1. INTRODUCTION

Over the past 2 decades, in many developed and developing countries, life expectancy has greatly increased owing to the decrease in mortality. However, this positive change has raised new questions concerning the quality of the years of life gained, particularly for older people. Indeed, the individuals who escape death may still accumulate disabilities, after effects of accidents, or consequences of chronic diseases. So is there reason to fear that current and future progress in life expectancy will bring a deterioration in the mean health status of the population? Several theories have been put forward to answer this question. We will begin by presenting the general outlines of these theories.

These theories need to be confirmed with facts, and an accurate appreciation of the direction in which the facts are evolving is essential to adapt public health policies accordingly. This is why the concepts of health state expectancy, a composite measure of morbidity and mortality, and disability-free life expectancy (DFLE; or active life expectancy [ALE]) have been developed to address this question. We will discuss the development and definition of health state expectancies, defining the concepts underpinning the measurement of health states and giving some results of differentials in health state expectancies to demonstrate the relevance and utility of these indicators.

2. EXPANSION OR COMPRESSION OF MORBIDITY?

For a long time, the increase in life expectancy meant an improvement in the health of populations. Today, this is no longer enough because chronic diseases have replaced, or are progressively replacing, infectious diseases and the risk of becoming ill is not solely linked to the risk of dying (Riley, 1990). Thus, with a constant recovery rate, if the risk of dying diminishes more than the risk of becoming ill, the risk of being ill increases. In other words, the prevalence of chronic disease in the population can increase as a result of an increase in the duration of survival if the decrease in fatality is not offset by an equivalent decrease in incidence.

In the absence of pertinent data on the evolution of morbidity, the relationships that can exist between the patterns of evolution of these risks have been debated, gradually focusing on three theories: (1) an improvement in the state of health or a compression of morbidity (Fries, 1980, 1989); (2) a decline in the state of health leading to an expansion of morbidity (Gruenberg, 1977; Kramer, 1980; Olshansky et al., 1991); and (3) dynamic equilibrium, a kind of status quo (Manton, 1982).

The theory of compression of morbidity states that (1) if the morbid period is defined as the period from appearance of the chronic disability until death, and (2) if the moment when such a morbid event appears...
can be postponed, and (3) if adult life expectancy is relatively constant, then (4) morbidity will be compressed into a shorter time (Fries, 1989).

According to Ernest Gruenberg and Michael Kramer, the decline in mortality is owing to the decrease in the fatality rate of chronic diseases and not to a reduction in their incidence or a slowing down in their rate of progression. Postponement of the moment of death causes more severe states of chronic disease to appear. This is the theory of the **pandemic of mental disorders and disabilities** or, more generally, expansion of morbidity.

Kenneth Manton (1982), who introduced the concept of dynamic equilibrium, proposed that the increase in life expectancy could be explained partly by a slowing down of the rate of progression of chronic diseases. Thus, the prevalence increases as mortality falls, but the prevalent states are, on average, less severe.

These three theories require the development of additional concepts such as the severity of prevalent states or that of disability. Indeed, the consequences of chronic disease are varied, ranging from death to the absence of any discomfort. They have been the object of international classifications (WHO, 1980, 2001), which place disability at their center. Disability is, at the same time, an indicator of the severity of morbid states and an indicator of the quality of years lived. Its introduction led to a considerable improvement in models of health (Fig. 80–1); the risks of disability can thus be added to the risks of disease. By distinguishing levels of severity, the risks of decline or improvement in the functional state of an individual can be measured.

First, the concept of disability allows us to rigorously define the progress of different scenarios of a populations’ health corresponding to the three theories summarized above. Second, the breakdown of life expectancy into the years lived with or without disability provides the necessary tools to observe empirically which of these scenarios is confirmed. Thus, the theory of expansion of morbidity corresponds to the scenario in which the proportion of years lived with disability increases within life expectancy. The theory of compression of morbidity translates into the scenario in which the proportion of years lived with disability decreases within life expectancy. It thus becomes clear that the theory of compression of morbidity is not inevitably linked to the rectangularization of the survival curve (see Chapter 48 of Volume III). It is simply a verifiable fact that the survival rates without disability increase relatively more than do standard survival rates. Finally, taking into account the severity level of the disability, the theory of dynamic equilibrium corresponds to the scenario in which the proportion of years lived with disability—all levels combined—increases while the proportion of years lived with severe disability remains the same or even decreases within life expectancy. These theories correspond to different displacements of the survival curves of Fig. 80–1 to the right. One can imagine that they correspond to different phases in the health transition (see Chapter 57 of Volume III).

The first indicators of health state expectancy to be proposed were disability-free life expectancy (Sullivan, 1971) and, more particularly for the elderly, ALE (Katz et al., 1983). A first calculation of health state expectancy, mostly DFLE, has been made for 49 countries, and repeated calculations exist for 14 of them (Robine and Romieu, 1998; Robine et al., 1999). These calculations pertain to 20 of the 25 developed market economy countries; 4 of the least developed countries; 22 of 97 other developing countries; and 3 of the 22 economies in transition (Table 80–1). At present, it is impossible to compare these health state expectancies directly as the methods and the data used are very different from one country to another (UN, 1990). Similarly, for lack of comparable data, the World Health Organization (WHO) is currently producing crude estimates of disability-adjusted life expectancy for the 191 countries belonging to the organization (WHO, 2000).

An international research network, REVES (Réseau Espérance de Vie en Santé/Network on
Health Expectancy and the Disability Process was set up in 1989 to facilitate international comparisons by examining the requirements for harmonization of health state expectancies (Bone, 1992). The network includes nearly 200 researchers from more than 100 research institutes or universities worldwide. The growth in the numbers of calculations shows there are as many possible health state expectancies as there are health concepts.

### 3. DEFINING AND CALCULATING HEALTH STATE EXPECTANCIES

An important first step toward valid international comparisons of health state expectancies is the harmonization of the conceptual approach to health state measurement. In the following section, we outline the functional approach to health, this being the main category of health state expectancies calculated to date. We also present the calculation methods actually used, because their convergence and harmonization constitute the second step in permitting international comparison of health state expectancies. However, it is important to note that other factors also require harmonization—such as the severity of the states of health taken into account, the protocol of surveys, and the formulation of questionnaires—before the calculations are strictly comparable.

In contrast to mortality, notions such as health or morbidity are complex and thus difficult to define. Health is “a composite of current state and prognosis (i.e., the probability of movement to other states) that occurs throughout an individual’s life” (Fanshel and Bush, 1970). In this way, health is not only “the ability to function now, but the outlook for future functional ability” (Fanshel, 1972). This life-course definition of health is the justification for the use of health state expectancies, as fundamental health indicators for populations, because they measure the lifetime spent in different health states.

During the 20th century, the epidemiological framework changed from communicable and acute diseases to long-term chronic diseases, with a consequent change in the approach to diseases and health. Beyond the presence or absence of disease, the classical biomedic approach, health status may be assessed through perceptual, functional, or adaptive approaches. With the functional approach, good health relates to ideas of effective achievement of roles and tasks, the fulfillment, without difficulty, of different activities. With the perceptual approach, good health relates to ideas such as well-being; a happy attitude to life; or a full, fruitful, and creative life. With the adaptive approach to health, good adaptation testifies to a harmonious relationship with one’s environment. The functional approach and the underlying conceptual framework of the disablement process are key factors in the health assessment of older people, making health state expectancies in combination with this approach and the resulting DFLE, of the utmost importance. Because the majority of health state expectancies calculated can be classified under the functional approach, we will look at this in more detail.

#### The Functional Approach

The functional approach to health is mainly addressed by four models, with some overlap: the model of disablement process (Nagi, 1965, 1976, 1991); the model of the International Classification of Impairments, Disabilities, and Handicaps (ICIDH) (WHO, 1980); the model proposed for the revision of the classification, the International Classification of Functioning, Disability and Health (ICF, WHO, 2001); and the model of handicap creation process (Fougeyrollas et al., 1998). The majority of these models distinguish between a maximum of five states: disease, impairments, functional limitations, activity restriction, and handicap.

Saad Nagi (1991) has the first three states (disease, impairments, functional limitations) followed by disability, which is defined as the inability or limitation in the fulfillment of activities and social roles in relation to work, the family, and an independent life (Nagi, 1991).

The ICIDH combines functional limitations and activity restriction under disability (Fig. 80–2), corresponding to any restriction or lack (resulting from an impairment) of ability to perform an activity in the

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**TABLE 80–1 Health State Expectancy in the World According to Level of Economic Development**

<table>
<thead>
<tr>
<th>Level of development</th>
<th>Number of countries</th>
<th>Countries with calculations</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMEC</td>
<td>25</td>
<td>20</td>
</tr>
<tr>
<td>LDC</td>
<td>47</td>
<td>4</td>
</tr>
<tr>
<td>ODC</td>
<td>97</td>
<td>22</td>
</tr>
<tr>
<td>ET</td>
<td>22</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>191</td>
<td>49</td>
</tr>
</tbody>
</table>

DMEC, developed market economy countries; LDC, least developed countries; ODC, other developing countries; ET, economies in transition.

From Robine and Romieu, 1998.
manner or within the range considered normal for a human being. Under this framework, handicap is characterized by discordance between the activity and status of the individual and the expectations of his social environment (WHO, 1980). For fuller definitions see Appendix 80–1.

The boundary difficulties encountered, together with a need to further specify the area of mental health in the framework, made a revision of the ICIDH necessary. This revision, the ICF (WHO 2001), defines “functioning” and “disability” as umbrella terms covering the three new dimensions: (1) body functions and structure; (2) activities at the individual level, from simple to complex activities; and (3) participation in society. Functioning and disability are conceived as dynamic interactions between health conditions and contextual factors, which include both personal and environmental factors.

At the same time as the revision, an alternative model was devised that established the importance of the environment in the creation of handicap (Fougeyrollas et al., 1998). This model of handicap creation puts the interaction between personal factors (organic systems and abilities) and environmental factors (facilitators or obstacles) at the heart of the model, the result of handicap situations (life habits). Risk factors (causes) are associated with personal factors, organic systems range from integrity to impairment, and abilities range from ability to disability.

Several attempts have been made to combine all or a part of the models described above through a disablement process (Verbrugge and Jette, 1994) or a general model (Robine et al., 1997). The distinction between functional limitations and activity restrictions is central to these attempts, and the scheme with five levels (Fig. 80–3) (Wood, 1975) is preferred by those concerned with international comparisons as it clarifies the limits between impairment and disability and between disability and handicap. Thus, a difficulty concerning actions such as bending or reaching an object is a functional limitation, whereas difficulties concerning activities of daily life (dressing or domestic chores) are activity restrictions. The distinction between functional limitations and activity restrictions has been further blurred by existing measurement instruments that often combine these two levels and rely on apparently similar questions. Moreover, it has been suggested that functional limitations may be used as early indicators of activity restriction, thus avoiding potential heavier care burdens (Fried et al., 1996; Lawrence and Jette, 1996). This two-step approach opens the way for research into new methods of measuring the functional health of populations by using functional limitation and activity restriction as two levels at which public health action could intervene.

The Health Expectancy Classification System

Initially, the term disability-free life expectancy was used without any reference to specific disability concepts. It was sometimes even used as a generic term to designate all health state expectancies. The concepts of the ICIDH (WHO, 1980) makes an initial distinction between life expectancies with or without impairment, life expectancies with or without disability, and life expectancies with or without handicap (social disadvantage). The clarification of concepts and terminology is very important; it facilitates communication between scientists at national and international levels and provides a means to promote these concepts.
more effectively among those responsible for health policy and the general public. It is the first step toward international harmonization of health state expectancies.

Table 80–2 summarizes the classification system currently used (Mathers, 2002; Robine 2002), which generalizes a first system developed by REVES for the WHO on the occasion of the first World Health Report (Robine et al., 1995; WHO, 1995) and is based on previous work by The Netherlands Organization for Applied Scientific Research (Boshuizen and van de Water, 1994) and REVES (Mathers et al., 1994).

Health expectancy is a generic term for all the health-related indicators expressed in terms of expectancy. It includes two main classes of indicators, the health state expectancies and the health-adjusted life expectancies.

Health state expectancy is a generic term for all the health-related indicators that express a defined state of health in terms of life expectancy. These indicators apply equally to positive and negative states of health. Thus, the sum of a complementary series of health state expectancies must always be equal to total life expectancy (Mathers et al., 1994). The calculations of health state expectancy aim to provide indications on the current conditions of mortality and health. The repetition of calculations would make it possible to assess the progress of these conditions.

According to the concepts of the International Classification of Diseases (WHO, 1992), life expectancy with or without disease is the average number of years an individual can expect to live with or without disease if the current conditions of mortality and morbidity persist. A well-known example of this indicator is that of life expectancy with or without senile dementia (Ritchie et al., 1993).

The International Classification of Handicaps (WHO, 1980) distinguishes among the concepts of (1) life expectancy with or without impairment, the average number of years an individual can expect to live with or without

<table>
<thead>
<tr>
<th>TABLE 80–2</th>
<th>Classification System of Health Expectancies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Concepts</strong></td>
<td><strong>Indicators</strong></td>
</tr>
<tr>
<td>Expectancy</td>
<td>Health expectancies (generic term for all)</td>
</tr>
<tr>
<td><strong>Health state</strong></td>
<td>Health state expectancies</td>
</tr>
<tr>
<td>Biomedical approach Disease (ICD)</td>
<td>Life expectancy with or without disease</td>
</tr>
<tr>
<td>—Impairment</td>
<td>e.g., life expectancy with or without dementia</td>
</tr>
<tr>
<td>Functional approach</td>
<td>—Life expectancy with or without impairment</td>
</tr>
<tr>
<td>—Impairment</td>
<td>—Life expectancy with or without functional limitation</td>
</tr>
<tr>
<td>—Disability</td>
<td>—Life expectancy with or without activity restriction</td>
</tr>
<tr>
<td>—Handicap</td>
<td>—Life expectancy with or without handicap</td>
</tr>
<tr>
<td>—Reduction in physical independence</td>
<td>—Life expectancy with or without reduction in physical independence</td>
</tr>
<tr>
<td>—ADL measures</td>
<td>—Active (independent) life expectancy¹</td>
</tr>
<tr>
<td>—Mobility</td>
<td>—Life expectancy with or without mobility handicap</td>
</tr>
<tr>
<td>—Occupation</td>
<td>—Life expectancy with or without occupational handicap</td>
</tr>
<tr>
<td>—Other ICF (2001)</td>
<td>—Life expectancy with or without other handicap</td>
</tr>
<tr>
<td>—Impairment</td>
<td>—Life expectancy with or without impairment</td>
</tr>
<tr>
<td>—Activity limitation</td>
<td>—Life expectancy with or without activity limitation</td>
</tr>
<tr>
<td>—Participation restriction</td>
<td>—Life expectancy with or without participation restriction</td>
</tr>
<tr>
<td>Perceived health approach</td>
<td>Life expectancy in good perceived health / life expectancy in bad perceived health ²</td>
</tr>
<tr>
<td><strong>Health-adjusted</strong></td>
<td>Health-adjusted life expectancies</td>
</tr>
<tr>
<td>Functional approach</td>
<td>Disability adjusted life expectancy (DALE)³ (WHO, 2000)</td>
</tr>
<tr>
<td>Disability</td>
<td></td>
</tr>
</tbody>
</table>

¹The current REVES system for the functional approach combines the International Classification of Impairments, Disabilities, and Handicaps concepts, (WHO, 1980), the activities of daily living measures (Katz, 1983) and the REVES recommendations (1990).

²The use of the term independent life expectancy in place of active life expectancy is recommended to facilitate translation and comparability between countries.

³The terms healthy life expectancy or unhealthy life expectancy are often used for life expectancy in good perceived health or life expectancy in bad perceived health respectively. This was previously recommended by REVES, but given the current use of healthy life expectancy as a synonym of health expectancy by the WHO, this terminology should no longer be used.

⁴As proposed by the WHO (2000) to summarize the health of a population.
or without impairment; (2) life expectancy with or without disability, the average number of years an individual can expect to live with or without disability; and (3) life expectancy with or without handicap, the average number of years an individual can expect to live with or without handicap if the current conditions of mortality and impairment, disability, or handicap persist (cf. definitions in Appendix 80–1). The ICF (WHO, 2001), for its part, distinguishes among (1) life expectancy with or without impairment, the average number of years an individual can expect to live with or without impairment (i.e., with functional and structural integrity); (2) life expectancy with or without activity limitation, the average number of years an individual can expect to live with or without activity limitation; and (3) life expectancy with or without participation restriction, the average number of years an individual can expect to live with or without participation restriction if the current conditions of mortality and impairment, activity, or participation persist (cf. definitions in Appendix 80–1). The correspondence between the two classifications has yet to be defined, but life expectancy with a handicap in the original ICIDH meaning (WHO, 1980) is the nearest indicator to consequences of accidents and chronic diseases in daily life. Fortunately, all deficiencies (impairments) do not lead to a disability (or an activity limitation), and all disabilities do not lead to a handicap in daily life (or an participation restriction). The original ICIDH defines seven major dimensions of handicap (social disadvantage): handicaps of orientation, physical independence, mobility, occupation, social integration, economic self-sufficiency, and the other handicaps. In the same way, definitions are given for life expectancies with or without handicap of physical independence, of mobility, of occupation, etc. However, when the handicap is measured in a global manner, the corresponding indicator is a life expectancy with or without handicap in a general sense.

According to the recommendations of the committee of REVES on conceptual harmonization (Chamie, 1990) and to the attempts to combine the different conceptual models (Verbrugge and Jette, 1994; Robine et al., 1997), life expectancy without disability sensu original ICIDH, encompasses the following concepts: (1) life expectancy with or without functional limitation, the average number of years an individual can expect to live with or without functional limitation; and (2) life expectancy with or without activity restriction, the average number of years an individual can expect to live with or without activity restriction if the present conditions of mortality and functional limitation or activity restriction, respectively, persist (cf. definitions in Appendix 80–1). According to Katz et al. (1983), the ALE measures the average number of years an individual can expect to live without needing help to accomplish a whole series of basic activities of daily life or activities of daily living (ADL), if the current conditions of mortality and disability persist (cf. definitions in Appendix 80–1). ALE is, therefore, a life expectancy without handicap of physical independence in the sense of the original ICIDH. For this reason, it has been suggested that the term active life expectancy be replaced by independent life expectancy. This calculation can be extended to the need for help in realizing a whole series of complementary activities or instrumental activities of daily living.1

According to the perceived health approach, it is necessary to distinguish between perceived health expectancies. Perceived health expectancy is a generic term for all health state expectancies based on data on the perceived state of health. Thus, life expectancy in good perceived health is the average number of years an individual can expect to live in the favorable part of the distribution of perceived states of health (generally according to a scale of the form very good, good, fair, bad, or very bad).

Health-adjusted life expectancy is a generic term for all the life expectancies weighted by the social value given to different states of health in which the years are lived. The weighting used generally ranges from zero for death to one for perfect health (Mathers et al., 1994; Mathers, 2002). This class of indicators is much less developed and contains mainly the disability-adjusted life expectancy, the new WHO indicator for the World Health Report (WHO, 2000), partly drawn from a Canadian indicator (Wolfson, 1996).

Calculation Methods

There are three calculation methods for health state expectancy: (1) the method of observed prevalence tables (Sullivan, 1971), (2) the method of double extinction tables (Katz et al., 1983), (3) and the method of multistate tables (Rogers et al., 1989). In this section the historic DFLE is taken as an example, but the different methods discussed here apply equally well to any other health state.

The main advantage of the method of observed prevalence tables (or Sullivan’s method) stems from separate

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1 In French espérance de vie active means working life expectancy, with actif meaning in the labour force (occupied or unemployed). In English active life expectancy means life expectancy without physical dependence for personal care activities. As demographers have always paid attention to ease of translation, we strongly recommend the common use of independent and dependent life expectancy.
The method of double extinction tables is based on the observation of two events during the study corresponding to two possible departures from the state of good health: death and entry into disability. In practice, it is sufficient to observe directly the probabilities of survival without disability. The main advantage of this method is that it provides a true period indicator from data that are not too difficult to collect. However, the method assumes that the disability studied is irreversible, which is the case with dementia, and that the recovery of lost functions is negligible.

The method of multistate tables was proposed to take recovery to good health into account. The main advantage of this method, based on transitions between different states of health, is that it provides a period indicator that takes the reversibility of states of disability into account. However, the data necessary for the calculation are scarce as they are difficult and expensive to collect. Finally, note that the multistate methods, as the method of double extinction, imply that the data on mortality and disability are collected in the course of the same study. The precision of mortality data depends, as a consequence, on the sample being of a sufficient size.

Most of the calculations of health state expectancy have been obtained with the method of observed prevalence tables (Sullivan’s method, cf. Appendix 80–1). This method provides a very useful indicator as long as its limits are well understood (Robine and Mathers, 1993). The difference between the Sullivan and the multistate methods is not the use of prevalence versus the use of incidence and recovery. In both methods the prevalence is used in the calculation and comes from incidence and duration (recovery and lethality). But in the Sullivan method, the cross-sectionality observed (or current) prevalence comes mainly from past flows of incidence and recovery, whereas in multistate methods, the equilibrium prevalence (or table prevalence) comes from current flows only. So the use of observed prevalences is not a suitable method for making instantaneous comparisons of health conditions in two countries or for establishing projections concerning the future health of populations. For all these reasons, it is preferable to observe and to use the period transitions between the different states of health. (For more details on the standard and advanced methods, respectively, see Cambois et al., 1999; Laditka and Wolf, 1998.) EuroREVES, the European REVES committee has produced a first manual on the Sullivan method (Jagger, 1997), and a software application on the multistate approach has been finalized (Lièvre et al., 2003).

The health state expectancies aim to answer practical questions. Is the increase in life expectancy accompanied or not by an increase in the time lived with disability? Is DFLE increasing faster than is life expectancy, leading eventually to a compression of the time lived with disability? With the current concepts of disability, health state expectancies now aim to assess eventual differentials in the evolution of life expectancy without functional limitation and life expectancy without activity restriction. The disablement process—leading from accidents or chronic diseases to activity restrictions and social participation limitations—is complex, and measures to halt the process may be taken at different levels. Thus, an increase in the time lived with functional limitation may not necessarily be followed by an increase in the time lived with activity restriction or social participation limitation. Another question is whether or not an increase in the time lived without disability is accompanied by an increase in the time lived in good perceived health, a closer indication of individual satisfaction.

The goal of health state expectancies is clearly to monitor health transitions at work through the different components of health: mortality/longevity, measured or reported morbidity, functional limitation at the body level, activity restriction in daily life (i.e., in the daily environment), and perceived health. The

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2 In epidemiology, cross-sectional surveys study a population at one point in time: they serve to collect information on stocks (prevalence) or on past events. Longitudinal surveys follow a group of subjects over a period of time and allow the registration of new events (incidence). Demographers would prefer the term point survey to cross-sectional survey and the term prospective survey to "longitudinal survey", but the terms cross-sectional and longitudinal are standard throughout the literature.

3 In this regard, the Sullivan method is much more robust than is the multistate approach. The methodology to assess the accuracy and quality of data collected through cross-sectional surveys is well developed, known, and used. It constitutes the topic of several chapters in statistical textbooks about the accuracy of estimations (e.g., confidence interval) and in epidemiology textbooks about the validity of indicators (e.g., sensitivity, specificity). Conversely, the methodology to assess the quality of data on individual transitions through longitudinal surveys is underdeveloped: in particular, how should expected misclassifications be separated from true transitions (according to the sensitivity-specificity of the indicator used) in the successive waves?

4 Imach Version 0.8 (Lièvre et al., 2003) available via the Internet (http://euroreves.inded.fr/imach).
period life table offers a strong conceptual and statistical framework for this, making it possible to design a complete family of integrated indicators. Health state expectancies, together with life expectancy, thus form a coherent set of health indicators to monitor health transitions at work in different countries. All the indicators are expressed in years so that basic combinations, such as summation or ratios, are easy to calculate and are immediately meaningful. The aim of these indicators is to summarize the health and mortality conditions over a period of time. This period characteristic is the essential precondition for monitoring change over time by repetition of the calculations.

4. TRENDS AND DIFFERENTIALS IN HEALTH STATE EXPECTANCIES

In addition to change over time, the estimates of health state expectancies already reported have brought information on sex, socioeconomic, and geographic differentials. They have also supplied information on the causes of morbidity and disability. The references of the studies summarized here can be found in Robine and Romieu (1998) or Robine et al. (1999), otherwise they are given in notes.

Sex Differentials

The wide differential between sexes found in life expectancies is not reproduced as strongly with the health state expectancies. Most studies indicate that life expectancy and positive health state expectancy (e.g., handicap-free, disability-free) are longer for women, and that the proportion of positive health state expectancy to total life expectancy is slightly lower for women in developed (Fig. 80–4) and in developing countries (Lamb, 1999).

Results from studies using data from repeated waves of surveys have suggested that the greater proportion of years lived with disability or handicap by women may be explained by the relatively higher survival of women after the development of these disabilities or handicaps (Robine and Ritchie, 1991; Mor et al., 1994).

Socioeconomic and Sociodemographic Differentials

To date, socioeconomic variables have been included in studies from nine developed countries: Austria, Belgium, Canada, Finland, France, The Netherlands, Sweden, the United Kingdom (London), and the United States. All studies except one from the United States (Guralnik et al., 1993) have demonstrated that social inequalities in health are much greater than has been shown by differential mortality: not only do the poorest and the least educated not live as long, but they also experience a greater part of their life with disability or handicap.

This was first observed in Canada, according to income levels (Wilkins and Adams, 1983). The gap in life expectancy between the richest and poorest sections of the community increased from 6.3 years for overall life expectancy to 14.3 years for occupational handicap-free life expectancy (Table 80–3).

Finnish and Dutch studies point to socioeconomic inequalities by level of education. The conclusions are
similar: the higher the educational level, the higher the life expectancy and positive health expectancy. The calculations comparing different ethnic groups in the United States (Hayward and Heron, 1999) show dramatic differences to the detriment of the black population and to the benefit of the Asian population.

In France, repetition of the calculations at 10-year intervals shows that social inequalities in health remained constant for men over age 35 over the 1980s: gaps between the managerial staff group and the manual workers group in terms of life expectancy and DFLE, at ages 35 and 60, have not changed. In 1980 and 1991, at age 35, the managers group could expect an additional 5.4 years of life and an additional 7 years of life without disability compared with levels for the manual workers group. At age 60, the gaps reached 3 expected years of life and 4 expected years of life without disability. Nevertheless, this upholding of inequalities over the period is the result of an equivalent increase in life expectancy and DFLE for the socio-occupational groups (Cambois et al., 2001).

National Geographic Comparisons

Several countries have computed estimates in order to make geographic comparisons across large geographic areas (Australia, Canada, France, Italy, Spain, and United Kingdom) (Robine and Romieu I, 1998) or between rural and urban areas (China and India). As with differences in life expectancy, differences in health expectancy across different geographic areas in the same country vary widely, although no general trends can be inferred.

In India, for example, comparisons in physical DFLE have been made between rural and urban males and females. Both life expectancy and physical DFLE are longer in more developed urban areas than in the less developed rural areas (see Table 80–5).

Figure 80–5 illustrates the area variations by using data for the United Kingdom. British researchers have computed expected years of ill health for numerous local areas, using data from the 1991 census. These calculations show that the local area with the shortest life expectancies also have the largest expected number of years in ill health. Whatever the causes of these area variations, it is more obvious that there may be a strong relationship between short life expectancy and amount of morbidity.

In all the situations studied and presented here based on sex, socioeconomic status, and geographic differentials, life expectancy and DFLE are positively associated with little evidence of the hypothetical trade-off between quantity and quality of life.

### TABLE 80–4 Life Expectancy and Disability-Free Life Expectancy for Two Occupational Groups and for the Total French Male Population, 1980 and 1991

<table>
<thead>
<tr>
<th>Occupational groups</th>
<th>Life expectancy</th>
<th>Disability-free life expectancy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>35 years</td>
<td>60 years</td>
</tr>
<tr>
<td></td>
<td>35 years</td>
<td>60 years</td>
</tr>
<tr>
<td>Managers</td>
<td>41.3 43.5</td>
<td>19.1 21.1</td>
</tr>
<tr>
<td>Manual workers</td>
<td>35.9 38.1</td>
<td>15.8 18.0</td>
</tr>
<tr>
<td>Total male population</td>
<td>37.9 40.2</td>
<td>17.3 19.2</td>
</tr>
<tr>
<td>From Cambois et al., 2001.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### TABLE 80–5 Physical Disability-Free Life Expectancy in India by Sex and Residence, 1991

<table>
<thead>
<tr>
<th></th>
<th>At birth</th>
<th>At age 65</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male Rural Urban</td>
<td>Male Rural Urban</td>
</tr>
<tr>
<td></td>
<td>Female Rural Urban</td>
<td>Female Rural Urban</td>
</tr>
<tr>
<td>Life expectancy</td>
<td>58.4 63.7</td>
<td>12.7 12.8</td>
</tr>
<tr>
<td>Physical disability-free life expectancy</td>
<td>56.6 60.7</td>
<td>6.6 7.4</td>
</tr>
</tbody>
</table>

From Guha, 1995.
Causes of Handicap, Disability, and Mortality

Potential gains in DFLE can be calculated after elimination of various pathologies, with a resulting ranking of the causes contributing to mortality and prevalence of morbidity (disability or handicap). Studies of this type have been undertaken to date for five developed countries (Australia, Canada, The Netherlands, United Kingdom, and United States). These studies have demonstrated an important effect produced by the elimination of osteo-articular diseases and accidents; in developed countries, these causes are of major importance after cardiovascular disease.

The results for The Netherlands in 1987–1988 show that although the elimination of fatal diseases leads to an increase in life expectancy and DFLE, it may also lead to an increase in life expectancy with disability, thus increasing the burden of disability to society (Nusselder et al., 1996). However, the elimination of disabling nonfatal diseases results in a decline in life expectancy with disability (Table 80–6). Thus, the suppression of certain cancers would strongly increase life expectancy without increasing DFLE in the same proportion and therefore would strongly increase life expectancy with disability. Conversely, the suppression of nonfatal diseases, such as arthritis, would strongly increase DFLE without changing total life expectancy and therefore would strongly decrease life expectancy with disability. Between these two extremes, the suppression of fatal disabling diseases, such as heart diseases, would increase life expectancy and DFLE in various proportions.

Time Trends

Several time series of handicap-free life expectancy or DFLE have now been produced for 15 developed countries. A time series consists of at least two cross-sectional health surveys using the same measure of disability and handicap and comparable samples allowing comparisons over time. When the series are juxtaposed, they cover a period that extends over more than 30 years. Most authors distinguish between life expectancy without severe disability and life expectancy without disability, all levels of severity combined. DFLE most often means all levels of disabilities combined.

Figure 80–6 presents total life expectancy and life expectancy without disability—all disability levels combined—at age 65 in men in eight countries (United States, United Kingdom, Finland, Australia, France, New Zealand, Germany, and Canada) from 1970 to 1995. The analysis of the oldest series demonstrates that life expectancy without disability—all levels combined—is stagnating. However, the series across countries differentiate over time. For instance, the Canadian and Finnish series still suggest that DFLE is leveling off, whereas the American, French, British, and German series show that DFLE is now increasing, and the Australian series is decreasing. Hence, no general conclusion can be firmly drawn for this level of disability even if the general perception—when looking at Figure 80–7—is that although life expectancy is increasing whatever the country, DFLE—all severity levels combined—is apparently leveling.
**TABLE 80–6** Change in Total Life Expectancy, Disability-Free Life Expectancy, Life Expectancy with Disability, and Percentage of Life Free of Disability Owing to the Elimination of the Specific Disease, The Netherlands, 1987–1988

<table>
<thead>
<tr>
<th>Disease</th>
<th>Male at age 65</th>
<th>Female at age 65</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LE  DFLE  LED  % DFLE/LE</td>
<td>LE  DFLE  LED  % DFLE/LE</td>
</tr>
<tr>
<td>At baseline</td>
<td>14.2 6.9 7.3 48.9</td>
<td>18.8 6.2 12.6 33.1</td>
</tr>
<tr>
<td>Chronic nonspecific lung disease</td>
<td>0.3 0.5 –0.2 2.2</td>
<td>0.1 0.2 –0.1 1.0</td>
</tr>
<tr>
<td>Heart disease</td>
<td>3.1 1.5 1.6 0.0</td>
<td>2.7 0.9 1.8 0.0</td>
</tr>
<tr>
<td>Cancer</td>
<td>3.1 1.5 1.6 0.0</td>
<td>2.7 0.9 1.8 0.0</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>0.1 0.0 0.1 –0.1</td>
<td>0.3 0.3 0.0 1.0</td>
</tr>
<tr>
<td>Arthritis/back complaints</td>
<td>0.0 0.7 –0.7 5.0</td>
<td>0.1 1.0 –1.0 5.3</td>
</tr>
<tr>
<td>Migraine/severe headache</td>
<td>0.0 0.1 –0.1 0.4</td>
<td>0.0 0.1 –0.1 0.4</td>
</tr>
<tr>
<td>Other neurological diseases</td>
<td>0.1 0.1 0.0 0.3</td>
<td>0.1 0.1 0.0 0.3</td>
</tr>
</tbody>
</table>

From Nusselder *et al.*, 1996.

**FIGURE 80–6** Evolution of life expectancy and disability-free life expectancy—all disability levels combined—in various countries at age 65. (From Robine and Romieu, 1998.)
Total life expectancy and life expectancy without severe disability at age 65 is shown for men in six countries (United States, Japan, United Kingdom, Australia, France, and Canada) from 1970 to 1994 (Fig. 80–7). Life expectancy without severe disability roughly parallels total life expectancy, meaning that the number of years lived with severe disability is leveling off. This result can be verified whatever the developed country or the period of time studied or the indicator of severe disability considered (e.g., institutionalization in the United States; institutionalization or confinement to house for France; personal help or supervision required or impossibility to perform basic tasks in relation with self care, mobility, and verbal communication in Australia).

It is probable that the difference between the results obtained for severe disability and disability (all levels combined) is attributable to the less subjective declaration of severe disability compared with declaration of light disability. As time goes on, health requirements are increasing, and what was once considered normal for an age, sex, or social position is now considered disabling. This may well explain an apparent decrease in DFLE as well as incoherent trends between countries, with cultural differences explaining different perceptions of health. Nevertheless, this type of subjective trend has a greater effect on light disabilities than on severe disabilities, as the latter have always been perceived as disabling. The trends in severe DFLE are probably much more representative of the health status of the population.

In summary, it is apparent from the data available, that the increase in life expectancy is not accompanied by an increase in the time spent with severe disability. The results indicate at worst a pandemic of light and moderate, but not severe, disabilities. These results therefore tend to confirm the theory of dynamic equilibrium, which partly explains the increase in life expectancy by a slowing down in the rate of progression of chronic diseases (Manton, 1982). Thus, although the decline in mortality can lead to an increase in the prevalence of disabilities, these disabilities are less severe.

In France the general model of health transitions (WHO, 1984) has been used to compare the evolutions of life expectancy, DFLE, and life expectancy without chronic disease. The results show that the increase in life expectancy between 1981 and 1991 has been accompanied by a parallel increase in DFLE, and life expectancy without chronic disease has remained constant (Fig. 80–8). This apparent contradiction in the evolutions of morbidity and disability again illustrates the theory of dynamic equilibrium proposed by Manton in 1982: with the decline in mortality, the prevalence of chronic diseases increases but the diseases are less severe (Robine et al., 1996).
5. WHAT CONDITIONS CONSTITUTE THE YEARS LIVED IN BAD HEALTH OR WITH DISABILITY?

Finally, Tables 80–7 and 80–8 are given to illustrate the nature of years lived in bad health or in disability by people over 65 years.

In France, the health survey of 1991–1992 showed that a problem of disability or of handicap affected 39.8% of years lived outside institutions by men over 65 in France and 51.2% of years in women (Table 80–7). In men, 28.7% of years lived were with functional limitations of mobility and agility (unable to walk 200 m without stopping and without severe discomfort, great difficulty in going up and down stairs, or picking up an object from the floor), whereas 14.7% of years were with difficulties of communication (great difficulty in reading or following a conversation on the telephone), 12.1% of years were confined to the home, and 9.0% of years were lived with handicaps of physical independence (confined to a bed or an armchair or great difficulty getting dressed, washing, going to the toilet, and using the toilet).

**TABLE 80–7** Different Health State Expectancies at Age 65, France, 1991

<table>
<thead>
<tr>
<th>Quality of life</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Life expectancy</td>
<td>15.7</td>
<td>20.1</td>
</tr>
<tr>
<td>Institutionalized</td>
<td>0.5</td>
<td>1.2</td>
</tr>
<tr>
<td>Noninstitutionalized</td>
<td>15.2</td>
<td>100</td>
</tr>
<tr>
<td>of which</td>
<td></td>
<td></td>
</tr>
<tr>
<td>With functional limitations of mobility and agility</td>
<td>4.4</td>
<td>28.7</td>
</tr>
<tr>
<td>With a diff. of communication</td>
<td>2.2</td>
<td>14.7</td>
</tr>
<tr>
<td>Home confined</td>
<td>1.8</td>
<td>12.1</td>
</tr>
<tr>
<td>Physically dependent (ADL)</td>
<td>1.4</td>
<td>9.0</td>
</tr>
<tr>
<td>Dependent for eating</td>
<td>0.5</td>
<td>2.9</td>
</tr>
<tr>
<td>Confined to bed or armchair</td>
<td>0.4</td>
<td>2.8</td>
</tr>
<tr>
<td>At least one of these problems</td>
<td>6.0</td>
<td>39.8</td>
</tr>
<tr>
<td>Without difficulty and performing</td>
<td>5.7</td>
<td>37.8</td>
</tr>
<tr>
<td>Without dementia*</td>
<td>15.1</td>
<td>19.2</td>
</tr>
<tr>
<td>With dementia</td>
<td>0.6</td>
<td>0.9</td>
</tr>
</tbody>
</table>

*Life expectancy with or without dementia (Ritchie et al., 1994). From Robine et al., 1995.
or feeding oneself). For 2.9% of the time lived, men had great difficulty in feeding. It can also be seen that each of the most severe levels (time lived with great difficulty in feeding, in institutions, or with a dementia or time confined to a bed or an armchair) concerns only a small part of the years lived. The table also shows that although women declare many more functional limitations of mobility and agility, there are no great differences in the handicaps of physical independence. On the contrary, with regard to the proportion of years lived, not only without disability but also with good performance in the instrumental activities of daily life such as preparing a meal or filling in care expenditure claim forms, the proportion is higher for women (43.8%) than for men (37.8%).

Table 80–8 shows similar information from longitudinal surveys in Nottingham and Leicestershire, England, in 1985: 37.3% of years lived by men over 65 years are not perceived as years of good health (52.0% for women), 14.6% of years are lived with urinary incontinence, 8.9% with depression, 8.3% with mental impairments, and 4.5% with impairments of mobility (idea close to confinement to bed or an armchair).

The development of dementia-free life expectancies initiated by Ritchie (1991) has been conducted in 10 countries (Australia, Belgium, Denmark, France, Japan, The Netherlands, Spain [Catalonia], Switzerland, United Kingdom, and United States), although only 4 of the calculations are presented at a national level. In parallel with dementia-free life expectancies, other types of mental health expectancies are now being developed such as depression-free life expectancy and life expectancy in good mental health (Jagger et al., 1998).

Health state expectancies can also assist in establishing public health priorities when potential gains are calculated. Gains in health state expectancies make it possible to classify priorities according to the survival or health criteria used in the calculation. This leaves a degree of choice to public health authorities by providing them with all the elements necessary to decide between longevity and, for example, duration of life with or without disability.

Health state expectancies can be used for direct comparison of the different groups that make up the population, whatever the distribution criterion used—e.g., sex, socio-occupational category, region—because, for their calculation, the years lived are divided by the number of survivors, which make them independent of the size and age structure of the populations from which the data are obtained.

As a rule, the calculations of health state expectancies are based on observed data: period life tables, results of population censuses, and results of various surveys (e.g., living conditions, health, disability, labour force). This explains why estimations of health state expectancies are currently available for only about 50 countries, and why these estimations are not directly comparable from one country to another. In fact, the national characteristics of the different surveys, in terms of protocol, questionnaire, or question formulation, make international comparisons difficult. This is the major weakness of the present calculations of health state expectancy.

5 However, when the data necessary to the methodological works devoted to health expectancies and its calculation methods were not available, they have been simulated (Mathers and Robine, 1997).
The profusion of possible indicators, as illustrated by Tables 80–7 and 8, makes it necessary to make a choice, consistent with the basic conceptual framework, because too many indicators may divert attention and too few indicators may hide the possible trade-off between the different facets of health as well as the effects.

Standardization of disability data should become a priority. A first objective could be the harmonization of the underlying concepts followed by the measurement of disability according to severity levels in the general population. For the most severe states, a consensus should not be too difficult to find, as almost all the countries use measures of personal care activities limitations to calculate severe disability (e.g., eating, dressing, washing). Moreover, these elementary activities are universal. The extension of this approach to other types of activity is worth exploring to standardize the measurement of less severe disability levels (e.g., mobility, household care activities, professional or school activities).

In conclusion, health state expectancy indicators are relevant and meaningful indicators for policymaking. Health state expectancies are not summary measures of population health aimed at replacing life expectancy or the most basic indicators, such as the prevalence or the raw figures. However, they do make it possible to assess whether the increase in life expectancy is accompanied by a compression of morbidity or by an expansion of disability. Very recent studies show that people with the lower risks (defined on the basis of smoking, body mass index, and exercise patterns) not only live longer but experience fewer years of disability before death (Vita et al., 1998; Ferrucci et al., 1999; Nusselder et al., 2000). None of these three studies suggest that there is a trade-off between quantity and quality of life but rather, at least for two of them, that there is a possible compression of disability, with quantity and quality going hand in hand. Thus, if future increases in life expectancy are owing to better behaviors, they could be accompanied by a larger increase in DFLE, leading to a compression of morbidity. In fact, in the United States, certain forecasts of disability in elderly populations are very optimistic (Manton et al., 1997).

Nevertheless, health state expectancies have not become a routine indicator of the health status of the population as they are not currently comparable across countries. Standardization of the concept and of the disability questionnaire used to calculate health state expectancies would resolve this problem. Direct comparisons across countries would then be as easy as the comparisons of life expectancies are today, and this task has already begun in the European Union (Robine et al., 2001).

References


to the Department of Health. Leicester, University of Leicester and University of Nottingham.


APPENDIX 80–1

1. International Classification of Impairments, Disabilities, and Handicaps

In the International Classification of Impairments, Disabilities, and Handicaps (ICIDH), the World Health Organization distinguishes among impairments, disabilities and handicaps (WHO, 1980). Basically, one finds an organic or functional anomaly corresponding to the intrinsic situation, which can be exteriorized by the impairment, objectivized by the disability, and socialized by the handicap.

Impairments

In the field of health, impairment corresponds to all loss of substance or alteration in a physiological or anatomical structure or function (WHO, 1980). Impairments are linked to pathologies that can be organic as well as functional.

Note that impairment is wrongly interpreted as an organic or functional lessening as it also means all forms of organic or functional surplus (having six fingers on one hand is an impairment) likely to hinder the normal function of an individual’s faculties.

Disabilities

In the field of health, a disability corresponds to any partial or total reduction (resulting from an impairment) in the capacity to carry out an activity in the manner or in the limits considered normal for a human being (WHO, 1980).

Within the subject of disability, a distinction can be made between functional limitations and activity restrictions if one chooses to distinguish between the realization of actions and the realization of activities, which the WHO does not do.

Note that disability is wrongly interpreted only as an “impossibility or a difficulty in realizing an activity,” whereas all forms of inappropriate, exaggerated, or untimely realization of an activity outside the normal must be considered.

Handicaps

“In the field of health, the handicap (social disadvantage) for a given individual results from an impairment or a disability which limits or prevents the accomplishment of a normal role (consistent with age, sex, social and cultural factors)” (WHO, 1980). Such a handicap is assessed on the basis of a judgment, which depends on the performance of activities making up the role studied.

2. Functional Limitation and Activity Restriction, REVES Classification System

Functional Limitation

Depending on the degree of severity, functional limitation is impossibility or difficulty in performing an action. The measurement of functional limitation is
complicated, as individuals generally have daily activities in common (eating, personal hygiene, housework, etc.), but they are not always challenged by the same actions in the course of these activities (e.g., housework does not necessarily mean climbing stairs, reaching up, bending down, etc., for everyone.) It thus becomes difficult to obtain information on the performances of the subject; to reveal a specific functional limitation, it is preferable to obtain information either on the aptitude in performing a defined action or the cause of the difficulty encountered when faced with a particular activity, generally including the realization of the action being studied.

**Activity Restriction**

This represents impossibility or difficulty, depending on the degree of severity in performing an activity. It is measured in terms of performances when the activity is considered to be an unavoidable component of a role studied. For example, all subjects whose social role is housekeeping will be questioned on their ability to wash the dishes, do the housework, and do the laundry.

Finally, a distinction can be made between the difficulty or impossibility, depending on the degree of severity, of carrying out a gesture, an action, an activity, or a role. When limited to the field of locomotion, which is more illustrative, a correspondence table grading these different types of difficulty can be drawn up. A difficulty in performing a gesture is an impairment. A difficulty in performing an action a functional limitation. A difficulty in performing an activity corresponds to an activity restriction. A difficulty in performing a role corresponds to a handicap.

3. Activities of Daily Living, Basic or Instrumental, Proposed by Katz et al. (1963) or Lawton and Brody (1969)

**Personal Care Activities**

These are a set of activities considered to be indispensable for ensuring minimal independency such as washing and eating. They correspond to activities that the subject must do for himself, with or without help, and that nobody else can do for him. From this definition, Sydney Katz et al. (1963) elaborated a model bringing together six activities of daily living considered to be common to all with the aim of minimal independency: feeding, bathing, going to toilet, dressing, transfer (moving in and out of bed or chair), continence. This forms the model of reference for many studies.

**Household Care Activities**

These are all the activities representing the ability to live alone in a private home. They include household care activities known as instrumental activities of daily living such as filling in forms, shopping, or cooking. They correspond to activities normally carried out by the subject in daily life, with or without help, but that may possibly be carried out by someone else. The model of reference was proposed by Powell Lawton and Eliane Brody (1969).

4. International Classification of Functioning, Disability, and Health (ICF, WHO, 2001)

In the context of a health condition:

**Body functions** are the physiological functions of body systems (including psychological functions).

**Body structures** are anatomic parts of the body such as organs, limbs, and their components.

**Impairments** are problems in body function or structure such as a significant deviation or loss.

**Activity** is the execution of a task or action by an individual.

**Activity limitations** are difficulties an individual may have in the performance of activities.

**Participation** is involvement in a life situation.

**Participation restrictions** are problems an individual may experience in involvement in life situations.

**Environmental factors** make up the physical, social, and attitudinal environment in which people live and conduct their lives.

**Sullivan’s Method**

**Principle**

The years lived by the population in a life table are separated into years lived with or without disability. The rates of institutionalization (which generally come from population censuses) and the short-term or long-term disability prevalence rates (which generally come from health or disability surveys) can be used for this purpose. Once the table is modified, life expectancies with or without disability are calculated in the usual way. Thus, by including only the years lived without disability, a life expectancy without disability is obtained, or conversely, by including only the years lived with disability, a life expectancy with disability is obtained.
**Calculation**

Using the survivors (b) from a life table (cf. table below), the number of years lived between each age (c) is calculated. The prevalence rates of disability (d) can then be used to calculate the number of years lived with disability. By simple subtraction, the number of years lived without disability (e) is obtained. These years are then added together (f) from any age x and divided by the total number of survivors at this age (b) to obtain the life expectancy without disability (g).

**Example**

The total number of years lived without disability from 65 years of age is 1,153,013.2 in the table. This total is divided by the number of survivors at 65 years old to estimate life expectancy without disability at this age: 1,153,013.2 (f) divided by 89,347 (b), i.e., 12.9 years (g).

For more information, see Jagger (1997).

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**TABLE 80–A Disability-Free Life Expectancy According to Sullivan's Method, France, 1991, Female**

(Simplified Estimation Calculated from Long-Term Disability)

<table>
<thead>
<tr>
<th>Age (x) (a)</th>
<th>Survivors (Sx) (b)</th>
<th>Years lived between x and x + a (c)</th>
<th>Prevalence of disability between x and x + a (d)</th>
<th>Years lived without disability between x and x + a (e)</th>
<th>Years lived without disability from x (f)</th>
<th>Long term DFLE from x (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>100,000</td>
<td>496,176.5</td>
<td>0.0097</td>
<td>491,366.7</td>
<td>7,075,234.3</td>
<td>70.8</td>
</tr>
<tr>
<td>5</td>
<td>99,242</td>
<td>496,287.5</td>
<td>0.0242</td>
<td>484,295.5</td>
<td>6,583,867.6</td>
<td>66.3</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>65</td>
<td>89,347</td>
<td>436,686.7</td>
<td>0.1885</td>
<td>354,389.6</td>
<td>1,153,013.2</td>
<td>12.9</td>
</tr>
<tr>
<td>70</td>
<td>84,952</td>
<td>408,481.5</td>
<td>0.2740</td>
<td>296,546.1</td>
<td>798,623.6</td>
<td>9.4</td>
</tr>
<tr>
<td>75</td>
<td>78,000</td>
<td>363,545.5</td>
<td>0.3455</td>
<td>237,955.9</td>
<td>502,077.5</td>
<td>6.4</td>
</tr>
<tr>
<td>80</td>
<td>66,522</td>
<td>290,185.4</td>
<td>0.4675</td>
<td>154,519.8</td>
<td>264,121.6</td>
<td>4.0</td>
</tr>
<tr>
<td>85</td>
<td>48,434</td>
<td>297,869.1</td>
<td>0.6320</td>
<td>109,601.8</td>
<td>109,601.8</td>
<td>2.3</td>
</tr>
</tbody>
</table>

DFLE, disease-free life expectancy.
Data from Robine and Mormiche P, 1994.
Dear Author:

During the preparation of your manuscript for publication, the questions listed below have arisen. Please attend to these matters and return this form with your proof. Many thanks for your assistance.

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<tr>
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</tbody>
</table>