also has been a need to describe, in a summary way, the current health of the population.

Some summary measures combine both the quality and quantity of life to reflect years of health and can be used to monitor progress toward the first of the overarching goals. Because they are comparable across populations with different age structures, these measures also can be useful for monitoring progress toward the second goal of eliminating health disparities. More specifically, summary measures of population health combine age-specific schedules of health and mortality to derive global measures of population health that reflect both mortality and morbidity; in this way, expected years of life can be divided into healthy and unhealthy life. They have been proposed as the most comprehensive measures for evaluating overall trends and differences in population health.

As an initial effort in the development of summary measures of health, the National Center for Health Statistics (NCHS), Centers for Disease Control and Prevention, sponsored a workshop entitled ''Identifying Summary Measures for *Healthy People 2010*'' on September 17–18, 1998, at the University of Maryland's University College Conference Center. The purpose of this workshop was to identify a set of ''summary'' measures that could be used to evaluate progress toward the overall goals of *Healthy People 2010*.

The central question addressed at this workshop was how to best characterize the process of health change and differentials in a set of summary measures that could be estimated reliably and potentially used by Federal and State governments to determine trends as well as differences in health by age, gender, race or ethnicity, and geographic area.

The objectives of the workshop were to:

- Provide a brief overview of the role of summary measures in *Healthy People 2000/2010,* including reporting requirements and data constraints;
- Identify a set of potential summary measures that should be considered for monitoring progress toward the first goal of *Healthy People 2010*;
- Specify ability to compute the potential measures with existing data collection systems or cost-effective modifications to existing data that would allow the computation of measures; and
- Specify a research agenda for the next decade to evaluate potential summary measures.

This report presents the findings of research that was initiated in response to the workshop recommendations. The

work focuses on methodologic and data issues. The report provides definitions of concepts and methods for calculating the recommended summary measures; evaluates a number of possible measures of morbidity; reviews the trends over a decade for one measure of healthy life expectancy; and examines the effect of combining data from different sources.

1.2 Overview of the Role of Summary Measures in Health

This chapter summarizes conceptual material about health and mortality that is identified, summarized, measured, and tracked with summary measures. In order to identify the prospective summary measures that best monitor the quality and years of healthy life (i.e., one of the overarching goals of *Healthy People 2010*) it is necessary to first clarify the dimensions of population health and show how they are related to health behaviors and potential interventions.

Mortality often has been used as a basic indicator of health. Life expectancy is the most frequently used summary measure of mortality conditions because it summarizes mortality rates across the entire age range. Two characteristics of life expectancy make it a valuable measure for portraying mortality conditions to audiences that include the general public and policy makers. First, it is not affected by population age-structure. This means that values can be compared for different subgroups of the population at one point in time or for the same groups at different points in time. In addition, because life expectancy is expressed in years of life, it is easily interpreted by both policy makers and the public. Both of these characteristics make life expectancy an essential tool for monitoring both trends and differences in mortality for the population and subgroups of the population. Consequently, extending this statistical concept to incorporate various states of health may generate acceptable and understandable statistics.

The extension of the basic life table model to include measures of health can be used to create summary measures of population health that divide expected life into healthy and unhealthy years (11,12). When health status is dominated by chronic conditions at older ages rather than infectious diseases at younger ages, it is possible to have both longer life and deteriorating population health (13). For instance, if increased treatment of heart disease results in mortality decline, people will live longer with the disease; this, in turn, will result in increased heart disease prevalence, especially if new cases are not prevented. If the years of life lived with heart disease continue to be characterized by diminished functioning, overall population health will deteriorate as life expectancy increases.

The association between mortality change and health change is weakened further because many causes of morbidity are not fatal conditions. For instance, osteoarthritis is among the leading causes of disability among older people, but it is not a likely cause of death. As mortality from other causes declines, osteoarthritis prevalence could increase. Summary measures that combine mortality and morbidity attempt to capture these aspects of health status.

1.2.1 The process of population health change

The key issue in developing summary measures is defining and measuring health and health change. Individual researchers and international groups have done significant work in defining the dimensions of health and clarifying the process of population health change (14,15). A conceptual outline of the dimensions of health and the process of change in population health is shown in figure 1.1 (16). Any or all of the dimensions of health could be captured in summary measures.

Diseases, conditions, and impairments (e.g., heart disease, arthritis, and visual impairment) occur before there is a loss in functioning or the ability to perform certain actions (e.g., walking a block, climbing a specific number of stairs, or sitting for an allotted time). Functioning loss can then result in disability or an inability to perform an expected social role, often defined as work for the middle-aged and self-care or independent living for an older population. Death is the end of the process. Over time, change can occur in some or all of these dimensions, that is, getting or living with diseases, experiencing functioning loss, and dying (17).

Disability in this context refers to the situation in which an individual's abilities or limitations are determined by the interaction of their physical, mental, or cognitive status with the environment in which they would perform social roles. The degree of limitation or disability is dependent on how

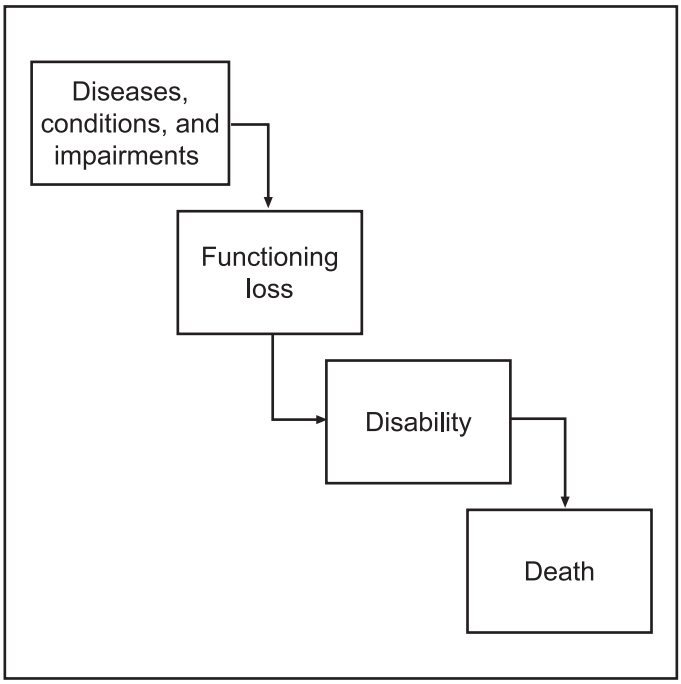

Figure 1.1. Population health change

SOURCE: Verbrugge and Jette. "The Disablement Process." *Social Sciences and Medicine*, 1994.

well the personal environment accommodates the loss in functioning. This definition is equivalent to that developed in the Institute of Medical Model (18) and similar to the participation dimension of the International Classification of Functioning, Disability and Health. In other contexts, disability is used to refer to the physical, mental, or cognitive status of the individual. Although considerable work has been done over the last few years toward clarifying the meaning of disability, there is still some confusion involving terminology. However, researchers are coming to more of a consensus that disability is a complex phenomenon and that neither of the definitions outlined above adequately describes all the characteristics of the phenomenon.

This scheme is only appropriate for population health change, not individual life cycle change. The complexity of change at the individual level is shown in figure 1.2. Each arrow represents a potential health change for an individual.

The sum of these changes across all individuals is, of course, what produces change in the population. Any individual can skip stages and may not necessarily experience any stage other than death. Individuals can also experience change in both directions, that is, they may become impaired and may regain functioning. For populations, however, the order of health change in figure 1.1 is appropriate; on average, disease occurs first, followed by functioning loss and disability, and finally, death. The difference between individuals and populations is important in evaluating the type of data and methods used for summary measures. Information on the individual processes requires longitudinal data and methods; information on the population may be collected as cross-sectional information.

1.2.2 Past use of summary measures

Summary measures of population health can be categorized into two major groups. The first major group of measures is called health expectancy (HE), and includes measures such as disability-free life expectancy (DFLE) and healthy life expectancy (HLE). The second major group, which measures health gaps, includes health measures such as disability-adjusted life expectancy (DALY) (19). Although the summary measures that indicate years of healthy and non-healthy life derived from these two general approaches (and their myriad variations) may look similar to the consumer of the research findings, summary measures currently in use are based on a variety of health outcomes, assumptions, and methods. These differences are important because they relate to the validity and reliability of the measures. Because the outcomes of all measures appear similar and are expressed in years of life, they may all be equally acceptable to the general public; however, researchers evaluate the potential uses of the indices quite differently. Summarizing health is made considerably more complex by the need for multiple measures and the need to look at healthy life as measured in both years and as a percentage of remaining life spent in the healthy state. This evidence supports the conclusion that there are no simple measures of health.

Healthy life expectancy (HLE)—This summary measure that links health dimensions and mortality was proposed more than 30 years ago (1,3). The methods developed by Sullivan, at NCHS, have been adopted worldwide and are the basis for the HLE family of measures (20). (See chapter 2 for details of the methodology.) A substantial body of work using Sullivan's proposed summary measures and with modifications to fit available data has been developed over the last 10 years. Modifications to the original formulation are due to the specific dimension of health used in defining healthy life. Often applications of this method have been determined by available data more than any clear theoretical idea of what aspect of health is appropriate. Most of this research has focused on comparing length of life in different health states at various points in time and across population groups at one point in time.

The originally proposed measure linked mortality to measures of long- and short-term disability to estimate life with and without disability using data from the National

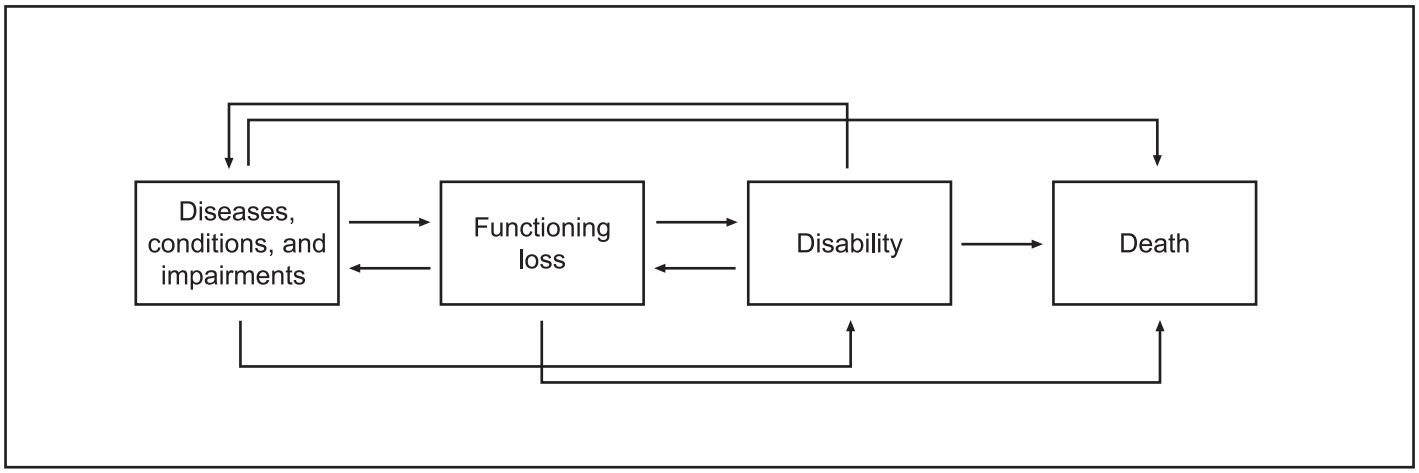

Figure 1.2. Potential health changes for individuals

Health Interview Survey (NHIS) (3). Years lived with disability could be further divided into severe or moderate disability and years of life in an institution.

In the last 10 years, a number of additional approaches to measuring healthy life expectancy using different generalizations of disability or health have been developed. For instance, in the older population, disability has often been indicated by the inability to perform Activities of Daily Living (ADL) or Instrumental Activities of Daily Living (IADL), tasks which reflect an inability to live independently. Other estimates of healthy life expectancy have been based on measures that categorize years of life using disease states or loss of cognitive functioning as measures of health state. For example, healthy life is estimated as years without heart disease or years without impaired cognitive functioning or dementia.

Measures of healthy life expectancy have been used to track and explain changes in population health. For example, research by Crimmins and associates has shown that the 1980s were a period when increases in life expectancy were concentrated in years without disability; in contrast, gains in life expectancy during the 1970s were in disabled years. This approach has also been important in determining age, socioeconomic, and racial differentials (21,22). Hayward and Heron (1999) have looked at the relationship between disability and life expectancy for ethnic groups in the United States; their research has shown that some ethnic groups have longer life but worse health (Native Americans) than the non-Hispanic white population, while others have longer life and better health (Asian Americans) (23).

The healthy life expectancy measures described above incorporate nominally defined states of health, and they estimate life with and without health in these nominally defined states. In order to expand the range of health included in the definition of healthy life, some researchers have weighted states of health according to an index of health problem severity. Measures of healthy life developed in this manner may weight states that characterize one dimension of health or combine health dimensions into states which are weighted to produce a multidimensional index of healthy life expectancy. These measures, often called Health-Adjusted Life Expectancies (HALE) or Health-Adjusted Life Years (HALY), can use a wide variety of dimensions to define a set of health states to which the weighting scheme is then applied. These include social functioning, cognitive functioning, social activities, psychological function, pain and symptoms, as well as loss in function and disability. The weighting schemes provide a number ranging from 0 to 1 to reflect the quality of life or the social utility of the health state individuals experience (24). Optimal health is valued at 1; death is valued at 0. These measures are then integrated with life tables to produce health-adjusted life expectancy. Because the weights are so important in determining the outcome, and because they have great social significance, much effort, discussion, and evaluation has gone into producing the weighting schemes for use in these measures. Agreement has not been reached, however, on the validity of the various schemes.

In summary, measures reflecting healthy life expectancy can be based on a variety of definitions of health and can utilize a variety of methods. No single measure has been agreed upon as the best approach. The appropriateness of measures depends on the dimensions of health of primary interest (e.g., disability or disease). If there is a desire to link these measures to health policies and programs and to individual health behaviors, the points of intervention in the health process should be considered (figure 1.3). Observed changes in these measures can reflect a range of factors. Healthy life expectancy can be brought about by changes in risk-related health behaviors (because of technological or medical advancement affecting the diagnosis, treatment, and progression of diseases) or because disability has been reduced (by better intrinsic health or because the extrinsic environment becomes more adapted to persons with functioning problems). Consequently, care and additional data are required to interpret the analyses underlying these statistics.

Disability-Adjusted Life Years (DALYs)—The World Bank and World Health Organization have supported a project to develop methods to evaluate the distribution of scarce health resources in developing countries. As a result, there is now a growing interest in another approach to summary measures—Disability-Adjusted Life Years—DALYs (25–32). DALYs represent an alternative

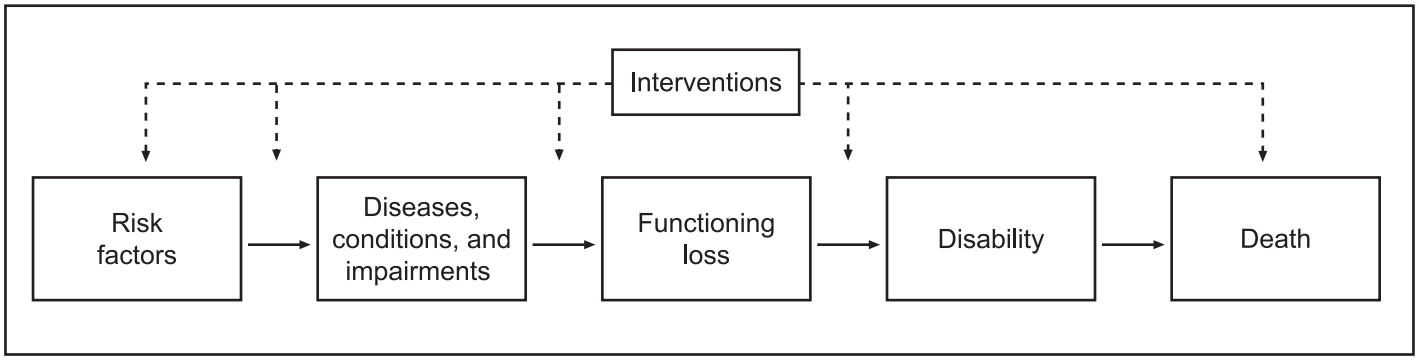

Figure 1.3. Health care and public health intervention opportunities

approach to summary measure construction that links disease, disability, and death. This approach estimates years of life lost from deaths which occur before some theoretically achievable age (e.g., international reports use 80 years for men and 82.5 years for women) and attributing this loss to death rates. Next, years lost to nonfatal diseases are calculated by linking the incidence of diseases to disability levels and length of time with disability. DALYs differ from other measures described because they reflect years lost to ill-health instead of years lived with ill-health; another difference is that they link two major dimensions of health: disease and disability.

DALYs also incorporate weights to reflect the severity of disability, and, because of the emphasis on health policy in the international applications, DALYs incorporate an additional economic approach to weighting years of life. This approach gives current years of life higher weights than future years of life, and life in the productive years or working ages is given higher weights than life in nonproductive years. These weighting schemes dramatically affect how years of healthy life are calculated for people of different ages as well as for people with different disabilities.

In contrast to the cross-sectional Sullivan approach to estimating healthy life expectancy, DALYs have been developed as an incidence-based measure, that is, one that is based on the transition into disease or disability. Incidence is a flow measure, whereas prevalence is a stock measure. Researchers have long recognized that incidence rates are theoretically preferable to prevalence data for indicating health change: incidence rates reflect only recent events, while prevalence data reflect events that occurred earlier in a person's lifetime. Incidence rates, however, require longitudinal data from large samples, and they usually are not available for most conditions or for nationally representative populations of most ages.

Because the incidence data required for input to the DALYs do not exist, they have been estimated from whatever epidemiological information can be pieced together. For example, community-based surveys like the Framingham Study provide a source of information on disease onset. Disability levels related to disease onset were then determined using ''expert'' opinions. Weights for the value of life spent in disease-disability levels were then developed in a series of workshops with a variety of ''experts.''

1.3 Potential Summary Measures Suggested for *Healthy People 2010*

After discussing both general approaches to estimating summary measures and a large number of specific approaches to these measures, workshop attendees were asked to recommend summary measures for consideration for the *Healthy People 2010*, keeping data availability in mind. The most important recommendation resulting from this meeting was that:

> *No single measure can adequately incorporate all aspects of health and mortality. A set of summary measures including both mortality and various aspects of morbidity or health that can be calculated from existing or collectable data should be proposed for Healthy People 2010.*

Using a set of measures rather than a single measure will make it possible to trace a variety of healthy life dimensions and to note differences in various aspects of health. It will also be possible to identify progress in some domains of health that have led to what appears to be deterioration in other aspects of health. For instance, progress made in prolonging the lives of persons with AIDS (brought about by a variety of pharmaceutical developments) may lengthen average life, increase the number of years lived with AIDS, lead to an increase in the number of people with AIDS in the population, and change the health status of those living with AIDS. Using a set of summary measures instead of a single measure will help clarify the meaning of change in the most general measures and disentangle either programmatic or medical influences; thus, progress toward reaching *Healthy People 2010* goals can be better monitored.

> *Although the two types of measures, HLE and DALYs, were discussed, HLE measures were recommended for Healthy People 2010. In addition, all suggested measures were based on cross-sectional data. Further investigation of the properties of incidence-based measures needs to be completed before using them for health monitoring.*

The set of measures recommended for monitoring the first goal of *Healthy People 2010* include the following:

Years of healthy life defined as life without disability: This represents one of the most general summary measures as disability is a late stage in figure 1.1 and reflects population health states of all the prior health dimensions. Because disability refers to the inability to perform expected tasks, this definition of years of healthy life may reflect the overall impact of health problems. Healthy life can be defined as life lived without any health limitation that prevents normal activity. Life with disability can be subdivided into ''life with severe and moderate disability'' as well as ''life with limitation in personal care, work, or school.'' This type of measure can clearly define and characterize a healthy year of life, that is, a year without disability.

Years of Healthy Life (as used for Healthy People 2000): The summary measure that was developed for *Healthy People 2000* represents multiple dimensions of health (33). It includes both disability and the individual's assessment of all aspects of health. It should continue to be included among the *Healthy People 2010* measures for comparison over time and with other measures. This measure uses a weighting scheme; that is, it includes severity of health problems in the calculation. It is more difficult to define the meaning of a year of healthy life with this measure because it incorporates multiple aspects of health.

In addition to the two measures above, more narrowly defined measures of health also can be the basis of summary measures that are comparable over time and across population subgroups. Measures based on health-related behaviors, functioning, disease, and self-assessed health, coupled with mortality, were suggested. These additional measures have the potential to clarify which dimensions of health are changing and thus can be linked to programs and policies that might be causing health change. Such measures can include:

Years of life without functioning problems: Summary measures based on functioning could be defined by ability to perform certain functions, such as walking, lifting, picking up objects, etc. For this purpose, both physical and mental functioning should be considered.

Years of life without specified diseases: Summary measures could include years without a variety of major diseases and conditions; the converse, years with conditions, could also be estimated.

Years of life in excellent or very good health: Self-perceived health can be used alone in a summary measure to reflect change in peoples' assessment of their health. Length of life in excellent health or in very good or excellent health can be a summary measure as can years spent in poor health or fair or poor health.

Years of life lived with good health behavior: This measure can serve as a summary measure of years spent with risk factors for some of the other health outcomes. For instance, the average years with no risky health behavior (e.g., smoking, drinking, obesity, and no health care) can be estimated. Estimates can be based on single behaviors or groups of behaviors. Years without any risk behaviors can also be estimated.

All of the proposed summary measures can be constructed with available data and should be available for major subgroups of the population. Some can be constructed for sub-national geographical areas such as States. All the recommended measures can be used to reflect progress toward both goals of increasing the quality and years of healthy life and decreasing health disparities as they can be estimated for gender and major racial and ethnic groups.

1.4 Availability of Data for Estimating the Proposed Measures

The suggested measures can be estimated for a number of years in the 1990s using available data from NHIS. However, the 1997 redesign of the NHIS survey will make it difficult to have a lengthy series for some of the measures. For subgroups of the population, it may be necessary to combine years to produce reliable estimates for some age, racial, and ethnic groups. One necessary component of the measures is the annual life table for the population along with the life tables for the subgroups of interest. Life tables by socioeconomic status (SES) are not regularly produced but could be produced using data such as the mortality followup for NHIS. Consideration should be given to the reliability of annual changes of mortality as well as health data.

It will be important to apply these measures across various geographic and political levels, including States and municipalities. Many of these measures can be estimated for States. The possibility of estimating these statistics for smaller geographic areas needs to be investigated. Estimates for the institutional population need to be included in the summary measures. Estimates of the size and composition of the relevant institutional population are difficult to obtain but need to be part of the measures if they are to describe the entire population. Issues of data availability for the institutional population need to be addressed.

This report presents the results of research conducted to investigate various issues of immediate interest for monitoring progress toward the *Healthy People 2010* goals. Healthy life expectancies were estimated using different definitions of health. Selected estimates for various population subgroups are presented in chapter 3. All of the estimates presented in the chapter are calculated based on health data from NHIS. Since NHIS does not include the institutional population, the estimates in chapter 3 might be at variance with estimates made including the institutional population. The possible impact of not including the institutional population in estimating healthy life expectancies is discussed in chapter 5. Two other important points should be kept in mind in reading the estimated healthy life expectancies in this report. First, the expected years of healthy life presented in this report are different from the Years of Healthy Life (YHL) used in *Healthy People 2000* in both the interpretation of the results as well as in the method of calculation. (The method of calculation and interpretation of YHL used in *Healthy People 2000* is described in Statistical Notes no 7 (33).) Second, the survey instruments and method of data collection of NHIS were revised in 1997. However, since all NHIS data used in this report are from surveys conducted prior to 1997, the 1997 revision of NHIS does not affect the results of this report.

Data used for this report are mainly from the NCHS and the U.S. Census Bureau. The method that is widely used for calculating healthy life expectation using cross-section data is explained succinctly following this introductory chapter. Expected years of healthy life under various definitions of health and variation of results by measure are discussed in chapter 3. Chapter 4 summarizes trends in years free of activity limitation for the period 1985–95. In addition to estimating healthy life expectancy under different attributes of health and looking at trends in limitation-free life, the report includes a test of the effect of including data from different sources on estimated healthy or limitation-free years. An illustration of this impact analysis is presented in chapter 5. The overall summary of the report and recommendations for the longer term endeavor of solving problems of data constraints and the construction of more comprehensive models of summary measures of health are highlighted in the last chapter.

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2. Methods for Calculating Healthy Life Expectancy

2.1 Introduction

Healthy life expectancies are calculated using models that incorporate measures of mortality and morbidity as schematically presented in figure 2.1 (1).

Age-specific death rates account for the mortality component. Age-specific rates of population morbidity, disability, or some other aspect of health account for the morbidity component. These two components are combined using a mathematical function that transforms the two sets of partial measures into a single composite measure using a life table methodology. Figure 2.2 displays the framework of this calculation, including the type of data needed and the techniques used to estimate the two components of the measure at the national level.

National mortality data are obtained from the National Vital Statistics System of NCHS. Mortality data are collected by each State and the District of Columbia and compiled at the national level by NCHS. Mid-year population estimates are from the U.S. Census Bureau.

Health data can come from a number of different sources, depending on the type of health measure and the population being considered. The range of items that could be used to characterize health is illustrated by a "health state classification system" developed by Boyle and Torrance (displayed, in part, in figure 2.3) (2). The classification system of Boyle and Torrance conceptualizes the interrelationship of health attributes as hierarchal, based on breadth and on coverage of different aspects of health. For example, physical function, which is one of the primary health attributes, has four secondary attributes, one of which is self-care. Self-care may, in turn, be disaggregated into more specific health attributes, shown as the third level of classification in figure 2.3.

The estimation of healthy life expectancy begins with the calculation of life table values followed by the calculation of age-specific prevalence rates of being healthy and not being healthy. The formulas needed to calculate the life table values for an abridged life table are summarized in section 2.2.1. To calculate the age-specific prevalence rates of being healthy, first calculate the rates of reporting "fair or poor" health (${}_n\pi_x$). The rates of being healthy, that is, reporting "good or better" health is then ($1-{}_n\pi_x$). Then for each age interval (x, $x+n$), the rates of being healthy ($1-{}_n\pi_x$) are multiplied by the total number of years lived within the same age interval (${}_nL_x$). This calculation provides an estimate of the total number of years a group of persons are expected to live in a healthy state during the interval. The age interval (n, $n+x$) equals 1 for single-year age groups; it equals 5 if data used are in 5-year age groups and 10 for 10-year age groups. The model used to estimate HLE (i.e., the expected number of years in good or better health) is summarized in section 2.2.2.

Healthy life expectancy could be estimated using a variety of health attributes. For instance, the model may be used to estimate disability-free life expectancy or life without activity limitation, also referred to as expected years of active life. Regardless of the health attribute chosen, the model uses two separate and independent partial health measures: ($1-{}_n\pi_x$) for the morbidity component and l_x and ${}_nL_x$ for the mortality component.

2.2 The Life Table Technique

The life table, also known as the mortality table, is used to present the "most complete statistical description" of mortality (3). The life table also has been an important tool for demographers who are interested in estimating the probability of marriage and remarriage, widowhood, orphanhood, and in migration and population projections (4). A brief summary of the method commonly used to estimate life table values, healthy life expectancy, and the standard errors of HLE will be presented in the remaining parts of this chapter. For a more detailed explanation of the method with illustrative examples and the associated sensitivity analysis, refer to *Healthy People 2010* Statistical Notes, No. 21 and No. 22 (5,6).

2.2.1 Estimating the average expectation of life

The objective of the life table is to calculate the expected number of years lived, if a group of people, currently age x, lived the rest of their lives experiencing all the age-specific mortality rates observed for the population at a specific time. The estimation of life table values, such as the expectation of life, begins with the computation of age-specific death rates. The two sets of data required to construct a life table are the mid-year population and the number of deaths in that year. These data could be analyzed in single years of age or 5- or 10-year age groups. (Methods for constructing a complete annual life table are discussed in NCHS Vital and Health Statistics, no. 129.) (7) The process could be applied to the construction of a life table for national, State, or local populations.

The estimation begins with counts for the population ${}_nP_x$ and deaths ${}_nD_x$ for each age group. Population counts are based on mid-year estimates. Deaths are for the entire year. These are used to compute the average death rate of each age group for the year (${}_nM_x$, where n, the number of years in the age group, can be 5 or 10 years), as

$$ {}_nM_x = {}_nD_x / {}_nP_x . \qquad [1] $$

The computed age-specific death rates need to be checked for stability. Age-specific death rates are considered to be stable if they are based on 20 or more deaths. Rates based on fewer than 20 deaths have a "relative standard error of 23 percent or more and therefore are considered highly variable." (8)

The conditional probability of dying within a given age group ${}_nq_x$ is the proportion of people in the age group alive at the beginning of the age interval who die before reaching the next age group. Whereas ${}_nM_x$ is an annual death rate, ${}_nq_x$ is a conditional probability of dying. This probability is estimated as:

$$ {}_nq_x = [n\ {}_nM_x] / [1 + n(1-a_x)\ {}_nM_x] , \qquad [2] $$

where a_x is the average proportion of years lived by those who died in this age interval. The conditional probability of dying is assumed to be 1.0 for the open, oldest age interval. In the example presented here, n is 5 years, so the probability becomes:

$$ {}_5q_x = [5\ {}_5M_x] / [1 + 5(1-a_x)\ {}_5M_x] . $$

The values for a_x are constants derived from the complete life tables (9). For single-year life table value calculations, a_x may be assumed to be ½.

Having calculated the conditional probability of dying, one can now calculate the probability of surviving to an exact age marking the beginning of an interval. In the life table, this is expressed as the number of persons surviving to an exact age (or the exact age at the beginning of an age interval when group data are used), starting with an assumed cohort population (l_0) frequently expressed as 100,000 at birth. For any other age x, the number of survivors at that age l_x can be calculated. Hence, the number alive at exact age $x+n$ (l_{x+n}) is calculated by multiplying the number of survivors at exact age x (l_x) by the probability of surviving from age x to age $x+n$ ($1-{}_nq_x$) or:

$$ l_{x+n} = l_x\ (1-{}_nq_x) . \qquad [3] $$

The total number of person-years lived for those people who were alive at the beginning of the age interval x to $x+n$ is then the sum of the total number of years lived by individuals surviving to the end of the age interval plus the total number of years lived by those who died in the age interval. This becomes:

$$ {}_nL_x = n\ \{l_{x+n} + a_x\ (l_x - l_{x+n})\} . \qquad [4] $$

In the example presented here, $n = 5$ so,

$$ {}_5L_x = 5\{l_{x+5} + a_x\ (l_x - l_{x+5})\} . $$

The person-years remaining for the population, that is, T_x, is simply the total of all the person-years for age x and all subsequent age groups, or:

$$ T_x = \Sigma\ {}_nL_i \text{ for } i = x,\ x+n,\ \ldots\ , \text{oldest age group.} \qquad [5] $$

The average expected years per person is then the total person-years divided by the number of persons surviving to the beginning of the age interval x, or:

$$ e_x = T_x / l_x . \qquad [6] $$

2.2.2 Estimating healthy life expectancy

The life table technique is a powerful tool for estimating the remaining years of life that a group of persons would

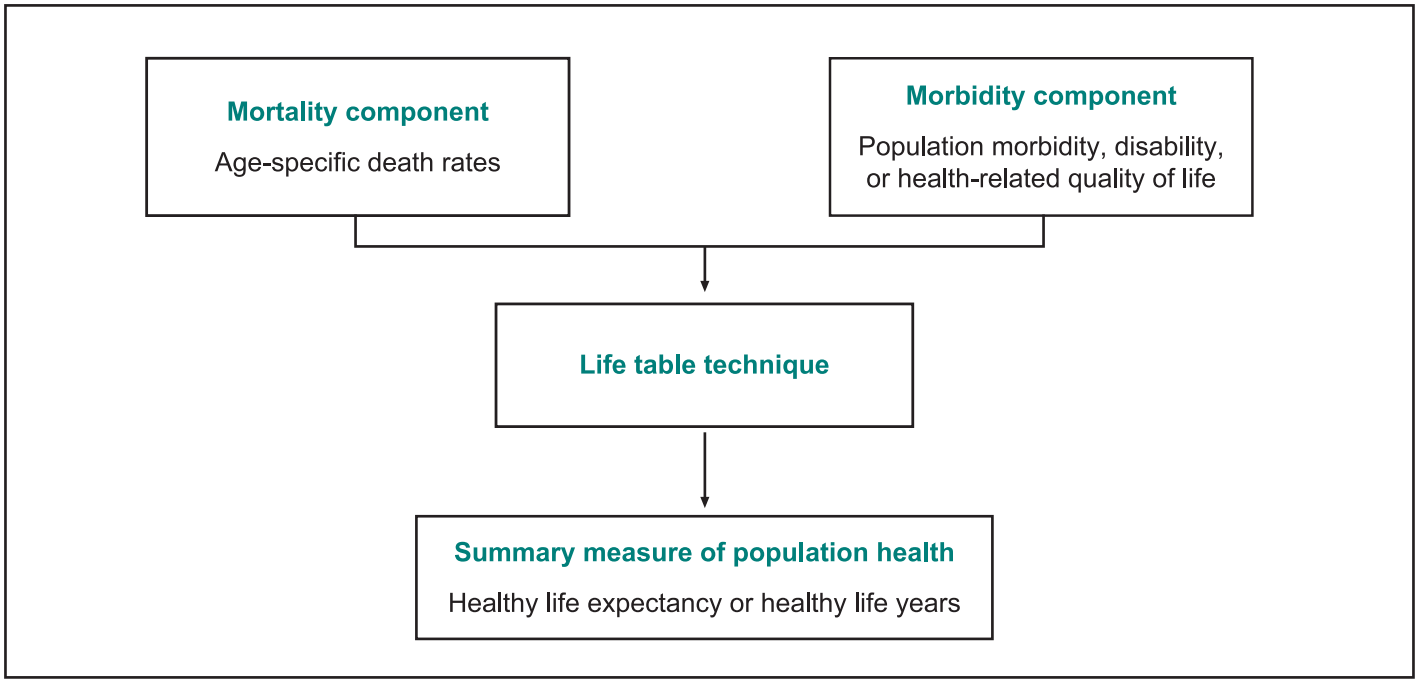

Figure 2.1. A schematic presentation of the model

SOURCE: Adapted from a model by the Institute of Medicine, National Academy of Sciences, 1998.

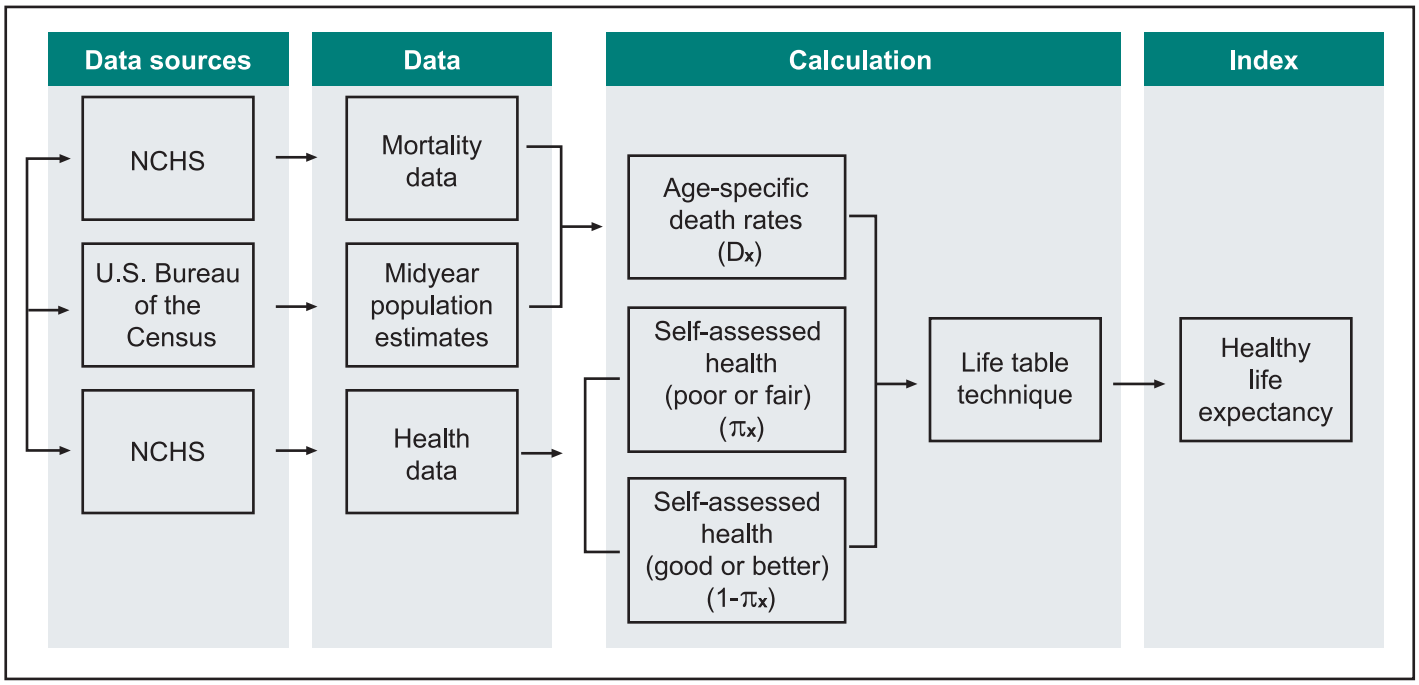

Figure 2.2. A schematic framework for estimating healthy life expectancy at the national level using respondent-assessed health status as an example

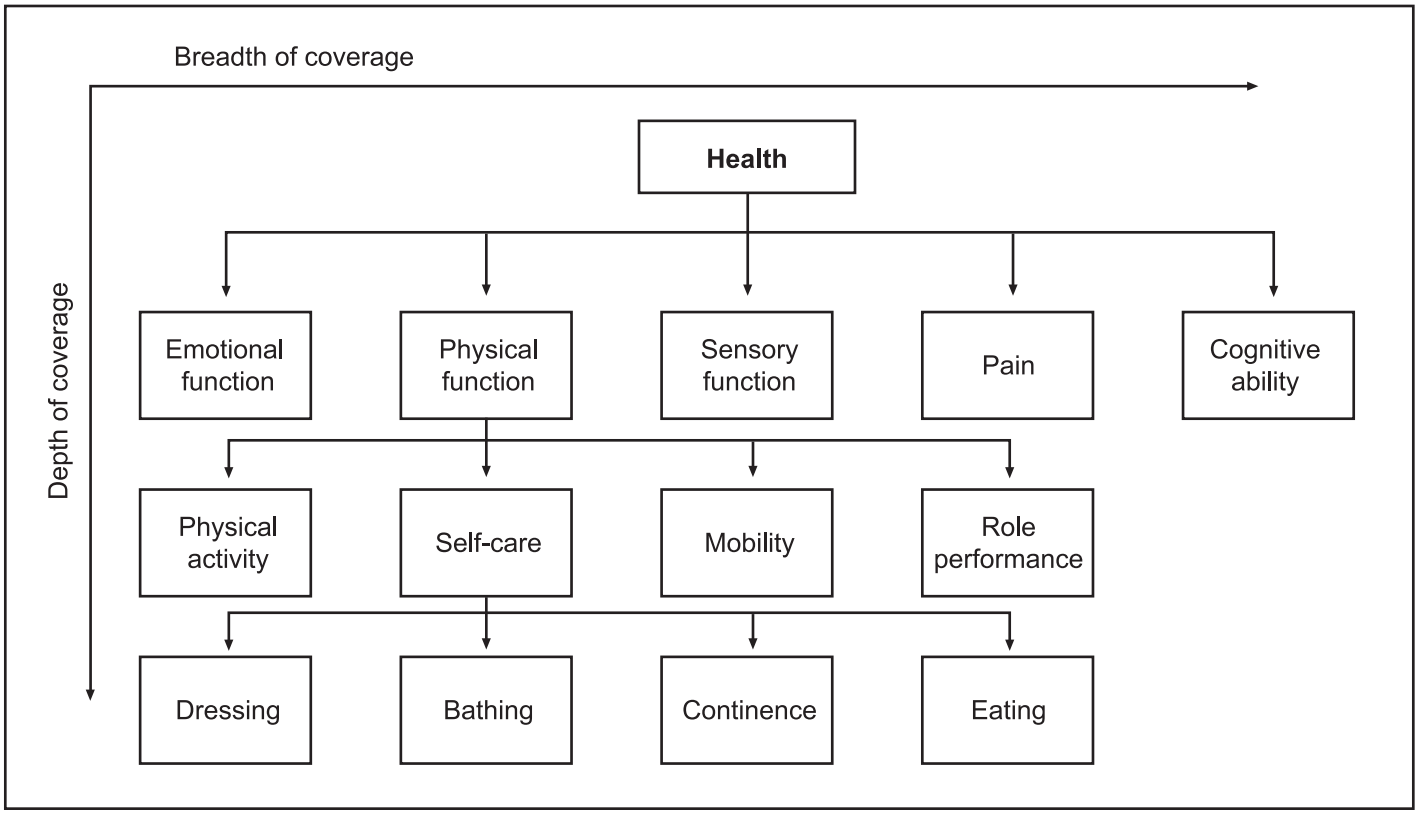

Figure 2.3. Example of attributes for health classification system

SOURCE: Boyle and Torrance. "Developing Multi-attribute Health Indexes." *Medical Care*, 1984.

expect to live once they had reached a certain age. Regardless of their age, the remaining years of life might be lived in good health or in less optimal health states or some combination of both. The traditional life table technique does not distinguish between remaining healthy years and unhealthy years. Additional data are needed to disaggregate the total number of years into expected years of healthy and of unhealthy life.

The total number of expected years of life are partitioned into healthy and unhealthy years using health data (figure 2.2). In general, health data, collected through health surveys or from clinical observations, are used to estimate the prevalence of different health states. The population is then partitioned into proportions that are experiencing varying states of health. The partition may be as simple as dividing the population into those who are healthy and those who are unhealthy. Or, the population may be partitioned into more than two population subgroups, according to varying degrees of health, using multidimensional scaling to describe health states.

To calculate HLE, the population of each age interval in the life table is partitioned into the proportion experiencing an unhealthy condition (${}_5\pi_x$) and those that are considered "healthy" ($1-{}_n\pi_x$). Since ${}_nL_x$ is the total number of person-years lived for the population in age interval x to $x+n$ (equation 5), the proportion of these years lived in a healthy state (${}_nL_x$) is then:

$$ {}_xL'_x = (1-{}_n\pi_x)\ {}_nL_x\,. \qquad [7] $$

One of the following two equations can be used to determine HLE:

$$ e'_x = \frac{1}{l_x}\sum_{i=x}^{w} {}_nL'_x\,. \qquad [8] $$

or

$$ e'_x = \frac{1}{l_x}\sum_{i=x}^{w} (1-{}_n\pi_i)\ {}_nL_i \qquad [9] $$

where

e'_x is HLE at age x, or the number of remaining years of healthy life for persons who have reached age x;

l_x is the number of survivors at age x;

$(1-{}_n\pi_x)$ represents the age-specific rate of being healthy;

${}_nL_x$ is the total number of years lived by a cohort in the age interval (x, $x+n$); and

w is the oldest age category.

The expected years of unhealthy life is $e_x - e'_x$. However, if multiple states of health status are described, the prevalence for each of those states for each age interval must be calculated. Equations similar to [8] and [9] are used to estimate separately the expected years of life in those health states.

2.2.3 Standard errors of healthy life expectancy

The estimates for age-specific prevalence of healthy and unhealthy states are derived from surveys or samples. Consequently, these estimates have associated sampling error. Calculating the standard error of the resulting estimated HLE is especially important when comparing population subgroups. This section discusses the method of estimating the standard errors of HLE, with and without information on the survey sample design. Standard errors for the other life table values can be calculated separately when needed. See Chiang and Keyfitz for details (10,11).

Each age-specific value of the prevalence of the population experiencing healthy life, $(1-{}_n\pi_x)$, is an estimated proportion with an associated variance and standard error. The variances of these proportions and their standard errors may be estimated using routine statistical methods. Consequently, the variance (S^2) is given by the binomial variance of:

$$ S^2({}_n\pi_x) = [{}_n\pi_x\,(1-{}_n\pi_x)] \,/\, {}_nN_x\,, \qquad [10] $$

where ${}_nN_x$ is the number of persons in the age interval (x, $x+n$) of the sample from which the prevalence rates were computed.

The variances of the prevalence rates from equation 10 can be used to estimate the overall variance of e'_x using the following formula:

$$ VAR(e'_x) = \frac{1}{l_x^2}\sum_{i=x}^{w} [{}_nL_i^2\ S^2(1-{}_n\pi_i)]\,. \qquad [11] $$

Illustrative applications of the variance of HLE using 1995 U.S. population data are presented in *Healthy People 2010* Statistical Note No. 21 (5).

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3. Expected Years of Healthy Life Under Various Definitions of Health

3.1 Introduction

No single definition of the component of healthy life expectancy measures the nonfatal health outcome. Prevalence or incidence of health-related occurrences are numerous and measure different aspects of health. These include self-rated health or measures of work, activity, or functional limitations. They could also be observed rates or probabilities of the occurrence of bad physical or mental health, acute or chronic conditions, health-related behaviors, or even health service utilization. In this chapter, the practical application of the composite measure is illustrated by combining various nonfatal health outcome measures with life table values; these combinations are used to estimate a variety of healthy life measures such as expected life in good or better health, free of activity limitation, or without needing help in ADL or IADL.

Healthy life expectancy will be estimated first as expected years without health-related limitation. That is, the prevalence of activity, work, and functional limitations will be used as the nonfatal measure. Second, healthy life expectancy from the perspective of diseases or chronic conditions will be discussed using the prevalence of chronic arthritis, heart diseases, hypertension, and diabetes. Prevalence of overweight and obesity among adults will be used to discuss healthy life expectancy as a measure of health-related behavior.

Healthy life expectancies are estimated by 5-year age group and sex. Estimates are also presented by race whenever data by race are considered reliable. Data from various sources are used for the estimates. Life expectancies by 5-year age group, sex, and race are estimated using data from NCHS and the U.S. Census Bureau as described in chapter 2. Prevalence rates of the various health states are calculated from the person and condition files of NHIS for the years 1985–96.

3.2 Expected Years of Healthy Life for Males and Females

As numerous studies have shown that healthy life expectancies vary considerably both by age and sex (1–4), disparities in healthy life expectancies will be discussed for subgroups defined by these factors. Measures used for the discussion include expected years in good or better health, years in excellent health, years without activity limitation, years without work limitation, years without limitation in ADL or IADL, and years without disease or chronic conditions.

3.2.1 Expected years in good or better health

Expected years of life is first measured using "expected years in good or better health." First, respondents who stated that they were in good, very good, or excellent health were classified as "persons in good or better health"; respondents who assessed their health as fair or poor were considered "persons in poor health." Expected years of healthy life can also be estimated using "expected years in excellent health." To estimate expected years in excellent health, respondents were classified depending on whether their self-assessed health was excellent. Figure 3.1 presents the distribution of those reporting good or better health by 5-year age group and sex. The percentage of those who were in good or better health declines with age, slowly for younger adults, but relatively faster for older adults. The estimated years in good or better health and in excellent health for selected ages by sex are presented also in table 3.1.

The table indicates that in 1995, a newborn baby would expect to live 75.8 years (72.8 years for males and 78.8 years for females). Of this total expected life span, 66.5 years (87.7 percent) were expected to be in good or better health, whereas only 26.4 years (34.8 percent) were expected to be in excellent health. Expected years of healthy life, measured in years as well as a percentage of total life expectancy, varies by age. As one gets older, years in good or better health decrease in both absolute and relative terms. In 1995, for example, a person at age 20 would expect to spend 84.3 percent of his or her future life in good or better health and only about 29.0 percent in excellent health. At age 65, these percentages declined to 71.0 percent and 14.9, respectively.

Expected years in good or better health and in excellent health also varied by sex. Females could expect to live more years in good or better health than their male counterparts. On the other hand, males could expect a relatively higher proportion of their future life in good or better health at the younger ages whereas females seem slightly better off after age 65 (figure 3.2). When healthy life is measured in terms of expected years in excellent health, males at younger ages would expect to spend more years and a higher proportion of their lives in excellent health than females. The opposite was true after age 75. The table also indicates that as the population ages, the difference in healthy life between males and females declines slightly, especially when healthy life is measured in years rather than as a percent of life expectancy. The difference between expected years in good or better health for males and females is statistically significant ($p<0.05$) except at age 85.

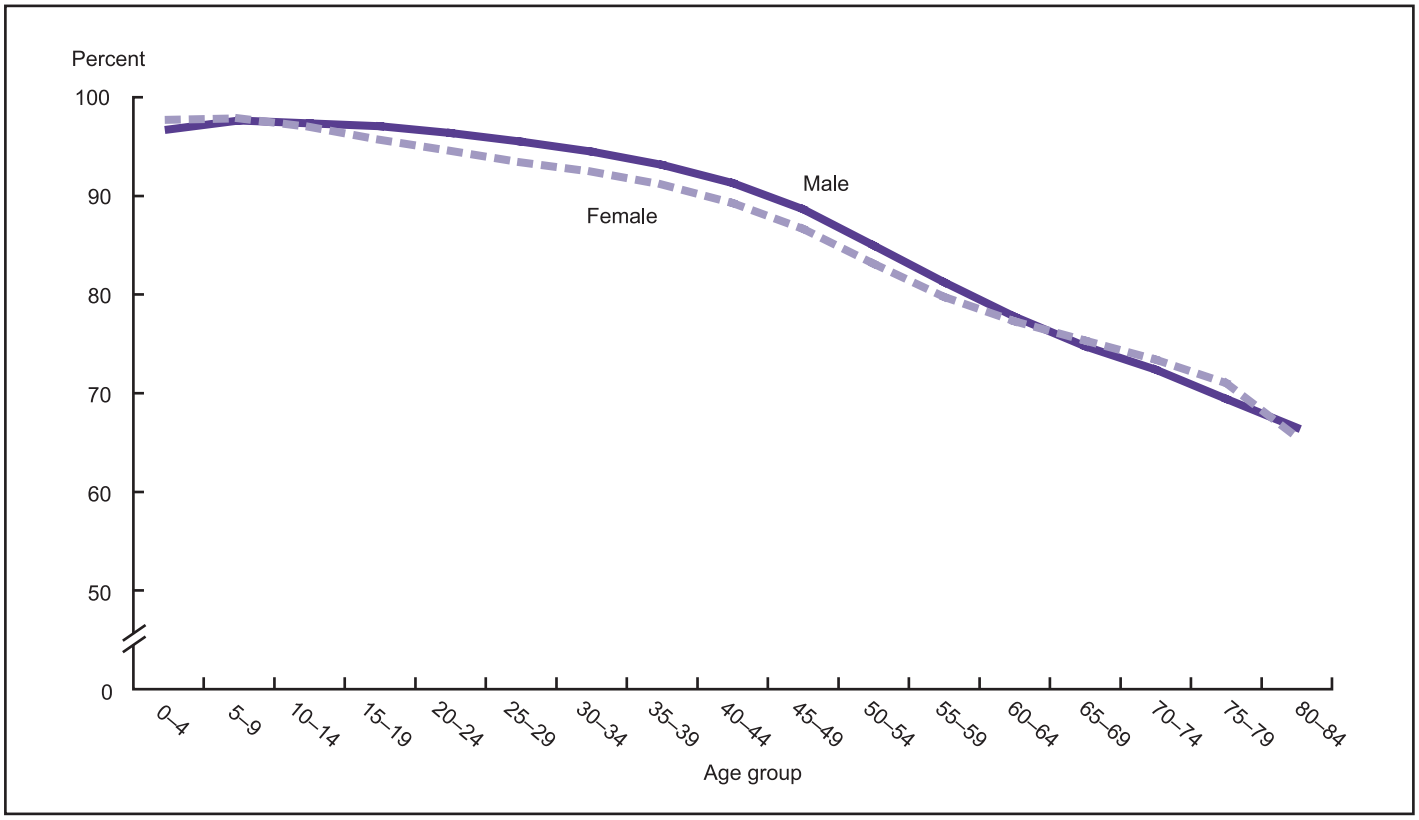

Figure 3.1. Percentage of persons reporting good or better health, by age and sex: United States, 1995

3.2.2 Expected years without activity limitation

In the 1995 NHIS, respondents were asked about activity limitation. Respondents were categorized into one of the following groups: not limited in any way; unable to perform their major activity; limited either in kind/amount of their major activity; and limited in activities other than the one identified as the major activity. Respondents with unknown activity limitation status were assumed to be not limited (5). Expected years of healthy life defined as disability-free life expectancy (DFLE) were estimated based on the prevalence of major activity limitation only and on any type of activity limitation. The distribution of those free of any activity limitation by 5-year age group and sex is presented in figure 3.3. The figure indicates that activity limitation is a function of age. The percentage of males and females without any activity limitation declines with age at a slower rate at the younger ages and a relatively faster rate at the older ages.

The expected years without major activity limitation and years without any limitation for selected ages by sex is presented in table 3.2 and figure 3.4. On average, individuals of all ages could expect to spend more than 4 of every 5 years without limitation in their major activity. A baby born in 1995 would be expected to spend more than 94 percent (94.1 for males and 94.7 percent for females) of his or her total life expectancy without limitation in major activity. At age 65, this percentage dropped only by about 5 percentage points to 89.1 percent (88.6 for males and 89.5 percent for females). On the other hand, when the broader definition of the measure "any activity limitation" is used, the percentage of life expected to be without limitation declined from 94.4 to 82.5 percent at birth (from 94.1 to 83.2 percent for males and from 94.7 to 81.9 percent for females) and from 89.1 to 61.3 percent at age 65.

Females could expect to live more years without major or any other type of activity limitation. The difference between males and females in expected years without major

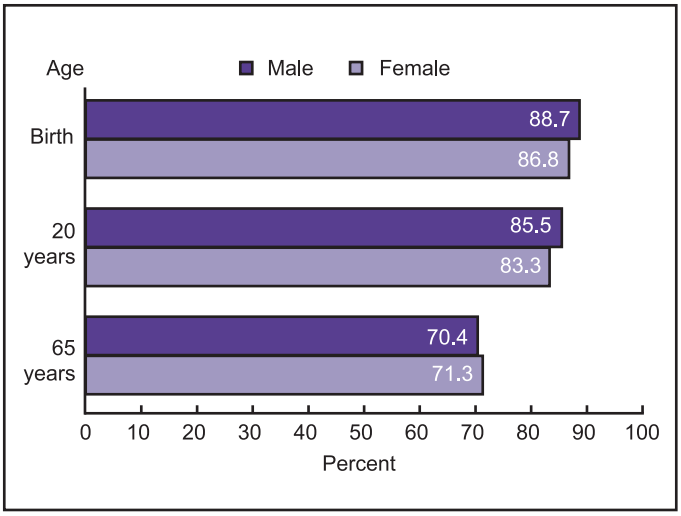

Figure 3.2. Percentage of expected life in good or better health at birth, 20, and 65 years of age, by sex: United States, 1995

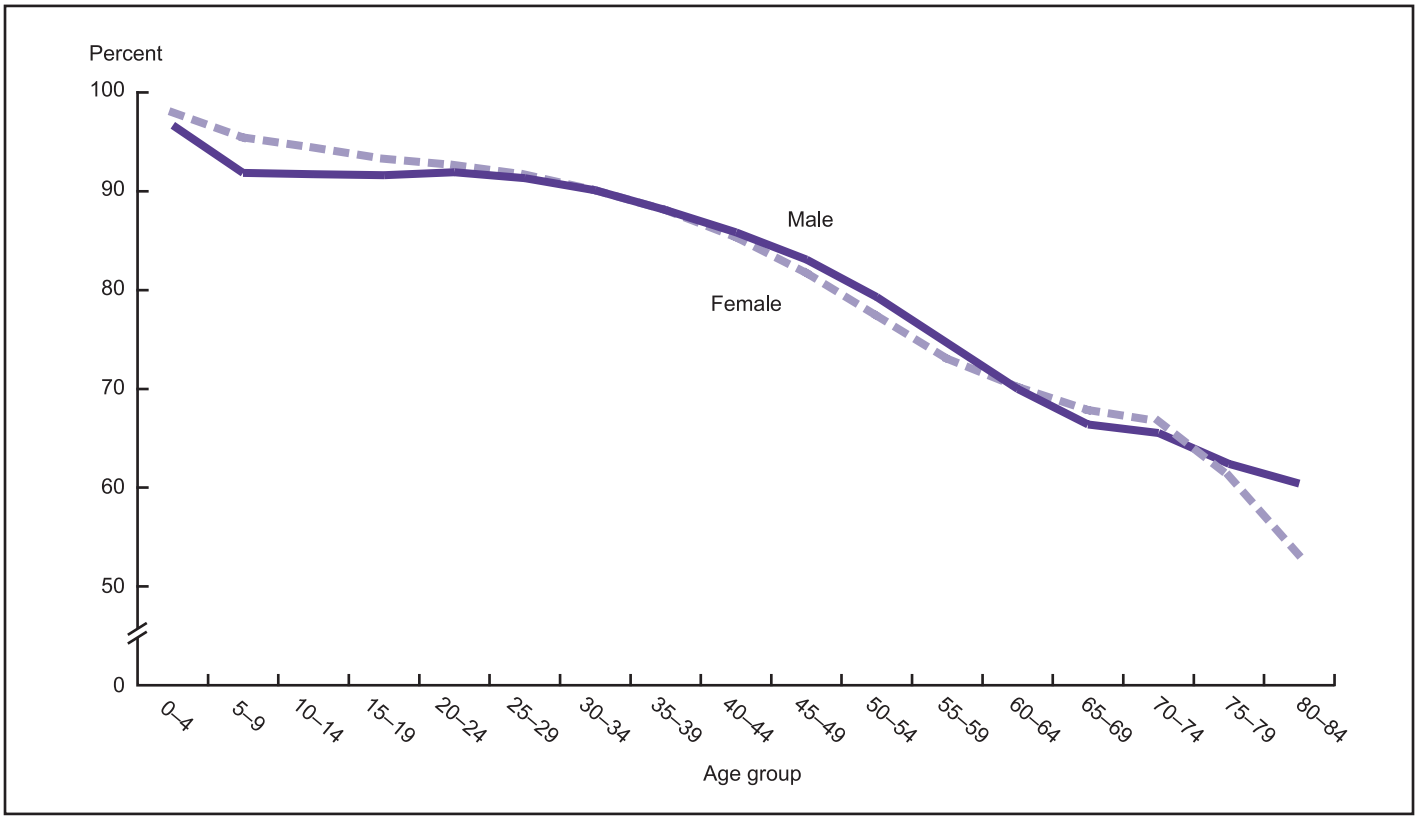

Figure 3.3. Percentage free of activity limitation, by age and sex: United States, 1995

activity limitation is statistically significant ($p<0.05$) except at age 85; likewise, the difference between males and females in expected years without any activity limitation is statistically significant, except at age 80. On the other hand, the results of the comparison of activity limitations as a percent of total life expectancy by gender are not clear-cut. Females could expect to have a larger percentage of their future life free of major activity limitation at almost every age except for the oldest. On the other hand, controlling for age, males could expect a larger part of their life to be free of any activity limitation.

3.2.3 Expected years without work limitation

In the 1995 NHIS, activity limitation status can also be measured based on "ability to work" for adults between 18 and 69 years of age. Based on their responses, respondents were classified as "unable to work," "limited in kind/amount of work," and "with no work limitation." Adults between the ages of 18 and 69 with unknown work limitation status were considered "not limited." The proportion able to work and without any work limitation was used to estimate expected years able to work and expected years without any work limitation. The results for selected ages by sex are presented in table 3.3.

On average, in 1995 a person would expect to live 42.8 years between age 20 and 69. For 39 of these expected years of life (91.2 percent), the person would be able to work, and 36.6 of those years (85.5 percent) would be without any type of work limitation. Males would expect to live an average of 41.2 years between the ages of 20 and 69. For 37.5 years (91 percent), an adult male would expect to be able to work; the same adult male would spend 35.1 of those years (85.2 percent) without any type of work limitation.

Between age 20 and 69, compared to adult males, adult females would expect to spend more years and larger percentage of their average expected years able to work and without any type of work limitation. The table shows that, on average, an adult female between ages 20 and 69 expected to live 44.6 years. For 40.8 of those years (91.4 percent) they would expect to be able to work, and they would expect to be free of any work limitation for 38.3 years. The number of years a person would expect to be able to work and the expected number of years free of any work limitation declined with age, but the years expressed as a percentage of life expectancy remained fairly constant over age for both males and females.

3.2.4 Expected years without functional dependency

In the 1995 NHIS, respondents 65 years of age and over were also asked whether or not they needed help from other persons for their personal care or other routine needs because of physical, mental, or emotional problems. Personal care needs or ADL included bathing or showering; dressing; eating; getting in and out of bed or chairs; using the toilet, including getting to the toilet; and getting around inside the home. Other routine needs or IADL included preparing own

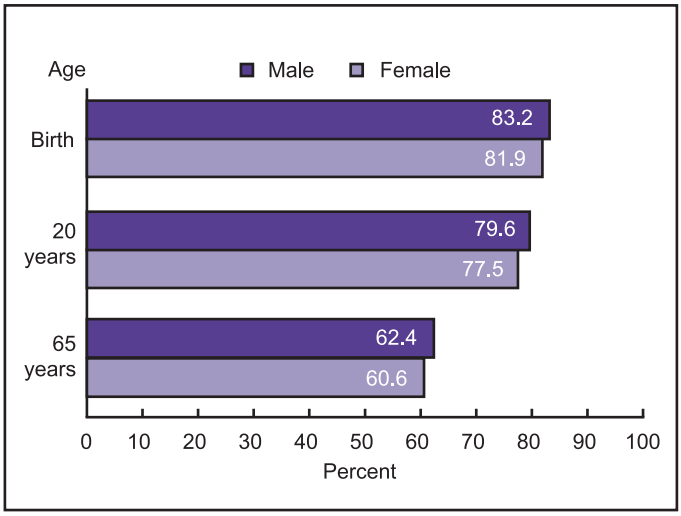

Figure 3.4. Percentage of life expectancy free of any activity limitation at birth, 20, and 65 years of age, by sex: United States, 1995

food; shopping for personal items; managing money; using the telephone; and doing heavy work around the house (5).

The recoded response categories were persons who need the help of other persons to "perform personal care needs," those who need the help of other persons "to perform other routine needs," and those who are "not limited in performing personal or routine needs." Those with unknown limitation status were assumed to be not limited in performing personal care or other routine needs. Figure 3.5 presents the percentage distribution of those who were able to perform personal care needs or who were not limited in other routine needs of daily living by 5-year age group and sex. The distribution indicates that limitation in personal care or other routine needs of daily living was a health problem mostly associated with old age. Expected years without functional dependency were calculated, and the results for some selected ages by sex are presented in table 3.4.

According to the results of the 1995 NHIS data, those who were younger than age 75 could expect to live more than 90 percent of their remaining life without functional dependency. A 75-year-old male would expect to live about 90.2 percent of his total expectation of life without functional dependency. The percentage declined to only 88.1 percent at age 80. At age 75, on average, adult females would expect to live nearly 88 percent of the remainder of their lives free of functional dependency. On average, an 80-year-old female would expect to live 83.4 percent of her life expectation free of functional dependency.

When years without limitation were measured in terms of functional dependency due to limitations in ADL or other routine needs (IADL), adults younger than 65 years of age could expect to live more than 80 percent of their expected lives free of limitation (more than 86.5 percent for males and 80.1 percent for female). At any given age, females would expect to live more years without functional dependency because of ADL or IADL limitation. The difference between males and females in expected years without ADL or IADL

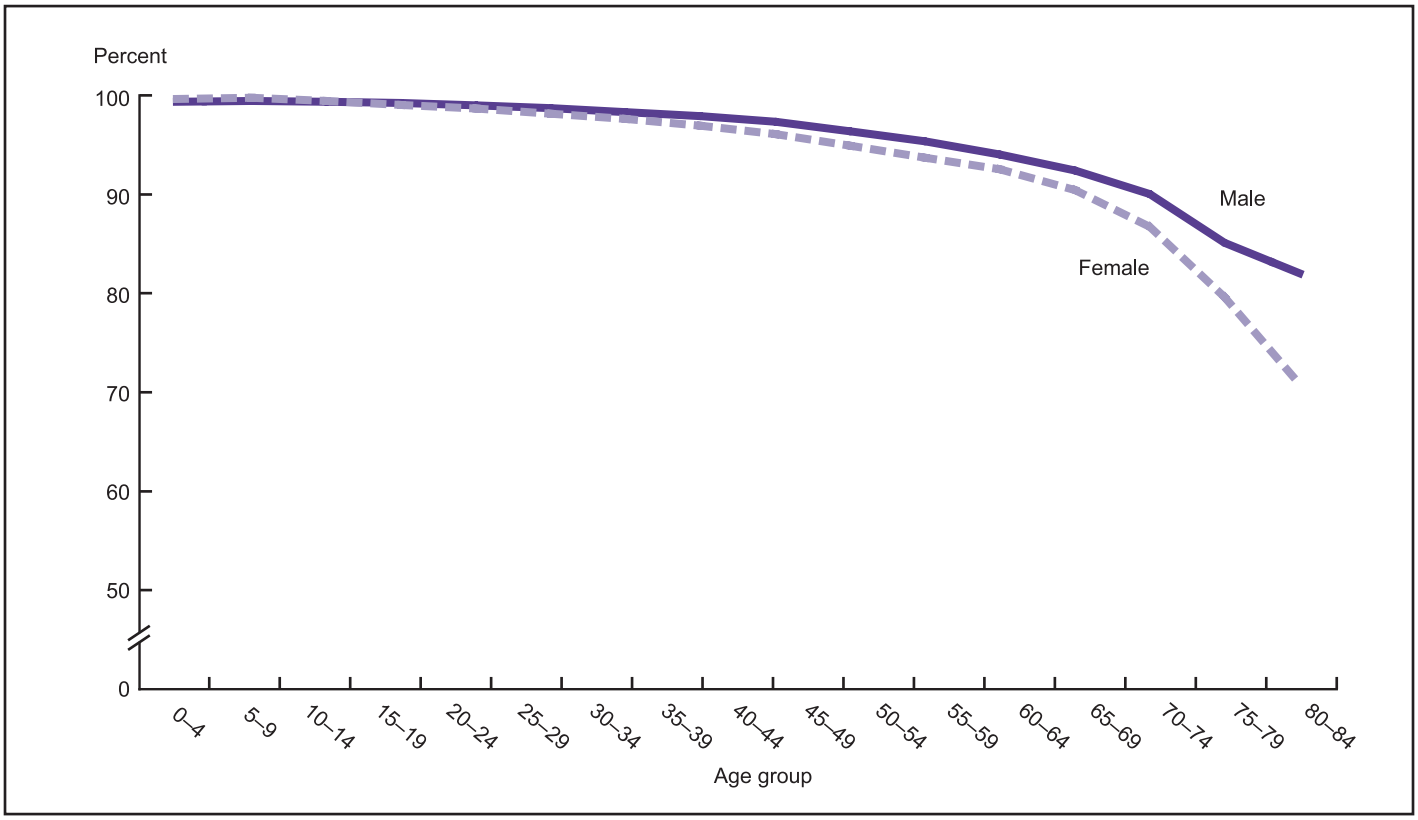

Figure 3.5. Percentage able to perform personal care needs or not limited in other routine needs, by age and sex: United States, 1995

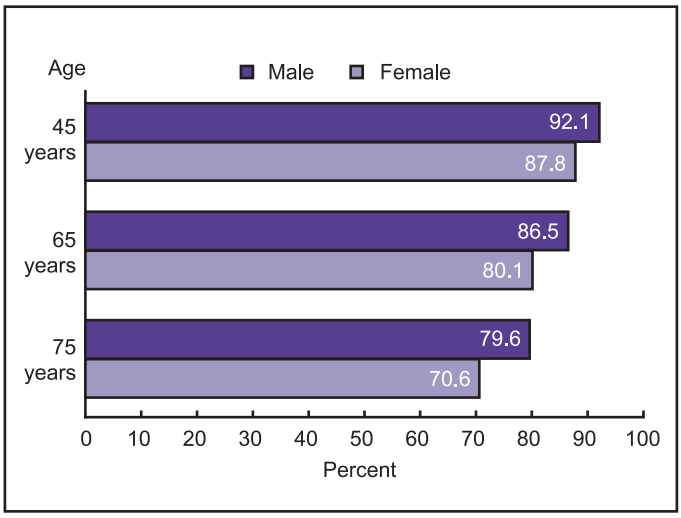

Figure 3.6. Percentage of life expectancy able to perform personal care needs or not limited in other routine needs at 45, 65, and 75 years of age, by sex: United States, 1995

limitation is statistically significant ($p<0.05$) at all ages. However, as a percent of life expectancy, males had more functional dependency-free life. At age 65, for example, males could expect to live 86.5 percent of their remaining lives free of functional limitation because of limitation in ADL or IADL. On the other hand, females of the same age could expect to live 80.1 percent of their remaining life free of functional dependency because of ADL or IADL limitation (figure 3.6). This is consistent with other research findings (6).

3.2.5 Expected years without diseases or chronic conditions

Expected years of healthy life were also estimated based on the prevalence of four selected chronic conditions: arthritis, hypertension, heart disease, and diabetes. To improve reliability of estimates, the prevalence rates were estimated using 3 years of NHIS data, 1994–96. Age-specific prevalence rates for males and females between 30 and 84 years of age are presented in table A. The estimates are assumed to represent the midyear of the 3-year interval, 1995. Expected years without each of the four chronic conditions are estimated for persons 30 years of age and over; the results are presented in tables 3.6 and 3.7.

In 1995, a 30-year-old could expect to live another 47.5 years of which 34.7 years (73 percent) were expected to be free of chronic arthritis. On the other hand, a person aged 65 years could expect to live 17.5 more years, of which only 8.8 (50.2 percent) years were expected to be free of chronic arthritis. By age 75, expectation of life would drop to about 11 years and expected years free of chronic arthritis to about 5 years (about 46 percent of life expectancy).

Though females could expect to live longer, at every age males could expect to live more chronic arthritis-free years than females of the same age both in terms of number of years and as a proportion of their life expectancies. The difference between males and females in expected years free of chronic arthritis is statistically significant ($p<0.05$) at all ages. At age 30 for example, females could expect to live 50.1 years and males to live only 44. 9 years. But at the same age, females expected to live only 34 years (68 percent of their life expectancy) free of chronic arthritis while males of the same age could expect to live 35.4 years (nearly 79 percent of their life expectancy) free of chronic arthritis (table 3.5). At age 65, females could expect to live less than half (44.8 percent) of their remaining years free of chronic arthritis, while males 65 years of age expected to live 58.1 percent of their remaining years free of chronic arthritis (figure 3.7).

Table A also shows that, compared to years free of chronic arthritis, both male and female adults 30 years old and over could expect to live more years free of chronic heart diseases. A 30-year-old male could expect to live 37.1 years of his remaining 44.9 years free of chronic heart diseases. A 30-year-old female, on the other hand, could expect to live 42.7 years of the 50.1 years of her future life free of chronic heart diseases. In terms of percentages of expectation of life, while a 30-year-old male on average could expect to live 82.8 percent of his future years free of chronic heart diseases, a female of the same age could expect to live 85.3 percent of her remaining life free of chronic heart diseases (figure 3.8).

On the other hand, a 65-year-old male could expect to live 15.9 years, of which 10.2 years would be free of chronic heart diseases. In other words, 64.5 percent of the

Table A. Rates per thousand with chronic condition, by type of condition and sex at selected ages: United States, 1994–96

Age	Diabetes		Arthritis		Heart diseases		Hypertension	
	Male	Female	Male	Female	Male	Female	Male	Female
	Per 1,000 population							
30–34	6.0	10.7	39.3	47.0	24.9	36.4	35.5	40.5
40–44	17.7	24.5	80.0	121.8	49.6	60.4	109.8	106.5
50–54	47.6	53.3	158.1	290.9	109.4	88.6	207.7	211.4
60–64	96.3	108.5	297.3	430.3	276.4	104.2	316.7	305.0
70–74	123.6	116.3	455.2	487.6	340.1	247.0	343.8	440.8
80–84	111.5	76.9	502.8	600.6	414.7	297.7	294.7	374.2

SOURCE: National Center for Health Statistics. National Health Interview Survey, 1994–96.

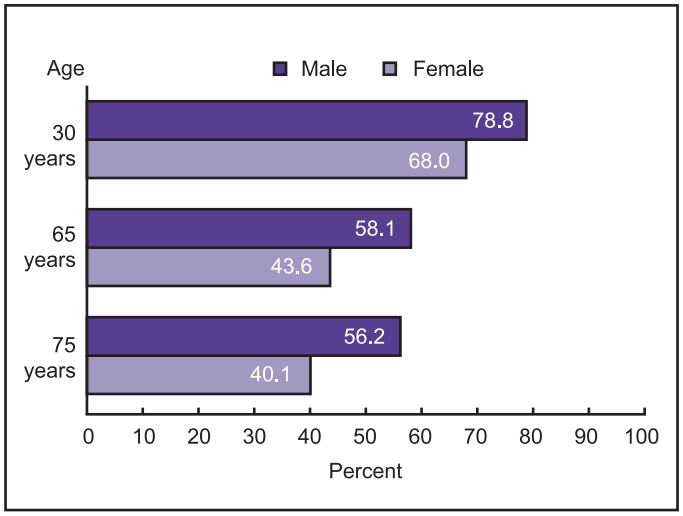

Figure 3.7. Percentage of life expectancy free of chronic arthritis at 30, 65, and 75 years of age, by sex: United States, 1994–96

life expectancy of a 65-year-old male would be free of chronic heart diseases. Alternatively, a 65-year-old female could expect to live 18.8 more years. Of her total life expectancy at this age, 13.6 years (or 72.3 percent) would be free of chronic heart disease. Compared to adult males of the same age, adult females could expect to live a larger proportion of their future lives free of chronic heart diseases. The difference between males and females in expected years free of chronic heart disease is statistically significant ($p<0.05$), except at age 85.

The number of years that adults could expect to live free of chronic hypertension at selected ages is presented in table 3.6. The table also presents the expected years adults could expect to live without chronic diabetes. In 1995, a 30-year-old adult could expect to live for another 47.5 years, of which 36.8 years (77.4 percent) would be free of chronic hypertension. By age 65, total life expectancy would decline to 17.5 years, and the percentage of life free of chronic hypertension would also go down to about 62 percent.

Based on the 1995 mortality schedule and the 1994–96 age-sex-specific prevalence of chronic hypertension, a 30-year-old male, on average, could expect to live about 35.7 years (79.5 percent of his life expectancy) free of chronic hypertension. At age 65, the average expected years free of chronic hypertension would drop to 10.8 (68 percent of life expectancy). Compared to males, females could expect to live more years without chronic hypertension at age 30, but by age 65, gender difference in the expected years without chronic hypertension has almost disappeared. However, at both the younger and older ages, the percentages of remaining life free of chronic hypertension were greater for males than for females (figure 3.9).

The table also shows that at almost all ages, adults 30 years of age or older could expect about 9 of every 10 of their remaining years to be free of chronic diabetes. At age 30, almost 94 percent of life was expected to be chronic diabetes-free, and this percentage declined by only about 5 percentage points to about 89 percent at age 65. Though the gender difference in the percentage of life free of diabetes was marginal, at each age, females could expect to live more chronic diabetes-free years than males because of the gender difference in total life expectancies. The difference between males and females in expected years free of chronic diabetes is statistically significant ($p<0.05$) at all ages.

3.2.6 Expected years with body mass index (BMI) less than 25 and years with BMI less than 30

Expected years of healthy life can also be estimated using risk factors such as body mass index (BMI). BMI relates the weight of individuals to their height. The specific values of the BMI differentiates adults that are considered overweight or obese from adults who are not considered

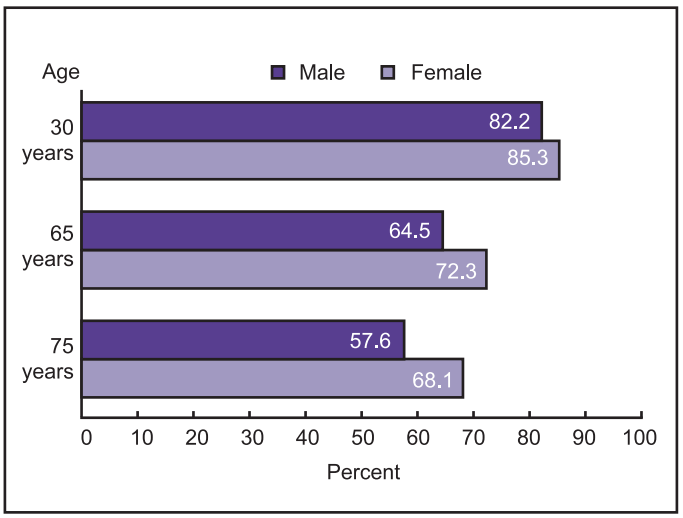

Figure 3.8. Percentage of life expectancy free of chronic heart disease at 30, 65, and 75 years of age, by sex: United States, 1994–96

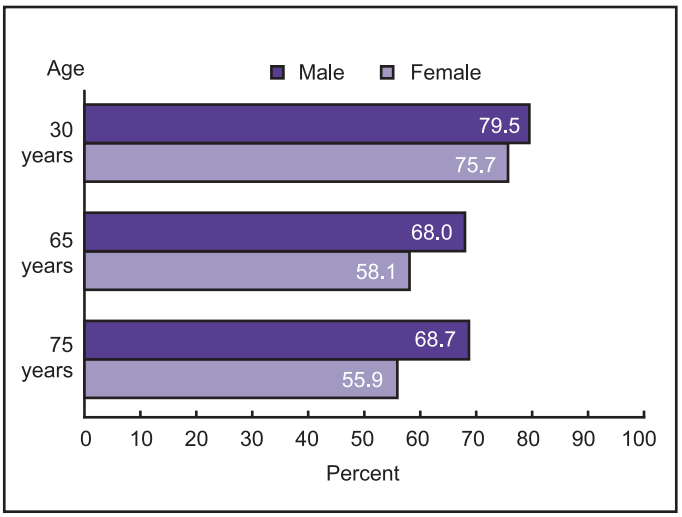

Figure 3.9. Percentage of life expectancy free of chronic hypertension at 30, 65, and 75 years of age, by sex: United States, 1994–96

Table B. Classification of overweight and obesity by body mass index (BMI): Adults, 18 years of age and over

Weight	*Obesity class*	*BMI*
Underweight		Less than 18.5
Normal range		18.5–24.9
Pre-obese		25.0–29.9
Obesity	I	30.0–34.9
	II	35.0–39.9
Extreme obesity	III	Greater than or equal to 40

SOURCES: NIH (NHLBI), 1998; WHO, 2000.

overweight or obese. As is shown in table B, the National Institutes of Health (NIH) and the World Health Organization (WHO) classify an adult 18 years of age and over as overweight if his/her BMI is 25 or over and as obese if his/her BMI is greater than or equal to 30 (7,8). These definitions were used to classify the adult population 18 years of age and over by BMI category using NHIS data for the years 1994–96. The distribution of the population aged 20 and over that is not obese (BMI<30) by 5-year age group and sex is presented in figure 3.10. The percentage of those not obese declines until age 50 and then starts to rise again after that age. Controlling for age, the percentage of males and females who were not obese was similar for young adults; however, after age 55, the difference between the sexes is substantial, with males having a higher percentage not obese.

The age-sex specific adult BMIs in combination with 1995 life table values were used to estimate the expected years with BMI less than 25 and with BMI less than 30. The results are presented in table B. Based on the mortality schedules of 1995 and the average 1994–96 BMI, at age 20, only half (49 percent) of the remaining life of a person was expected to be spent with BMI less than 25 (i.e., within a weight/height proportion accepted as "normal range" for a healthy life).

Body Mass Index for different population subgroups was calculated based on reported weights and heights. Compared to BMIs calculated based on measured weights, BMIs calculated based on reported weights tend to underestimate overweight and obesity rates. BMIs calculated based on measured weights (NHANES 1988–94) (9) were compared to BMIs calculated based on reported weights (NHIS 1988–94). For the population aged 20 to 74 years old, BMIs calculated based on reported weights underestimate both overweight and obesity rates. Percent overweight was underestimated by 3.1 percent for males (3.9 percent for white, but overestimated by 2.2 percent for black) and 12.4 percent for females (12.9 percent for white and 9.2 percent for black). Percent obese is underestimated by 6.2 percent for males (6.6 percent for white and 3.8 percent for black) and 11.1 percent for females (10.8 percent for white and 11.8 percent for black). The underestimation of overweight and obesity rates due to the use of reported

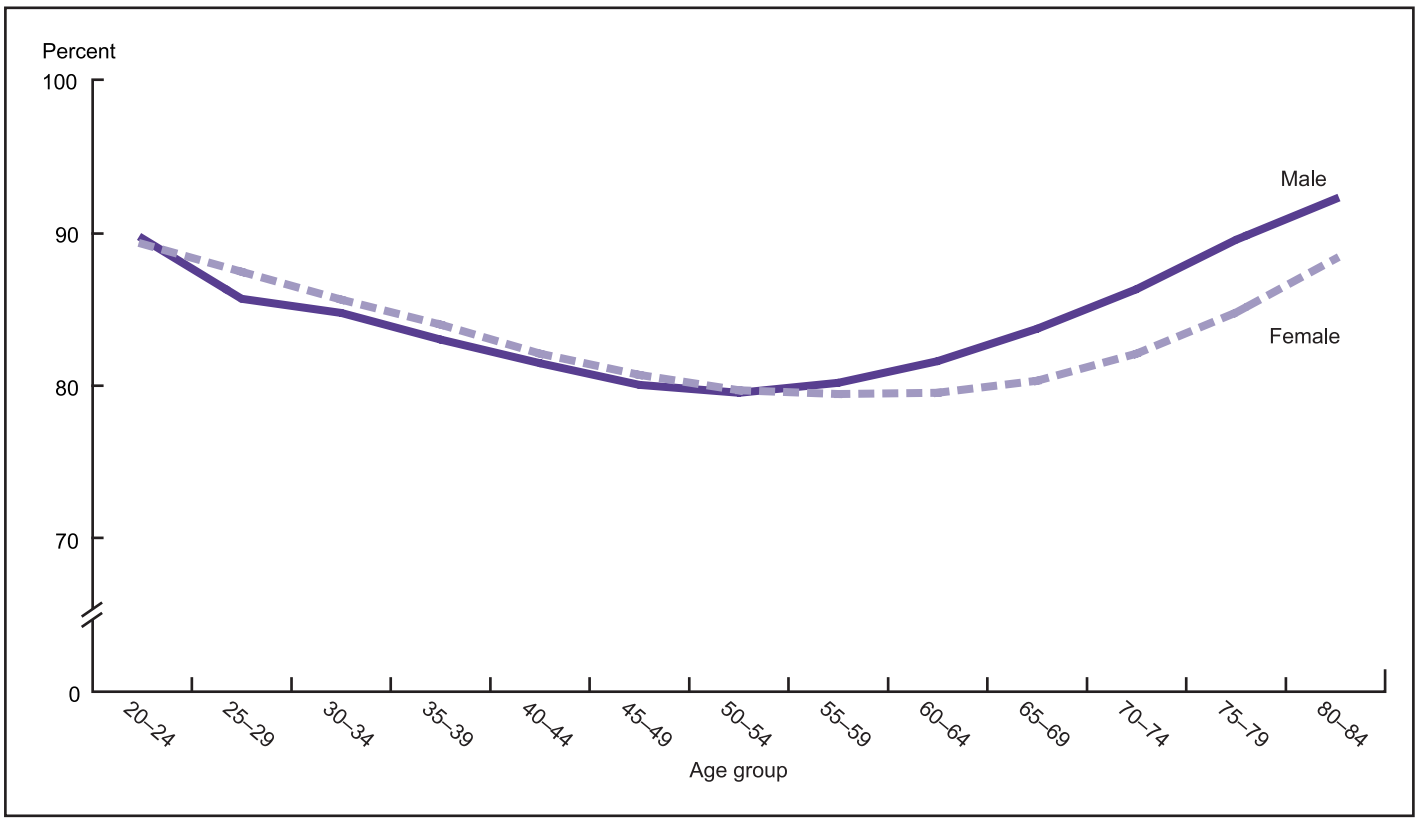

Figure 3.10. Percentage not obese, by age and sex: United States, 1994–96

NOTE: Not obese is defined as Body Mass Index (BMI) less than 30.

weight in the calculation of BMIs results in the overestimation of expected life with BMI less than 25 and with BMI less than 30.

The percentage of adult life expectancy expected to be spent with BMI less than 25 decreased continuously with age for younger adults and then rose at the older ages. By age 65, the percentage was 50.4, and by age 80, it was 63.6 percent. At each age, adult females expected to spend a larger share of their future years with a BMI less than 25 than did adult males. At age 20, for example, while adult females could expect to spend 57.2 percent of their average life expectancy with a BMI less than 25; the share of average life expectancy for adult males of the same age was only 40 percent. At age 65, the percentage of life expectancy to be spent with a BMI less than 25 rose to about 54 percent for adult females but was expected to be only 50 percent for adult males.

The table also shows that, on average, adults aged 20 years and over could expect to spend more than four fifths of their lives without being obese (BMI less than 30); they also could expect the percentage of remaining life expected to be spent without being obese would rise with age, for both adult males and females. At age 20, on average, adult females could expect to spend 83.4 percent of their expected lives with BMI less than 30, while adult males could expect to spend 84 percent of their remaining lives with an average BMI less than 30. At age 65, the average percentage of remaining life expected to be spent with a BMI of less than 30 was 84.2 for females and 88 for males. Because of their higher life expectancies compared to males of the same age, adult females expected to spend more of their remaining years with a BMI of less than 25 as well as a BMI of less than 30. The difference between male and female expected years with BMI less than 25 and BMI less than 30 is significant ($p<0.05$) at all ages. Compared to males, adult females at every age expected to spend a larger share of their expected lives with a BMI less than 25; adult males expected to spend a slightly larger percentage of their remaining lives with a BMI less than 30 than females.

3.3 Expected Years of Healthy Life for the White and Black Populations

Several studies have shown that the black population in the United States has higher mortality than the white population (10–12). Life expectancies by race indicate that across all ages, white males have higher life expectancy than black males, and white females have higher life expectancy than black females. This difference has persisted except for the oldest old where some studies have shown that black mortality was lower than that of the white population (13–15). Other researchers also have shown that the black population has higher levels of ill health than the white population. This difference persists even after controlling for income and education (16). In this section, racial group disparities in health outcomes will be analyzed using different aspects of HLE, including years of life in good or better health; expected years without limitation in major activity; expected years without activities of daily living; and expected years with a BMI less than 30.

3.3.1 Expected years in good or better health for the white and black populations

To assess the disparities in self-rated health between the black and white populations of the United States in 1995, the percent in good or better health by 5-year age groups and race were calculated using the 1995 NHIS data. The results are presented in figure 3.11. Life tables were constructed for the two groups separately by sex and expected years in good or better health were computed. The expected years in good or better health at selected ages are presented in table 3.8. In 1995, a newly born white baby could expect to live 76.6 years (73.7 years for a white male baby and 79.5 years for a white female baby). In contrast, a newly born black baby could expect to live 69.7 years (65.4 for a black male baby and 73.9 years for a black female baby). This implies a difference of nearly 7 years (8 years for males and about 5.5 years for females) between the life expectancies of babies of the two races. Though the difference between the races tends to decline with age, it persists into old age. At age 65, for example, on average, the white population could expect to live 17.6 years (16 years for white males and 18.9 years for females), while the black population could expect to live only 9 years (8.4 years for black males and 9.6 years for black females).

A white baby born in 1995 could expect to spend 67.8 years (88.5 percent of life expectancy) in good or better health versus only 56.9 years (81.6 percent of life expectancy) for a black baby born the same year. The difference in life with good or better health between the two babies was nearly 11 years. The racial disparities in life with good or better health declined with age, as did the difference in life expectancies. At age 65, for example, the racial disparity in life in good or better health was only 3.6 years.

Racial disparities in life with good or better health were slightly larger between females than between males of the two races. A white baby girl born in 1995 could expect to spend 11.4 more years in good or better health than a black baby girl born the same year. At age 65, a white female could expect to spend 13.8 years (72.9 percent of her life expectancy) in good or better health compared to a 65-year-old black female who could expect 9.6 years (55.9 percent of her life expectancy) in good or better health. A white male baby born in 1995 could expect to live 65.7 years (89.2 percent of his life) in good or better health. A black male baby, on the other hand, could expect to spend 55.3 years (84.5 percent of his life expectancy) in good or better health. At age 65, a white male expected to spend 11.4 more years of his life in good or better health, while a black male of the same age expected to spend 8.4 years of his remaining life in good or better health. Expected life in good or better health at age 65 was 71.3 percent of life

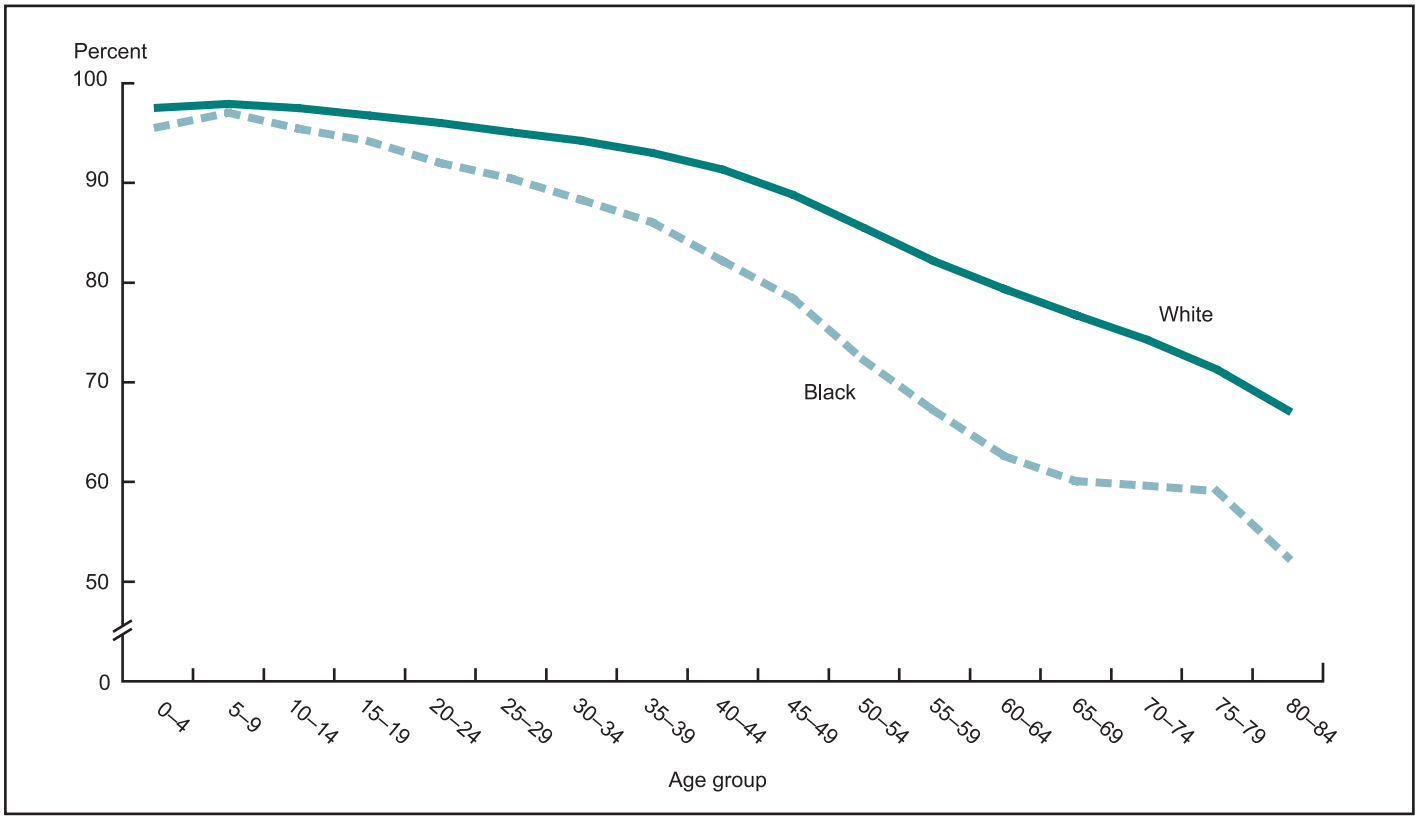

Figure 3.11. Percentage in good or better health, by age and race: United States, 1995

expectancy for a white male; yet, it was only 60.1 percent for a 65-year-old black male.

The last two columns of the table show the racial differences both in life expectancy and expected years in good or better health. For males as well as females, the difference in years in good or better health is larger than the difference in life expectancy. At any given age, the difference in life expectancy is larger between males than between females of the two races. On the other hand, the difference in years in good or better health is larger between females than between males of the two races. The difference between the white and black population in expected years with good or better health is statistically significant ($p<0.05$) at all ages, except between white and black females at age 80.

3.3.2 Expected years without any activity limitation for the white and black populations

Figure 3.12 presents the percent of those who were free of any type of activity limitation by age and race. The percent of the population free of any activity limitation falls with age for both racial groups. Age-specific prevalence rates were combined with life table person-years lived to estimate expected years free of activity limitation. The expected years without limitation in any activity are presented in table 3.9. In 1995, the white and black populations could expect to spend a larger share of their remaining lives free of any activity limitation. As expected, life free of activity limitation as a percent of life expectancy declined with age for males as well as females of both races. In 1995, a 20-year-old white male could expect to spend 43.7 years (nearly 80 percent of his remaining life) without any activity limitation. A 20-year-old black male, in contrast, could expect to spend 36.2 years (about 76 percent of his remaining life) free of any activity limitation. At age 65, the expected years free of any activity limitation declined to 62.6 percent of life expectancy for white males and 58.1 percent of life expectancy for black males.

On average, a 20-year-old white female could expect to live 47 more years (nearly 78 percent of her life expectancy) free of any activity limitation. A white female of age 65 could expect to live 11.6 more years (61.4 percent of her life expectancy) without any activity limitation. A 20-year-old black female could expect to live about 40 more years (72.5 percent of life expectancy) free of activity limitation, whereas a 65-year-old black female could expect to live 8.6 more years (about half of her life expectancy) free of any activity limitation. The difference between the white and black populations in expected years without any activity limitation is statistically significant ($p<0.05$) at all ages, except at 75 years of age and over for males and at 80 years of age and over for females.

As indicated in the last two columns of table 3.9, at any given age, the difference in life expectancy between white and black males is almost the same as the difference in expected life free of any activity limitation. At older ages

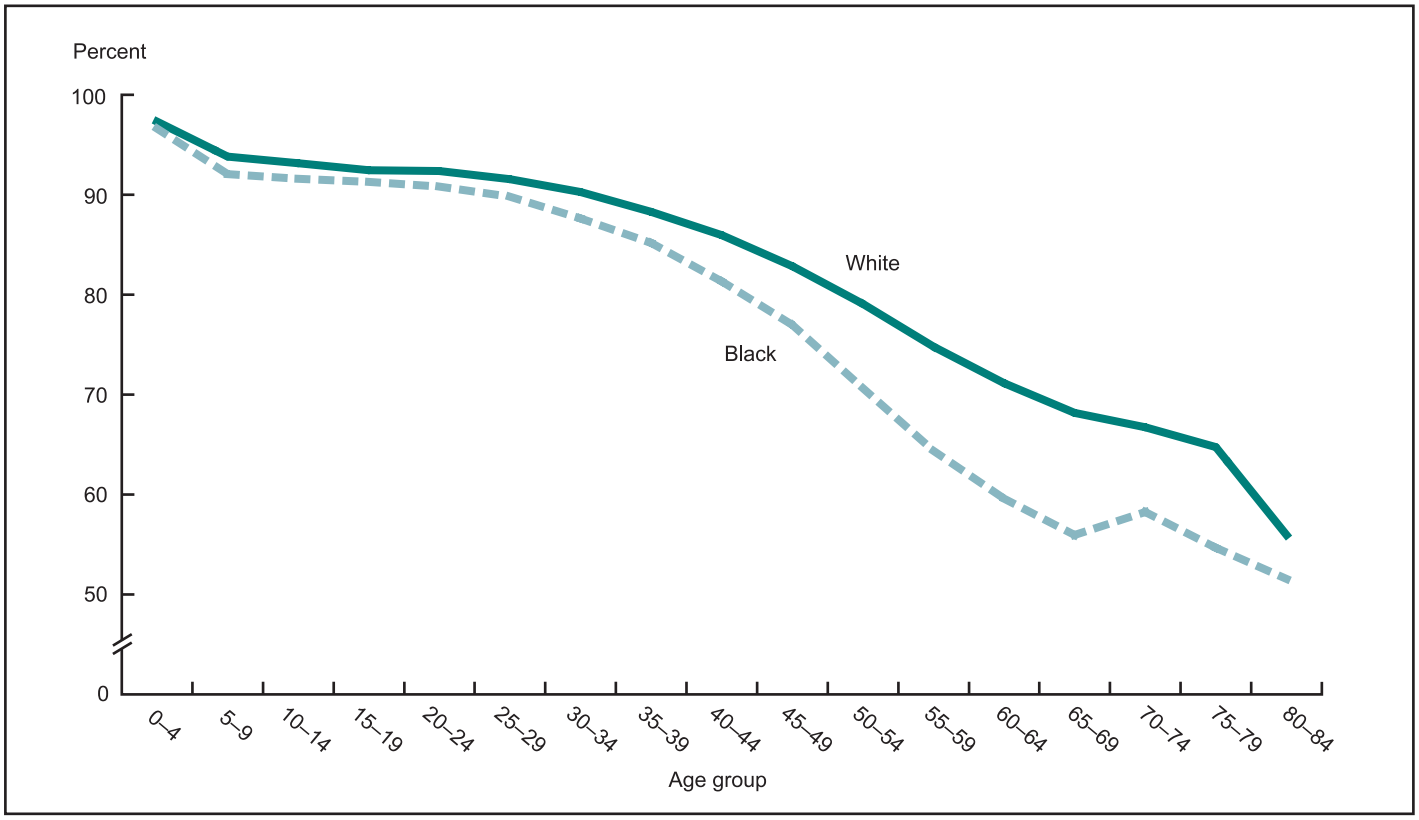

Figure 3.12. Percentage free of any type of activity limitation, by age and race: United States, 1995

(70 years and older), the difference in life expectancy without activity limitation is actually less than the difference in overall life expectancy; this indicates that black men have a greater proportion of life in a healthy state than white men. For females, at any given age, the difference in life expectancy between the races is smaller than the difference in life without activity limitation. Though females could expect to live more years (except after age 75 for the white population and after age 70 for the black population) free of activity limitation compared to males of the same age and race, males could expect to spend a greater share of their life expectancies free of any activity limitation.

3.3.3 Expected years without ADL or IADL limitation for the white and black populations

The 1995 NHIS data were used to calculate percent of the population able to perform personal care needs or not limited in other routine needs of daily living by 5-year age groups and race (figure 3.13). These results were used in combination with life table estimates of person-years lived to calculate expected years without ADL or IADL limitation. Table 3.10 presents expected years without limitation in ADL or other routine needs for the 1995 white and black population by sex. The table indicates that ADL or IADL limitation was strongly associated with old age. At the younger ages, males and females of both races would expect to live more than nine tenths of their lives free of ADL or IADL limitation.

At age 65, however, the share of life expected to be free of ADL or IADL limitation was about 87 percent for white males, 83 percent for black males, about 80 percent for white females, and slightly more than 72 percent for black females. At age 80, the corresponding percentages were about 75 for white males, 69 for black males, 63.5 for white females, and 53.5 for black females. At any given age, the racial difference in life expectancy for males is almost the same as the difference in life free of ADL or IADL limitation. For females, on the other hand, the racial difference in life free of ADL or IADL limitation was greater than the difference in life expectancy. The difference between white and black expected years without ADL or IADL limitation is significant ($p<0.05$) at all ages, except at 80 years of age and over for males and at 85 years of age and over for females. Also, at each age and within each race, males could expect to live a larger share of their lives free of any limitation than females.

3.3.4 Expected years with BMI less than 30 for the white and black populations

The percentage of the population aged 20 years and over that is not obese (BMI less than 30) by 5-year age groups and race was estimated using the 1994, 1995, and 1996 NHIS data, and the results are presented graphically in figure 3.14. Expected years with BMI less than 30 were also estimated using these distributions and estimates of person-years lived from a 1995 abridged life table. The

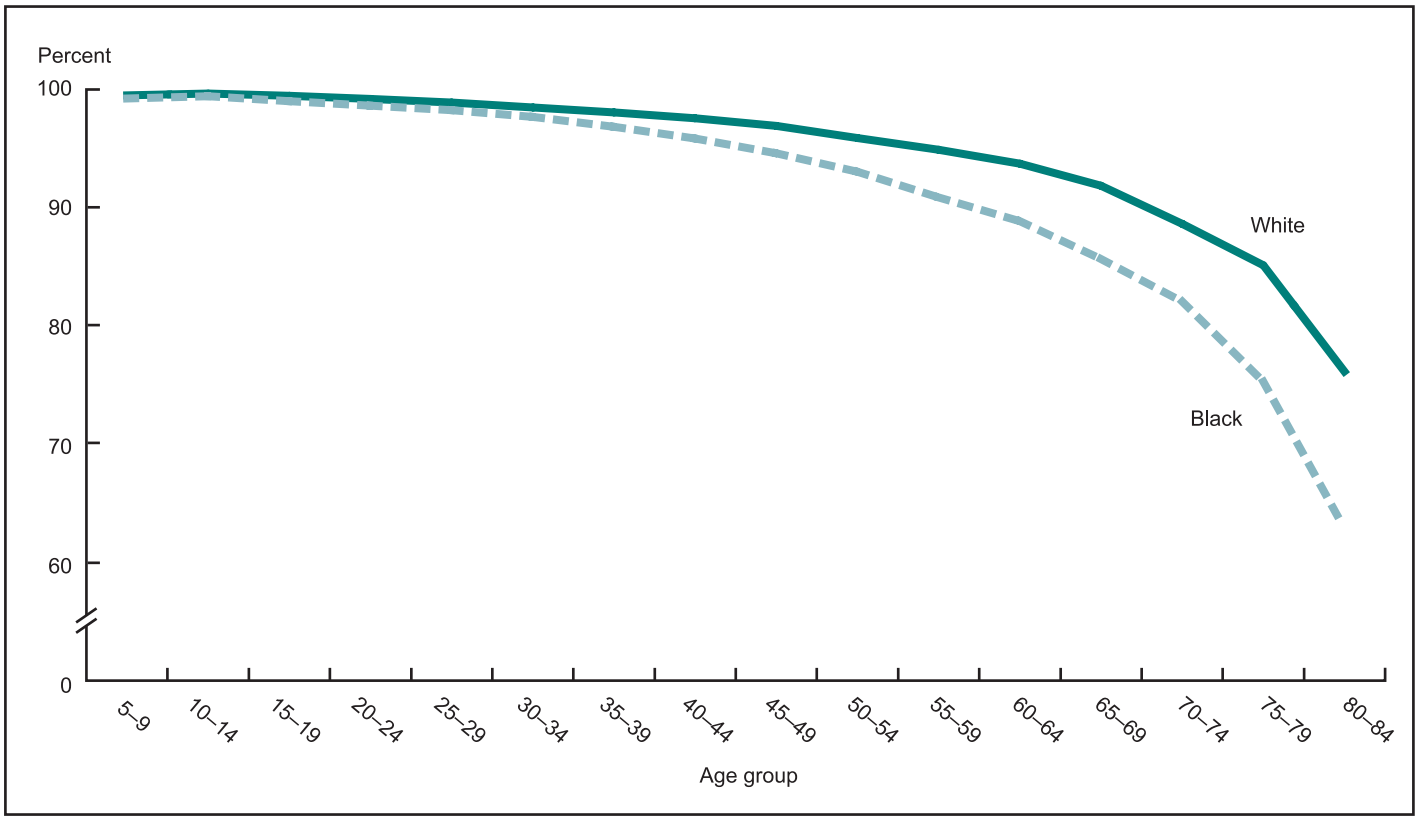

Figure 3.13. Percentage able to perform personal care needs or not limited in other routine needs, by age and race: United States, 1995

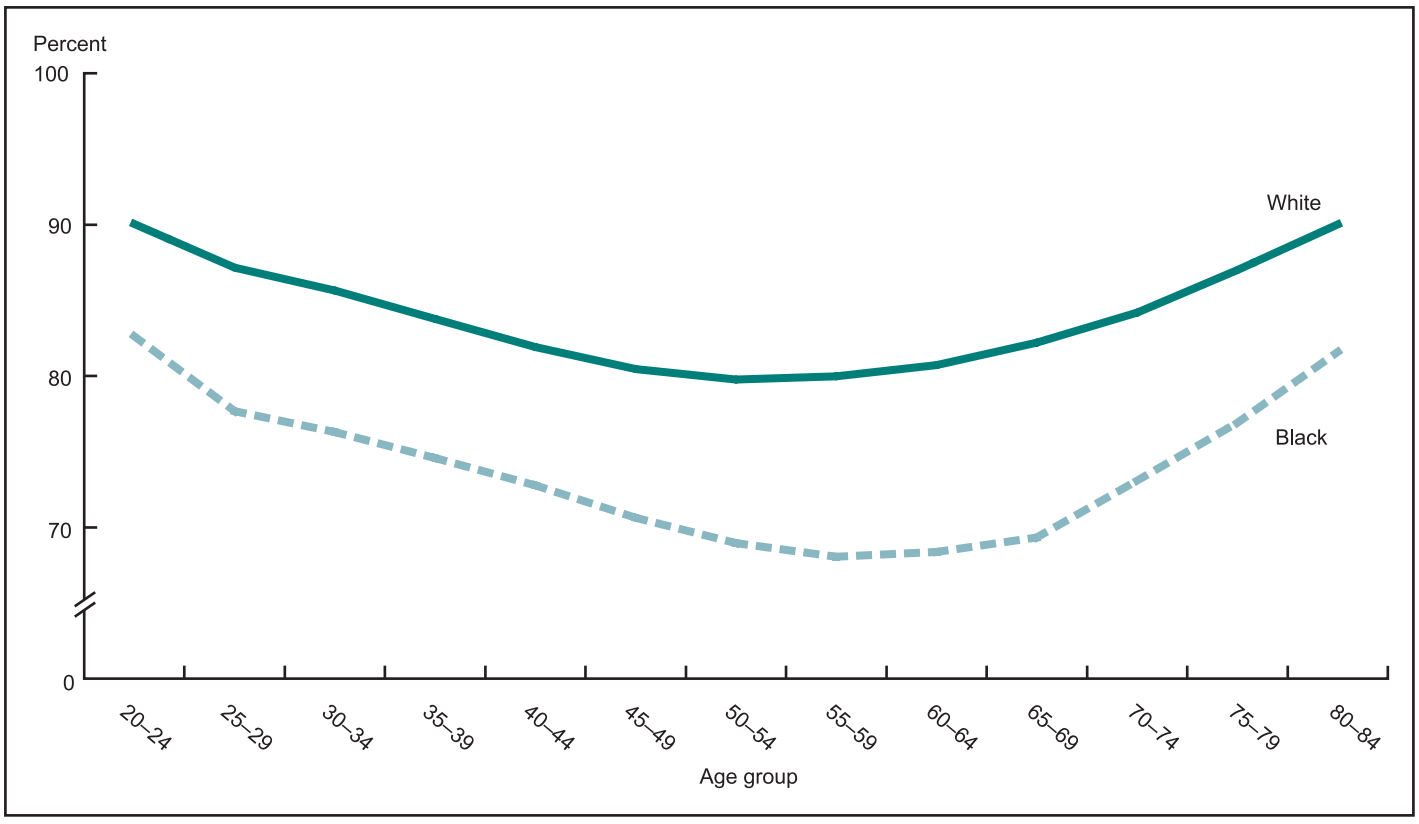

Figure 3.14. Percentage not obese, by age and race: United States, 1994–96

average number of expected years with BMI less than 30 at selected ages for the white and black populations are presented in table 3.11. At any age, on average, the white population could expect to spend a greater percentage of their lives with BMI less than 30 than the black population. At age 20, for example, the percentage of life expectancy that was expected to be with BMI less than 30 was 83.9 for the white population of both sexes and 73.8 for the black population. At age 65, the percentages rose slightly to 86.2 for the white population and to 74.8 percent for the black population.

On average, the percentage of remaining life that was expected to be with BMI less than 30 for white males was 83.6 at age 20, 87.8 at age 65, and 94 at age 80. For black males, it was 79.5 at age 20, 84.1 at age 65, and 94.3 at age 80. For white females, on average, the percentage of remaining life that was expected to be with BMI less than 30 was 84.3 at age 20, about 85 at age 65, and 90.5 at age 80. For black females, the corresponding percentages were 69.3 at age 20, 69 percent at age 65, and about 80 percent at age 80.

At any age, the difference between white and black males in expected years with BMI less than 30 was about the same as the difference in life expectancy. On the other hand, the difference between white and black females in average expected years with BMI less than 30 was almost three times larger than the difference in their expectation of life. The difference between the white and black populations in expected years with BMI less than 30 is statistically significant ($p<0.05$) at all ages, except at 85 years of age and over for males.

3.4 Comparison of Results from the Various Measures of Health

Estimates of healthy life expectancy under various definitions of health were provided in sections 3.2 and 3.3. The main purpose of providing these results was to illustrate the application of the method and interpretation of the results. A second, even more important purpose of estimating healthy life expectancies under the various definitions of health was to analyze the variation of the results across the measures. Analyzing the results across the measures is important because the magnitude and pattern of the variation across measures provide answers to health-related questions with important policy implications.

This section presents a comparison of the results across measures. Results across measures will be compared first for the adult population at 30 and 65 years of age. This will be followed by a comparison of the results at age 65 for males and females separately. Results will also be compared across measures by sex and age, followed by race and age. Measures used for the comparison include expected life

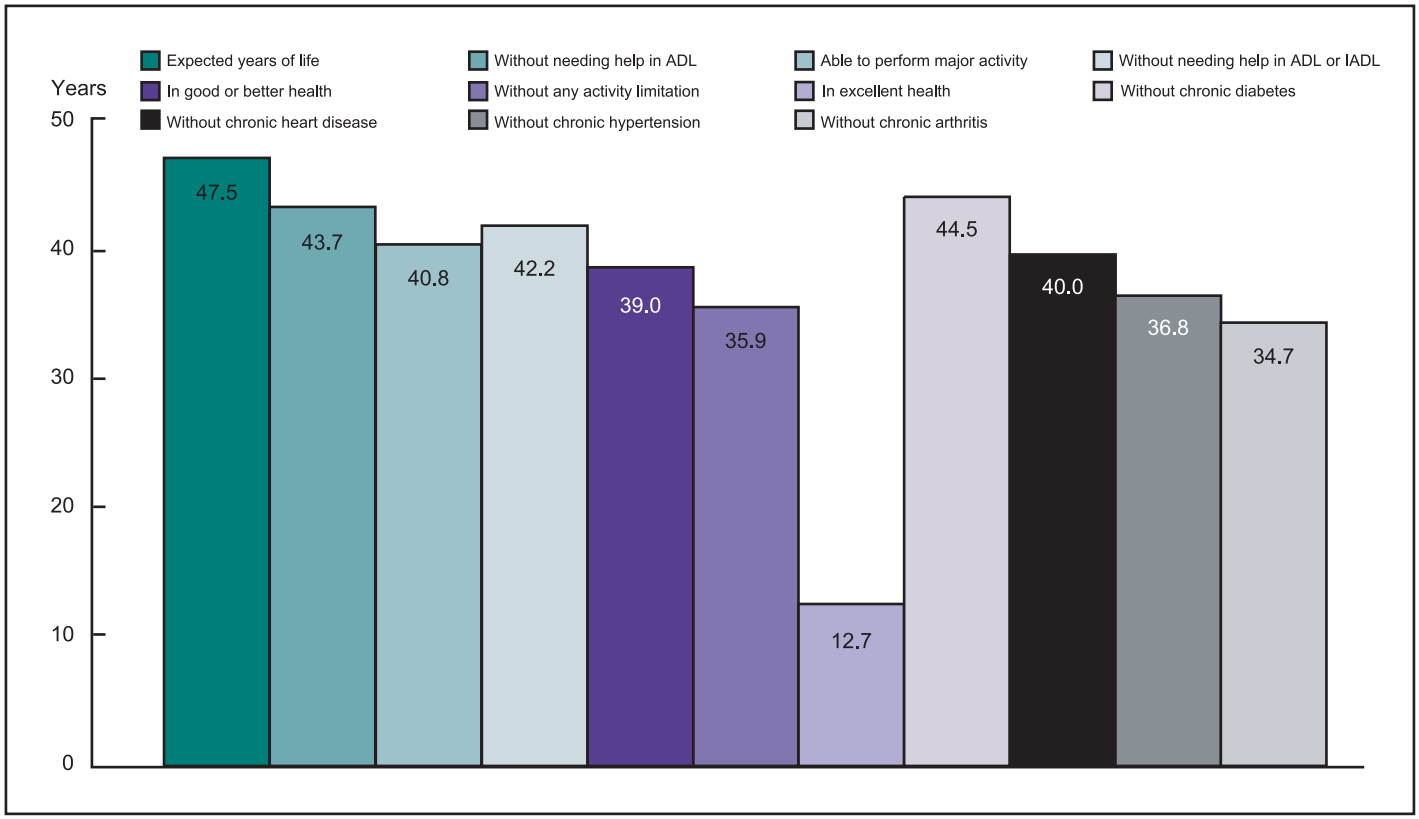

Figure 3.15. Life expectancy and expected years of healthy life under different definitions of health at 30 years of age, both sexes: United States, 1995

NOTE: ADL refers to activities of daily living; IADL refers to instrumental activities of daily living.

without the need for help in ADL (also ADL or IADL); years able to perform major activities; years without any activity limitation; years in good or better health; and years in excellent health. Also included are expected years without chronic diabetes, heart disease, hypertension, and arthritis.

3.4.1 Comparison across measures at 30 and 65 years of age

Life expectancies and expected years of healthy life for the total population at 30 and 65 years of age are presented in table 3.12 and figures 3.15 and 3.16. In 1995, on average, a 35-year-old would expect to live 47.5 more years. Regardless of the health measure used, most of the remaining years of life were expected to be healthy. On the other hand, the number of years of healthy life varied by type of measure used. The expected number of years of healthy life was 44.5 years (nearly 94 percent of life expectancy at age 30) when measured in terms of expected years without the need for help in ADL, while it was 34.7 years (73.1 percent of life expectancy) when measured in terms of years free of chronic arthritis. Expected years of healthy life at age 30 based on self-assessed health (good or better) was 39 years (82.1 percent of life expectancy).

3.4.2 Comparison across measures for males and females at 65 years of age

In 1995, 65-year-old males could expect to live an additional 15.9 years, and females could expect to live 18.8 years (table 3.13 and figures 3.17 and 3.18). At 65, males could also expect to perform their major activities for nearly 89 percent of their remaining years. They could expect to spend more than 70 percent of their life expectancy in good or better health and only spend 5.7 years of their life expectancy with heart disease. They would not expect to need the help of another person in carrying out their ADL or IADL.

At age 65, females could expect to live 18.8 more years. According to almost all the health measures used (with the exception of expected years with chronic arthritis), more than half of their life expectancy would be spent in healthy life. On average, they could expect to spend 13.4 years (71.3 percent of life expectancy) in good or better health and could expect to be able to perform their major activities for 16.8 years. They would not expect to need the help of another person in the course of their ADL for 92 percent of their remaining years. On the other hand, they could expect to spend 10.4 (55.3 percent) years of their life expectancy with chronic arthritis.

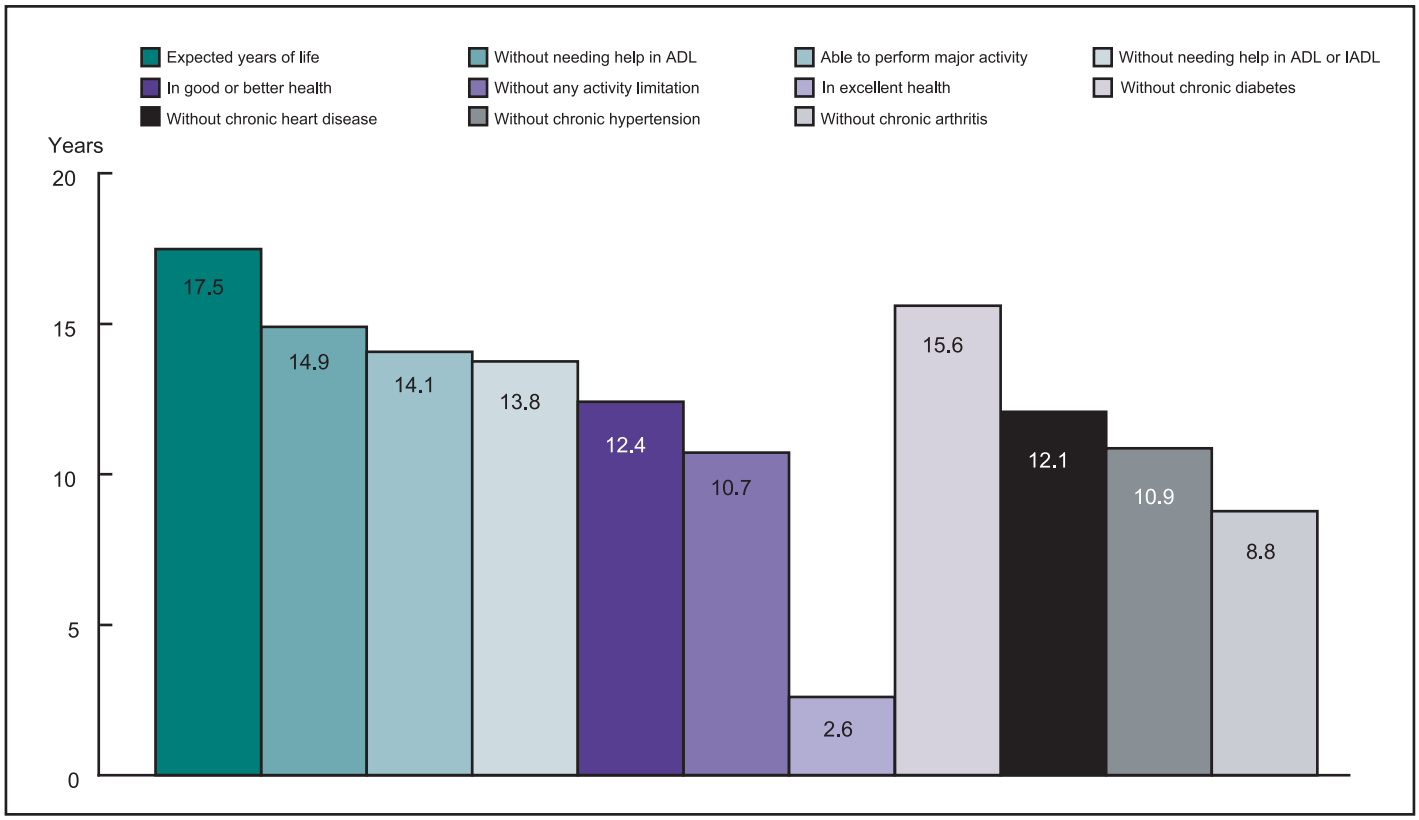

Figure 3.16. Life expectancy and expected years of healthy life under different definitions of health at 65 years of age, both sexes: United States, 1995

NOTE: ADL refers to activities of daily living; IADL refers to instrumental activities of daily living.

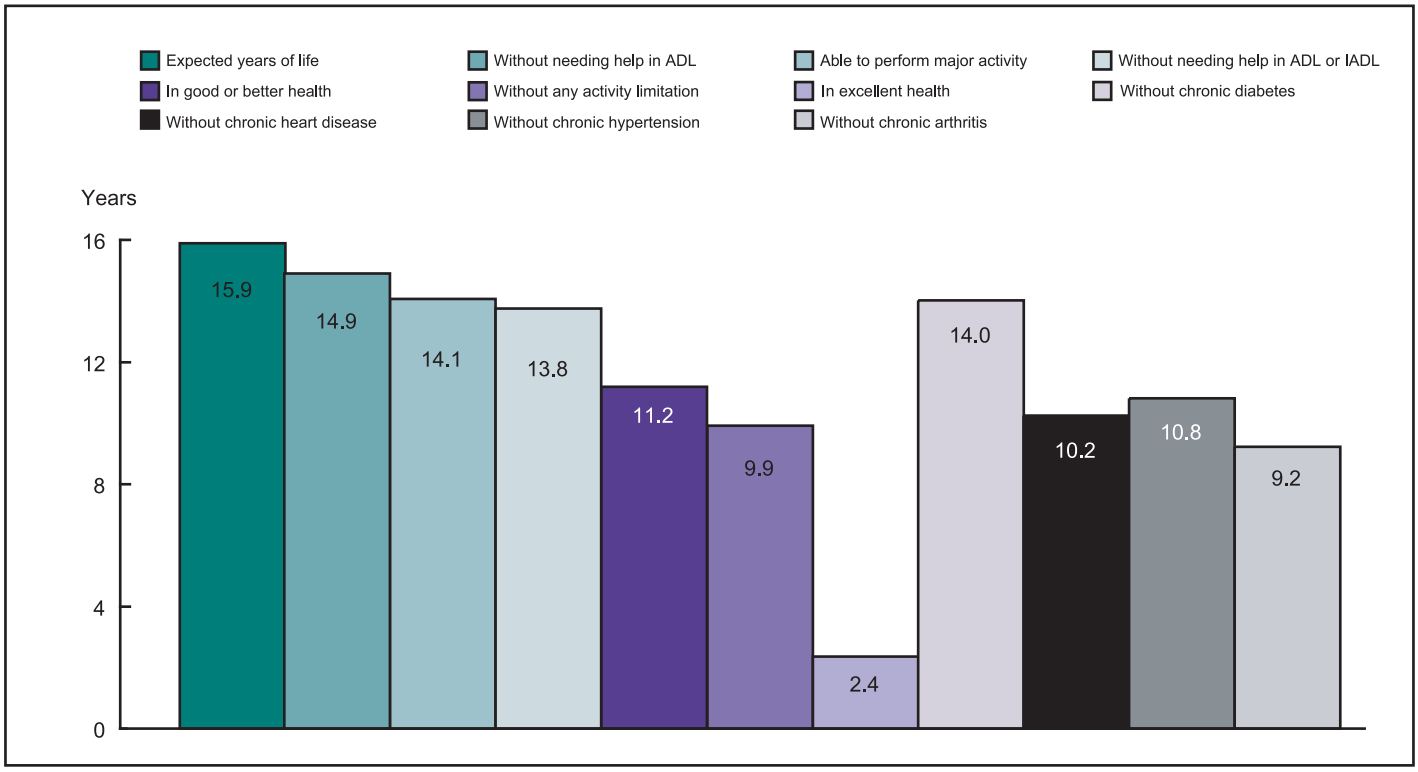

Figure 3.17. Life expectancy and expected years of healthy life for males under different definitions of health at 65 years of age: United States, 1995

NOTE: ADL refers to activities of daily living; IADL refers to instrumental activities of daily living.

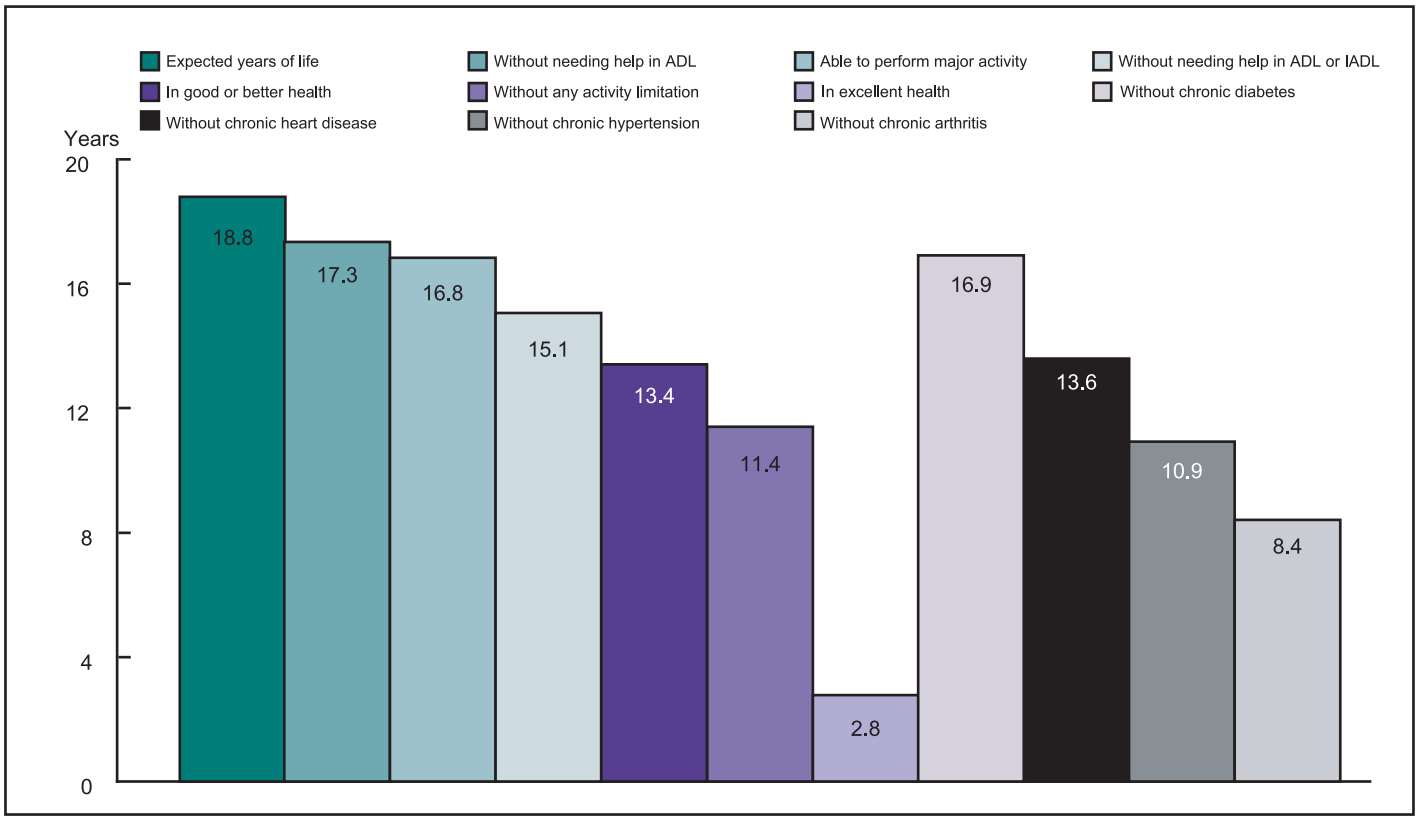

Figure 3.18. Life expectancy and expected years of healthy life for females under different definitions of health at 65 years of age: United States, 1995

NOTE: ADL refers to activities of daily living; IADL refers to instrumental activities of daily living.

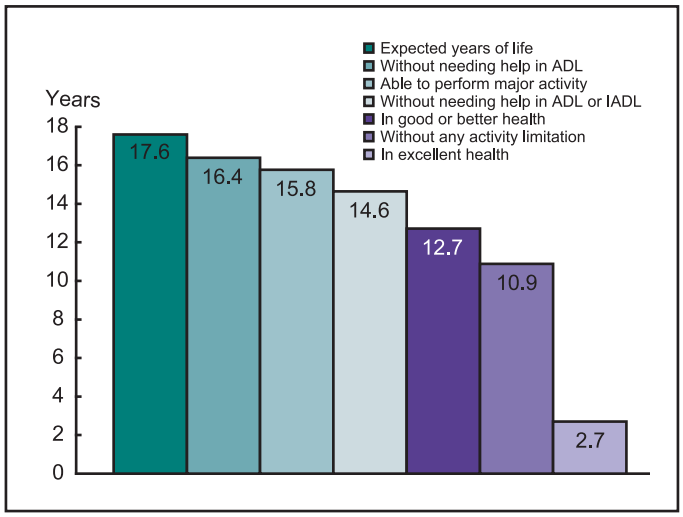

Figure 3.19. Life expectancy and expected years of healthy life for the white population under different definitions of health at 65 years of age: United States, 1995

NOTE: ADL refers to activities of daily living; IADL refers to instrumental activities of daily living.

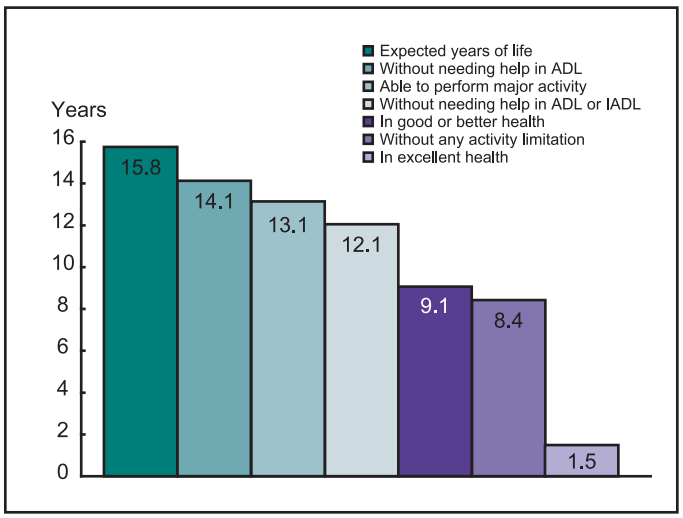

Figure 3.20. Life expectancy and expected years of healthy life for the black population under different definitions of health at 65 years of age: United States, 1995

NOTE: ADL refers to activities of daily living; IADL refers to instrumental activities of daily living.

3.4.3 Comparison across measures for the white and black populations at 65 years of age

In 1995, life expectancy at age 65 was 17.6 years for the white population and 15.8 years for the black population. Table 3.14 and figures 3.19 and 3.20 present HLE at age 65 for each race using six different definitions of health. For each race the expected years of healthy life at age 65 varied by health measure. The white population could expect to live 12.7 years (72.2 percent of life expectancy at age 65) in good or better health and 10.9 years (almost 62 percent of average life expectancy at age 65) without any activity limitation. The black population could expect to spend 9.1 years of the total life expectancy of 15.5 years in good or better health.

3.4.4 Comparison across measures by age, sex, and race

Expected years of healthy life varied by measure even when controlling for age, sex, and race. This is expected because the health state definition used in each measure was based on different dimensions of health. The observed variations in the results are important because, in addition to shedding some light on the within- and across-group variations in health, these variations are also indicative of the absolute necessity to use multiple measures to assess the various dimensions of population health.

Age-specific health disparities between males and females estimated using six measures including life expectancy are presented in figure 3.21, and age-specific health disparities between the white and the black population estimated using the same six measures are presented in figure 3.22. Figure 3.21 shows the age-specific ratios of female and male HLEs. At a given age, a ratio in excess of 1 implies a higher female life expectancy compared to that of males; a ratio less than 1 indicates a higher life expectancy for males compared to that of females of the same age. Figure 3.22 depicts the ratio of health expectancy for the white population (and life expectancy) compared to that for the black population. Holding age constant, a ratio in excess of 1 implies a higher health expectancy for the white population compared to that of the black population.

Figure 3.21 shows that health disparities between males and females varied by measure. The implied variations are smaller at the younger ages and much larger at the older ages. The smallest health disparities between males and females are observed when the health measure used is "expected years without needing help in ADL or IADL." The largest disparities were observed when health is measured using ability to perform major activity at younger and middle ages; at the older ages, the largest disparities were observed when health is measured using expected years in good or better health. All measures implied higher female healthy life expectancy (and life expectancy) at all ages except expected years without needing help in ADL or IADL and expected years without any limitation, both at age 80.

The differences in expectation of life and HLE between the white and black population by type of measure are presented in figure 3.22. The health disparity pattern between the two races is different from the health disparity pattern between males and females (figure 3.21). Health disparities by measure varied more between races than between sexes. The disparity between the white and the black population is lowest when measured by life expectancy. Conversely, life expectancy was one of the two measures that implied the largest health disparities between males and females at almost every age.

The six measures have clearly shown that using different health measures result in different patterns and magnitudes

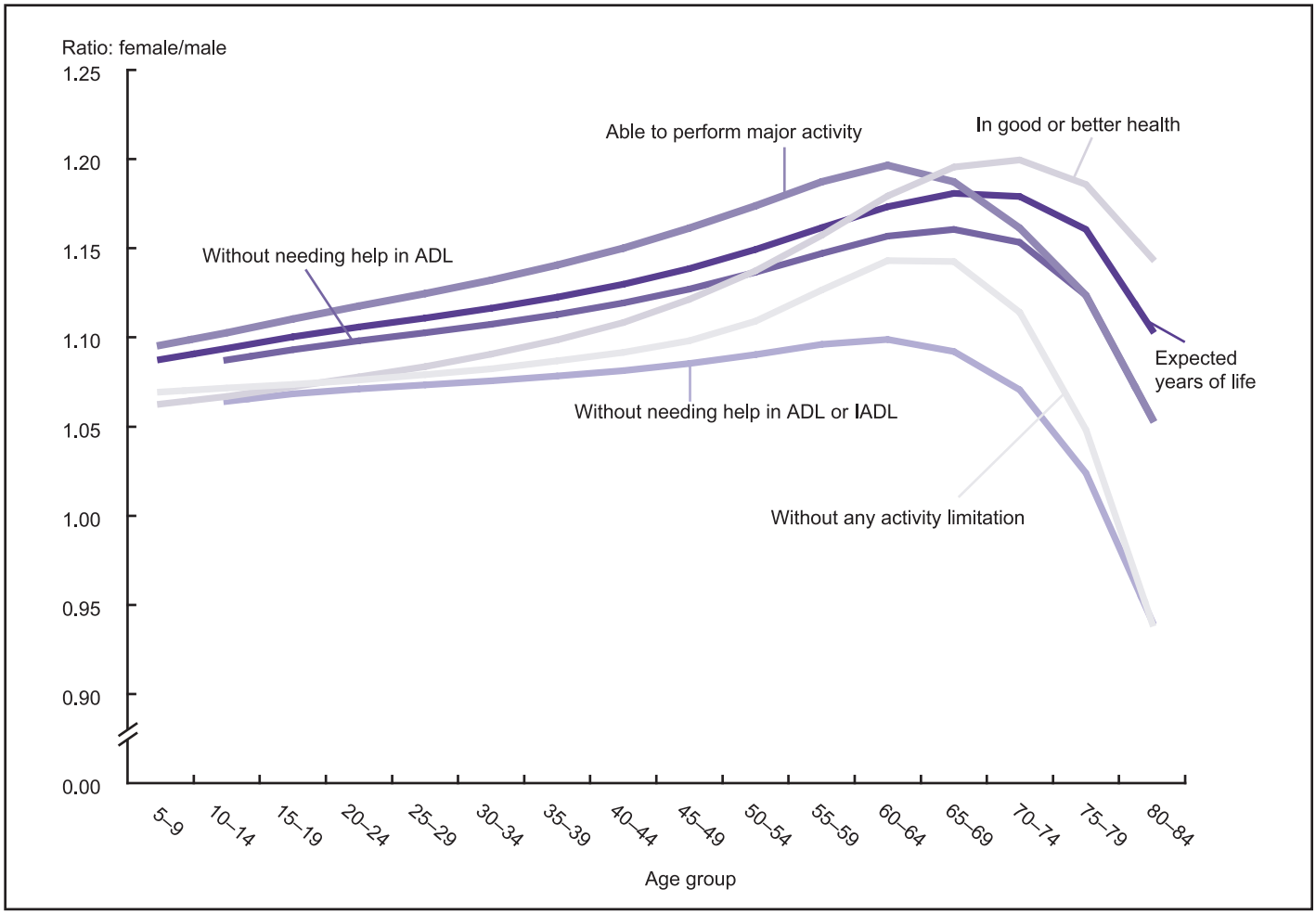

Figure 3.21. Sex disparities in health under various definitions of health status, by age: United States, 1995

of health disparities between population groups. While part of the variations in health disparities result from the difference in the measure used, part of the observed variation might have resulted from other factors exogenous to the health measure used. In addition to the different methods used, HLE estimates are affected by the health data used in their estimation. Healthy life expectancy for all measures was estimated using data from NHIS, a survey which does not include data on the institutionalized population. To the extent that the age, sex, racial composition, and health status of the institutional population is different from that of the noninstitutionalized civilian population (which NHIS covers), estimated HLEs would be expected to be biased differently by age, sex, and race. Male and female expected years without any activity limitation will be used to illustrate the pattern and magnitude of bias that could be introduced by not including the nursing home population in the estimation of the prevalence of activity limitation.

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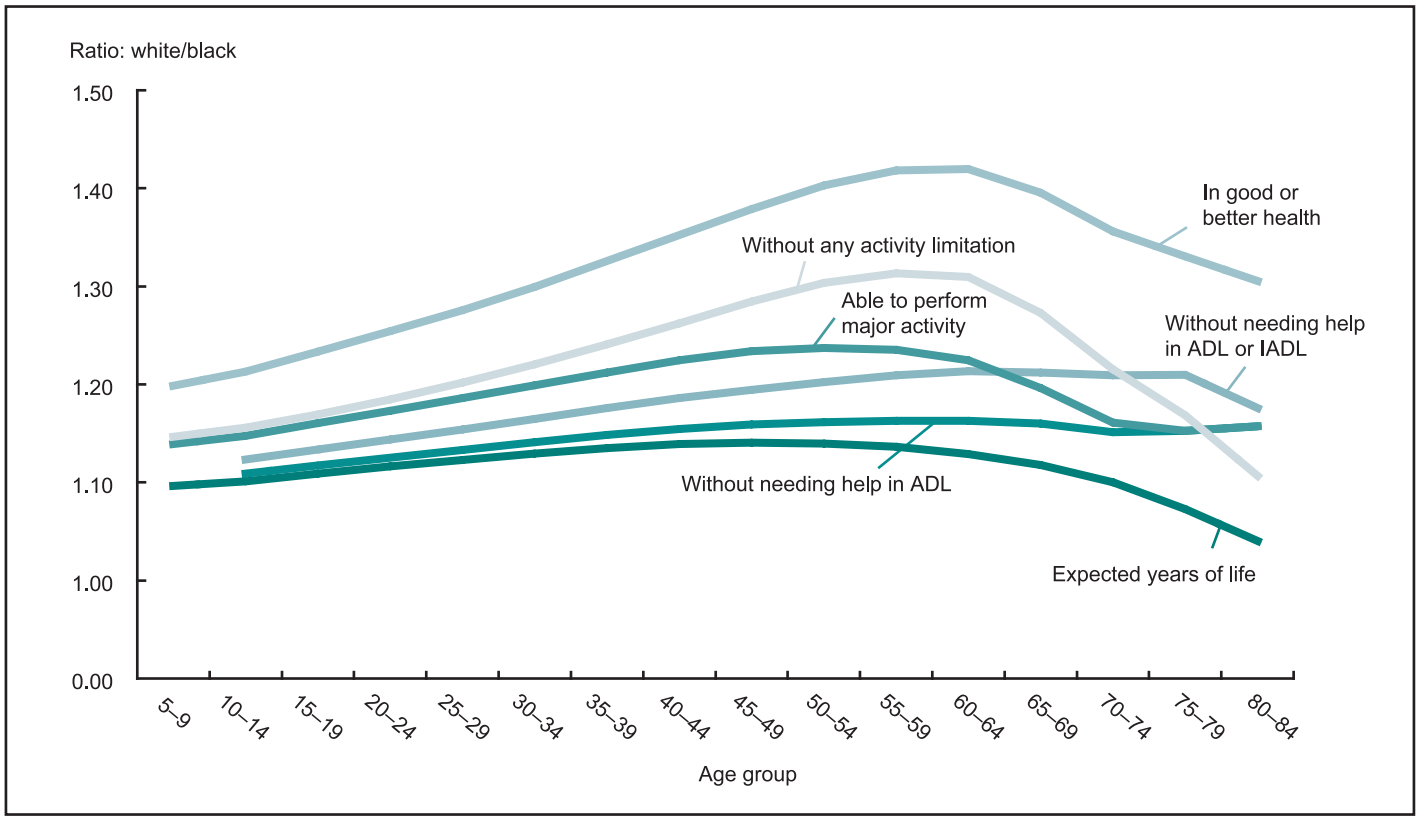

Figure 3.22. Racial disparities in health between white and black populations under various definitions of health status, by age: United States, 1995

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Table 3.1. Life expectancies and expected years in good or better health and excellent health for selected ages, by sex: United States, 1995

Sex and age	Expected years of life	Expected years in good or better health	Years in good or better health as a % of life expectancy	Expected years in excellent health	Years in excellent health as a % of life expectancy
Both sexes					
Birth	75.8	66.5	87.7	26.4	34.8
20 years	56.9	48.0	84.3	16.5	29.0
30 years	47.5	39.0	82.1	12.7	26.6
45 years	33.8	26.2	77.5	7.3	21.7
65 years	17.5	12.4	71.0	2.6	14.9
70 years	14.1	9.8	69.7	2.0	13.9
75 years	11.1	7.4	67.4	1.4	13.1
80 years	8.3	5.4	65.3	1.1	13.0
Male					
Birth	72.8	64.6	88.7	27.1	37.3
20 years	54.0	46.2	85.5	17.2	31.9
30 years	44.9	37.3	83.1	13.0	29.0
45 years	31.5	24.6	78.1	7.4	23.3
65 years	15.9	11.2	70.4	2.4	14.9
70 years	12.8	8.8	68.9	1.7	13.6
75 years	10.1	6.7	66.5	1.2	11.8
80 years	7.7	4.9	64.2	0.8	10.8
Female					
Birth	78.8	68.4	86.8	25.7	32.6
20 years	59.8	49.8	83.3	15.8	26.4
30 years	50.1	40.6	81.2	12.3	24.6
45 years	35.9	27.6	76.9	7.3	20.2
65 years	18.8	13.4	71.3	2.8	14.8
70 years	15.1	10.6	70.1	2.1	14.0
75 years	11.7	8.0	67.9	1.6	13.7
80 years	8.7	5.7	65.9	1.2	14.2
Gender difference[1]					
Birth	†6.1	†3.9	. . .	–1.4	. . .
20 years	†5.7	†3.6	. . .	–1.4	. . .
30 years	†5.2	†3.4	. . .	–0.7	. . .
45 years	†4.3	†3.0	. . .	–0.1	. . .
65 years	†2.9	†2.2	. . .	0.4	. . .
70 years	†2.3	†1.8	. . .	0.4	. . .
75 years	†1.7	†1.3	. . .	0.4	. . .
80 years	†1.0	†0.8	. . .	0.4	. . .

†Statistically significant ($p<0.05$).

. . . Category not applicable.

[1]Calculated by subtracting expected years for males from expected years for females.

SOURCES: Estimated based on data from the Division of Vital Statistics, National Health Interview Surveys, National Center for Health Statistics; and the U.S. Census Bureau.

Table 3.2. Life expectancies and expected years without limitation in activity for selected ages, by sex and type of activity: United States, 1995

Sex and age	Expected years of life	Expected years without major activity limitation	Years without major activity limitation as a % of life expectancy	Expected years without any activity limitation	Years without any activity limitation as a % of life expectancy
Both sexes					
Birth	75.8	71.6	94.4	62.5	82.5
20 years	56.9	52.8	92.7	44.7	78.5
30 years	47.5	43.5	91.6	35.9	75.5
45 years	33.8	30.3	89.5	23.6	69.8
65 years	17.5	15.6	89.1	10.7	61.3
70 years	14.1	12.9	91.3	8.5	60.4
75 years	11.1	9.8	88.7	6.1	55.5
80 years	8.3	7.1	85.1	4.1	49.7
Male					
Birth	72.8	68.5	94.1	60.5	83.2
20 years	54.0	49.8	92.2	43.0	79.6
30 years	44.9	40.8	90.9	34.4	76.8
45 years	31.5	27.9	88.6	22.5	71.2
65 years	15.9	14.1	88.6	9.9	62.4
70 years	12.8	11.8	92.6	8.0	62.4
75 years	10.1	9.1	90.2	5.9	58.9
80 years	7.7	6.8	88.1	4.3	55.4
Female					
Birth	78.8	74.7	94.7	64.6	81.9
20 years	59.8	55.7	93.1	46.3	77.5
30 years	50.1	46.1	92.2	37.3	74.4
45 years	35.9	32.4	90.3	24.6	68.6
65 years	18.8	16.8	89.5	11.4	60.6
70 years	15.1	13.7	90.5	8.9	59.2
75 years	11.7	10.3	87.8	6.3	53.6
80 years	8.7	7.2	83.4	4.0	46.6
Gender difference[1]					
Birth	†6.1	†6.2	. . .	†4.0	. . .
20 years	†5.7	†5.9	. . .	†3.3	. . .
30 years	†5.2	†5.4	. . .	†2.8	. . .
45 years	†4.3	†4.5	. . .	†2.2	. . .
65 years	†2.9	†2.8	. . .	†1.5	. . .
70 years	†2.3	†1.8	. . .	†1.0	. . .
75 years	†1.7	†1.2	. . .	†0.4	. . .
80 years	†1.0	†0.4	. . .	–0.2	. . .

†Statistically significant ($p<0.05$).

. . . Category not applicable.

[1]Calculated by subtracting expected years for males from expected years for females.

SOURCES: Estimated based on data from the Division of Vital Statistics, National Health Interview Surveys, National Center for Health Statistics; and the U.S. Census Bureau.

Table 3.3. Life expectancies and expected years without work limitation for selected ages, by sex: United States, 1995

Sex and age	Expected years of life	Expected years able to work	Years able to work as a % of life expectancy	Expected years without work limitation	Years without work limitation as a % of life expectancy
Both sexes					
20 years	56.9	53.1	93.4	50.7	89.1
30 years	47.5	43.9	92.4	41.8	87.9
45 years	33.8	30.8	91.0	29.2	86.3
65 years	17.5	16.5	94.6	16.1	92.3
20 to 69 years	42.8	39.0	91.2	36.6	85.5
Male					
20 years	54.0	50.3	93.1	47.9	88.7
30 years	44.9	41.3	92.1	39.2	87.3
45 years	31.5	28.5	90.4	26.9	85.5
65 years	15.9	14.9	93.6	14.4	90.7
20 to 69 years	41.2	37.5	91.0	35.1	85.2
Female					
20 years	59.8	55.9	93.6	53.5	89.5
30 years	50.1	46.4	92.8	44.3	88.4
45 years	35.9	32.8	91.5	31.2	87.0
65 years	18.8	17.9	95.3	17.6	93.4
20 to 69 years	44.6	40.8	91.4	38.3	85.9
Gender difference[1]					
20 years	†5.7	†5.6	. . .	†5.5	. . .
30 years	†5.2	†5.2	. . .	†5.1	. . .
45 years	†4.3	†4.3	. . .	†4.3	. . .
65 years	†3.0	†3.0	. . .	†3.2	. . .

†Statistically significant ($p<0.05$).

. . . Category not applicable.

[1]Calculated by subtracting expected years for males from expected years for females.

SOURCES: Estimated based on data from the Division of Vital Statistics, National Health Interview Surveys, National Center for Health Statistics; and the U.S. Census Bureau.

Table 3.4. Life expectancies and expected years without functional dependency for selected ages, by sex: United States, 1995

Sex and age	Expected years of life	Expected years without needing help in ADL[1]	Years without ADL help as a % of life expectancy[1]	Expected years without needing help in ADL or IADL[1–2]	Years without ADL or IADL help as a % of life expectancy[1–2]
Both sexes					
5 years	71.5	70.1	98.0	67.8	94.7
20 years	56.9	55.5	97.5	53.2	93.4
30 years	47.5	46.1	97.1	43.8	92.3
45 years	33.8	32.4	96.0	30.3	89.7
65 years	17.5	16.2	92.8	14.5	82.7
70 years	14.1	12.9	91.3	11.2	79.3
75 years	11.1	9.8	88.7	8.2	73.9
80 years	8.3	7.1	85.1	5.5	66.8
Male					
5 years	68.5	67.3	98.2	65.8	96.0
20 years	54.0	52.9	97.9	51.3	95.1
30 years	44.9	43.7	97.5	42.2	94.1
45 years	31.5	30.4	96.5	29.0	92.1
65 years	15.9	14.9	93.8	13.8	86.5
70 years	12.8	11.8	92.6	10.7	83.9
75 years	10.1	9.1	90.2	8.0	79.6
80 years	7.7	6.8	88.1	5.7	74.4
Female					
5 years	74.5	72.8	97.7	69.7	93.6
20 years	59.8	58.1	97.2	55.0	92.1
30 years	50.1	48.4	96.7	45.4	90.7
45 years	35.9	34.3	95.6	31.5	87.8
65 years	18.8	17.3	92.2	15.1	80.1
70 years	15.1	13.7	90.5	11.5	76.3
75 years	11.7	10.3	87.8	8.3	70.6
80 years	8.7	7.2	83.4	5.4	62.8
Gender difference[3]					
Birth	†6.1	†5.5	. . .	†3.9	. . .
20 years	†5.7	†5.2	. . .	†3.7	. . .
30 years	†5.2	†4.7	. . .	†3.2	. . .
45 years	†4.3	†3.9	. . .	†2.5	. . .
65 years	†2.9	†2.4	. . .	†1.3	. . .
70 years	†2.3	†1.8	. . .	†0.8	. . .
75 years	†1.7	†1.2	. . .	†0.3	. . .
80 years	†1.0	†0.4	. . .	–0.3	. . .

†Statistically significant ($p<0.05$).

. . . Category not applicable.

[1]ADL refers to activities of daily living.

[2]IADL refers to instrumental activities of daily living.

[3]Calculated by subtracting expected years for males from expected years for females.

SOURCES: Estimated based on data from the Division of Vital Statistics, National Health Interview Surveys, National Center for Health Statistics; and the U.S. Census Bureau.

Table 3.5. Life expectancies and expected years without chronic arthritis and chronic heart diseases for selected ages, by sex: United States, 1994–96

Sex and age	Expected years of life	Expected years without chronic arthritis	Years without chronic arthritis as a % of life expectancy	Expected years without chronic heart diseases	Years without chronic heart diseases as a % of life expectancy
Both sexes					
30 years	47.5	34.7	73.0	40.0	84.1
45 years	33.8	21.6	63.9	26.7	79.0
65 years	17.5	8.8	50.2	12.1	69.1
70 years	14.1	6.8	48.2	9.4	66.5
75 years	11.1	5.1	46.1	7.1	64.2
80 years	8.3	3.8	45.9	5.3	64.1
Male					
30 years	44.9	35.4	78.8	37.1	82.8
45 years	31.5	22.5	71.3	24.0	76.1
65 years	15.9	9.2	58.1	10.2	64.5
70 years	12.8	7.1	55.6	7.7	60.6
75 years	10.1	5.7	56.2	5.8	57.6
80 years	7.7	4.2	54.0	4.5	58.8
Female					
30 years	50.1	34.0	68.0	42.7	85.3
45 years	35.9	20.8	57.9	29.2	81.3
65 years	18.8	8.4	44.8	13.6	72.3
70 years	15.1	6.6	43.6	10.6	70.4
75 years	11.7	4.7	40.1	8.0	68.1
80 years	8.7	3.6	41.6	5.8	67.0
Gender difference[1]					
30 years	†5.2	†–1.3	. . .	†5.6	. . .
45 years	†4.3	†–1.7	. . .	†5.2	. . .
65 years	†2.9	†–0.8	. . .	†3.3	. . .
70 years	†2.3	†–0.5	. . .	†2.9	. . .
75 years	†1.7	†–0.9	. . .	†2.2	. . .
80 years	†1.0	†–0.6	. . .	†1.3	. . .

†Statistically significant ($p<0.05$).

. . . Category not applicable.

[1]Calculated by subtracting expected years for males from expected years for females.

SOURCES: Estimated based on data from the Division of Vital Statistics, National Health Interview Surveys, National Center for Health Statistics; and the U.S. Census Bureau.

Table 3.6. Life expectancies and expected years without chronic hypertension and chronic diabetes for selected ages, by sex: United States, 1994–96

Sex and age	Expected years of life	Expected years without chronic hypertension	Years without chronic hypertension as a % of life expectancy	Expected years without chronic diabetes	Years without chronic diabetes as a % of life expectancy
Both sexes					
30 years	47.5	36.8	77.4	44.5	93.7
45 years	33.8	23.8	70.3	30.9	91.6
65 years	17.5	10.9	62.1	15.6	89.3
70 years	14.1	8.5	60.4	12.6	89.1
75 years	11.1	6.7	60.6	9.9	89.6
80 years	8.3	5.3	63.5	7.6	91.7
Male					
30 years	44.9	35.7	79.5	42.0	93.7
45 years	31.5	23.0	73.1	28.8	91.3
65 years	15.9	10.8	68.0	14.0	88.3
70 years	12.8	8.6	67.6	11.2	88.0
75 years	10.1	6.9	68.7	8.9	88.2
80 years	7.7	5.6	72.3	6.9	89.3
Female					
30 years	50.1	37.9	75.7	46.9	93.6
45 years	35.9	24.5	68.2	32.9	91.8
65 years	18.8	10.9	58.1	16.9	89.9
70 years	15.1	8.5	55.9	13.6	89.8
75 years	11.7	6.6	55.9	10.6	90.5
80 years	8.7	5.1	58.9	8.1	93.0
Gender difference[1]					
30 years	†5.2	†2.2	. . .	†4.9	. . .
45 years	†4.3	†1.4	. . .	†4.1	. . .
65 years	†2.9	0.1	. . .	†2.9	. . .
70 years	†2.3	–0.2	. . .	†2.3	. . .
75 years	†1.7	†–0.3	. . .	†1.7	. . .
80 years	†1.0	†–0.5	. . .	†1.2	. . .

†Statistically significant ($p < 0.05$).

. . . Category not applicable.

[1]Calculated by subtracting expected years for males from expected years for females.

SOURCES: Estimated based on data from the Division of Vital Statistics, National Health Interview Surveys, National Center for Health Statistics; and the U.S. Census Bureau.

Table 3.7. Life expectancies and expected years with body mass index less than 25 and years with body mass index less than 30 for selected ages, by sex: United States, 1994–96

Sex and age	Expected years of life	Expected years with BMI[1] less than 25	Years with BMI[1] less than 25 as a % of life expectancy	Expected years with BMI[1] less than 30	Years with BMI[1] less than 30 as a % of life expectancy
Both sexes					
20 years	56.9	27.9	49.0	47.6	83.7
30 years	47.5	22.0	46.4	39.3	82.7
45 years	33.8	15.2	44.9	27.8	82.4
65 years	17.5	8.8	50.4	15.0	85.8
70 years	14.1	7.5	53.5	12.3	87.5
75 years	11.1	6.4	57.9	9.9	89.6
80 years	8.3	5.3	63.6	7.6	91.5
Male					
20 years	54.0	21.6	40.0	45.4	84.0
30 years	44.9	16.7	37.1	37.3	83.1
45 years	31.5	11.6	36.8	26.2	83.1
65 years	15.9	7.1	44.9	14.0	88.0
70 years	12.8	6.2	48.8	11.5	90.0
75 years	10.1	5.5	54.2	9.3	92.2
80 years	7.7	4.6	60.3	7.3	94.2
Female					
20 years	59.8	34.2	57.2	49.8	83.4
30 years	50.1	27.4	54.6	41.2	82.4
45 years	35.9	18.6	51.8	29.3	81.8
65 years	18.8	10.2	54.3	15.8	84.2
70 years	15.1	8.6	56.6	13.0	85.9
75 years	11.7	7.1	60.2	10.3	88.0
80 years	8.7	5.7	65.3	7.8	90.1
Gender difference[2]					
20 years	†5.7	†12.6	. . .	†4.5	. . .
30 years	†5.2	†10.7	. . .	†4.0	. . .
45 years	†4.3	†7.0	. . .	†3.1	. . .
65 years	†2.9	†3.1	. . .	†1.9	. . .
70 years	†2.3	†2.3	. . .	†1.5	. . .
75 years	†1.7	†1.6	. . .	†1.1	. . .
80 years	†1.0	†1.0	. . .	†0.5	. . .

†Statistically significant ($p<0.05$).

. . . Category not applicable.

[1]BMI refers to body mass index.

[2]Calculated by subtracting expected years for males from expected years for females.

SOURCES: Estimated based on data from the Division of Vital Statistics, National Health Interview Surveys, National Center for Health Statistics; and the U.S. Census Bureau.

Table 3.8. Life expectancies and expected years in good or better health for selected ages of the white and black population, by sex: United States, 1995

Sex and age	White			Black			Difference in years	
	Expected years of life	Expected years in good or better health	Years in good or better health as a % of life expectancy	Expected years of life	Expected years in good or better health	Years in good or better health as a % of life expectancy	Expected years of life	Expected years in good or better health
Both sexes								
Birth	76.6	67.8	88.5	69.7	56.9	81.6	†6.8	†10.9
20 years	57.5	49.1	85.4	51.5	39.1	75.9	†6.0	†10.0
30 years	48.0	40.0	83.3	42.5	30.8	72.4	†5.5	†9.2
45 years	34.2	26.9	78.8	29.9	19.6	65.4	†4.2	†7.3
65 years	17.6	12.7	72.2	15.8	9.1	57.6	†1.8	†3.6
70 years	14.2	10.0	70.7	12.8	7.4	58.0	†1.4	†2.6
75 years	11.1	7.6	68.4	10.4	5.7	55.3	†0.7	†1.9
80 years	8.3	5.5	66.5	8.0	4.2	52.5	†0.4	†1.4
Male								
Birth	73.7	65.7	89.2	65.4	55.3	84.5	†8.2	†10.5
20 years	54.8	47.2	86.2	47.4	37.7	79.5	†7.3	†9.5
30 years	45.5	38.1	83.9	38.8	29.7	76.4	†6.7	†8.5
45 years	32.0	25.2	79.0	26.9	18.7	69.6	†5.1	†6.5
65 years	16.0	11.4	71.3	14.0	8.4	60.1	†2.1	†3.0
70 years	12.9	9.0	69.6	11.3	6.8	59.9	†1.5	†2.2
75 years	10.1	6.8	67.3	9.3	5.3	57.6	†0.8	†1.4
80 years	7.7	5.0	65.2	7.3	3.9	54.0	†0.4	†1.1
Female								
Birth	79.5	69.8	87.9	73.9	58.4	79.1	†5.6	†11.4
20 years	60.2	51.0	84.7	55.4	40.5	73.1	†4.8	†10.5
30 years	50.5	41.8	82.7	46.0	31.8	69.2	†4.5	10.0
45 years	36.2	28.5	78.7	32.6	20.3	62.3	†3.6	†8.1
65 years	18.9	13.8	72.9	17.1	9.6	55.9	†1.8	†4.2
70 years	15.2	10.8	71.4	13.9	7.9	56.8	†1.3	†3.0
75 years	11.8	8.1	69.1	11.1	6.0	54.0	†0.7	†2.2
80 years	8.7	5.8	67.1	8.3	4.3	51.6	†0.4	†1.5

†Statistically significant ($p<0.05$).

SOURCES: Estimated based on data from the Division of Vital Statistics, National Health Interview Surveys, National Center for Health Statistics; and the U.S. Census Bureau.

Table 3.9. Life expectancies and expected years without any type of activity limitation for selected ages of the white and black population, by sex: United States, 1995

Sex and age	White			Black			Difference in years	
	Expected years of life	*Expected years without any activity limitation*	*Years without any activity limitation as a % of life expectancy*	*Expected years of life*	*Expected years without any activity limitation*	*Years without any activity limitation as a % of life expectancy*	*Expected years of life*	*Expected years without any activity limitation*
Both sexes								
Birth	76.6	63.4	82.7	69.7	55.4	79.4	†6.8	†7.9
20 years	57.5	45.4	78.8	51.5	38.3	74.3	†6.0	†7.1
30 years	48.0	36.5	76.0	42.5	29.9	70.3	†5.5	†6.6
45 years	34.2	24.0	70.4	29.9	18.7	62.6	†4.2	†5.3
65 years	17.6	10.9	61.8	15.8	8.4	53.5	†1.8	†2.5
70 years	14.2	8.6	60.6	12.8	7.2	56.3	†1.4	†1.4
75 years	11.1	6.2	55.8	10.4	5.2	50.2	†0.7	†1.0
80 years	8.3	4.1	49.6	8.0	3.7	46.9	†0.4	0.4
Male								
Birth	73.7	61.4	83.3	65.4	52.9	80.8	†8.2	†8.5
20 years	54.8	43.7	79.9	47.4	36.2	76.3	†7.3	†7.6
30 years	45.5	35.1	77.1	38.8	28.2	72.7	†6.7	†6.9
45 years	32.0	22.9	71.5	26.9	17.9	66.5	†5.1	†5.0
65 years	16.0	10.0	62.6	14.0	8.1	58.1	†2.1	†1.9
70 years	12.9	8.0	62.3	11.3	7.0	61.7	†1.5	†1.0
75 years	10.1	5.9	58.8	9.3	5.6	60.0	†0.8	0.4
80 years	7.7	4.2	55.1	7.3	4.3	58.4	†0.4	0.0
Female								
Birth	79.5	65.3	82.2	73.9	57.8	78.2	†5.6	†7.5
20 years	60.2	47.0	77.9	55.4	40.2	72.5	†4.8	†6.8
30 years	50.5	37.9	75.0	46.0	31.4	68.3	†4.5	†6.5
45 years	36.2	25.1	69.4	32.6	19.5	59.7	†3.6	†5.7
65 years	18.9	11.6	61.4	17.1	8.6	50.4	†1.8	†3.0
70 years	15.2	9.0	59.5	13.9	7.4	53.1	†1.3	†1.7
75 years	11.8	6.4	54.0	11.1	5.0	45.0	†0.7	†1.4
80 years	8.7	4.1	46.7	8.3	3.4	41.4	†0.4	0.6

†Statistically significant ($p < 0.05$).

SOURCES: Estimated based on data from the Division of Vital Statistics, National Health Interview Surveys, National Center for Health Statistics; and the U.S. Census Bureau.

Table 3.10. Life expectancies and expected years without limitation in personal care or other routine needs for selected ages of the white and black populations, by sex: United States, 1995

Sex and age	White			Black			Difference in years	
	Expected years of life	*Expected years without needing help in ADL or IADL*[1]	*Years without ADL or IADL*[1] *help as a % of life expectancy*	*Expected years of life*	*Expected years without needing help in ADL or IADL*[1]	*Years without ADL or IADL*[1] *help as a % of life expectancy*	*Expected years of life*	*Expected years without needing help in ADL or IADL*[1]
Both sexes								
5 years	72.2	68.5	94.9	66.0	61.5	93.2	†6.2	†7.0
20 years	57.5	53.9	93.7	51.5	47.1	91.4	†6.0	†6.8
30 years	48.0	44.5	92.5	42.5	38.2	89.8	†5.5	†6.3
45 years	34.2	30.8	90.1	29.9	25.7	86.0	†4.2	†5.0
65 years	17.6	14.6	83.2	15.8	12.1	76.5	†1.8	†2.6
70 years	14.2	11.3	79.8	12.8	9.4	73.3	†1.4	†1.9
75 years	11.1	8.3	74.6	10.4	6.8	65.7	†0.7	†1.5
80 years	8.3	5.6	67.5	8.0	4.7	58.6	†0.4	†0.9
Male								
5 years	69.3	66.6	96.1	61.7	58.6	95.0	†7.6	†8.0
20 years	54.8	52.1	95.2	47.4	44.4	93.7	†7.3	†7.7
30 years	45.5	42.9	94.3	38.8	35.9	92.5	†6.7	†7.0
45 years	32.0	29.5	92.3	26.9	24.2	90.0	†5.1	†5.3
65 years	16.0	13.9	86.8	14.0	11.6	83.0	†2.1	†2.3
70 years	12.9	10.8	84.2	11.3	9.1	80.1	†1.5	†1.7
75 years	10.1	8.1	80.2	9.3	6.8	73.1	†0.8	†1.3
80 years	7.7	5.8	74.8	7.3	5.1	69.1	†0.4	0.7
Female								
5 years	75.0	70.4	93.8	70.1	64.2	91.6	4.9	†6.1
20 years	60.2	55.6	92.3	55.4	49.6	89.5	†4.8	†6.0
30 years	50.5	46.0	91.0	46.0	40.2	87.5	†4.5	†5.7
45 years	36.2	32.0	88.3	32.6	27.1	83.0	†3.6	†4.9
65 years	18.9	15.3	80.8	17.1	12.4	72.4	†1.8	†2.9
70 years	15.2	11.7	77.0	13.9	9.6	69.5	†1.3	†2.1
75 years	11.8	8.4	71.4	11.1	6.8	61.7	†0.7	†1.6
80 years	8.7	5.5	63.5	8.3	4.4	53.5	†0.4	†1.1

†Statistically significant ($p<0.05$).
[1]ADL refers to activities of daily living; IADL refers to instrumental activities of daily living.

SOURCES: Estimated based on data from the Division of Vital Statistics, National Health Interview Surveys, National Center for Health Statistics; and the U.S. Census Bureau.

Table 3.11. Life expectancies and expected years with body mass index less than 30 for selected ages of the white and black populations, by sex: United States, 1994–96

Sex and age	White			Black			Difference in years	
	Expected years of life	Expected years with BMI[1] less than 30	Years with BMI[1] less than 30 as a % of life expectancy	Expected years of life	Expected years with BMI[1] less than 30	Years with BMI[1] less than 30 as a % of life expectancy	Expected years of life	Expected years with BMI[1] less than 30
Both sexes								
20 years	57.5	48.3	83.9	51.5	38.0	73.8	†6.0	†10.2
30 years	48.0	39.9	83.0	42.5	30.8	72.3	†5.5	†9.1
45 years	34.2	28.2	82.6	29.9	21.3	71.1	†4.2	†6.9
65 years	17.6	15.2	86.2	15.8	11.8	74.8	†1.8	†3.4
70 years	14.2	12.4	87.7	12.8	10.1	78.6	†1.4	†2.4
75 years	11.1	10.0	89.8	10.4	8.4	81.2	†0.7	†1.5
80 years	8.3	7.6	91.8	8.0	6.7	84.4	†0.4	†0.9
Male								
20 years	54.8	45.8	83.6	47.4	37.7	79.5	†7.3	†8.1
30 years	45.5	37.6	82.6	38.8	30.6	78.9	†6.7	†6.9
45 years	32.0	26.4	82.5	26.9	21.2	78.9	†5.1	†5.1
65 years	16.0	14.1	87.8	14.0	11.7	84.1	†2.1	†2.3
70 years	12.9	11.5	89.7	11.3	10.0	88.6	†1.5	†1.5
75 years	10.1	9.3	92.0	9.3	8.4	90.7	†0.8	†0.9
80 years	7.7	7.3	94.0	7.3	6.9	94.3	†0.4	†0.4
Female								
20 years	60.2	50.8	84.3	55.4	38.4	69.3	†4.8	†12.4
30 years	50.5	42.1	83.3	46.0	30.9	67.2	†4.5	†11.2
45 years	36.2	29.9	82.7	32.6	21.3	65.4	†3.6	†8.6
65 years	18.9	16.1	85.0	17.1	11.8	69.0	†2.4	†4.3
70 years	15.2	13.1	86.4	13.9	10.1	72.7	†1.3	†3.0
75 years	11.8	10.4	88.5	11.1	8.4	76.1	†0.7	†2.0
80 years	8.7	7.9	90.5	8.3	6.7	80.1	†0.4	†1.2

†Statistically significant ($p<0.05$).
[1]BMI refers to body mass index.

SOURCES: Estimated based on data from the Division of Vital Statistics, National Health Interview Surveys, National Center for Health Statistics; and the U.S. Census Bureau.

Table 3.12. Expected years at age 30 and 65 estimated using different definitions of health, by health status: United States, 1995

Measure	At age 30				At age 65			
	Expected years in years	Healthy years as a % of life expectancy	Years expected not to be healthy	Years not expected to be healthy as % of life expectancy	Expected years in years	Healthy years as a % of life expectancy	Years expected not to be healthy	Years not expected to be healthy as % of life expectancy
Expected years of life	47.5	100.0	0.0	0.0	17.5	100.0	0.0	0.0
Without needing help in ADL[1]	43.7	92.0	3.8	8.0	14.9	85.1	2.6	14.9
Able to perform major activity	40.8	85.9	6.7	14.1	14.1	80.6	3.4	19.4
Without needing help in ADL or IADL[2]	42.2	88.8	5.3	11.2	13.8	78.9	3.7	21.1
In good or better health	39.0	82.1	8.5	17.9	12.4	70.9	5.1	29.1
Without any activity limitation	35.9	75.6	11.6	24.4	10.7	61.1	6.8	38.9
In excellent health	12.7	26.7	34.8	73.3	2.6	14.9	14.9	85.1
Without chronic diabetes	44.5	93.7	3.0	6.3	15.6	89.1	1.9	10.9
Without heart disease	40.0	84.2	7.5	15.8	12.1	69.1	5.4	30.9
Without hypertension	36.8	77.5	10.7	22.5	10.9	62.3	6.6	37.7
Without chronic arthritis	34.7	73.1	12.8	26.9	8.8	50.3	8.7	49.7

[1]ADL refers to activities of daily living.
[2]IADL refers to instrumental activities of daily living.

SOURCES: Estimated based on data from the Division of Vital Statistics, National Health Interview Surveys, National Center for Health Statistics; and the U.S. Census Bureau.

Table 3.13. Expected years at age 65 estimated using different definitions of health, by health status and sex: United States, 1995

Measure	Male				Female			
	Expected years in years	*Healthy years as a % of life expectancy*	*Years expected not to be healthy*	*Years not expected to be healthy as % of life expectancy*	*Expected years in years*	*Healthy years as a % of life expectancy*	*Years expected not to be healthy*	*Years not expected to be healthy as % of life expectancy*
Expected years of life	15.9	100.0	0.0	0.0	18.8	100.0	0.0	0.0
Without needing help in ADL[1]	14.9	93.7	1.0	6.3	17.3	92.0	1.5	8.0
Able to perform major activity	14.1	88.7	1.8	11.3	16.8	89.4	2.0	10.6
Without needing help in ADL or IADL[2]	13.8	86.8	2.1	13.2	15.1	80.3	3.7	19.7
In good or better health	11.2	70.4	4.7	29.6	13.4	71.3	5.4	28.7
Without any activity limitation	9.9	62.3	6.0	37.7	11.4	60.6	7.4	39.4
In excellent health	2.4	15.1	13.5	84.9	2.8	14.9	16.0	85.1
Without chronic diabetes	14.0	88.1	1.9	11.9	16.9	89.9	1.9	10.1
Without heart disease	10.2	64.2	5.7	35.8	13.6	72.3	5.2	27.7
Without hypertension	10.8	67.9	5.1	32.1	10.9	58.0	7.9	42.0
Without chronic arthritis	9.2	57.9	6.7	42.1	8.4	44.7	10.4	55.3

[1]ADL refers to activities of daily living.
[2]IADL refers to instrumental activities of daily living.

SOURCES: Estimated based on data from the Division of Vital Statistics, National Health Interview Surveys, National Center for Health Statistics; and the U.S. Census Bureau.

Table 3.14. Expected years at age 65 estimated using different definitions of health, by health status and race: United States, 1995

Measure	White				Black			
	Expected years in years	*Healthy years as a % of life expectancy*	*Years expected not to be healthy*	*Years not expected to be healthy as % of life expectancy*	*Expected years in years*	*Healthy years as a % of life expectancy*	*Years expected not to be healthy*	*Years not expected to be healthy as % of life expectancy*
Expected years of life	17.6	100.0	0.0	0.0	15.8	100.0	0.0	0.0
Without needing help in ADL[1]	16.4	93.2	1.2	6.8	14.1	89.2	1.7	10.8
Able to perform major activity	15.8	89.8	1.8	10.2	13.1	82.9	2.7	17.1
Without needing help in ADL or IADL[2]	14.6	83.0	3.0	17.0	12.1	76.6	3.7	23.4
In good or better health	12.7	72.2	4.9	27.8	9.1	57.6	6.7	42.4
Without any activity limitation	10.9	61.9	6.7	38.1	8.4	53.2	7.4	46.8
In excellent health	2.7	15.3	14.9	84.7	1.5	9.5	14.3	90.5

[1]ADL refers to activities of daily living.
[2]IADL refers to instrumental activities of daily living.

SOURCES: Estimated based on data from the Division of Vital Statistics, National Health Interview Surveys, National Center for Health Statistics; and the U.S. Census Bureau.

4. Trends in Life Free of Activity Limitation: United States, 1985–95

4.1 Introduction

Trends in the health status of the U.S. population are of major interest to researchers, health planners, and policy makers. Trends in years gained due to the decline in mortality are important, given their effect on other health-related issues such as the aging of the population; the prevalence of nonfatal chronic conditions; and the compression (or expansion) of mortality. The additional years gained—caused by the continuous decline of mortality observed over the last several decades—might have been totally or partially healthy years, depending on the age, sex, and socioeconomic status of the population subgroup under study. Hence, numerous researchers have focused on trends in years gained due to the decline of mortality (especially at the older ages) (1–3).

Conclusions on whether the years gained because of the decline in mortality were healthy varied depending on the specific health measure used, the period covered, and the population subgroups studied. Using data from the NCHS, Colvez and Blanchet showed that, between 1966 and 1976, the proportion of persons who claimed to have been permanently disabled in their major activity rose by 37 percent. Crimmins and her colleagues, who studied trends in disability-free life expectancy between 1970 and 1990, concluded that almost all the additional years in life expectancy during the 1970s were in disabled years, while years gained in the 1980s were years without disability. They also noted that, while both males and females gained disability-free years in the latter decade, males made larger gains than females. A 1989 study on the pattern of change in disability and well-being that focused on self-rated health and activity level showed a slight decline in physical health and an improvement in activity level (4).

According to these and other health researchers, various reasons accounted for the observed changes in disability-free or limitation-free life expectancy. Some of the reasons were found to be health-related, whereas others were not. In the 1966–76 period, increases in the incidence of certain disorders and the increased use of the health care system were among factors that contributed to the 37 percent increase in permanent activity limitation (5). A trend study in the prevalence of work disability and their correlates in the period 1962–84 attributed most of the changes in work disability to changes in pathology/impairment-behavior factors and change in the age structure of the population (6). A study on the effect of eliminating fatal and nonfatal diseases on life with or without disability concluded that, while eliminating nonfatal diseases such as arthritis and back complaints led to the decline of expected life with disability (or compression of morbidity), the elimination of fatal diseases (such as cancer) suggested the expansion of morbidity because it increased both the number of years and the proportion of life with disability (7).

This chapter discusses changes in both life expectancy and years free of activity limitation of the U.S. population in the period between 1985 and 1995. Activity limitation is defined based on the ability of a person to perform a set of social roles. A person is assumed to perform a set of social roles, and one of these social roles is usually identified as his/her major activity. The major activity for a person 5–17 years of age is going to school, whereas the major activity for younger and middle-aged adults is either working or keeping house, and the major activity for the elderly population is considered to be ADL. Depending on the ability of a person to perform the social roles expected of his or her age, each person is classified into one of the following four categories: not limited; unable to perform major activity; limited in kind and/or amount of major activity; or limited in other activities (8–10).

Trends in life expectancy and years free of activity limitation will be presented for the white and black population subgroups and by sex within each population subgroup. Life expectancies for each of the four population subgroups will be calculated for each of the 11 years using mortality data from NCHS and annual midyear population estimates from the U.S. Census Bureau. Age-sex-specific activity limitation prevalence rates will be computed based on data from NHIS 1985–95.

4.2 Age-Adjusted Death and Activity Limitation Rates: United States, 1985–95

Trends in life expectancy and prevalence of activity limitation are the major determinants of trends in activity limitation-free life expectancy. Trends in life expectancy, in turn, are determined by trends in population death rates. Hence, the discussion of the dynamics in life free of activity limitation over time must start with discussion of trends in death rates and activity limitation prevalence rates. The age-adjusted death and activity rates for the four population subgroups for the period 1985–95 are presented in tables 4.1 and 4.2.

Annual death rates (table 4.1) and activity limitation rates (table 4.2) are age-adjusted using the U.S. standard million population. Each number in the table presents the number of deaths per 1,000 resident population. As has already been observed by several other NCHS reports (10,11), the adjusted rates also indicate that death rates varied by race and gender. As expected, white females have the lowest adjusted death rates, while black males have the highest

rates. The rates for the other subgroups fall between the two extremes. The table also shows that mortality has fallen between the years 1985 and 1995 for all four population subgroups. Decline in mortality continued from 1985 to 1993, rose slightly in 1993, and continued to fall again after that year. The adjusted rates for the year 1993 rose for all four population subgroups. Compared to the other three population subgroups, white males were the major beneficiaries of the decline in mortality in the period. Between 1985 and 1995, age-adjusted death rates fell by 0.84 point for white males, 0.26 point for white females, 0.38 point for black males, and 0.26 point for black females.

In the period between 1985 and 1995, observed trends in activity limitation rates differed from trends in death rates. Between 1985 and 1995, age-adjusted activity limitation rates rose slightly for all four groups. Activity limitation rates for the black population were higher compared to white rates, and for most of the 11 years, adjusted rates for white males were higher than white females rates. Within the black population, females had higher age-adjusted rates for most of the years in the first half of the period, whereas the opposite was true for most of the years in the second half. During the period, white activity limitation rates rose and fell, with a peak in 1993. For the black population, the activity limitation rates rose until a peak was reached in 1994, then fell. The 1995 activity limitation rates for black males and females were lower than their respective 1994 rates.

4.3 Age-Specific Death and Activity Limitation Rates: United States, 1985 and 1995

The overall age-adjusted death rates have declined, and the overall age-adjusted activity limitation rates have increased between 1985 and 1995; however, death rates did not decline, and activity limitation rates did not rise, for all age groups within the four population subgroups. The contribution of changes in age-specific rates to the overall changes in mortality and activity limitation could be illustrated by comparing 1985 and 1995 age-specific rates for each subgroup using the analytic summaries presented in tables 4.3 and 4.4 and figures 4.1 through 4.8.

Between 1985 and 1995, death rates fell for most age groups in all four population subgroups. However, there were age groups within each of the four population subgroups where the observed 1995 death rates were higher than the 1985 rates. For white males, 1995 death rates were lower than the 1985 rates for all except the three 5-year age groups between 30 and 44 years of age. For these three age groups, unlike the other 5-year age groups, death rates have gone up between 1985 and 1995. The rise in death rates has also been observed for white females between 25 and 40 years of age.

Between 1985 and 1995, age-specific death rates rose in only three 5-year age groups of the white population. On the other hand, age-specific death rates rose in many more age groups of the black population. For black males, death rates fell in half of the 5-year age groups, but death rates rose in the other half. Age-specific death rates rose starting with the 10–14-year age group and continued through the 45–49-year age group; these rates also rose through the open-age interval of 85 years of age and over. Compared to 1985, higher 1995 death rates were observed for black females in all 5-year age groups between ages 10 and 44 and for those who were 85 years or older.

The higher 1995 age-specific death rates in the black population are different not only in the number of 5-year age groups where they occurred, but also in the relative sizes of the rates. For any given 5-year age group, the age-specific death rate for black males was higher than that for white males, and the rate for black females was higher than for white females. The impact of the difference in magnitude is captured by figures 4.1 through 4.4. For white adults

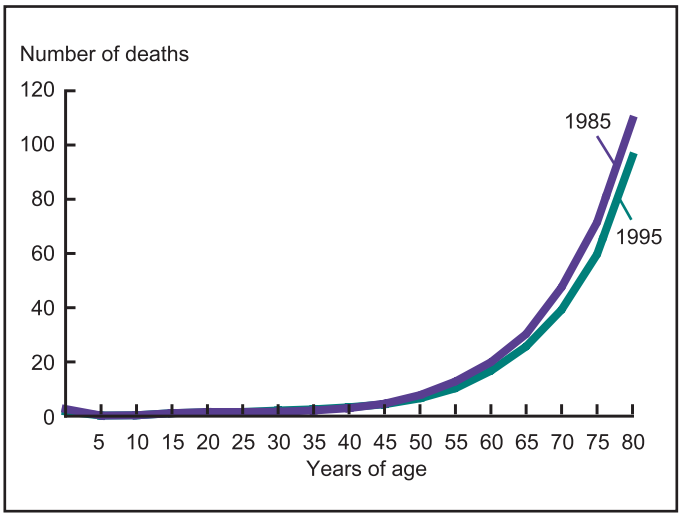

Figure 4.1. Number of deaths per 1,000 for white males, by age: United States, 1985 and 1995

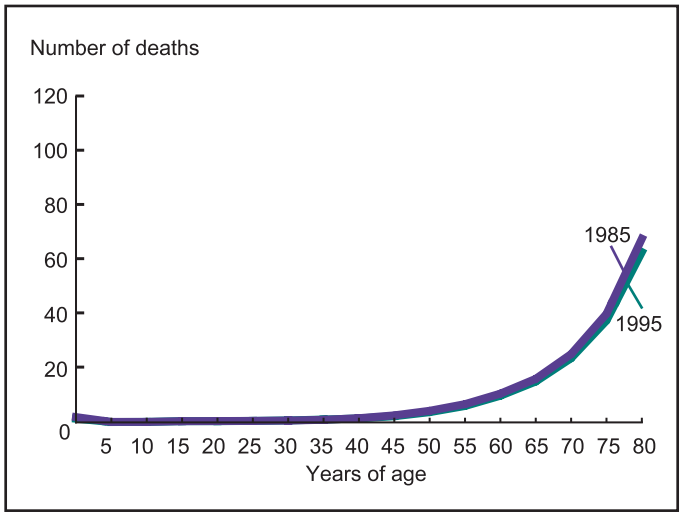

Figure 4.2. Number of deaths per 1,000 for white females, by age: United States, 1985 and 1995

between ages 10 and 50 years, the 1995 higher age-specific rates were hardly different from the 1985 rates (figures 4.1 and 4.2). Conversely, for the black population of the same ages, the higher 1995 rates were clearly visible, especially for black males (figure 4.3). The four figures also clearly show that, between 1985 and 1995, mortality has fallen for adults between ages 50 and 80. Mortality declined at these ages in all four population subgroups, relatively more for males than females.

The 1985 and 1995 age-specific activity limitation estimates for the four population subgroups are presented in table 4.4. According to the figures in the table, age-specific activity limitation rates for 1995 were higher than the 1985 rates for most of the age groups in the four population subgroups. Between 1985 and 1995, activity limitation rates for the younger population increased more than for the older population. The difference in the 1985 and 1995 activity limitation rates by age are presented graphically in figures 4.5 through 4.8. For all four population subgroups, the 1995 age-specific rates were higher than the 1985 rates for the younger ages, and these rates were lower at the older ages. Controlling for sex, the observed difference between the 1985 and 1995 rates was larger for the black population compared to the white.

Overall, between 1985 and 1995, mortality has declined when measured using age-adjusted rates. A comparison of the 1985 and 1995 age-specific rates also shows that mortality had declined during the period for most 5-year age groups, more at the older ages compared to the younger ages. On the other hand, between 1985 and 1995, the age-adjusted activity limitation rates rose and then declined, with the observed peak occurring in 1993 and 1994. The 1985 and 1995 age-specific activity rates also showed that, for most 5-year age groups of all four population subgroups, limitation rates were relatively higher in 1995 compared to 1985. The following paragraphs discuss the combined impact of these changes in mortality and activity limitation on expected years of life free of activity limitation.

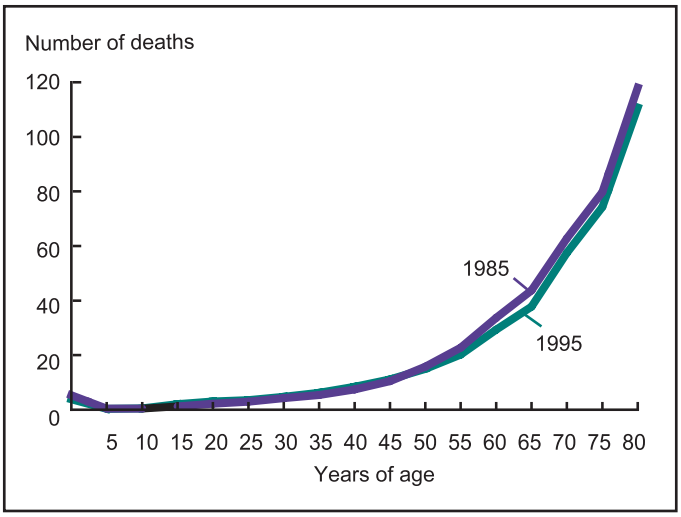

Figure 4.3. Number of deaths per 1,000 for black males, by age: United States, 1985 and 1995

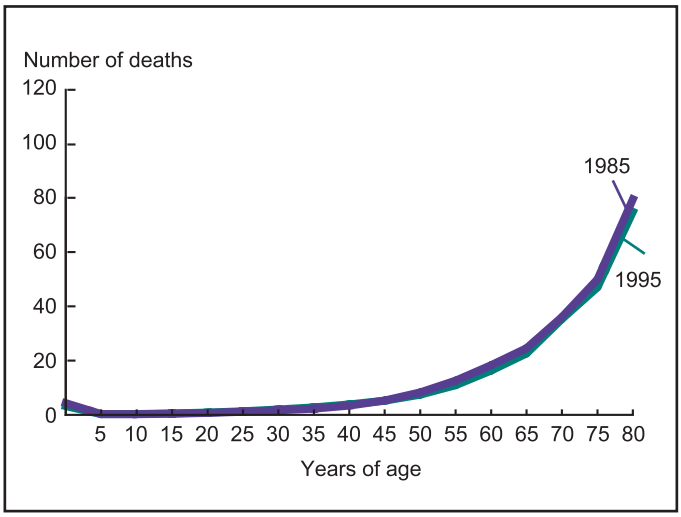

Figure 4.4. Number of deaths per 1,000 for black females, by age: United States, 1985 and 1995

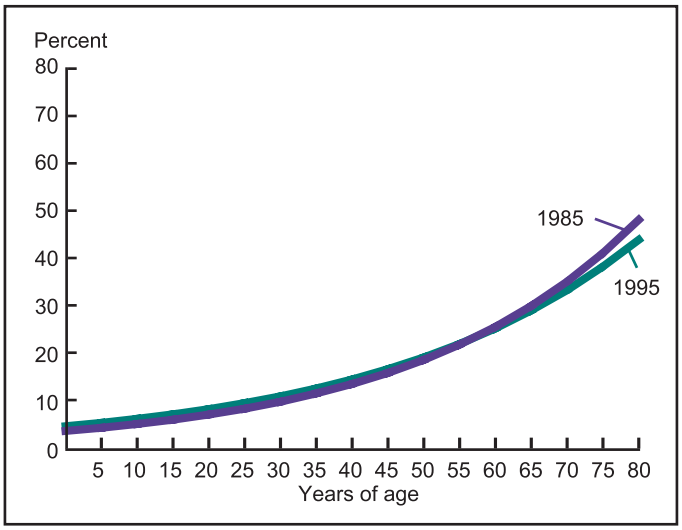

Figure 4.5. Percentage of white males with activity limitation from any cause, by age: United States, 1985 and 1995

4.4 Years Free of Activity Limitation: United States, 1985–95

Life expectancy at birth and expected years free of activity limitation for the years 1985 through 1995 are presented in table 4.5 for white and black males and in table 4.6 for white and black females. For each of the four population subgroups, the tables also present the percentage of remaining life that is expected to be free of activity limitation. For males, expectation of life rose continuously between 1985 and 1992, fell slightly in 1993, and started to rise again after that. During the same period, the trends in expected years free of activity limitation for both white and black males were less stable than the trends in life

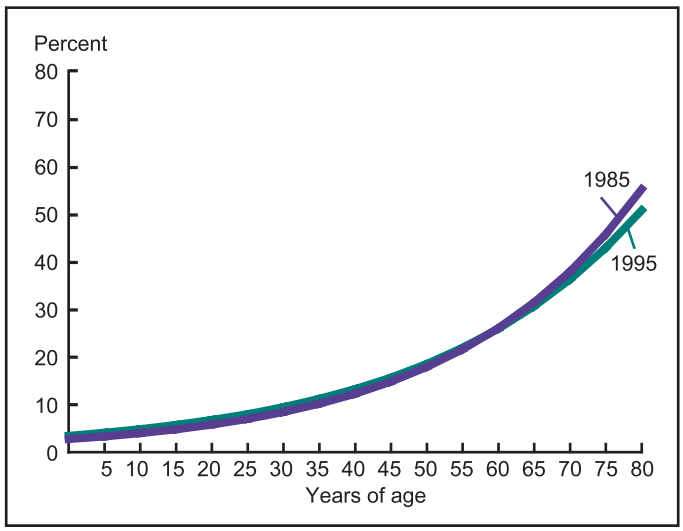

Figure 4.6. Percentage of white females with activity limitation from any cause, by age: United States, 1985 and 1995

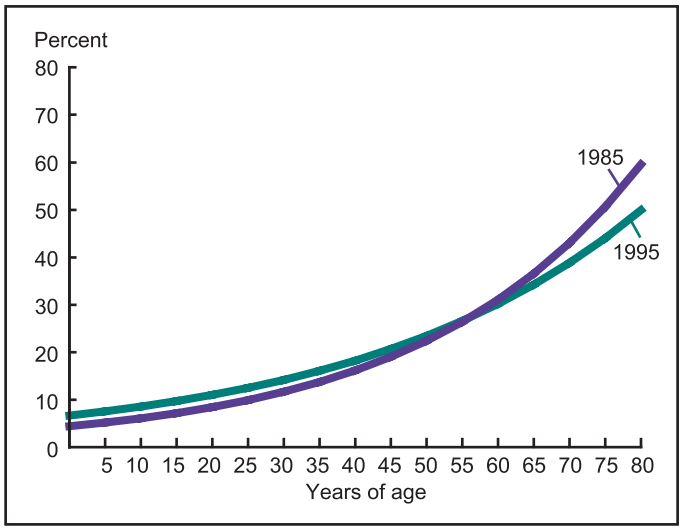

Figure 4.7. Percentage of black males with activity limitation from any cause, by age: United States, 1985 and 1995

expectancy. For white males, expected years free of activity limitation at birth, which was 60.5 years in 1985, rose to 61.4 in 1995. On the other hand, for black males, the 1985 expected years free of activity limitation at birth was 53.6 and dropped to 52.9 years in 1995. The proportion of life expected to be free of activity limitation has declined slightly for both white and black males. In 1985, about 84.3 percent of a white male baby's life at birth would be expected to be free of activity limitation. By 1995 that percentage had dropped by 0.6 percentage point to 83.7 percent. The percentage of a newly born black male baby's life that would be expected to be free of activity of limitation in 1985, on the other hand, was about 82.5. That percentage dropped to 81.1 by 1995, resulting in a decline of 1.4 percentage points.

Similarly, for females, expectation of life increased continuously between 1985 and 1992, declined slightly in 1993, and rose again after that year. During the period 1985–95, trends in the expected years free of activity limitation for females were unstable. Although the differences are small, both white and black females would expect to spend more years free of activity limitation in 1995 compared to 1985. In 1985, white females would expect to live 65 years free of activity limitation. In 1995, their expected years free of activity limitation had risen to 65.3 years. In 1985, black females would expect to live 57.6 years of their future lives free of activity limitation. By 1995, the expected years free of activity limitation for black females had gone up to 57.8 years.

Although both white and black females would expect to live more limitation-free years in 1995 compared to 1985, for each group, the percentages of expected life free of activity limitation were relatively smaller in 1995 compared to 1985. In 1985, a white female would expect to live about 82.6 percent of her future life free of activity limitation; in 1995, the percentage dropped to 82, a loss of 0.6 percentage point. In 1985, the percentage of life a black female would expect to live free of activity limitation was 78.5 percent, and that percentage fell to 78.2 in 1995.

4.5 Gains in Life Expectancy and Expected Limitation-Free Years: United States, 1985–95

Life expectancy and life free of activity limitation at birth, age 20, and 65 in 1985 for each population subgroup were compared to life expectancy and life free of activity limitation at the same ages in 1995. At the end of the study period, each group had a net gain in life expectancy at birth, age 20, and 65 (table 4.7). Gains in life expectancy varied by race, sex, and age. For white persons, males gained more than females at all ages. Black females gained more at birth and age 20 than did black males, but at age 65, black males gained more expected life than females.

White male gains in life expectancy were larger than gains for black males at all three ages. White and black females expected to gain three tenths of a year at age 65. At birth and at age 20, white females gained more than black females.

When the difference in the 1985 and 1995 life expectancies are measured in absolute terms (in years), the gains for white persons of both sexes and for black females were larger at the younger ages and smaller at the older ages. The life expectancy gain for black males was larger at age 65 than at birth or at age 20. On the other hand, when the differences are measured in relative terms (difference in 1985 and 1995 life expectancies as a percentage of the 1985 life expectancies), gain in life expectancy is larger at age 65 compared to the younger ages for each of the four groups.

Between 1985 and 1995, white males, white females, and black females expected to gain more activity limitation-free time at birth, age 20, and age 65. For these three groups, the expected gain in life free of activity limitation varied by age

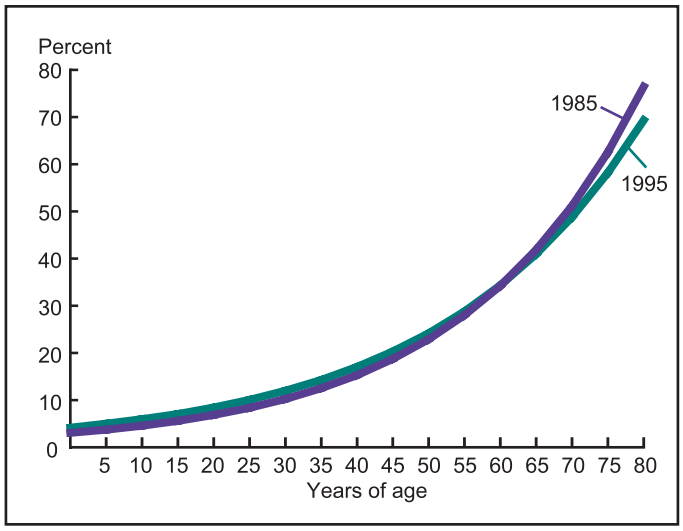

Figure 4.8. Percentage of black females with activity limitation from any cause, by age: United States, 1985 and 1995

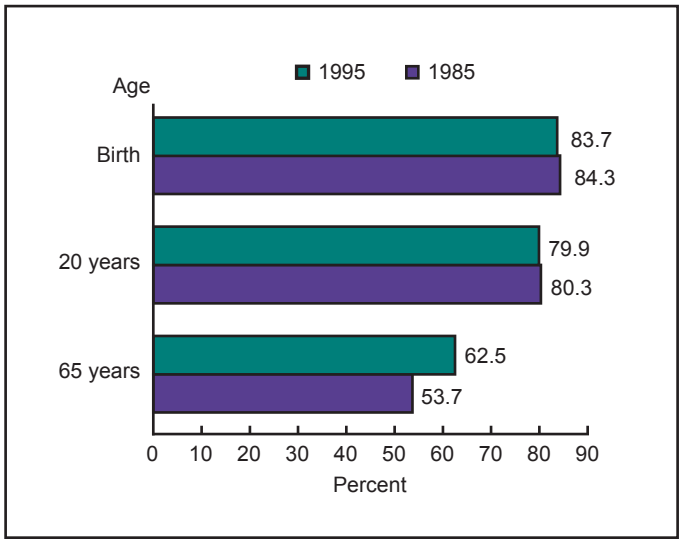

Figure 4.9. Expected years free of activity limitation as percentage of life expectancy, white males: United States, 1985 and 1995

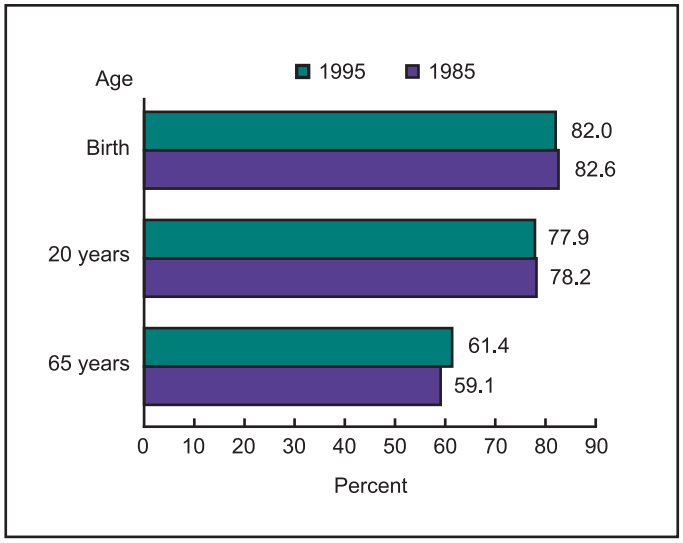

Figure 4.10. Expected years free of activity limitation as percentage of life expectancy, white females: United States, 1985 and 1995

and race. White males expected to gain more than females of either race at all the three ages. The expected gain in life free of activity limitation was similar at each of the three ages for white and black females. The net change in life free of activity limitation is different for black males. Black males expected to gain activity limitation-free life at age 65. At birth and at age 20, they expected to lose all their gains in life expectancy to activity limitation. Contrary to the gains in life expectancy, the gains in activity limitation-free life were larger in the older ages for each of the four groups, whether measured in years or as percentage of the expected limitation-free years of 1985.

For each population subgroup, gains in life expectancy differed from gains in years free of activity limitation. At birth, gains in life expectancy were more than gains in activity limitation-free years. For white males, white females, and black females, only part of the expected gain in life expectancy would be free of activity limitation. For black males, the total gain in life expectancy (a meager two tenths of a year) was expected to be lost to activity limitation (seven-tenths of a year). For white males and females of either race, the gain of life expectancy at age 20 would be partially free of activity limitation, while part would be lost to activity limitation. For black males, the years gained in life expectancy at age 20 would be totally lost to activity limitation. At age 65, gain in life expectancy was totally free of activity limitation for each of the four population subgroups.

The changes in life free of activity limitation at baseline and the end of the study period were compared using the proportion of life expectancy expected to be free of activity limitation; the results are presented in figures 4.9 through 4.12. The figures indicated that for each of the four population subgroups, the percentage of life expected to be free of activity limitation at birth and age 20 hardly changed between 1985 and 1995. The only exception, perhaps, was the slight change for black males (figure 4.11). On the other hand, for each of the four population subgroups, the 1985 percentage of expected life free of activity limitation at age 65 was markedly different from that of 1995. At age 65, the percentage of life free of activity limitation rose between 1985 and 1995 for each of the four population subgroups. The percentages rose from 54 to nearly 63 for white males (figure 4.9), 59 to 61 for white females (figure 4.10), 52 to 58 for black males (figure 4.11), and 47 to 50 for black females (figure 4.12).

4.6 Summary

Between 1985 and 1995, life expectancy at birth went up for the white as well as the black population. Expected years free of activity limitation at birth also increased for white

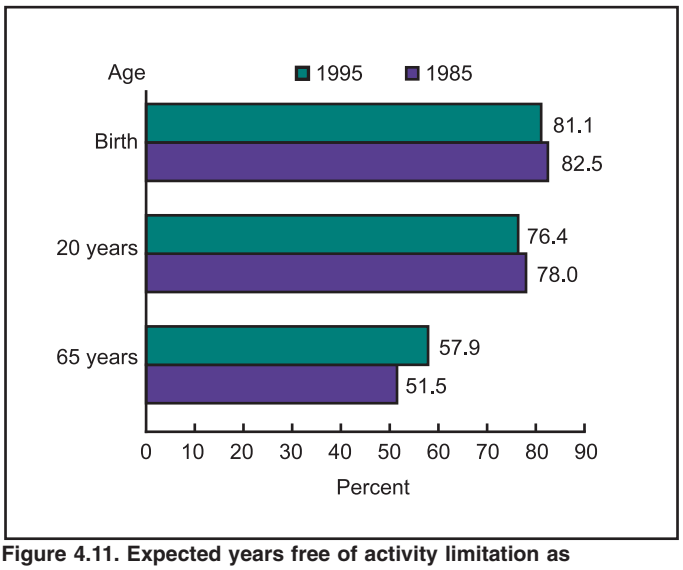

Figure 4.11. Expected years free of activity limitation as percentage of life expectancy, black males: United States, 1985 and 1995

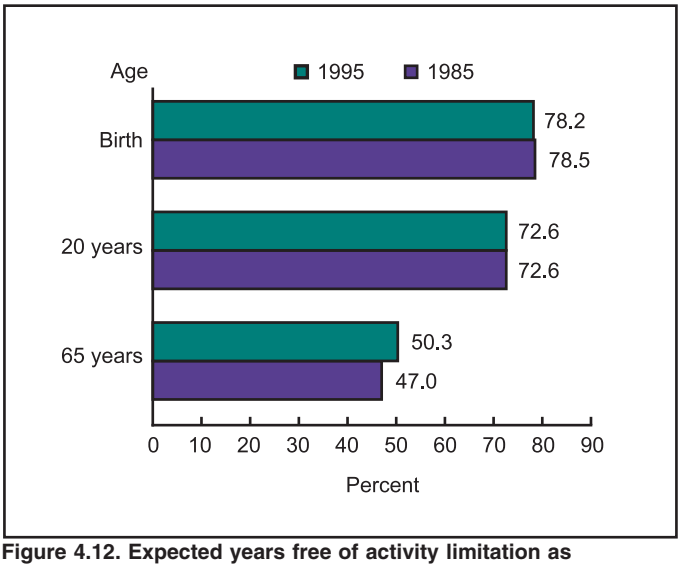

Figure 4.12. Expected years free of activity limitation as percentage of life expectancy, black females: United States, 1985 and 1995

males, white females, and black females, but decreased slightly for black males. However, when measured as a percentage of life expectancy expected years free of activity limitation decreased for each of the four subgroups. For black males, expected years free of activity limitation measured at birth decreased both in absolute terms and as a percentage of life expectancy.

Changes in life expectancy and expected years free of activity limitation in the period were also calculated at birth, 20, and 65 years of age for the white and black populations separately by sex. Though differences in the magnitude of the increase were noted, life expectancy increased at each of the three ages for each of the four population groups. The gains in life expectancy measured as a percentage of the 1985 life expectancy were much higher at age 65 compared to the percentage gain at birth or at age 20.

For the white population, at each of the three ages, the percentage gain was larger for males than for females. For the black population, the percentage gains at birth and at age 20 were larger for females than for males; conversely, at age 65, the percentage gain for males was larger than for females.

For the white population of both sexes and for black females, expected years free of activity limitation increased at birth, age 20, and age 65. For black males, however, expected years free of activity of limitation decreased at birth and at age 20, but increased substantially at age 65. Just like the gains in life expectancy, for the white population, gains in life free of activity limitation were larger for males than for females. For the black population, gain in expected years free of activity limitation at birth and at age 20 was larger for females than for males, but, at age 65, the gain was larger for males than for females. The gain in expected life free of activity limitation at age 65 was remarkable for two reasons. First, each of the four groups gained in expected life free of activity limitation at this age. Second, the gain measured as a percentage of the 1985 expected years free of activity limitation at age 65 was much larger for males than for females both for the black and white populations.

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Table 4.1. Age-adjusted death rates for all ages, by race and sex: United States, 1985–95

Year	White			Black			U.S. total		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
	Deaths per 1,000 resident population								
1985	6.94	3.91	5.25	10.54	5.95	7.94	7.23	4.10	5.49
1986	6.85	3.88	5.20	10.63	5.95	7.97	7.17	4.08	5.45
1987	6.74	3.85	5.14	10.64	5.93	7.97	7.07	4.05	5.39
1988	6.74	3.85	5.14	10.91	6.02	8.13	7.09	4.06	5.41
1989	6.52	3.76	5.00	10.83	5.94	8.06	6.90	3.97	5.28
1990	6.42	3.69	4.91	10.56	5.79	7.86	6.77	3.89	5.18
1991	6.34	3.66	4.86	10.51	5.76	7.82	6.70	3.86	5.14
1992	6.21	3.60	4.77	10.25	5.68	7.66	6.56	3.80	5.04
1993	6.27	3.68	4.85	10.51	5.79	8.10	6.64	3.88	5.13
1994	6.17	3.65	4.80	10.29	5.72	7.72	6.53	3.85	5.07
1995	6.10	3.65	4.76	10.16	5.71	7.66	6.45	3.85	5.03

SOURCE: National Center for Health Statistics. Deaths: Final data for 1985–1995.

Table 4.2. Age-adjusted activity limitation rates from any cause for all ages, by race and sex: United States, 1985–95

Year	White			Black			U.S. total		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
	Percent with activity limitation								
1985	13.49	12.85	13.19	16.09	16.43	16.36	13.71	13.22	13.50
1986	13.47	12.99	13.24	15.63	16.59	16.24	13.47	13.24	13.42
1987	12.85	12.58	12.73	15.48	16.36	16.04	13.00	12.86	12.95
1988	13.11	12.61	12.90	16.06	16.48	16.36	13.30	12.97	13.12
1989	13.45	12.84	13.18	16.35	16.34	16.42	13.62	13.07	13.42
1990	12.82	12.75	12.83	15.26	15.79	15.61	12.95	13.03	13.00
1991	13.66	13.22	13.42	16.35	15.40	15.91	13.82	13.30	13.56
1992	14.13	13.76	13.92	17.34	17.21	17.33	14.39	13.99	14.21
1993	14.67	14.07	14.41	18.02	17.62	17.89	14.86	14.39	14.63
1994	13.95	13.96	14.01	18.37	17.79	18.10	14.34	14.30	14.36
1995	13.94	13.36	13.66	17.65	17.16	17.53	14.22	13.64	13.93

SOURCE: National Center for Health Statistics. National Health Interview Survey, 1985–1995.

Table 4.3. Number of deaths from all causes for the white and black populations, by sex: United States, 1985 and 1995

Age	White males		White females		Black males		Black females	
	1985	1995	1985	1995	1985	1995	1985	1995
	Per 1,000 population							
0–4 years	2.60	1.71	1.97	1.36	5.28	3.88	4.32	3.26
5–9 years	0.26	0.20	0.19	0.15	0.40	0.35	0.32	0.26
10–14 years	0.34	0.29	0.20	0.18	0.44	0.46	0.25	0.28
15–19 years	1.12	1.04	0.47	0.44	1.26	2.02	0.45	0.56
20–24 years	1.53	1.39	0.49	0.44	2.22	2.99	0.74	0.85
25–29 years	1.52	1.51	0.53	0.54	2.93	3.55	1.11	1.33
30–34 years	1.66	2.03	0.67	0.73	4.21	4.75	1.67	1.96
35–39 years	2.05	2.53	0.96	1.05	5.42	6.20	2.27	2.77
40–44 years	2.90	3.26	1.54	1.48	7.46	8.40	3.41	3.85
45–49 years	4.61	4.37	2.60	2.28	10.46	11.12	5.26	5.25
50–54 years	7.74	6.59	4.28	3.78	15.75	14.93	8.27	7.43
55–59 years	12.78	10.27	6.75	6.08	22.69	20.19	12.60	10.95
60–64 years	19.90	16.73	10.63	9.83	33.71	29.34	18.30	16.35
65–69 years	30.30	25.71	16.11	15.11	43.76	37.73	24.55	22.61
70–74 years	47.51	39.28	25.18	23.68	62.82	57.49	36.06	35.33
75–79 years	71.51	59.66	40.08	37.59	79.78	74.32	49.99	47.01
80–84 years	109.24	95.71	67.80	62.88	118.03	110.76	79.45	74.86
85 years and over	189.84	177.66	147.55	145.16	157.95	163.19	126.73	133.24

SOURCES: Calculated based on data from the National Vital Statistics System, National Center for Health Statistics; and the U.S. Census Bureau.

Table 4.4. Limitation of activity from any cause for the white and black populations, by sex: United States, 1985 and 1995

Age	White males		White females		Black males		Black females	
	1985	1995	1985	1995	1985	1995	1985	1995
	Percent of population							
0–4 years	2.49	3.37	1.37	1.94	3.99	4.06	2.34	2.69
5–9 years	6.63	8.01	4.90	4.31	9.00	9.43	4.33	6.44
10–14 years	7.35	9.68	5.23	5.52	8.99	12.02	6.04	7.69
15–19 years	7.17	8.52	5.44	7.62	5.27	9.20	5.62	7.43
20–24 years	6.35	6.49	5.13	6.90	5.22	10.39	4.84	7.01
25–29 years	7.27	8.76	6.38	7.46	7.58	9.58	6.28	9.09
30–34 years	9.87	8.70	8.56	10.14	10.56	14.47	10.38	10.90
35–39 years	11.38	11.49	10.12	11.82	13.64	16.65	12.47	12.20
40–44 years	11.81	13.49	12.67	13.49	11.33	19.05	18.65	17.71
45–49 years	12.52	16.03	15.50	17.08	23.29	19.23	19.59	22.14
50–54 years	18.96	19.53	18.47	21.92	26.13	30.68	27.78	30.96
55–59 years	24.69	23.47	25.32	26.60	29.62	29.88	35.35	38.09
60–64 years	32.85	30.50	32.69	28.74	37.13	38.38	50.58	43.71
65–69 years	40.71	36.72	36.42	33.18	46.87	49.19	53.63	56.48
70–74 years	32.46	31.48	32.67	28.43	48.22	35.77	42.77	30.88
75–79 years	35.82	36.36	39.33	34.50	44.05	38.08	37.86	49.63
80–84 years	43.56	40.33	46.03	46.29	49.16	31.52	66.54	57.76
85 years and over	52.94	50.04	56.82	60.35	63.03	53.60	76.96	59.53

SOURCE: Calculated based on data from the 1985 and 1995 National Health Interview Surveys, National Center for Health Statistics.

Table 4.5. Life expectancy and expected years free of any activity limitation for males at birth, by race: United States, 1985–95

Year	White			Black			U.S. total		
	Life expectancy	Expected years free of activity limitation	Years free of activity limitation as % of life expectancy	Life expectancy	Expected years free of activity limitation	Years free of activity limitation as % of life expectancy	Life expectancy	Expected years free of activity limitation	Years free of activity limitation as % of life expectancy
1985	71.8	60.5	84.3	65.0	53.6	82.5	71.3	59.8	83.9
1986	71.9	60.7	84.4	64.8	53.7	82.9	71.2	60.1	84.4
1987	72.1	61.3	85.0	64.7	53.7	83.0	71.4	60.5	84.7
1988	72.2	61.2	84.8	64.4	53.0	82.3	71.4	60.3	84.5
1989	72.5	61.1	84.3	64.3	52.9	82.3	71.7	60.2	84.0
1990	72.7	61.7	84.9	64.5	53.9	83.6	71.8	60.9	84.8
1991	72.9	61.2	84.0	64.6	53.2	82.4	72.0	60.4	83.9
1992	73.2	60.7	82.9	65.0	52.2	80.3	72.3	60.3	83.4
1993	73.1	60.6	82.9	64.6	52.1	80.7	72.2	59.8	82.8
1994	73.3	61.3	83.6	64.9	52.1	80.3	72.4	60.3	83.3
1995	73.4	61.4	83.7	65.2	52.9	81.1	72.5	60.5	83.4

SOURCES: Estimated based on data from the National Vital Statistics System, National Health Interview Surveys, National Center for Health Statistics; and the U.S. Census Bureau.

Table 4.6. Life expectancy and expected years free of any activity limitation for females at birth, by race: United States, 1985–95

Year	White			Black			U.S. total		
	Life expectancy	Expected years free of activity limitation	Years free of activity limitation as % of life expectancy	Life expectancy	Expected years free of activity limitation	Years free of activity limitation as % of life expectancy	Life expectancy	Expected years free of activity limitation	Years free of activity limitation as % of life expectancy
1985	78.7	65.0	82.6	73.4	57.6	78.5	78.2	64.2	82.1
1986	78.8	64.9	82.4	73.4	57.7	78.6	78.2	64.2	82.1
1987	78.9	65.5	83.0	73.4	57.9	78.9	78.3	64.8	82.8
1988	78.9	65.6	83.1	73.2	57.7	78.8	78.3	64.8	82.8
1989	79.2	65.4	82.6	73.3	57.8	78.9	78.5	64.6	82.3
1990	79.4	65.6	82.6	73.6	58.7	79.8	78.8	64.8	82.2
1991	79.6	65.3	82.0	73.8	59.1	80.1	78.9	64.7	82.0
1992	79.8	64.8	81.2	73.9	57.4	77.7	79.1	64.0	80.9
1993	79.5	64.6	81.3	73.7	57.4	77.9	78.8	63.8	81.0
1994	79.6	64.8	81.4	73.9	57.4	77.7	79.0	64.0	81.0
1995	79.6	65.3	82.0	73.9	57.8	78.2	78.9	64.6	81.9

SOURCES: Estimated based on data from the National Vital Statistics System, National Health Interview Surveys, National Center for Health Statistics; and the U.S. Census Bureau.

Table 4.7. Life expectancy and expected years free of any limitation at birth, age 20, and age 65 for the white and black populations, by sex: United States, 1985 and 1995

Race, sex, and age	Life expectancy		Difference between 1985 and 1995 in life expectancy		Years free of activity limitation		Difference between 1985 and 1995 in limitation-free years	
	1985	1995	In years	As % of 1985 life expectancy	1985	1995	In years	As % of 1985 limitation-free years
White males								
Birth	71.8	73.4	1.6	2.2	60.5	61.4	0.9	1.5
20 years	53.4	54.8	1.4	2.6	42.9	43.8	0.9	2.1
65 years	14.9	16.0	1.1	7.4	8.0	10.0	2.0	25.0
White females								
Birth	78.7	79.6	0.9	1.1	65.0	65.3	0.3	0.5
20 years	59.7	60.3	0.6	1.0	46.7	47.0	0.3	0.6
65 years	18.6	18.9	0.3	1.6	11.0	11.6	0.6	5.5
Black males								
Birth	65.0	65.2	0.2	0.3	53.6	52.9	–0.7	–1.3
20 years	47.2	47.4	0.2	0.4	36.8	36.2	–0.6	–1.6
65 years	13.2	14.0	0.8	6.1	6.8	8.1	1.3	19.1
Black females								
Birth	73.4	73.9	0.5	0.7	57.6	57.8	0.2	0.3
20 years	55.1	55.4	0.3	0.5	40.0	40.2	0.2	0.5
65 years	16.8	17.1	0.3	1.8	7.9	8.6	0.7	8.9

SOURCES: Estimated based on data from the National Vital Statistics System, National Health Interview Surveys, National Center for Health Statistics; and the U.S. Census Bureau.

5. The Impact of Incomplete Data on Healthy Life Expectancy Estimates

5.1 Introduction

Data for the two components of summary measure of health come from different data sources. Mortality data come from vital records collected by States, the District of Columbia, and Territories, on all deaths occurring in those jurisdictions (1). Sources for morbidity data include administrative record surveys, such as hospital discharge and medical office records, interview surveys, and examination surveys. Surveys generally do not evaluate all segments of the population. For instance, household interview surveys generally do not include institutionalized populations; telephone interview surveys do not include people without access to a telephone; school-based surveys do not include children who have dropped out of school; medical office record surveys do not include people seeking medical help from emergency rooms; and hospital discharge surveys do not include ambulatory surgery patients. Consequently, the population on which death records are obtained is not often the same as the population included in a survey. There is substantial overlap, but the populations are not identical.

Because household surveys are commonly used to obtain health information, the purpose of this chapter is to evaluate which subgroups of the population are excluded from most of these surveys; obtain data on those subgroups; and determine the impact on estimates of summary measures of health including whether additional data in the morbidity component are considered.

Data from NHIS will be considered as the data source on the noninstitutionalized population for measures of morbidity included in a summary measure (2). NHIS is a survey of the community-dwelling population that does not include the institutional population. This means that health circumstances of this portion of the population would not be included in morbidity measures derived from the NHIS. The deaths of the institutional population, however, are included in national vital statistics data. If the health status of the institutional population were identical to that of the community-dwelling population, the summary measures constructed from the community-dwelling survey would not be biased. To the extent that the institutional population's health differs from that of the noninstitutionalized population, the summary measures will not accurately characterize the health status of the total population, and trends over time could be affected by changes in the institutional rates.

According to the 1990 census, about 97.3 percent of the population of the United States were community dwellers (table C). Of the remaining 2.7 percent of the population, about 1.3 percent were institutionalized, and about 1.4 percent of the population was neither community dwellers nor institutionalized. The last group included persons who were in dormitories, military quarters, shelters, group homes, crews of maritime vessels, staff residents of institutions, residents of living quarters for victims of disasters, and populations of other similar settings (3).

These three groups (the community dwellers, the institutionalized, and other) are comprised of persons of very different ages, and the age structure of any one of the three groups does not represent that of the total population. In addition, those in nursing homes and long-term care facilities clearly have different health status from the community-dwelling population of the same age. Because of the lower socioeconomic status of the population in correctional facilities and the high use of drugs and alcohol among inmates, the health status of the incarcerated population would be expected to be worse than the health status of the general population of the same age. The health status of those in the military probably does not differ substantially from the health status of the community-dwelling population. Because physical ability is a requirement for entry into the military and poor health conditions may often result in discharge, this group may even be healthier than the noninstitutionalized civilian population.

Table C. The community and institutionalized population, by sex: United States, 1990

Type of residence	*Both sexes*	*Male*	*Female*
Total	248,709,873	121,239,418	127,470,455
Community	242,012,129	117,450,800	124,561,329
Institutions	3,334,018	1,801,352	1,532,666
Nursing homes	1,772,032	493,609	1,278,423
Correctional institutions	1,115,111	1,030,207	84,904
Other institutions	446,875	227,536	169,339
Other	3,363,726	1,987,266	1,376,460

SOURCE: U.S. Census Bureau. 1990 Census of the population: General population characteristics, November 1992.

Table D. Percentage distribution of the noninstitutionalized and institutionalized population, by broad age group: United States, 1990

Age	Noninstitutionalized	Institutionalized		
		Nursing home	Prison	Military
0–14 years	22.14	0.00	0.00	0.00
15–64 years	65.74	10.23	99.32	99.99
65 years and over	12.12	89.77	0.68	0.01

SOURCE: U.S. Census Bureau. 1990 Census of the population: General population characteristics, November 1992.

In 1990, about half of the institutional population resided in nursing homes or long-term care facilities; one third were residents in correctional institutions. In addition to the nursing home population, the military, and the population in correctional institutions, the institutionalized population included those who were in hospital wards; schools for the mentally retarded or physically handicapped; those who had no usual homes elsewhere; and those who were in juvenile institutions.

About 5 percent of the population 65 years of age and older was living in institutions in 1990. The percentage is even higher in the oldest ages (24.5 percent among those 85 years and over). Older women are more likely than older men to be institutionalized (16.3 percent for men 85 years and over, and 27.7 percent for women in the same age group) (3).

The age distribution of the noninstitutionalized civilian population (also referred to as community dwellers) and the institutionalized populations in the nursing homes, local, State and Federal penitentiaries and those who are in the military is presented in table D. While about one out of every five community dwellers is younger than age 15, none of the three institutions has a measurable proportion of the population younger than age 15. A large segment of the community dwellers and almost all of the institutionalized population in prison and the military fall in the broad 15–64 year age group.

Only a small fraction of the nursing home population is younger than age 65. The distribution shows that nearly 90 percent of the nursing home population is older than age 65. Unlike the distributions of the noninstitutionalized civilian population or the other segments of the institutionalized population, the nursing home population distribution is also strongly skewed in favor of females, with nearly 260 females for every 100 males (table C). The observed differentials in age structure and sex composition, especially between the community dwellers and the nursing home population, is significant because health disparities have been shown to exist between such populations because of age and sex composition, even when controlling for all other factors that positively or negatively impact health (4–7).

5.2 The 1995 Noninstitutionalized Civilian and Institutionalized Populations

According to the 1995 NHIS, the civilian noninstitutionalized population of the United States was estimated to be 261,902,900, of which 127,576,500 were males and 134,326,400 were females. During the same survey year, 1,548,600 persons resided in nursing homes with three or more beds. Of the total nursing home population, only 422,300 were males, whereas 1,126,200 were females. The gender distributions for the groups of population indicate that, for persons 75 to 84 years of age, there were about 95 males for every 100 females in the community-dwelling population, but there were fewer than 40 males per 100 females among the nursing home population (table E). The last two columns of the table also show that the sex ratio of both population subgroups declines with age, with the sex ratio of the nursing home population declining much faster than that of the community dwellers. The two population subgroups are significantly different with regard to their age distribution.

While more than 80 percent of the community-dwelling population was younger than age 64, less than 20 percent of the nursing home population was younger than age 64.

Table E. Percentage distribution and sex ratio of community dwellers and the nursing home population, by broad age group: United States, 1995

Age	Age distribution		Sex ratio	
	Community	Nursing home	Community	Nursing home
0–64 years	89.7	15.3	98.7	108.0
65–74 years	6.5	18.7	80.4	72.2
75–84 years	3.1	34.3	64.9	39.9
85 years and over	0.7	31.7	95.0	22.5
All ages	100.0	100.0	95.0	37.5

NOTE: Sex ratio is defined as the number of males per 100 females.

SOURCE: National Center for Health Statistics. National Health Interview Survey, 1995; National Nursing Home Survey, 1995.

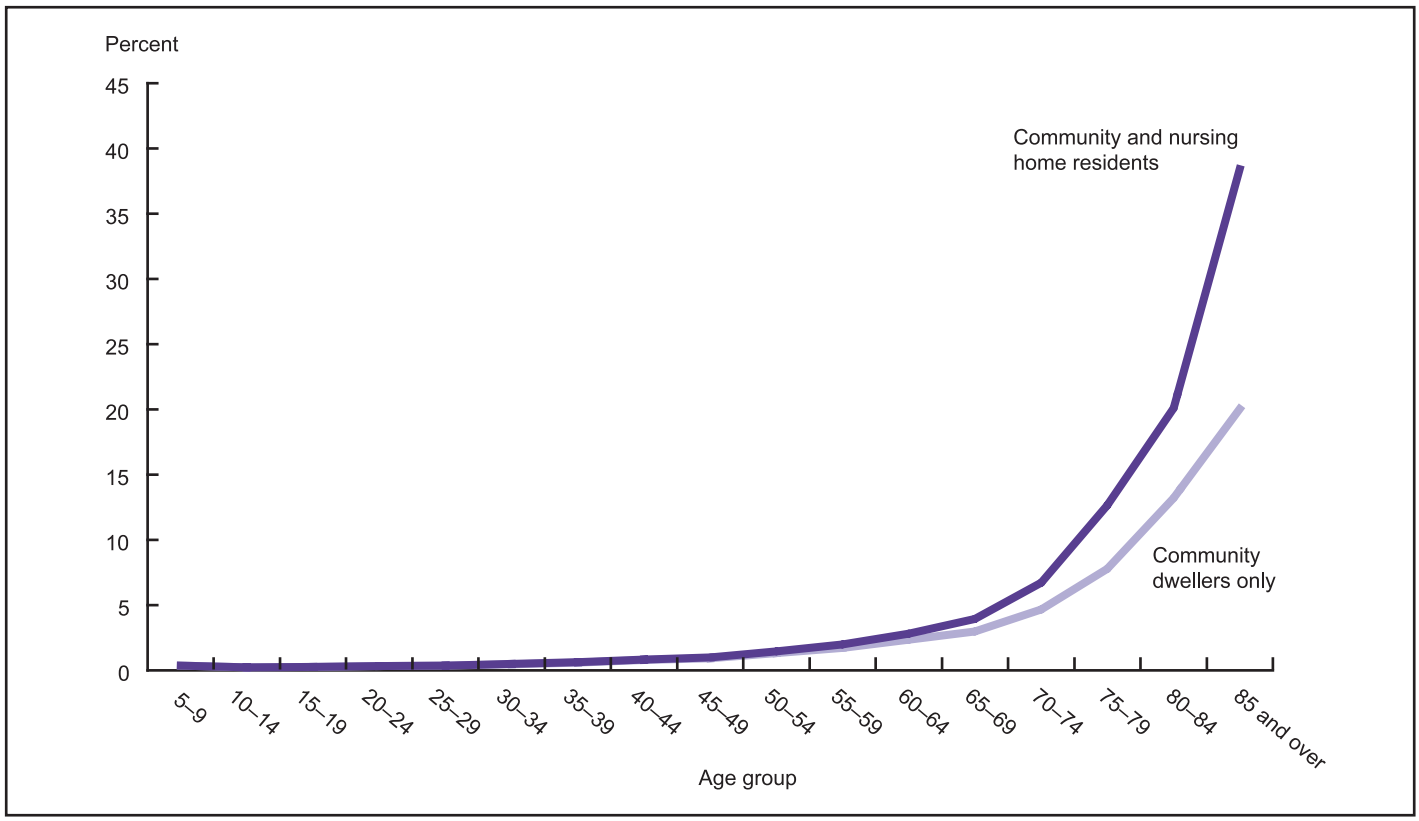

Figure 5.1. Percentage of the female population 65 years of age and over who need help with at least one activity of daily living, by age and residence: United States, 1995

5.2.1 The noninstitutionalized civilian population

About 12 percent of the 1995 noninstitutionalized civilian population was 65 years of age or older. Only 1 out of every 10 noninstitutionalized civilian males was 65 years or older, whereas nearly 14 percent of community-dwelling females were 65 years or older (table 5.1). In 1995, only 5.0 percent of the noninstitutionalized civilian population was 75 years or older (3.8 percent for males and 6.0 percent for females). The segment of the population 85 years of age or over accounted for 1.1 percent (0.7 percent for males and 1.4 percent for females).

With 92.2 percent younger than age 65, the black population was relatively younger compared to the white population. Only 87.1 percent of the white population was younger than age 65. In 1995, nearly 6 out of every 100 white, noninstitutionalized civilian persons were 75 years of age or older. On the other hand, only about 3 out of 100 members of the black, noninstitutionalized civilian population belonged to the age group 75 years or older. Only 1.2 percent of whites and 0.6 percent of blacks were members of the age groups commonly referred to as the oldest old.

5.2.2 The 1995 nursing home population

Table 5.2 provides data on the 1995 nursing home population. In 1995, slightly more than one and a half million persons resided in nursing homes. The residents were predominantly female. Male residents accounted for only 27.3 percent of the total residents. About 88.3 percent were white, and 9.6 percent were black. Only 8 percent of the nursing home population was younger than 65 years. The remaining 92 percent of the nursing home population was 65 years and older. More than half of the nursing home population aged 65 years and over was 85 years or older. Of the total 1995 nursing home population, 46.7 percent (31.6 percent for males and 52.4 percent for females) was in the oldest old age group.

The distribution of the nursing home population by age and race shows that 93 percent of the white and nearly 83 percent of the black nursing home population were 65 years and older. While nearly 49 percent of the white nursing home residents were 85 years of age and over, less than 31 percent of the black nursing home residents belonged to this age group. Finally, compared to the 1995 noninstitutionalized civilian population, the 1995 nursing home population was much older, mainly white, and predominantly female.

5.3 Functional Limitation: The Community and Nursing Home Populations

Data on the functioning status of the community and the nursing home population of 1995 are presented in table 5.3.

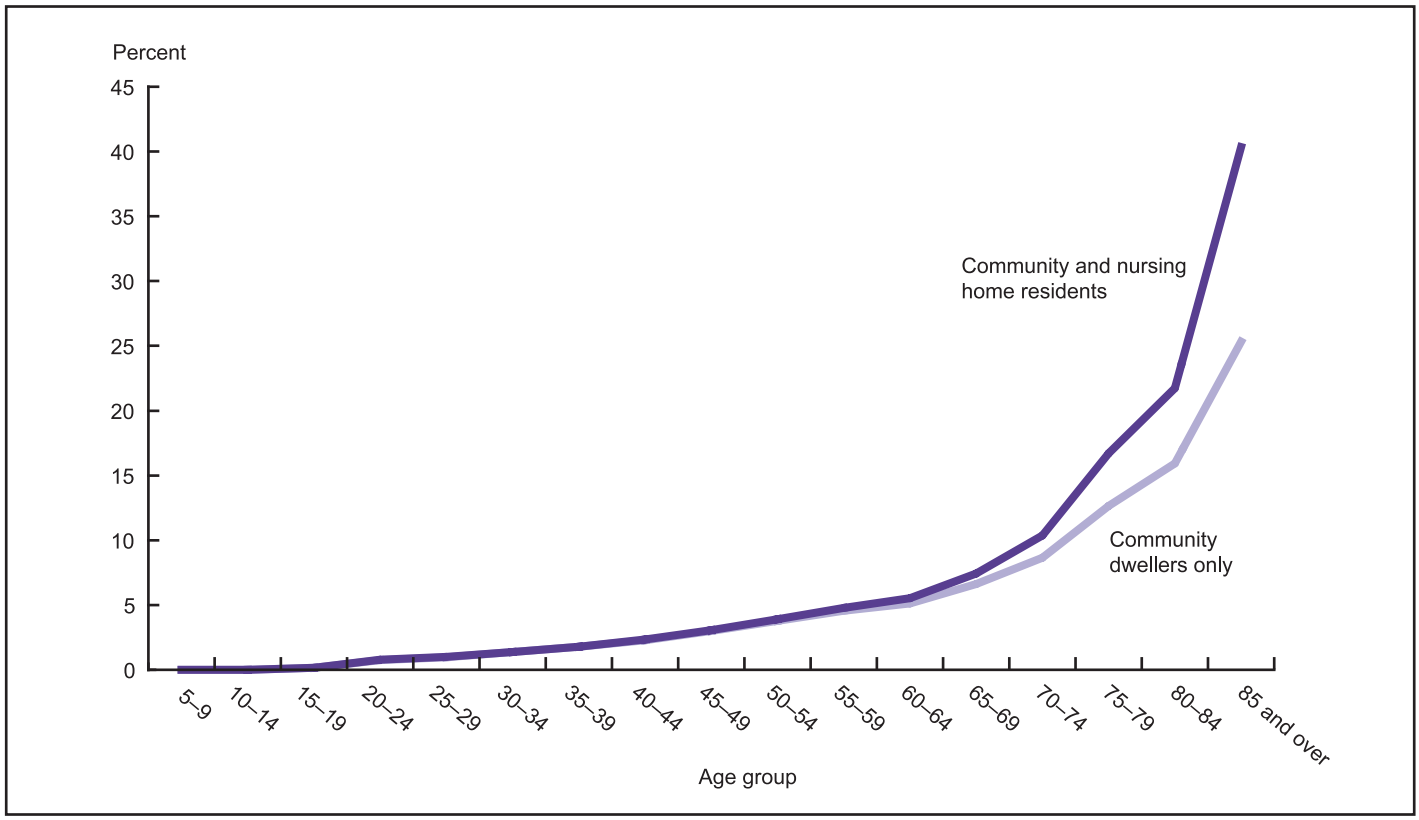

Figure 5.2. Percentage of the female population 65 years of age and over who need help with at least one instrumental activity of daily living, by age and residence: United States, 1995

Data presented in the top half of the table are the percentage of the population having limitation in at least one ADL. In addition to those with at least one ADL, the table also shows the proportion of the community and nursing home populations needing help with at least one ADL or IADL. ADL limitation is defined in terms of the resident's need for the help of another person. Instrumental activities of daily living include the four daily tasks: taking care of personal possessions; handling money; securing personal items; and using the telephone. IADL limitation is defined based on the residents's need for assistance or supervision in performing these activities. Expected years free of activity limitation were estimated using indicators of the need for the help of another person.

5.3.1 Functional limitation: The population 5 years of age and over

The data in table 5.3 show the magnitude of the difference between the prevalence rates of functional limitation in the community and nursing home population, a clear reflection of the role of nursing homes in providing care. According to the data, about 96 percent (93.9 percent for males and 97.0 percent for females) of the nursing home population would be considered limited in at least one ADL. The percentage of the nursing home population that needs help in at least one ADL or IADL rises to 98.4 percent (97.8 for males and 98.6 percent for females).

Age-adjusted prevalence rates show that, compared to the nursing home population, the community-dwelling population is almost free of ADL limitations. The adjusted prevalence rates of ADL limitation for this population is only 1 percent compared to 89.2 percent (86.1 for males and 92.5 percent for females) for the nursing home residents. A similar difference between age-adjusted prevalence rates of functional limitations is also observed when the adjusted rates are measured based on needing help in at least one ADL or IADL. The adjusted rate for the community population that needs help in at least one ADL or IADL is less than 3 percent. On the other hand, the adjusted prevalence rate for the nursing home residents is nearly 97 percent (95.9 for males and 98.0 percent for females).

According to the 1995 National Nursing Home Survey, personal care was provided to 91 percent of the residents 65 years of age and over in nursing homes to assist the residents with at least one ADL (8). The age-sex-specific rates by 5-year age group for the 1995 community and institutional populations needing help with at least one ADL are shown in table 5.4, and the rates for those needing help with at least one ADL or IADL are presented in table 5.5.

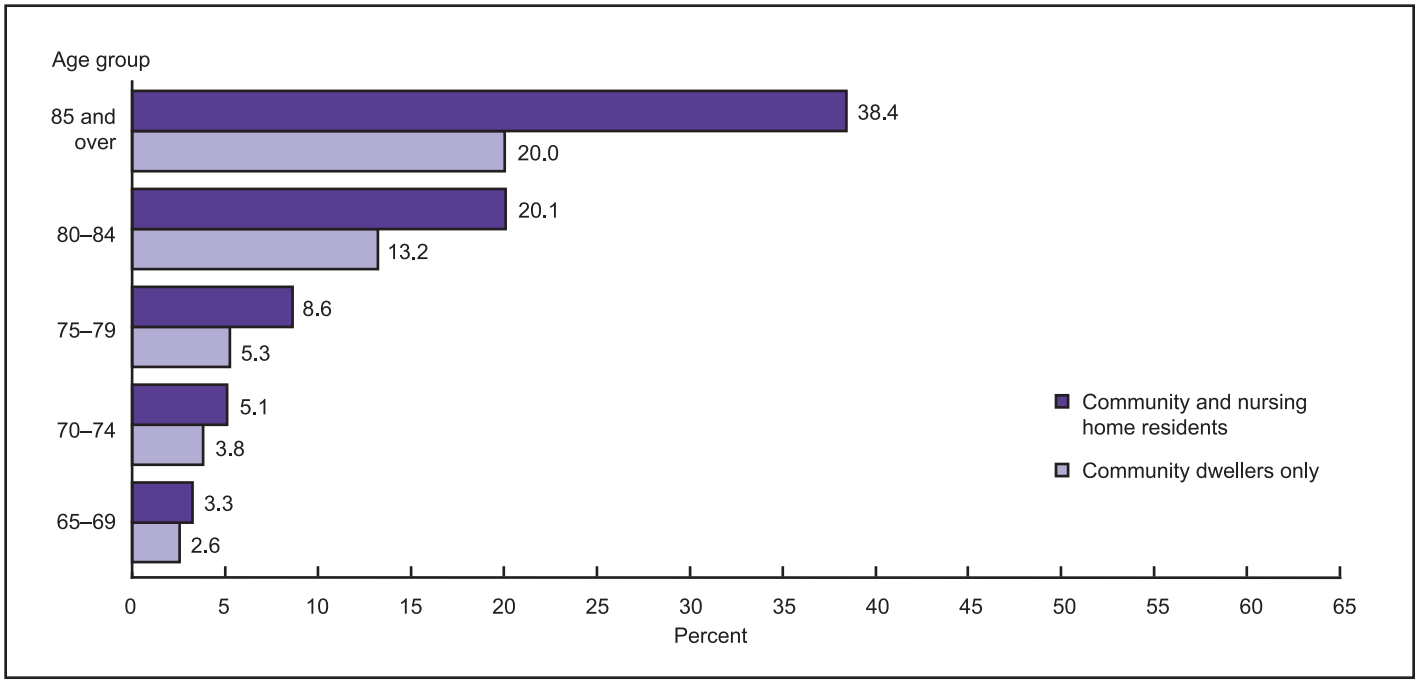

Figure 5.3. Percentage of the female population 65 years of age and over who need help with at least one activity of daily living, by age and residence: United States, 1995

5.3.2 Functional limitation: The population 65 years of age and over

Figures 5.1 and 5.2 show the differences in the prevalence rates of limitations between female community-dwelling and nursing home populations by 5-year age group. Figure 5.1 presents the age-specific difference in the prevalence of ADL-only limitation. Figure 5.2 presents the difference in limitations due to at least one IADL. Both figures indicate that limitations are relatively very low in the younger ages and increase continuously with age. The two figures also indicate that a clearly visible difference in activity limitations for the two population subgroups emerge starting at around 65 years of age. The data seem to suggest the presence of a strong positive correlation between ADL limitations and age, especially after age 65. After age 65, not only are the differences between the two subgroups visible, but they tend to increase with age at a relatively faster rate.

The relative differences in the prevalence rates for females aged 65 and over are presented in figures 5.3 and 5.4. According to figure 5.3, the prevalence rate of limitation in at least one ADL for community-dwelling females rises from 2.6 percent for the 65–69 year age group to about 20 percent for those who are 85 years or over. On the other hand, when ADL data for community-dwelling females are combined with ADL data for female nursing home residents, the percentage rises from 3.3 for the 65–69 year age group to 38.4 for those who are 85 years and over.

Figure 5.4 also shows differences in the age-specific rates of the two populations. Compared to the group differences observed in figure 5.3, the group differences in limitation in ADL or IADL for corresponding age groups tend to be smaller. For community-dwelling females, the prevalence of at least one ADL or IADL limitation rises from 9 percent for those in the 65–69 year age group to 45.4 percent for those who are 85 years of age or over. The corresponding percentages for females residing in nursing homes and female community dwellers combined are 9.7 at the younger age group and 58 at the older age group.

The four figures suggest that the female nursing home resident data's contribution to the variation in the estimation of functional limitations differs by age. The contribution is negligible at the younger ages but becomes substantially larger at the older ages, starting around 65 years of age. This is mainly because the nursing population is predominantly old. After age 65, the contribution to the difference in age-specific rates increases more steeply, whether the prevalence rates are measured based on ADL alone or on the ADL or IADL combination.

Such differences in functional limitation rates for population subgroups have an impact on the estimation of summary measures of health that use these rates as partial inputs or components of the overall estimated summary measure. In the next section, DFLE estimates will be used to demonstrate how including or excluding data on a segment of a population will affect the overall estimated value of a summary measure of health. Since separate mortality data for each population group are not available, the same life table will be used for each of the two population subgroups. It is important to note that a slight difference between the levels of mortality of the two subgroups may exist because of the difference in age and sex composition of the population subgroups. Healthy life expectancy is a summary

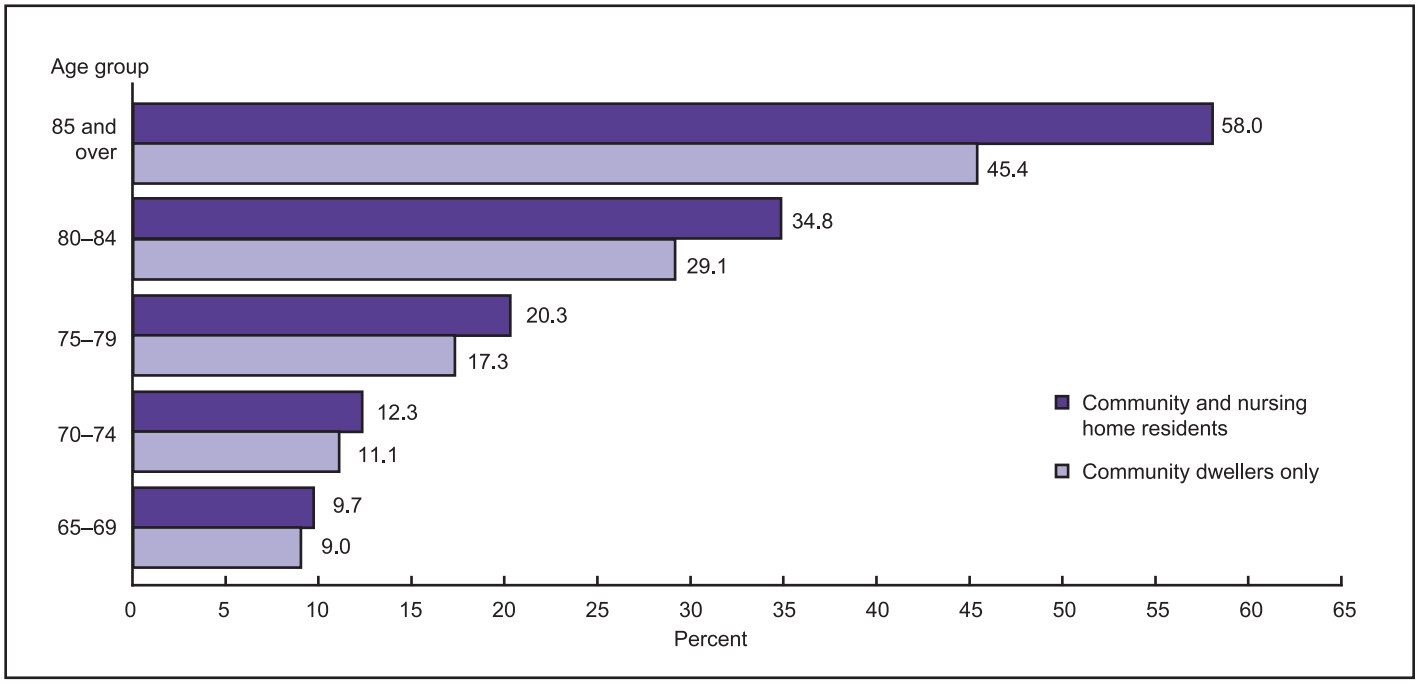

Figure 5.4. Percentage of the female population 65 years of age and over who need help with at least one activity of daily living or instrumental activity of daily living, by age and residence: United States, 1995

measure derived based on a mortality and morbidity (activity or functional limitation) components. Since the same level of mortality is assumed for both population subgroups, any observed difference in the estimated summary measures with and without the nursing home population data will be due to differences in the functional limitations of the two population subgroups.

5.4 Effect on Healthy Life Expectancy Estimates for the Older Population

Estimated life expectancies and HLEs for females in 1995 at selected ages are presented in table 5.6. Four sets of healthy life expectancies were estimated. The first two sets of healthy life expectancies were estimated using age-specific prevalence rates of limitation in at least one ADL. One set of HLEs is estimated for only female community dwellers. A second set of HLEs were estimated combining the data for females community dwellers and female nursing home residents. Two more sets of HLEs were estimated (one for female community residents and a second for the two female population subgroups combined) using prevalence rates of functional limitation in ADL or IADL. The results are presented in the last two columns.

On average, a female who was 65 years of age in 1995 would expect to live 18.8 more years, or to the age of 83.8 years. On the other hand an 80-year-old female would expect to live 8.7 more years. Since the same level of mortality level is assumed for females residing in the community and in nursing homes, the estimated life expectancies in the second column of table 5.6 apply to both groups. Life expectancies could not be estimated for the two groups separately because of data constraints. On the other hand, available data has made it possible to estimate HLEs for the female community population (based only on the population subgroup's health status data) and the combined health expectancies for the two subgroups (based on pooled health status data). Estimating HLE with and without the female nursing home population health data makes a relatively large difference. The differences between the two estimates in years and percentages are given in the fifth and sixth columns.

Estimated healthy years differ by nine-tenths of a year at age 65, by as much as one year at 70 and 75 years of age, and by more than 1 year (1.1 year) at 80 years of age and over. In terms of percentages, excluding nursing home population health data results in the overestimation of HLE at 65 years of age by more than 5 percent. The percentage of overestimation rises with age, relatively slowly at first, but very sharply at the older ages, reaching almost 23 percent at 80 years of age and over.

Healthy life expectancies with and without female nursing home resident data were estimated using data on activity limitation of ADL or IADL. The estimates and the differences (in years and percent) are presented in the last four columns of table 5.6. The differences between estimates with and without female nursing home population health data are very similar to the differences observed between estimates calculated based on functional limitation due to ADL only. When limitation in at least one ADL or IADL is used as the basis to differentiate health states, estimating HLE with and without female nursing home population health data differs from seven-tenths of a year at age 65 to eight-tenths of a year at 85 years of age and over. In terms

of percentages, overestimation of HLE ranges from 4.7 percent at age 65 to 24.2 percent at 85 years of age and over.

A z-score was constructed to test whether the age-specific differences between HLEs estimated with and without female nursing home population data were statistically significant. The statistical tests indicate that, regardless of the health status measure used to differentiate healthy and unhealthy states, excluding nursing home population health data results in a significantly different HLE estimate from one that includes nursing home population health data.

Another institutional population group that may affect the estimation of HLE of the total population is the population in correctional facilities. In 1990, more than one third of the institutional population (1.1 million or 33.4 percent of the institutional population) resided in Federal and State prisons (table C). Of a total of 1.1 million, more than 1 million were males, and about 85,000 were females (9). By 1995, the total population in correctional facilities rose to 1.6 million; about 1.5 million were males, while only about 115,000 were females. About 748,000 were white, and 676,000 were black (10). Detailed data on the health status of this population group were not available to estimate expected years of healthy life including or not including health data on this population group. It should be noted that, to the extent that the health status of this and other similar population subgroups differs from the health status of the noninstitutionalized civilian population covered by NHIS, a variation should be expected between estimates of HLEs estimated for the total population with and without data on any one of these and other population groups.

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Table 5.1. Number and percentage distribution of community residents by sex and race, according to age at interview: United States, 1995

Age at interview	All residents	Sex		Race	
		Males	Females	White	Black
			Number		
All ages	261,902,900	127,576,500	134,326,400	217,206,800	32,754,600
Under 65 years	230,436,500	114,437,000	115,999,500	189,104,200	30,214,400
65–74 years	18,461,400	8,228,800	10,232,600	16,259,000	1,684,000
75–84 years	10,191,500	4,009,400	6,182,100	9,273,000	672,500
85 years and over	2,813,500	901,300	1,912,200	2,570,600	183,700
			Percent distribution		
All ages	100.0	100.0	100.0	100.0	100.0
Under 65 years	88.0	89.7	86.4	87.1	92.2
65–74 years	7.0	6.5	7.6	7.5	5.1
75–84 years	3.9	3.1	4.6	4.3	2.1
85 years and over	1.1	0.7	1.4	1.2	0.6

SOURCE: National Center for Health Statistics. National Health Interview Survey.

Table 5.2. Number and percentage distribution of nursing home residents by sex and race, according to age at interview: United States, 1995

Age at interview	All residents	Sex		Race	
		Males	Females	White	Black
			Number		
All ages	1,548,600	422,300	1,126,200	1,367,200	148,400
Under 65 years	124,500	64,800	59,700	94,700	25,400
65–74 years	189,700	79,500	110,300	154,100	29,600
75–84 years	509,600	144,300	365,400	451,300	47,500
85 years and over	723,500	133,300	590,200	666,200	45,800
			Percent distribution		
All ages	100.0	100.0	100.0	100.0	100.0
Under 65 years	8.0	15.3	5.3	6.9	17.1
65–74 years	12.3	18.8	9.8	11.3	20.0
75–84 years	32.9	34.2	32.4	33.0	32.0
85 years and over	46.7	31.6	52.4	48.7	30.9

SOURCE: National Center for Health Statistics. National Health Interview Survey.

Table 5.3. Percentage of population needing help with at least one activity of daily living and needing help with at least one activity of daily living or instrumental activity of daily living, by broad age group, sex, and place of residence: United States, 1995

Type of assistance and population	Age (in years)					
	Less than 65	65–74	75–84	85 and over	5 and over	Age adjusted
Need personal help with ADL[1]	Percent					
Community population						
All persons	0.7	3.2	8.1	18.8	1.4	1.0
Males	0.7	3.3	7.5	16.0	1.2	1.0
Females	0.7	3.2	8.5	20.0	1.6	1.0
Nursing home population						
All persons	88.7	94.8	96.8	97.3	96.1	89.2
Males	85.5	93.3	96.5	95.5	93.9	86.1
Females	92.2	95.9	96.9	97.7	97.0	92.5
Need help with ADL or IADL[2]						
Community population						
All persons	2.0	9.1	19.4	41.8	3.8	2.8
Males	1.7	7.8	15.3	34.2	2.9	2.3
Females	2.3	10.1	22.1	45.4	4.6	3.1
Nursing home population						
All persons	96.8	98.1	98.5	98.6	98.4	96.9
Males	95.7	98.7	98.7	97.4	97.8	85.9
Females	98.0	97.6	98.5	98.8	98.6	98.0

[1]ADL refers to activity of daily living.
[2]IADL refers to instrumental activity of daily living.

SOURCE: National Center for Health Statistics. National Health Interview Survey (community), National Nursing Home Survey (nursing home residents), and Division of Vital Statistics.

Table 5.4. Percentage of population needing help with at least one activity of daily living, by age, sex, and place of residence: United States, 1995

Age	Community residents only			Community and nursing home residents		
	Male	Female	Total	Male	Female	Total
5–9 years	0.66	0.35	0.51	0.67	0.35	0.51
10–14 years	0.57	0.24	0.41	0.57	0.24	0.41
15–19 years	0.26	0.17	0.22	0.27	0.17	0.22
20–24 years	0.37	0.43	0.40	0.38	0.44	0.41
25–29 years	0.21	0.27	0.24	0.22	0.29	0.25
30–34 years	0.56	0.41	0.48	0.59	0.42	0.50
35–39 years	0.62	0.64	0.63	0.66	0.66	0.66
40–44 years	0.62	0.91	0.77	0.67	0.95	0.81
45–49 years	0.81	0.65	0.73	0.86	0.73	0.80
50–54 years	1.28	1.28	1.28	1.38	1.39	1.39
55–59 years	1.65	1.64	1.64	1.84	1.82	1.83
60–64 years	2.46	2.47	2.46	2.85	2.89	2.87
65–69 years	3.39	2.55	2.94	4.01	3.25	3.60
70–74 years	3.20	3.81	3.55	4.39	5.12	4.81
75–79 years	7.15	5.26	6.02	9.40	8.62	8.93
80–84 years	8.17	13.21	11.30	12.62	20.09	17.32
85 years and over	16.03	20.04	18.75	26.29	38.42	34.87
5 years and over	**1.24**	**1.56**	**1.40**	**1.57**	**2.42**	**2.01**

SOURCE: National Center for Health Statistics. National Health Interview Survey (community), National Nursing Home Survey (nursing home residents), and Division of Vital Statistics.

Table 5.5. Percentage of population needing help with at least one activity of daily living or instrumental activity of daily living, by age, sex, and place of residence: United States, 1995

Age	Community residents only			Community and nursing home residents		
	Male	Female	Total	Male	Female	Total
5–9 years	0.66	0.35	0.51	0.67	0.35	0.51
10–14 years	0.57	0.24	0.41	0.57	0.24	0.41
15–19 years	0.50	0.34	0.42	0.51	0.34	0.42
20–24 years	0.77	1.19	0.98	0.77	1.20	0.99
25–29 years	1.03	1.19	1.11	1.05	1.20	1.13
30–34 years	1.11	1.76	1.44	1.14	1.77	1.46
35–39 years	1.88	2.40	2.14	1.92	2.41	2.17
40–44 years	2.00	3.07	2.54	2.06	3.10	2.59
45–49 years	2.18	3.38	2.79	2.23	3.46	2.86
50–54 years	3.85	5.23	4.56	3.97	5.35	4.68
55–59 years	4.29	6.63	5.50	4.49	6.81	5.69
60–64 years	6.09	6.76	6.45	6.53	7.18	6.88
65–69 years	7.22	9.03	8.20	7.86	9.70	8.86
70–74 years	8.45	11.08	9.95	9.62	12.31	11.16
75–79 years	13.66	17.29	15.83	15.82	20.28	18.49
80–84 years	17.96	29.14	24.91	22.00	34.83	30.08
85 years and over	34.22	45.37	41.80	42.38	58.03	53.46
5 years and over	**2.85**	**4.59**	**3.75**	**3.19**	**5.44**	**4.35**

SOURCE: National Center for Health Statistics. National Health Interview Survey (community), National Nursing Home Survey (nursing home residents), and Division of Vital Statistics.

Table 5.6. Expected years of life and healthy years of female community dwellers and nursing home residents at selected ages: United States, 1995

Age	Life expectancy[3]	Healthy years[1]				Healthy years[2]			
		Community	Community and nursing home	Difference in years[4]	Difference in percent[5]	Community	Community and nursing home	Difference in years[4]	Difference in percent[5]
65 years	18.8	17.3	16.4	†0.900	5.2	15.0	14.3	†0.700	4.7
70 years	15.1	13.7	12.7	†0.994	7.3	11.5	10.8	†0.757	6.6
75 years	11.7	10.3	9.3	†1.000	9.7	8.3	7.5	†0.800	9.6
80 years	8.7	7.2	6.1	†1.091	15.1	5.4	4.6	†0.793	14.6
85 years and over	6.0	4.8	3.7	†1.100	22.9	3.3	2.5	†0.800	24.2

†Statistically significant ($p<0.05$).

[1]Expected years free of limitation in at least one activity of daily living.

[2]Expected years free of limitation in at least one activity of daily living or instrumental activity of daily living.

[3]Life expectancy at the indicated age for the female population, 1995.

[4]Calculated by subtracting "Community and nursing home" from "Community."

[5]Calculated by dividing "Difference in years" by "Community," then multiplying by 100.

SOURCE: National Center for Health Statistics. National Health Interview Survey (community), National Nursing Home Survey (nursing home residents), and Division of Vital Statistics.

6. Summary and Conclusion

In September 1998, NCHS sponsored a two-day workshop entitled "Identifying Summary Measures for *Healthy People 2010*." The workshop had the following objectives:

a) To provide a brief overview of the role of summary measures in *Healthy People 2010*;

b) To identify a set of potential summary measures that should be considered for monitoring progress toward the first goal of *Healthy People 2010*;

c) To examine the ability to compute the potential measures with existing data collection systems; and

d) To specify a research agenda for the next decade to evaluate potential summary of measures.

After considering a number of approaches, the panel recommended that *a set of summary measures including both mortality and various aspects of morbidity or health should be calculated from existing or collectable data.* The set of suggested measures that were suggested included: *years of healthy life defined as life without disability; years of life without functioning problems; years of life without specified diseases; years of life in very good health; and years of life lived with good health behaviors.*

It was also recommended that NCHS set a research agenda based on immediate, short-term, and long-term research needs. In the short-term, it was suggested that the potential need for incidence data be clarified; however, the measures selected for *Healthy People 2010* were to be based on simple prevalence models using already available data.

The purpose of this report is to present the summary of the work done in the initial stages of the summary measures development process. Though the work done so far is part of the overall process of building an integrated summary measure of health, the immediate focus was on the short-term needs of the research agenda. A summary measure of health with two components for accounting both fatal and non-fatal health outcomes was used to estimate expected years of healthy life.

The model used in this report is based partially on life table techniques. The model, now commonly called Sullivan's model, was first introduced in the United States in the late 1960s, and has been used by many countries since then. By 1998, for example, the number of countries that used Sullivan's model to calculate health expectancy had reached 49 (1). The model has been useful for monitoring health trends; measuring health disparities between population subgroups; directing health care planning; projecting short- and long-term health status; and predicting health outcomes achievable through alternative health programs (2). For instance, over the past several years, the model has been used to measure specific health states: life expectancy without limiting or extremely long-standing illness (3); changes in both physical and mental states (4); disability-free life expectancy (5–8); active life expectancy (9); life free of institutionalization (6); life free of severe handicap (6, 10); and dementia-free life expectancy (11–13).

For the purpose of the current project, the model was used to estimate healthy years using different definitions of health. Most data used in the analyses are from NCHS. The mortality data were compiled from death certificates by the NCHS. Data on the health of the noninstitutionalized population were from NHIS, collected by NCHS. Data on the nursing home population were from the National Nursing Home Survey, also collected by NCHS. Annual midyear population estimates were from the U.S. Census Bureau. Healthy years were discussed using the prevalence of activity, work, and functional limitations as well as the prevalence of chronic arthritis, heart diseases, hypertension, and diabetes. Prevalence of overweight and obesity among adults was used to discuss HLE as a measure in the context of health-related behavior. Results are presented both in years of healthy life and as the proportion of remaining life spent in the healthy state.

The report focused on the interpretation of the estimated HLEs and the variation of the results by measure. Healthy life expectancies estimated using different definitions of health were presented in chapter 3. Most of the measures used show that, compared to men of the same age, women would expect more years of healthy life (table 6.1). Yet, when HLE is expressed as a proportion of life expectancy, women would expect a smaller proportion of their lives to be healthy compared to men of the same age. These measures also show that the gender difference in the proportion of life expectancy that is considered healthy persists even at older ages. This is true both for white as well as black adults (table 6.2).

Annual data between 1985 and 1995 were used to investigate trends in life free of activity limitation by sex and race, and the results of the analysis are presented in chapter 4. The analysis revealed that trends in years of life free of activity limitation varied by age, sex, and race. Between 1985 and 1995, there have been net gains in life expectancy for each of the four population subgroups. With regard to years of life free of activity limitation, trends varied by race and sex. White males, and females of both races gained in activity limitation-free years between 1985 and 1995. The number of activity limitation-free years gained by white males were more than those gained by either white females or black females. The number of activity limitation-free years gained by white females were almost the same as years gained by black females. Except at age 65, between 1985 and 1995, black males lost all of their

gained life expectancy to activity limitation. At age 65, gains in life free of activity limitation were observed for all of the four population subgroups.

A comparison of gains in life expectancy and life free of activity limitation at birth, age 20, and age 65 revealed different patterns by age and ethnic group. At age 65, not only was there a gain in life expectancy for each group, but the gain was totally free of activity limitation. That is, there was an overall gain in quality life years. For younger age groups, in general, there was a gain in years free of activity limitation; however, the gain in life expectancy was greater than that in quality life years. However, for the black men, though there was a gain in life expectancy, there was a gain in years with activity limitation rather than years without activity limitation. Hence, not only were the years gained lost to activity limitation, but there was an increase in activity limitation in general.

The omission of data on the health status or mortality of a particular population subgroup will introduce a bias into estimates, especially when the health (or mortality) experience of the subgroup is different from the population at large. Such biases, however, can be reduced by incorporating data on the population subgroup from a different survey. The impact of bias introduced due to the incompleteness of data in the estimation of years of healthy life was tested using data from the NHIS and the NNHS data for the year 1995, and the results are presented in chapter 5.

Years free of functional limitation were estimated separately with and without the NNHS data. Not including the nursing home population in the morbidity component of summary measures of health would result in the overestimation of expected years of healthy life. The overestimation of healthy life increases with age, especially at the older ages. When measuring functional disability in terms of needing help in at least one ADL, without including health data on the nursing home population, healthy life at age 65 is overestimated by nine-tenths of a year or 5.2 percent (from 16.4 years to 17.3 years). At age 80, HLE is overestimated by 1.1 year or 15.1 percent, that is, from 6.1 to 7.2 years.

The report also compared results by measure for the total population and for population subgroups by holding constant major determinants of population subgroups such as age, sex, and race constant. The comparisons of results by measure show that estimates vary by measure, and this was to be expected because the measures assess different dimensions of health. Healthy life expectancies estimated using 11 different definitions of health were compared. The comparisons of the results by measure were made at 30 and 65 years of age for the total population, by sex. Results were also compared by measure, age, and sex, holding race constant; and by measure, age, and race (for white and black persons), holding sex constant.

Comparisons of results by measure at ages 30 and 65 showed that estimates varied by measure for the total population as well as for males and females. On average, a person at both 30 and 65 years of age would expect to have longer life of healthy years when health is defined based on years to be spent without needing help in ADL or IADL, and the same person would expect to have the shortest HLE when health is defined as self-assessed ‘‘excellent’’ health. Expected years of healthy life defined based on the prevalence of chronic diseases fell between the maximum and minimum estimates. Variations between results by measure were smaller at the younger ages compared to the older ages, and they were larger between the races (white versus black) than between the sexes (figures 3.21 and 3.22).

The variations of the results by measure have several implications. These variations support the fact that numerous health measures should be used to estimate various dimensions of health. At the same time, since the variation in results may be partly due to factors exogenous to the various definitions of health, the observed variations by measure should be interpreted prudently. As noted in chapter 5, for example, excluding the institutional population health data in the estimation of HLEs for the total population affects estimates at the older ages, and the exclusion of health data on the correction facilities population is expected to affect the HLE estimates of black adult males compared to any other population subgroup.

Results of the numerous analyses also suggest that HLE calculated using data that are readily available could sufficiently satisfy the short-term research needs of estimating trends and group disparities in health. The Sullivan method uses data on prevalence of health states. When incidence rates are stable over time, estimates derived based on this model are the same as estimates based on a multi-state life table model (14). It has also been noted that the Sullivan method tends to under- or overestimate health expectancy if incidence rates between states of health change rapidly, even when prevalence rates between two periods remain the same (15).

Finally, the model used in this study is simple, the estimates are easy to understand and interpret, and most of the data needed are available. The model can be used to measure trends in population health as well as health disparities between population subgroups. Since HLEs can be calculated based on a variety of health definitions, it could serve as a practical and useful tool for monitoring specific objectives of *Healthy People 2010* that are being tracked based on a single health attribute. The model can also be used as an integral part of a set of models that can measure current health status based prevalence rates and models that use longitudinal data to measure the dynamics of health states, including the transition from any health state to death. While the utility of the measures presented in this report needs to be optimized, the need for more health measures cannot be overemphasized. Also, the need for multiple measures and the need to measure in terms of years as well as percentage of remaining years in a given health state adds to the complexity and provides evidence for the conclusion that there are no simple measures of health.

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Table 6.1. Absolute and relative differences in male and female healthy life expectancy at 30 and 65 years of age: United States, 1995

Age	Women compared to men	
	Healthy life expectancy	*Proportion of life expectancy*
At 30 years of age		
In good or better health	More	Smaller
In excellent health	Less	Smaller
Without major activity limitation	More	Larger
Without any activity limitation	More	Smaller
Without functional limitation (ADL)[1]	More	Smaller
Without functional limitation (ADL or IADL)[2]	More	Smaller
Without chronic arthritis	Less	Smaller
Without chronic heart disease	More	Larger
Without hypertension	More	Smaller
Without diabetes	More	Similar
Without physical illness	More	Smaller
Without mental illness	More	Smaller
With BMI less than 25[3]	More	Larger
With BMI less than 30[3]	More	Smaller
Without a doctor visit	Less	Smaller
Without short hospital stay	More	Similar
At 65 years of age		
In good or better health	More	Larger
In excellent health	More	Similar
Without major activity limitation	More	Larger
Without any activity limitation	More	Smaller
Without functional limitation (ADL)[1]	More	Smaller
Without functional limitation (ADL or IADL)[2]	More	Smaller
Without chronic arthritis	Less	Smaller
Without chronic heart disease	More	Larger
Without hypertension	Same	Smaller
Without diabetes	More	Larger
Without physical illness	More	Smaller
Without mental illness	More	Smaller
With BMI less than 25[3]	More	Larger
With BMI less than 30[3]	More	Smaller
Without a doctor visit	Same	Smaller
Without short hospital stay	More	Larger

[1]ADL refers to activities of daily living.
[2]IADL refers to instrumental activities of daily living.
[3]BMI refers to body mass index.

Table 6.2. Absolute and relative differences in male and female healthy life expectancy for the white and black populations at 30 and 65 years of age: United States, 1995

Age, race, and health status	Women compared to men	
	Healthy life expectancy	Proportion of life expectancy
At 30 years of age		
White:		
In good or better health	More	Smaller
Without any activity limitation	More	Smaller
Without functional limitation (ADL or IADL)[1]	More	Smaller
With BMI less than 30[2]	More	Smaller
Black:		
In good or better health	More	Smaller
Without any activity limitation	More	Smaller
Without functional limitation (ADL or IADL)[1]	More	Smaller
With BMI less than 30[2]	Similar	Smaller
At 65 years of age		
White:		
In good or better health	More	Larger
Without any activity limitation	More	Smaller
Without functional limitation (ADL or IADL)[1]	More	Smaller
With BMI less than 30[2]	More	Smaller
Black:		
In good or better health	More	Smaller
Without any activity limitation	Similar	Smaller
Without functional limitation (ADL or IADL)[1]	More	Smaller
With BMI less than 30[2]	Similar	Smaller

[1]ADL refers to activities of daily living; IADL refers to instrumental activities of daily living.
[2]BMI refers to body mass index.

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