Health Expectancies in the European Union

Progress achieved

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This document has been prepared for the European Union. It is intended to contribute to the development of the health information system in Europe, in the framework of the community action on health monitoring (1997-2001) [Decision n°1400/97/EC, 1997]. It extends, a concerted action (1994-1997) in support of harmonization of health expectancy calculations in Europe: Euro-REVES (DG XII, Biomed I, n° BMH1-CT94-1491)

This report provides a study of the conceptual framework underlying health expectancy calculations, an analysis of the calculations conducted in the European countries, and a discussion of the policy relevance of these measures.

Five annexes provide more information on definitions and classifications of health expectancy measures (Annex 1) and on methods of calculations (Annex 2). They also provide crude results of calculations (Annexes 3, 4, and 5).

Contents:

Health Expectancy in the European countries: progress achieved

1. Introduction

Regarding European countries, the first calculations of health expectancy, disability-free life expectancy or life expectancy in good perceived health were published in the late 1980s. They concerned France in 1982 [Robine et al., 1986], England and Wales in 1976, 1981 and 1985 [Bebbington, 1988] and the Netherlands in 1981-1985 [van Ginneken and Bonte, 1989; van Ginneken et al., 1991].

REVES (Réseau Espérance de Vie en Santé / International Network on Health Expectancy), which was set up in 1989 on the initiative of INSERM (French National Institute for Health and Medical Research), promoted these calculations, particularly in Europe. They are now available in 13 out of the 15 European Union countries.

So far, chronological series of health expectancy have been carried out in 8 countries, Denmark (1987-1994), Finland (1978-1986), France (1981-1991), Germany (1986-1995), the Netherlands (1983-1994), Spain (1986-1991), Sweden (1975-1990) and the United Kingdom (1976-1994).

Most of European countries presently use these data in the official reports on their population's health status. Several of them have recently published complete reports or books entirely devoted to health expectancies, among which Finland [Sihvonen, 1994], the United Kingdom [Bone et al., 1995], Belgium [Roelands and Van Oyen, 1995], the Netherlands [van de Water et al., 1995; van der Maas and Kramers, 1997] or France [Dupâquier, 1995].

As regards non European countries, only Australia, Canada, Japan, New Zealand and the United States have similar data available on their population's health status. Among developing countries China, Korea and Taiwan have started to gather similar data.

However the major limit of the health expectancies that have been published so far is the fact that they cannot be compared at an international level. REVES European teams have examined this issue in full detail in the framework of BIOMED 1: Euro-REVES, a concerted action in support of harmonization of health expectancy calculations in Europe [Robine et al., 1997b]. As a health expectancy is the combination of a life expectancy with a concept of health, there are as many possible health expectancies as health concepts. Therefore it is necessary to choose first the health concepts which should be retained to carry out European comparisons of health expectancies, and then to define how to gather comparable data for the calculations.

Before going back, in our conclusion, to the three avenues that could be followed by the European Union to obtain health expectancies comparable among European countries, in the framework of the Health Monitoring Programme, we need first to assess the present state of the question.

International agencies (WHO, OECD...) have soon understood that health expectancies were of interest to compare the health status of the populations of different countries [for example, see WHO, 1984 and 1997a; OECD, 1976 and 1997].

In Europe, as early as 1985, the WHO retained disability-free life expectancy as one of the indicators making it possible to measure the implementation of the Health for All regional objectives. This indicator was then presented as optional, as the WHO stated that "further research was necessary to make a comparative use of this type of indicator possible" [WHO, 1985]. By the time, the harmonization of the calculation of disability-free life expectancies was part of the objectives of the Consultation to develop common methods and instruments for Health interview surveys, set up in Europe by the WHO as early as 1988. A working group, gathering France, the United Kingdom, the Netherlands, Sweden, as well as other concerned countries, was to be set up to devise a series of indicators on life expectancy free from disability to be promoted to the list of essential indicators [WHO, 1988]. But in fact, it never worked, and in the final report of the Consultation, the recommendations regarding disability-free life expectancy are still vague [WHO, 1996].

The Maastricht Treaty has given the European Commission an explicit mandate for undertaking action in the field of public health. Knowing about existing problems, their nature, and their extent is a prerequisite for such action. Thus, the Commission established as soon as 1993 a working party on health data and indicators. This working party recommended the development of a Community Health Information System [Ministry of Health, Denmark, 1994] and, in 1995, the Commission proposed the establishment of a five-year action programme on health monitoring which was adopted in July 1997.

In parallel, anticipating the Commission's needs, Eurostat established various task forces as early as 1996 to harmonize health statistics in the Union. These task forces were grouped together in the LEG Health in 1997. This work is being carried out in collaboration with WHO-Europe, which has just got a financial grant from BIOMED 2 to carry on their studies on the harmonization of interview health surveys in Europe (EuroHis).

The decision of the European Parliament and of the Council adopting a programme of Community action on health monitoring within the framework for action in the field of public health (1997-2001) is accompanied with a list of areas in which health indicators may be established. Health expectancies come first on this list.

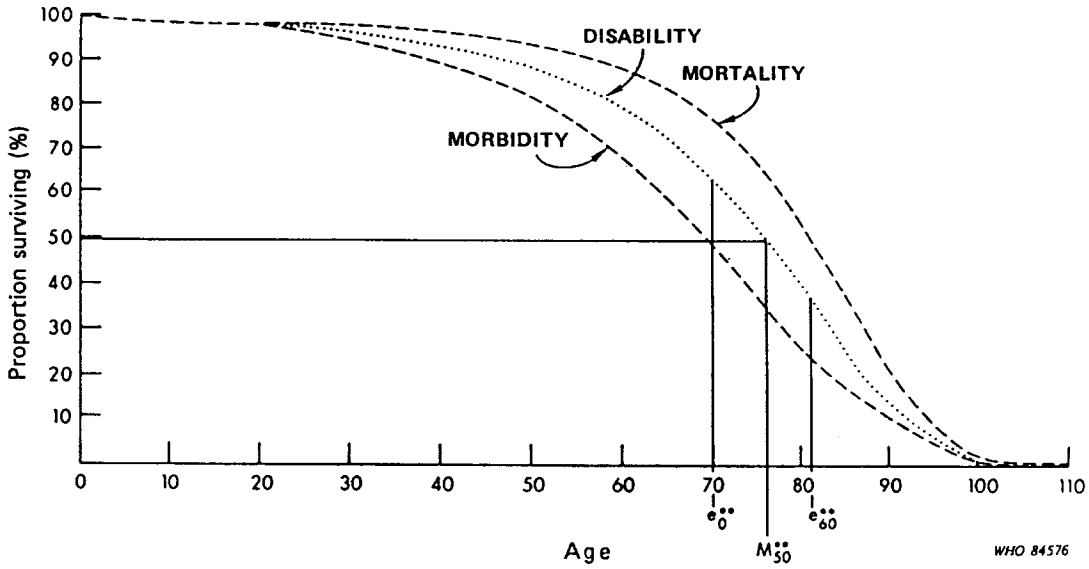
So, what about health expectancies in Europe? Before choosing any strategy, this report aims first to assess the present state of the question in Europe, by largely relying on the data gathered by the concerted action Euro-REVES and on the updated information provided by the European members of the REVES network.

2. Conceptual framework

2.1 General Model of Health Transitions

The calculation of health expectancies is based on a general model of health transitions which was proposed to the World Health Organisation (WHO) by a group of experts in epidemiology of ageing in 1984. This initial model, which distinguished between total survival, disability-free survival and survival without disabling chronic disease [WHO, 1984], led to the calculation of life expectancy (LE), disability-free life expectancy (DFLE), and life expectancy without chronic disease.

Figure 1: **General model of health transitions [WHO, 1984]:** The observed mortality and hypothetical morbidity and disability survival curves for females in the United States of America in 1980.



e_0^{**} and e_{60}^{**} are the number of years of autonomous life expected at birth and at age 60, respectively.
M_{50}^{**} is the age to which 50% of females could expect to survive without loss of autonomy.

This model is relevant in simultaneously assessing the evolution of mortality, morbidity and disability conditions. Thus, estimates can be made as to whether any of the different health scenarios proposed is occurring: pandemic of chronic diseases and disabilities [Gruenberg, 1977; Kramer, 1980], compression of morbidity [Fries, 1980, 1989], contradictory evolutions including the scenario of dynamic equilibrium [Manton, 1982], or postponement of all morbid events (diseases, disabilities and mortality) at older ages [Strehler, 1975].

Based on this model, three indicators - life expectancy (LE), disability-free life expectancy (DFLE), and life expectancy without chronic disease - are calculated and make up a family of indicators. These indicators can be interpreted independently from each other or according to each other. This property is explained by the fact that they are all derived from complex life tables - that is, extension of standard life tables to morbidity and disability - by breaking up life expectancy into

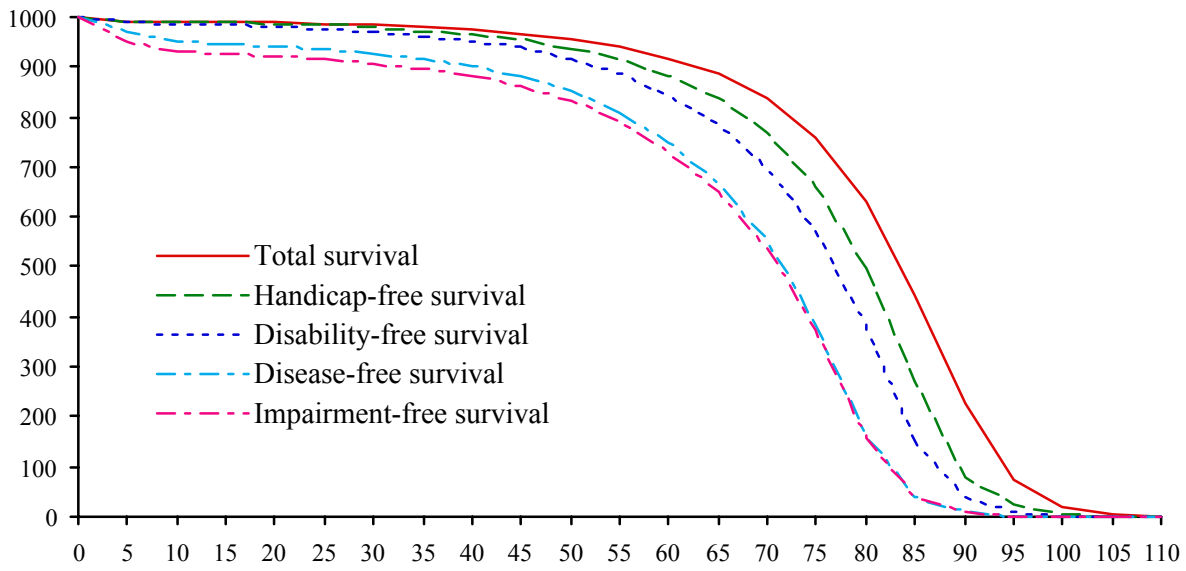
complementary series of health expectancies. Thus, whatever the studied distribution of health states may be, the sum of complementary health expectancies is always equal to total life expectancy (LE). For example, disability-free life expectancy (DFLE), plus life expectancy with disability (LEWD) is equal to total life expectancy (DFLE + LEWD = LE). Additionnaly, disability-free life expectancy divided by total life expectancy (DFLE / LE) provides the proportion of years lived without disability.

2.2 Concepts of health used in the calculation of health expectancy indicators

A health expectancy is clearly defined as the combination of a life expectancy with a concept of health making it possible to distribute the years lived according to the health state they are lived in. **Consequently, there are as many possible health expectancies as health concepts**. Since the initial model, several improvements have been proposed which increase the type of health information integrated to the family of health expectancies. For example, we can introduce the following notions: physical, mental or social well-being [UN, 1946], models of disease consequences [WHO, 1980] and disability processes [Nagi, 1976; Pope and Tarlov, 1991], models of performance for daily living activities [Katz et al., 1963; Lawton and Brody, 1969; Johnson and Wolinsky, 1993] or successful ageing [Rowe and Kahn, 1987].

Physical, mental or social well-being : the definition of health by the World Health Organization - "*Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity*" [UN, 1946] - introduces the notion of perceived health and provides a reference framework for the calculation of life expectancy in good health.

Figure 2: Application of the concepts of the International Classification of Impairments, Disabilities, and Handicaps [WHO, 1980] to the general model of health transitions (adjusted on the total survival curve observed in women, in France, 1986-1988)



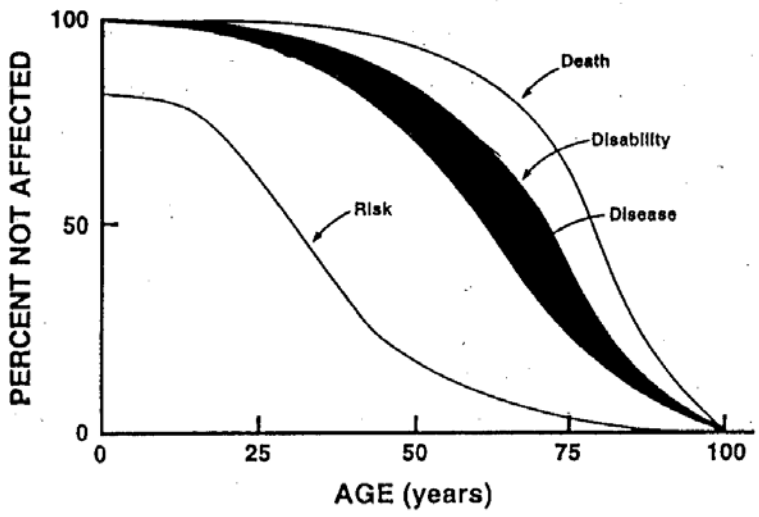
Consequences of disease and disability processes: the introduction of the concepts of the International Classification of Impairments, Disabilities, and Handicaps [WHO, 1980] allows to distinguish between disease-free survival, impairment-free survival, disability-free survival and handicap-free survival [Robine et al., 1997a], (Figure 2).

Physical independence: The introduction of models of performance for daily living activities (ADLs) makes it possible to calculate life expectancy without loss of independence, known as 'active life expectancy' [Katz et al., 1983].

Moreover, several levels of severity can be introduced for any of the concepts described above. Several authors distinguish between several levels of disability, in particular severe disability, resulting in the separate calculation of life expectancy without severe disability and disability-free life expectancy, all levels combined [Robine et al. 1997]. This will be explained more fully in Section 3.5.

Successful ageing: Taking into account models of successful ageing, combined with the introduction of a new curve called "survival without significant risk factor damage" [Manton, 1989] or more simply "risk" [Rowe, 1990] enables us to make a distinction, among survivors without chronic disease or disability, between those presenting significant risks to develop chronic diseases with ageing, what we call "normal ageing", and those presenting only low risks, what we call "successful ageing" [Rowe and Kahn, 1997], (Figure 3).

Figure 3: Application of successful ageing concepts [Rowe and Kahn, 1987] to the general model of health transitions [Rowe, 1990]



These models enable one to introduce such notions as survival without loss of autonomy [Grimley-Evans, 1983], survival without loss of robustness, or survival without loss of vitality (high functioning level).

2.3 The classification system developed by REVES:

In light of the increase in the number of concepts used to calculate health expectancy, there was a clear need to clarify the different concepts used. In 1994, REVES proposed a classification system of health expectancies based on the concepts of the WHO international classifications of diseases and their consequences [WHO, 1980, 1992], on those of perceived health and on those of adjustments on health [Robine et al., 1994], (see Annex 1).

Table 1 : Classification system of health expectancies developed by REVES, 1994

	Concepts	Health expectancies
ICD-10	Disease	With or without disease - With or without dementia
ICIDH	Impairment	With or without impairment
	Disability	With or without functional limitation With or without activity restriction
	Handicap	With or without handicap With or without physical independence handicap - (Independent) Active life expectancy With or without mobility handicap With or without occupational handicap With or without other handicap
	Perceived health	In good health / in bad health
	Health-adjusted	Health-adjusted

Source: Robine et al., 1994

With the classification system developed, we can thus distinguish between life expectancies with or without disease (senile dementia-free life expectancy proposed by Ritchie in 1991, for example), life expectancies with or without impairment, life expectancies with or without disability, and life expectancies with or without handicap (active life expectancy, for example). We can also distinguish life expectancies in good or bad perceived health.

Any other carefully defined concept of health, allowing one to distribute the years lived, can be used to calculate a specific health expectancy, in particular the new concepts of health expected to be introduced in the ICIDH-2 on the occasion of its revision process (WHO, 1997b). The flexibility of health expectancies makes it possible, for example, to calculate life expectancies within or outside institutions (nursing home...), life expectancies with or without loss of autonomy (or physical independence). As an example, Table 2 presents the different health expectancies worked out in United Kingdom in 1994.

Table 2: Health expectancies at age 65 according to the different concepts of health, United Kingdom, 1994

	Male		Female	
	1981	1994	1981	1994
Life expectancy	12,9	14,8	16,9	18,6
Life expectancy independent in ADLs	11,6	13,5	14,4	15,6
Life expectancy mobile outdoors unaided	11,6	12,9	13,3	14,0
Life expectancy without Limiting Long-standing Illness	-	8,5	-	9,8
Quality adjusted life years	-	11,2	-	12,6

Source: Bebbington and Darton, 1996

In addition, there has been recent developments of variations on life expectancies in good health - not based on the perceived health status data - such as, good mental health expectancy [Perenboom and van de Water, 1997]. New developments and applications of different health concepts will most likely lead to further revisions and new additions to the current classification system.

2.4 The methods of calculation

Three different methods of calculation of health expectancies exist, according to the data available: (i) the observed prevalence life table method (the Sullivan method); (ii) the double decrement life table method; (iii) and the multistate life table method (see Annex 2).

The Sullivan method is the most often used method since it relies on data which is currently available. Its limits are increasingly better understood and simulations provide a useful means of assessing its imprecision [Mathers and Robine, 1997]. Even if it would be preferable that all calculations be made with the multistate method - and this will naturally occur as period data estimates become available - the Sullivan method provides a useful indicator which can be used, as long as its limitations are understood.

3. Analysis of the main results

Health expectancy calculations have been carried out in 49 countries in the world, of which 18 out of the 41 European countries, principally using the observed prevalence life table method (the Sullivan method). The calculations mostly concern the European Union countries (13 out of 15).

Table 3: Health expectancy calculations in the European countries and in the remaining part of the world

	countries	countries with calculations	
	n	n	%
European Union countries	15	13	86,7
Other European countries	26	5	19,2
Non European countries	150	31	20,7
Total	191	49	25,6

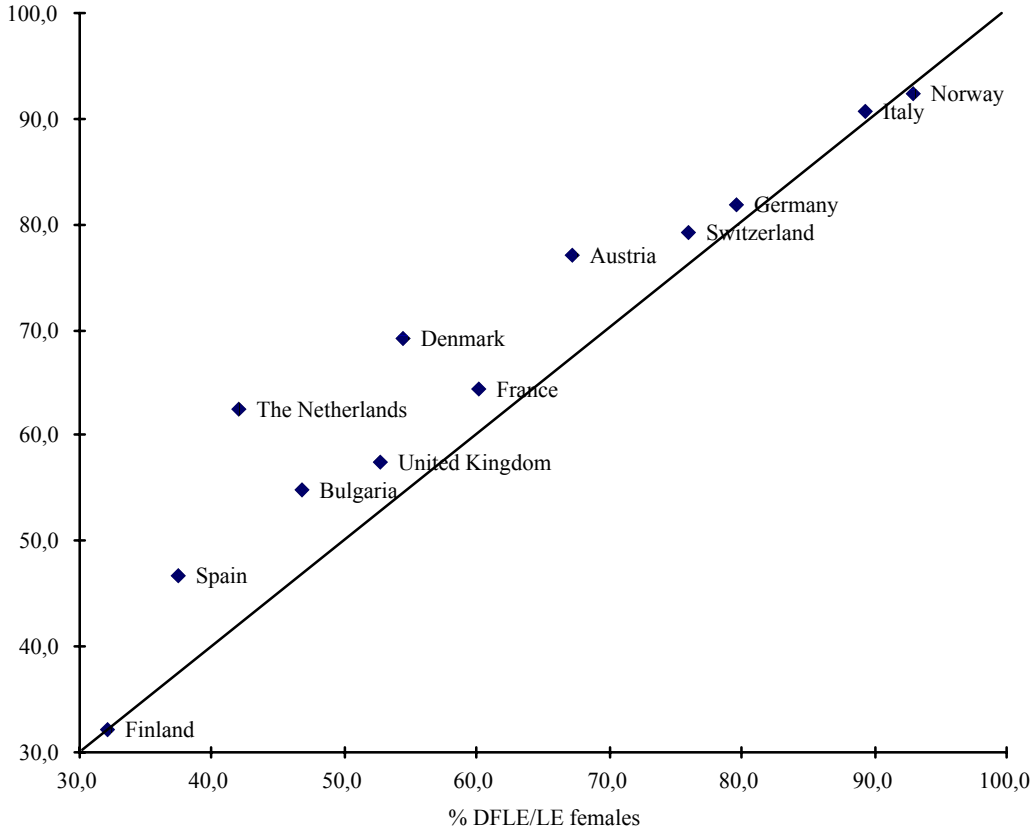
The results of the calculations vary greatly when they are not compared within the specific classification levels [Robine et al, 1994]. After reviewing the data in context of the REVES classification system, the results on the whole are more consistent when comparing across countries. (See Annex 3). **Even within classification levels, there may be variation in the wording of questions related to the concept of disability and handicap used in the calculation**. Nevertheless, some values stand out, as active life expectancy for Finland (See Annex 3, Table 2). This variation may be due to errors in classification of the different measures, although we have based our classification on all the available information from each country.

Annex 3 presents the most recent national results in four sets of tables of the main 'positive' health expectancies by sex at age 0 and at age 65, except for dementia-free life expectancy - which is reported at ages 65 and 85. Countries appear in a table only if these values are available. It is important that results not only be presented at birth, but also at higher ages in order to illustrate the changes in health status and shift between years of life in good health and ill health over lifetime. While the presentation of results at birth is obvious, the choice of a higher age is arbitrary. Age 65 may, however, be considered a reasonable compromise, as detailed prevalence data are not always available for higher than 65 age groups. For the countries presented in this study, complementary results for other ages may often be found in the original sources.

3-1 Gender differentials

The wide differential between sexes found in analysis of life expectancy is not so wide in the estimates of health expectancy. If most studies indicate that life expectancy and positive health expectancy (e.g., handicap-free, disability-free, etc.) are longer for females, they also indicate that the proportion of positive health expectancy to total life expectancy is slightly lower for females (see Graph 1).

Graph 1: Proportion of "Disability"-free life expectancy (% DFLE) in OECD countries: Males versus Females at age 65



Results from studies using data from repeated wave 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, 1989; Robine and Ritchie, 1991; Mor et al., 1994].

3-2 Socio-economic and socio-demographic differentials

To date, socio-economic variables have been included in studies from 6 countries: Austria, Belgium, Finland, the Netherlands, Sweden, and the United Kingdom (London). These studies 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 live not as long, but they also experience a greater part of their life with disability or handicap** [van den Bos and van der Maas, 1993; Boshuizen et al., 1994; van Oyen et al., 1994; Valkonen et al., 1994; Petterson, 1995 and 1998; Doblhamer and Kytir, 1996: Bebbington and Darton, 1996].

This was first observed in Canada by Wilkins and Adams [Wilkins and Adams, 1983a, 1983b], according to income levels. These authors have shown that the gap in life expectancy between the richest and poorest sections of the community increases from 6.3 years for overall life expectancy to 14.3 years for disability-free life expectancy.

Finnish and Dutch studies point to socio-economic inequalities by means of calculations of life expectancies and health expectancies for several educational levels (See Tables 4 and 5). The conclusions are similar: the higher the educational level, the higher the life expectancy and 'positive' health expectancy.

Table 4: General handicap-free life expectancy at age 65 in Finland by sex and level of education, 1986

	At birth				At age 65			
	Male		Female		Male		Female	
Levels of education	LE	HE	LE	HE	LE	HE	LE	HE
Basic	-	-	-	-	13,4	3,7	17,4	5,5
Secondary	-	-	-	-	14,6	5,5	18,6	5,9
Higher	-	-	-	-	15,8	8,6	19,4	9,0
All	-	-	-	-	13,6	4,4	17,6	5,7
Differences higher / basic	-	-	-	-	2,4	4,8	2,0	3,6

Author's denomination and source: *Disability-free life expectancy*, Valkonen et al.,1994

Table 5: Healthy life expectancy at birth in the Netherlands by social class (measured by level of education at age 18), 1990-1994

	At birth			
	Male		Female	
Levels of education	LE	HE	LE	HE
Low	72.2	52,0	79,1	54,5
Middle	74.0	58,2	80,0	61,3
High	75.7	63,8	82,6	66,0
Differences high / low	3,5	11,8	3,5	11,5

Author's denomination and source: *Life expectancy in good perceived health*, van Herten et al., 1997

Expected number of years in full health by socio-economic status has been calculated for the Swedish population aged 35-84, for four periods (1975-80; 1981-85; 1986-90; 1991-95). Table 7 shows the large differences in life expectancy in full health between classes. This difference is even increasing with time.

Table 6: Healthy life expectancy by socio-economic status between ages 35 and 84 in Sweden, 1991-95.

	Male		Female	
Socio-economic status 1991-95	LE	HE	LE	HE
Unskilled workers	40,7	14,9	44,6	15,3
Skilled workers	41,2	15,2	44,7	16,1
Salaried employees	41,3	19,1	44,7	18,7
Salaried employees high and middle	42,2	22,0	45,0	21,4
Differences high / low 1991-95	1,5	7,1	0,4	6,1
Differences high / low 1981-85	2,0	6,8	0,3	5,1

Author's denomination and source: *Expected number of years in full health*, Sweden's Public Health Report 1997, 1998; Petterson, 1998.

Preliminary calculations of trends in disability-free life expectancy by socio-economic status have been presented by Cambois [Cambois, 1997] for France during the last REVES meeting.

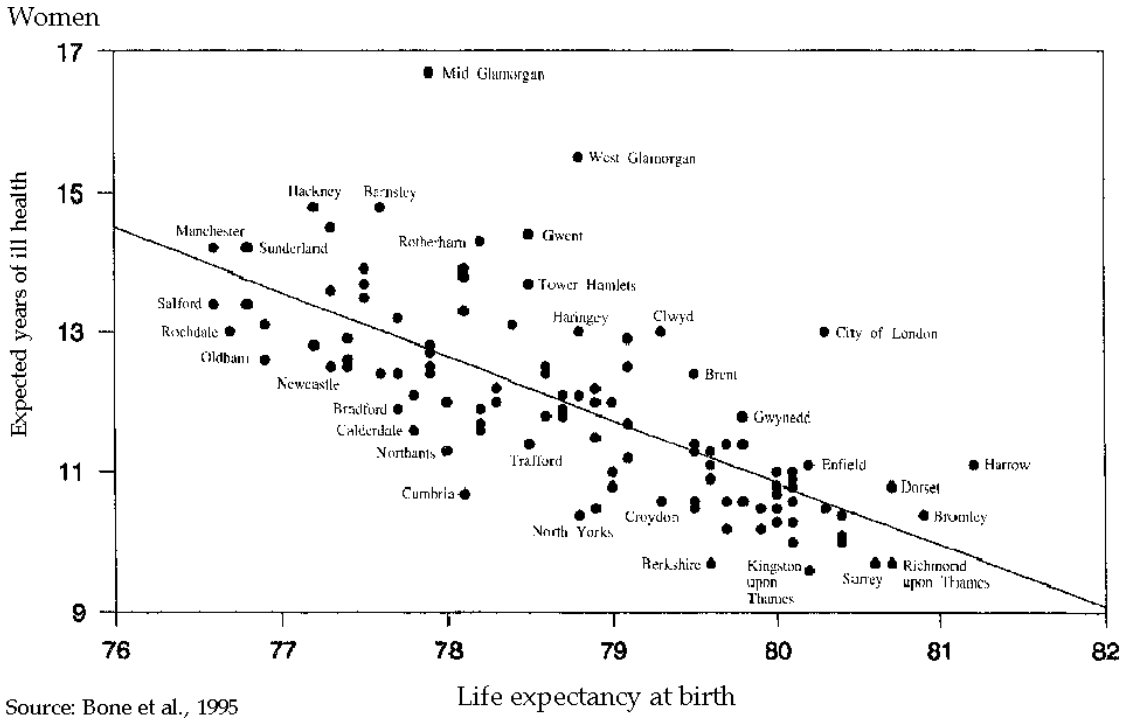
3-3 National geographic comparisons

United Kingdom, Spain, Italy, Belgium and France have computed estimates in order to make geographic comparisons across large geographic areas (Italy, [Burratta and Crialesi, 1993]; Belgium, [Van Oyen et al., 1994]), regional and local authority areas (United Kingdom, [Bone et al, 1995]), autonomous communities (Spain, [Regidor et al., 1995]) and regions (France, [Robine et al., 1998b]). Annex 4 presents the results for Spain, the United Kingdom, Italy, Belgium and France.

As with differences in life expectancy, differences in health expectancy across different geographic areas in the same country, are quite large. Graph 2 illustrates the area variations 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 has the largest expected number of years in ill health. Whatever the causes of these area variations, it is more and more evident that there may be a very strong relationship between short life expectancy and amount of morbidity.

In all the situations studied and presented here based on gender, socio-economic status and geographic differentials, life expectancy and disability-free life expectancy are positively associated and there is poor evidence concerning a hypothetical trade-off between quantity and quality of life.

Graph 2: Life expectancy at birth and expected years of ill health, local authorities in England and Wales, women, 1991



Source: Bone et al., 1995

3-4 Causes of handicap, disability and mortality

Potential gains in disability-free or handicap-free life expectancies can be calculated simulating the elimination of various pathologies. Based on this calculation, a ranking of the causes contributing to mortality and prevalence of ill health (disability or handicap) can be drawn. Studies of this type have been undertaken to date for 2 countries (the Netherlands and the United Kingdom). These studies have demonstrated an important effect produced by the elimination of locomotion disorders [van de Water et al., 1992], of musculoskeletal system diseases [Bone et al., 1995], of arthritis and back complaints [Nusselder et al., 1996] and of accidents [van de Water et al., 1992; Bone et al., 1995]. In the European Union countries, these causes are among the main ones behind cardio-vascular diseases in importance.

The results presented for the Netherlands in 1987-88 [Nusselder et al., 1996] show that while the elimination of fatal diseases leads to an increase in life expectancy and disability-free life expectancy, it may also lead to an increase in life expectancy with disability, thus increasing the burden of disability to society. On the other hand, the elimination of disabling non-fatal diseases results in a decline in life expectancy with disability (Table 7).

Table 7: Change in total life expectancy, disability-free life expectancy, life expectancy with disability, and percentage of life free of disability due to the elimination of the specific disease, the Netherlands, 1987-88

Disease	Male at age 65				Female at age 65			
	LE	DFLE	LED	% DFLE / LE	LE	DFLE	LED	% DFLE / LE
At baseline	14.2	6.9	7.3	48.9	18.8	6.2	12.6	33.1
Chronic nonspecific lung disease	0.3	0.5	-0.2	2.2	0.1	0.2	-0.1	1.0
Heart disease	3.1	1.5	1.6	0.0	2.7	0.9	1.8	0.0
Cancer	2.7	0.9	1.8	-2.3	1.9	0.4	1.5	-1.2
Diabetes mellitus	0.1	0.0	0.1	-0.1	0.3	0.3	0.0	1.0
Arthritis/back complaints	0.0	0.7	-0.7	5.0	0.1	1.0	-1.0	5.3
Migraine / severe headache	0.0	0.1	-0.1	0.4	0.0	0.1	-0.1	0.4
Other neurological diseases	0.1	0.1	0.0	0.3	0.1	0.1	0.0	0.3

Source: Nusselder et al., 1996

Several authors have also developed calculations based on a group of specific pathologies as 'major coronary events' [Egidi and Frova, 1997], or on one particular morbid condition as stroke or hip fracture [Herman et al., 1996; 1997]. Some research teams have undertaken more complex analysis of possible links between morbidity and disability [Robine et al., 1998a]. In her recent thesis, Nusselder has studied the effect of the elimination of smoking on health expectancy, and assessed whether this is likely to produce compression of morbidity (Nusselder, 1998).

There are several possible extensions to the calculations of potential gains in health expectancies. For example, the simulation of successive elimination of disability or handicap at different ages of life would assist in the evaluation of the contribution of each year of life to years lived in ill health.

3-5. Chronological series of health expectancies

Several time series of handicap-free or disability-free life expectancy have now been produced for several European countries (see Table 8). A chronological 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 from European countries are juxtaposed, they cover a period that extends over 20 years (1975-1995). Annex 5 is a compilation of the chronological series of health expectancies available for the European countries, by sex at age 0 and at age 65.

Most authors now distinguish between life expectancy without severe handicap or severe disability and life expectancy without handicap or disability, all levels combined. Handicap-free or disability-free life expectancy most often means: all levels of handicaps or disabilities combined.

A series of mental health expectancy is now available for the Netherlands from 1989 to 1995 [Perenboom and van de Water, 1997].

Table 8: European countries for which chronological series are available.

Countries	Reference	Available years
European Union countries:		
Denmark	Bronnum-Hansen, 1998	1987,1994
Finland	Sihvonen, 1994	1978, 1986
France	Robine and Mormiche, 1993	1981, 1991
	Robine et al., 1996	
Germany	Bruckner, 1997	1986, 1989, 1992, 1995
Netherlands	Perenboom et al, 1993	1983 to 1990
	Perenboom and van de Water, 1997	1989 to 1995
	Perenboom et al., 1997	1983 to 1994
Spain	Regidor et al., 1995	1986, 1991
Sweden	Petterson, 1998	1975-80, 1981-85, 1986-90, 1991-95
	Sweden's Public Health Report 1997, 1998	
United Kingdom	Bebbington and Darton, 1996	1976, 1981, 1985, 1988, 1991, 1992, 1994
Other European countries:		
Norway	Grotvedt and Viksand, 1994	1975, 1985

Graphs 3 and 4 present the compared evolutions of life expectancy and disability-free life expectancy in a selection of European countries. These graphs have been plotted using a log-linear extrapolation of the available values in the series. Information on the series used is available in Annex 5 which provides tables of values by country, classified according to the REVES classification system. Additionally, Annex 5 provides author's denomination and original sources where one can find more information on the data and the method used. The background to the graphs shows the evolutions in Australia, Canada, Japan, New Zealand and United States when available.

Graphs 3 present the evolution of total life expectancy and life expectancy without **severe** disability.

Graph 3.1 presents this evolution for females at age 65. One can notice two groups of curves.

The first one concerns the evolution of extremely severe disability-free life expectancy based on data on confinement (Japan), institutionalization (USA), institutionalization and confinement (France). Extremely severe disability-free life expectancy roughly progresses in parallel with total life expectancy.

The second group concerns the evolution of severe disability-free life expectancy (based on ADL type data). Here a stagnation can be observed until the beginning of the 80s followed by an evolution in parallel with total life expectancy. The same can be observed for females at birth (See annex 5, Graph 1).

Graph 3: Evolution of life expectancy and life expectancy without *severe* disability in various European countries.

Sources: Crimmins et al., 1989, 1997 ; Inoue et al., 1997 ; Grotvedt and Viksand, 1994 ; Bebbington and Darton, 1996 ; Mathers, 1991, 1996 ; Robine and Mormiche, 1994 ; Wilkins et al., 1994;

Graph 3.2:

Sources: Crimmins et al., 1989, 1997 ; Inoue et al., 1997 ; Mathers, 1991, 1996 ; Robine and Mormiche, 1994 ; Wilkins et al., 1994.

Graph 3.2 presents this evolution for males at birth. Severe disability-free life expectancy roughly progresses in parallel with total life expectancy and the difference between severe and extremely severe disability-free life expectancy is much less sensible. The same is observed for males at age 65 (See Annex 5, Graph 2).

This allows to conclude that the number of years lived with extremely severe and / or severe disability remains roughly constant.

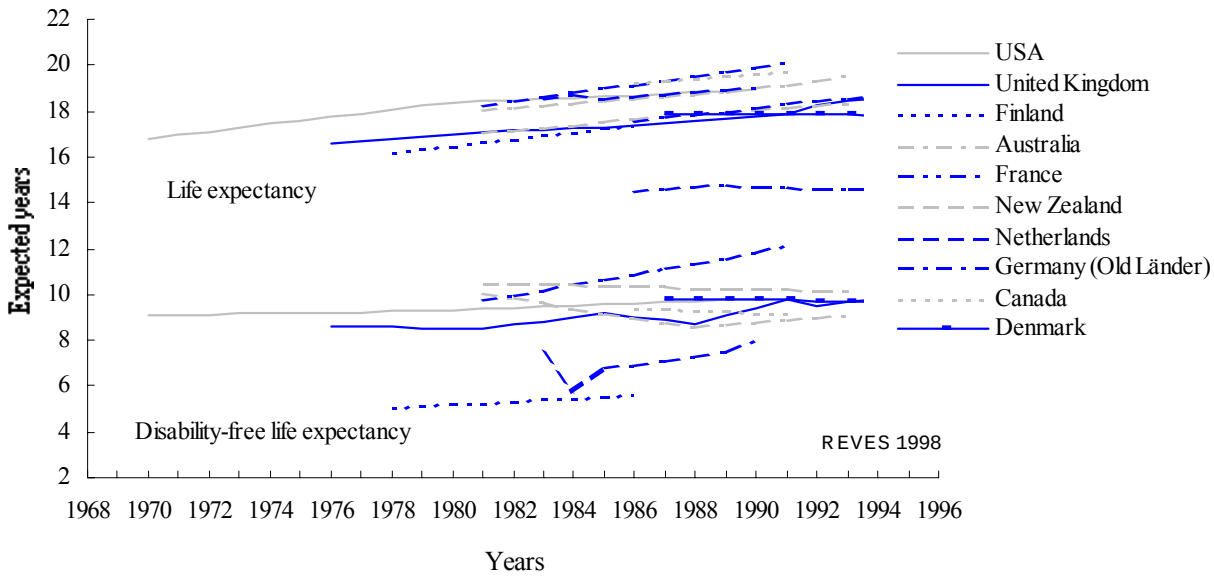
Graphs 4 present the evolution of total life expectancy and life expectancy without disability, **all disability levels combined**.
Graph 4.1 presents this evolution for males at birth. While disability-free life expectancy all disability levels combined stagnated during the 70s and the early 80s, during the last period it clearly increases for France, Germany, the Netherlands, the United Kingdom and the USA - nevertheless slower than total life expectancy - and a slight decrease is observed for Australia and Canada. This is verified for females at birth (See Annex 5, Graph 3).

Graph 4.2 presents this evolution for females at age 65. After a period of stagnation until the beginning of the 80s, an increase is observed for Australia, Finland, France, the Netherlands, the United kingdom and the USA, while a stagnation is observed for Germany and a slight decrease for Canada, Denmark and New Zealand. Similar conclusions can be drawn for males at age 65 (See Annex 5, Graph 4).

To summarize, it is apparent from the data available, that the increase in life expectancy in Europe is not accompanied by an increase in the time spent with severe handicap or severe disability. The results suggest at worst **a pandemic of light and moderate, but not of severe handicaps or 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 handicaps or disabilities, these handicaps or disabilities are less severe.

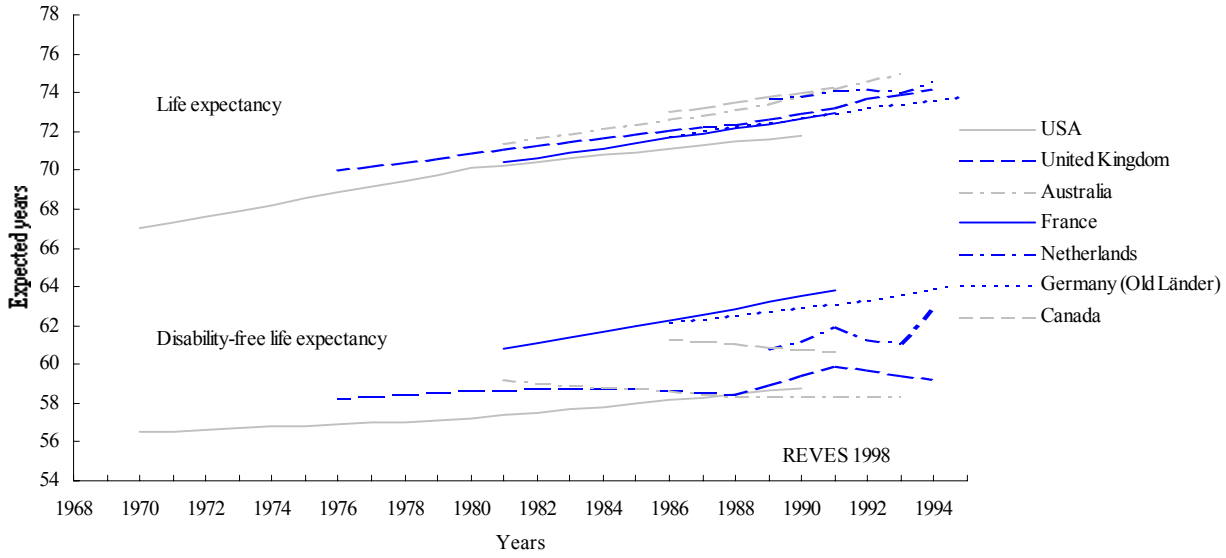
Graph 4: **Evolution of life expectancy and disability-free life expectancy - *all disability levels combined* - in various European countries.**

Graph 4.2: Disability-free life expectancy, all levels combined, females at age 65



Sources: Crimmins et al., 1989, 1997 ; Bebbington and Darton, 1996 ; Mathers, 1991, 1996 ; Robine and Mormiche, 1994 ; Perenboom et al., 1997 ; Brückner, 1997 ; Wilkins et al., 1994.

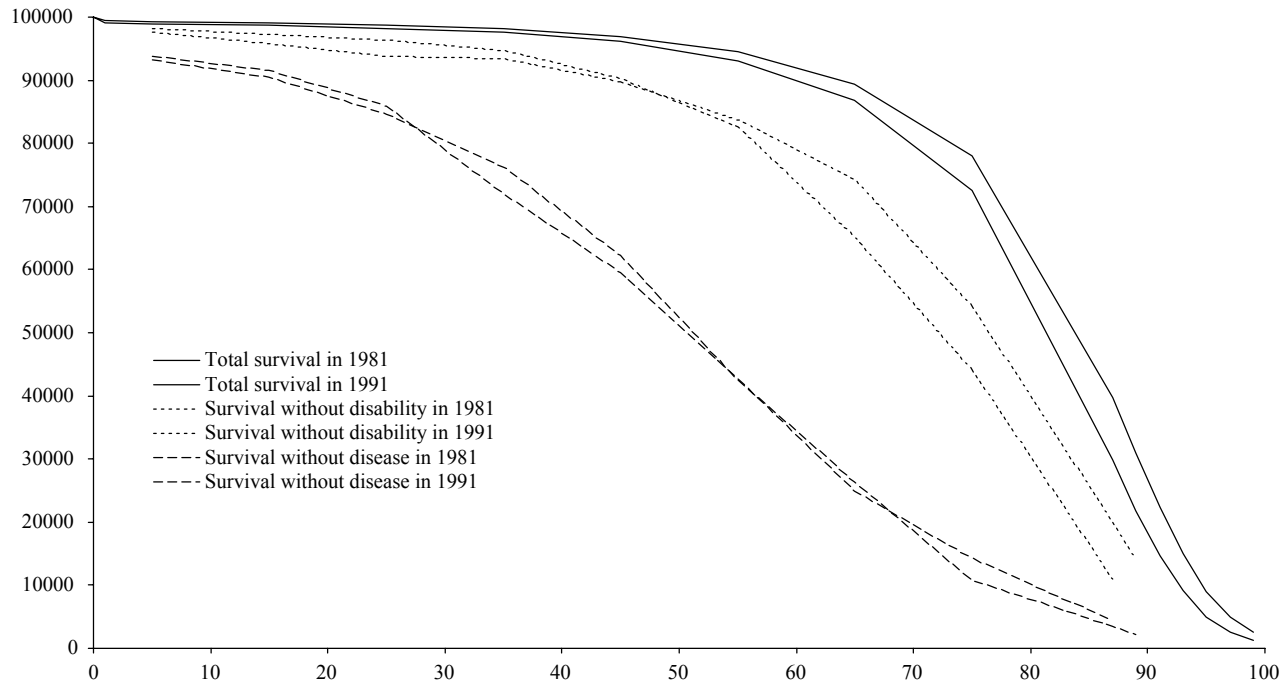
Graph 4.2: Disability-free life expectancy, all levels combined, males at birth



Sources: Crimmins et al., 1989, 1997 ; Bebbington and Darton, 1996 ; Sihvonen, 1994 ; Mathers, 1991, 1996 ; Robine and Mormiche, 1994 ; Graham and Davis, 1997 ; Perenboom et al., 1997 ; Brückner, 1997 ; Wilkins et al., 1994 ; Bronnum-Hansen, 1998.

In France the general model of health transitions [WHO, 1984] has been used to compare the evolutions of life expectancy, disability-free life expectancy and life expectancy without chronic disease. The results show that the increase in life expectancy between 1981 and 1991 has been accompanied with a parallel increase in disability-free life expectancy, and that life expectancy without chronic disease has remained constant (See Graph 5). 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].

Graph 5: Survival without disease and survival without disability (WHO model, 1984) France, 1981-1991, females



Source: Robine et al.,1996

3.6 Development of mental health expectancies

The development of dementia-free life expectancies initiated by Ritchie [Ritchie, 1991] has been conducted in 7 European countries of which 6 from the Union, (Belgium [Roelands et al., 1994], Denmark [Jagger et al.,1998], France [Ritchie et al., 1994b], the Netherlands [Perenboom et al., 1996], Spain (Catalonia) [Jagger et al.,1998], Switzerland [Herrmann and Michel, 1996], United Kingdom [Jagger et al.,1998]), though only 3 of the calculations are presented at a national level (See Annex 3).

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].

4. Policy relevance of health expectancy indicators: discussion of characteristics

Health expectancies offer a positive assessment of the time spent in different health states, similar to life expectancy which provides a positive indication of human longevity. They provide positive indications on populations' health, on their vitality or on their quality of life. Health expectancies can be considered a family of indicators where each can be analysed independently or according to each other [Robine and Michel, 1992]. They can be added to each other: for example, the sum of disability-free life expectancy plus life expectancy with disability is equal to total life expectancy. The substraction of life expectancy with moderate disability from life expectancy with "all levels of disability combined" gives the value of life expectancy with severe disability. They can also be presented, for example, as a ratio of disability-free life expectancy to total life expectancy - generally expressed in percentage - indicating the part of life expectancy lived without disability.

Health expectancies can also assist in establishing public health priorities when potential gains are calculated. Gains in health expectancies make it possible to classify priorities according to the survival or health criteria retained in the calculation, leaving significant choice to public health authorities, by providing them with all the elements necessary for arbitration between longevity, duration of life without disability and duration of life with disability.

Health expectancies permit direct comparisons of the different groups that make up the population whatever the criteria of distribution used may be: sexes, socio-professional categories, regions, etc, as, in their calculation, the years lived are reported to the number of survivors, which make them independent from the size and the age structure of the populations from which the data come.

If it is useful or required, a weighting system similar to that of DALYs can be introduced into the calculation of life expectancy, to take into account the severity of the disability the years are lived in. Thus, we obtain a life expectancy adjusted on disability or disability-adjusted life expectancy (DALE). By generalizing and by introducing any weighting system into the calculation of life expectancy, taking the health state in which the years are lived into account, we obtain a health-adjusted life expectancy (HALE) [Mathers, 1997; Wolfson, 1996]. Summing up the different complementary weighted health expectancies into a single value, health-adjusted life expectancy (HALE) is a global synthetic indicator which reduces life expectancy (LE) to its equivalent in years of perfect health. Nevertheless, only a few examples of such calculations are available in Europe, except in the Netherlands (Perenboom et al., 1997 ; Barendregt, 1998).

Significant questions regarding the validity of health expectancies, as those on the validity of the Sullivan method to assess a particular period value, have been clearly identified [Mathers and Robine, 1997]. Health expectancies essentially rely on the calculation of life expectancy and its reference framework, which has been under construction for three centuries [Dupâquier and Dupâquier, 1985]. In particular, they benefit from a clear distinction between the period

calculations and the calculations for real cohorts. They also benefit from an important number of theoretical works on the problem of the calculation of potential gains in life expectancy by suppression of the different causes of death [see, for example, Keyfitz, 1978; Tsai et al., 1978; Schatzkin, 1980; Manton et al., 1980; Olshansky, 1985 and 1987]. Finally, they benefit from the existence of an international research network which has been devoted to them since 1989, REVES, and from the publication of numerous scientific articles devoted to their calculation or use [REVES, 1997b].

As a rule, the calculations of health expectancies are based on observed data: period life tables, results of population censuses, and results of various surveys (Living conditions, Health, Disability, Labour force...)[1]. This explains why, on the one hand, estimations of health expectancies are presently available for about fifty countries only and why, on the other hand, these estimations are not directly comparable from a 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 expectancy**.

Standardization of disability data should become a priority. A first objective could be the harmonisation of the definition and the measure 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 activities of daily living limitations (ADL) measures to calculate severe disability (i.e. to eat, dress, wash...). The extension of this approach to other types of activities is worth being explored in order to standardize the measure of less severe disability levels (i.e. mobility, domestic activities, professional or school activities).

[1] 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).

Conclusion

To summarize, health expectancy appears to be a relevant and meaningful indicator for use in policymaking. In particular, it permits the assessment of whether the increase in life expectancy is accompanied or not with a compression of morbidity or with an expansion of disability.

Based on the data available, it appears across countries, that the increase in life expectancy is not accompanied with an increase in the time lived in severe disability. The synthesis of the results shows that it is more and more obvious that there is a very strong relationship between short life expectancy and amount of morbidity. However, there is poor evidence concerning an hypothetical trade-off between quantity and quality of life. In all the situations studied (gender, socio-economic status and geographic differentials), life expectancy and disability-free or handicap-free life expectancy are positively associated.

Distinguishing between gains in mortality and gains in morbidity or disability, the calculations of potential gains in health expectancy demonstrate whether the elimination of one or another pathology would compress or expand prevalent morbidity. Thus, the calculations worked out show that the elimination of osteo-articular diseases would result in important gains in health expectancy, comparable to those resulting from the elimination of cardiovascular diseases. The elimination of osteo-articular diseases would significantly increase disability-free life expectancy without influencing total life expectancy, and thus it would decrease the burden of disease.

Nevertheless, health expectancies have not become a routine indicator of the health status of the population as they are not comparable across countries. **The standardization of the concepts and questionnaires related to disability and handicap used to calculate health expectancies would resolve this problem**. Direct comparisons across countries would then be as easy as the comparisons of life expectancies are today.

Today, three avenues may be identified leading to a collection of comparable data in the Union countries, ie (1) to recommend the application of the recommendations of the WHO Europe (Consultation and Euro-HIS) ; (2) to develop common modules and introduce them in the social surveys existing in the different countries (Living conditions, health, or labor force surveys, etc.) ; and lastly (3) to develop and extend community surveys. These three avenues may be combined and the solutions chosen will not all bring the same degree of comparability. Thus, the recommendations of the WHO Europe may be followed to develop a community module. The introduction of a common module on health in the labor force surveys which are already well harmonized and include community modules, would provide data more comparable than the introduction of the same module in health surveys which are currently little harmonized. A priori, the development of community surveys will provide the best comparability of the data.

(1) The experience showed that the process of harmonization of the Health Interview Surveys (HIS) engaged by the WHO is very slow. Of course, it has to be continued, as all the European countries are concerned, but it is not sufficient for the Union.

(2) The development of common modules and their introduction in existing social surveys would allow to go further much quicker with the comparability of the data collected. As we already have underlined it, this avenue is not incompatible with the process of harmonization of the WHO. On the contrary, the use of the data collection instruments proposed by the WHO to build common modules would benefit both sides. Nevertheless, following this avenue would not solve all the problems. In particular, the different study protocols of the "host" surveys and the frequent exclusion of the population living in collective households would remain.

Concerning the non-comparability of the protocols, the inclusion of common modules in surveys already strongly harmonized and already including European modules - as the labor force surveys - would provide much more comparable data than its inclusion in little harmonized social surveys (living conditions, health, etc...). As a matter of fact, the protocols, objectives and periodicity of the social surveys in Europe are very different. As an example, the "health" survey is ran every year in the United Kingdom and only every ten years in France.

The exclusion of the population living in collective households is an important potential bias for the comparison of the health status between the European Union countries, as the population in ill health may be in collective households (institutions: long term hospitals, nursing homes, etc.) in different proportions according to the countries. This problem may be solved with the collection of comparable data on the health status of the population living in collective households in the different European countries.

(3) The development of a community survey on health or a general social survey including a "health" module would provide the most comparable data. The potential bias due to the differences in institutionalization may even be suppressed if the community surveys include the collective households.

Compared to the inclusion of common modules on health in any social survey, the ratio cost/efficiency of a community survey on health would obviously be much better. The periodic or permanent inclusion of a "health" module in the labor force surveys would perhaps have a better ratio cost/efficiency, but this inclusion would miss to solve the problem of the population living in collective households, and might miss to be at least periodic.

As there are potentially as many health expectancies as health concepts, the improvement in the comparability of health expectancies requires the harmonization of the health concepts considered for the calculations. One specific collection instrument should correspond with each morbidity or disability concept. Even if a plethora of specific instruments is available for some concepts, nothing

is currently available for others. Most often, the available collection instruments are not really specific and cover or mix several health concepts. If instruments specific of the concepts considered exist among the instruments recommended by the WHO Europe, they should be, of course, recommended and included in priority in the modules and in the community surveys. If not, instruments should be chosen elsewhere or developed at the European level.

The evaluation of the health expectancy calculations worked out in Europe shows that disability-free life expectancies are often calculated (1) from a global question on the difficulties in daily living, (2) from the difficulties or the help received to perform activities of daily living (ADL type question), (3) from the difficulties or the help received to perform instrumental activities of daily living (IADL type questions), and (4) from various functional limitations. Concerning these four points, there is no specific instrument recommended by the WHO. In order to work out these calculations the authors often use some items from the OECD instrument to assess long term disability [McWhinnie, 1981] or from the WHO instrument to assess long-term disability [WHO,1988 and 1996], according to their availability in the different surveys used.

Healthy life expectancy calculations are often worked out using the global question on perceived health recommended by the WHO Europe [WHO, 1988 and 1996]. The threshold between good and bad perceived health is still to be harmonized. On the other hand there is no set of questions recommended by the WHO allowing the validation and the analysis of the answers to the global question.

As no instrument recommended by the WHO exists to measure mental health or chronic morbidity, the corresponding health expectancies have been calculated according to the data available in the different surveys.

The next step to improve the comparability of the health expectancies calculated will be to choose and/or develop common collection instruments. Taking into account the state of the question in Europe and the evaluation worked out by Euro-REVES (Biomed I), one can already consider as common instruments to be developed:

(1) A global question on the difficulties in daily living
(2) A set of questions on the difficulties in activities of daily living and the help received (Set ADL)
(3) A set of questions on the difficulties in household activities of daily living and the help received (Set IADL)
(4) A set of questions on functional limitations
(5) A set of questions on perceived health
(6) A set of questions on mental health
(7) A set of questions on chronic morbidity

Of course, if some items of the instruments of the WHO Europe are convenient, they should be used (including the reference formulation) in priority, and by default the items of the OECD instrument.

References

Barendregt JL, Bonneux L, Van der Maas PJ (1998). Health expectancy: from a population health indiator to a tool for policy making*J Aging Health*. 10;2:242-258.

Bebbington AC (1988) The expectation of life without disability in England and Wales. *Soc Sci Med* 27:321-326.

Bebbington AC (1992) *Expectation of life without disability measured from the OPCS disability surveys*. In: Robine JM, Blanchet M, Dowd J-E, Eds. Health Expectancy. London: HMSO. p. 23-34.

Bebbington AC, Darton RA (1996) *Healthy life expectancy in England and Wales: recent evidence*. : PSSRU. 62p.

Berg RL (1973) Weighted life expectancy as a health status index. *Health Serv Res* **8**:153-156.

Bone M, Bebbington AC, Jagger C, Morgan K, Nicolaas G (1995) *Health expectancy and its uses*. London: HMSO. 90p.

Boshuizen HC, van de Water HPA (1994) *An international comparison of health expectancies*. Leiden: TNO Health Research. (TNO-PG 94.046)

Boshuizen HC, van de Water HPA, Perenboom RJM (1994). *Socio-economic differences in health expectancy in the Netherlands*. In: Mathers CD, McCallum J, Robine JM, (Eds). Advances in health expectancies. Canberra: Australian Institute of Health and Welfare, AGPS.

Bronnum-Hansen H (1998) Trends in health expectancy in Denmark, 1987-1994. *Danish Medical Bulletin* (In press).

Brückner G (1997) *Health-adjusted forms of life expectancy in Germany: what do we learn from the reunification process?* In: 10th Work-group meeting REVES, International Research Network for Interpretation of Observed Values of Healthy Life Expectancy, Tokyo, October.

Buratta V, Crialesi R (1993) *Salute e speranza di vita*. In: Studi di Popolazione. Nuovi approcci per la descrizione e l'interpretazione. Convegno dei Giovani studiosi dei problemi di Popolazione, Roma 2-4 Giugno 1993. Roma: Università " la Sapienza ", dipartimento di Scienze Demografiche, pp 677-689. [In Italian]

Bush JW, Chen MM, Patrick DL (1973) *Health status index in cost effectiveness: analysis of PKU program*. In: Berg RL, Ed. Health status indexes. Chicago: Hospital Research and Educational Trust:172-208.

Cambois E (1997) *Social inequalities in health expectancy in France*. In: 10th Work-group meeting REVES, International Research Network for Interpretation of Observed Values of Healthy Life Expectancy, Tokyo, October.

Chamie M (1990) *Report of the Committee on the Conceptual Harmonization of statistics for the study of Disability-Free Life Expectancy* (Strasbourg, November 1990) Reves Paper N° 41.

Crimmins EM, Saito Y (1997) *Trends in disability-free life expectancy in the United States, 1970-1990: gender, racial, and socio-economic differences*. In: 10th Work-group meeting REVES, International Research Network for Interpretation of Observed Values of Healthy Life Expectancy, Tokyo, October.

Crimmins EM, Saito Y, Ingegneri D (1989) Changes in life expectancy and disability-free life expectancy in the United States. *Popul Dev Rev* **15**:235-267.

Crimmins EM, Saito Y, Ingegneri D (1997) Trends in Disability-free life expectancy in the United States, 1970-90. *Population and Development Review* **23**(3):555-572.

Decision n°1400/97/EC of the European Parliament and of the Council of 30 June 1997 adopting a programme of Community action on health monitoring within the framework for action in the field of public health (1997 to 2001) (1997). *Official Journal of the European Communities L193* **40**:1-6.

Department of Health (1997) *On the state of the Public Health: the annual report of the Chief Medical Officer of the Department of Health for the year 1996*. London: Stationery Office.

Doblhammer G, Kytir J (1996) *Social inequalities in mortality and morbidity: Consequences for DFLE*. In: 9th Work-group meeting REVES, International Research Network for Interpretation of Observed Values of Healthy Life Expectancy, Rome, December.

Dupâquier J (1995). *L'espérance de vie sans incapacités : faits et tendances : premières tentatives d'explication*. Paris: Presses Universitaires de France, 286p.

Dupâquier J, Dupâquier M (1985) *Histoire de la démographie*. Paris: Perrin (Pour l'Histoire).

Egidi V, Frova L (1997) *Mortality, morbidity and health related quality of life in developed countries: concepts, methods and indicators*. In: International Population conference, Beijing. Liège: IUSSP.

Fries JF (1980) Aging, natural death, and the compression of morbidity. *N Engl J Med* **303**:130-135.

Fries JF (1989) The compression of morbidity: near or far? *Milbank Memorial Fund Q* **67**:208-232.

Graham P, Davis P (1997) Personal communication to REVES.

Grimley Evans J (1983) Prevention of age-associated loss of autonomy: epidemiological approaches. *J Chron Dis* **37**(5):353-363.

Grotvedt L, Viksand G (1994) *Life expectancy without diseases and disability in Norway.* In: Mathers CD, McCallum J, Robine JM, Eds. Advances in health expectancies. Canberra: Australian Institute of Health and Welfare, AGPS:224-235.

Gruenberg EM (1977) The failures of success. *Milbank Memorial Fund Q/ Health Soc* **55**: 3-24.

Haber LD, Dowd JE (1994) *A human development agenda for disability: statistical considerations. A report prepared for the United Nations Statistical Division*. (unpublished)

Herrmann FR, Michel JP (1996). *Dementia free life expectancy in Switzerland: comparison between expected and observed estimates.* In: 9th Work-group meeting REVES, International Research Network for Interpretation of Observed Values of Healthy Life Expectancy, Rome, December. [Abstract only]

Herrmann FR, Michel JP, Lalive d'Epinay C, Grab B (1996) *Hip fracture and healthy life expectancy.* In: 9th Work-group meeting REVES, International Research Network for Interpretation of Observed Values of Healthy Life Expectancy, Rome, December.

Herrmann FR, Benninger DH, Gostynski M, Ajdacic-Gross V, Gutzwiller F, Michel JP (1997) *Stroke free life expectancy in the Swiss elderly*. In: 10th Work-group meeting REVES, International Research Network for Interpretation of Observed Values of Healthy Life Expectancy, Tokyo, October.

Ìnoue T, Shigematsu T, Nanjo Z (1997) Health life tables in Japan, 1990: a quality of the longest life expectancy in the world. *Minzoku Eisei* **63**(4):226-240.

Jagger C (1997) Health expectancy calculation by the Sullivan method: a practical guide. Montpellier: Euro-REVES/INSERM.

Jagger C, Ritchie K, Bronnum-Hansen H, Deeg D, Gispert R, Grimley Evans J, Hibbett M, Lawlor B, the MRCCFAS group, Perenboom R, Polge C, Van Oyen H (1998) *Mental health expectancy - the European perspective: a synopsis of results presented at the conference of the European network for the calculation of health expectancies (Euro-REVES). Acta Psychiatrica Scandinavia* **98**:85-91.

Johnson RJ, Wolinsky FD (1993) The structure of health status among older adults: Disease, disability, functional limitation, and perceived health. *J Health Social Behavior* **34**:105-121.

Katz S, Ford AB, Moskowitz RW, Jackson BA, Jaffe MW (1963) Studies of illness in the aged. The Index of ADL: A standardized measure of biological and psychosocial function. *JAMA* **185**(12):914-919.

Katz S, Branch LG, Branson MH, Papsidero JA, Beck JC, Greer DS (1983) Active life expectancy. *N Engl J Med* **309**:1218-1224.

Keyfitz N (1978) Improving life expectancy: an uphill road ahead. *Am J Public Health* **68**(10):954-956.

Koizumi A (1985) Health problems of the year 2000 and beyond. *Health Policy* **4**:307-319.

Kramer M (1980) The rising pandemic of mental disorders and associated chronic diseases and disabilities. *Acta Psychiatrica Scandinavica* **62**(Suppl. 285):282-297.

Kytir J (1994) Lebenserwartung frei von Behinderung. *Statistische Nachrichten* (8):650-657.

Laditka SB, Wolf DA (1995) *Microsimulation of active life expectancy: methods and policy implications*. In: 8th Work-group meeting REVES, International Research Network for Interpretation of Observed Values of Healthy Life Expectancy, Chicago, October.

Lawton MP, Brody EM (1969) Assessment of older people: Self-maintenance and Instrumental Activities of Daily Living. *Gerontologist* **9**:179-186.

Manton KG (1982) Changing concepts of morbidity and mortality in the elderly population. *Milbank Memorial Fund Q / Health Soc* **60**:183-244.

Manton KG (1989) Epidemiological, demographic, and social correlates of disability among the elderly. *Milbank Q* **67**:13-58.

Manton KG, Patrick CH, Stallard E (1980) Mortality model based on delays in progression of chronic diseases : Alternative to cause elimination model. *Public Health Reports* **95**(6):580-588.

Mathers CD (1991) *Health expectancies in Australia, 1981 and 1988*. Canberra, ACT: Australian Institute of Health Publications.

Mathers CD (1996) Trends in health expectancies in Australia 1981-1993. *J Aust Popul Assoc* 13:1-15.

Mathers CD (1997) *Developments in the use of health expectancy indicators for monitoring and comparing the health of populations.* Report prepared for OECD (Background paper n°1).

Mathers CD, Robine JM (1997) How good is Sullivan's method for monitoring changes in population health expectancies. *J Epidemiol Community Health* **51**:80-86.

Mathers CD, Robine JM, Wilkins R (1994) *Health expectancy indicators: recommendations for terminology*. In: Mathers CD, McCallum J, Robine JM, (Eds). *Advances in health expectancies*. Canberra: Australian Institute of Health and Welfare, AGPS.

McWhinnie JR (1981) Disability assessment in population surveys: results of the OECD Common development effort. *Rev Epidem Sante Publ* **29**:414-419

Ministry of Health, Denmark (1994) *Recommendations to the high-level committee on health from the working party on community health data and indicators*. Denmark: Ministry of Health, 5 vol.

Mor V, Wilcox V, Rakowski W, Hiris J (1994) Functional transitions among the elderly: patterns, predictors, and related hospital use. *Am J Public Health* **84**(8):1274-1280.

Mutafova M (1997) Country report for Bulgaria. (Available from REVES)

Nagi SZ (1976) An epidemiology of disability among adults in the United States. *Milbank Memorial Fund Q / Health Soc* 54:439-467.

Nusselder WJ (1998) Compression or expansion of morbidity? A life table approach. Thesis Erasmus University Rotterdam.

Nusselder WJ, Van Der Velden K, Van Sonsbeek JLA, Lenior M, Van Den Bos GAM (1996) The elimination of selected chronic diseases in a population: the compression and expansion of morbidity. *Am J Public Health* **86**:187-194.

Olshansky SJ (1985) Pursuing longevity: delay vs elimination of degenerative diseases. *Am J Public Health* **75**(7):754-757.

Olshansky SJ (1987) Simultaneous / multiple cause-delay (SIMCAD): an epidemiological approach to projecting mortality. *J Gerontol* **42**(4):358-365.

Organization for Economic Co-operation and Development (1976) *Measuring social well-being: A progress report on the development of social indicators*. Paris, OECD (OECD Social indicator development programme; 3).

Organization for Economic Co-operation and Development (1997) *OECD Health Data 97*. Paris, OECD.

Perenboom RJM, van de Water HPA (1997) *Mental health expectancy in the Netherlands, 1989-1995*. Paper presented at the 10th Meeting of the International Network on Health Expectancy and the Disability Process (REVES), Tokyo, Japan, October 9-11.

Perenboom RJM, Boshuizen HC, van de Water HPA (1993) *Trends in health expectancies in the Netherlands, 1981-1990*. In: Robine JM, Mathers CD, Bone MR, Romieu I, Eds. Calculation of health expectancies; harmonization, consensus achieved and future perspectives. Montrouge: John Libbey Eurotext:309-320.

Perenboom RJM, Boshuizen HC, Breteler MMB, Ott A, Van de Water HPA (1996) Dementia-free life expectancy (DemFLE) in the Netherlands. *Soc Sci Med* 43:1703-1707.

Perenboom RJP, van Herten LM, Boshuizen HC, van de Water HPA (1997). *Trends in de gezonde levensverwachting in Nederland 1983-1994, met een verdeling naar arnst van ongezondheid*. In: van der Maas PJ, Kramers PGN

(Eds). Volsgezondheid toekomst verkenning 1997. III Gezondheid en levensverwachting gewogen. Bilthoven: RIVM.

Petterson H (1995) *Trends in health expectancy for socio-economic groups in Sweden*. In: 8th Work-group meeting REVES, International Research Network for Interpretation of Observed Values of Healthy Life Expectancy, Chicago, October.

Petterson H (1998) Personal communication to REVES.

Pope AM, Tarlov AR, eds (1991) *Disability in America: Toward a national agenda for prevention.* Washington, DC: Institute of Medicine, National Academy Press.

Regidor E, Rodriguez C, Gutiérrez-Fisac JL (1995) *Indicadores de Salud: Tercera evaluacion en Espana del programa regional europeo Salud Para Todos*. Madrid: Ministerio de Sanidad y Consumo.

REVES (1997a) *Statistical World Yearbook 'Health expectancy'*. Third edition. Will be soon available on Internet: <http://www.geronto.com/reves>

REVES (1997b) *Health expectancy: List of references* (Updated 12/97). Will be soon available on Internet: <http://www.geronto.com/reves>

Ritchie K (1991) La mesure de l'espérance de vie sans démence : étude préliminaire de faisabilité. *Cahiers Québécois de Démographie* **20**:253-268.

Ritchie K, Robine JM, Letenneur L, Dartigues JF (1994b) Dementia-free life expectancy in France. *Am J Public Health* 84(2):232-236.

Robine JM (1989) Estimation de la valeur de l'Espérance de Vie Sans Incapacité (EVSI) pour les pays occidentaux au cours de la dernière décennie: quelle peut être l'utilité de ce nouvel indicateur de l'état de santé ? *World Health Statistics Q Rapport Trimestriel des Statistiques Sanitaires Mondiales* 42:141-150.

Robine JM (1992) *Disability-free life expectancy*. In: *Health Expectancy.* London: HMSO. 172p.

Robine JM, Michel JP (1992) Towards international harmonization of health expectancy indices. In: REVES 5th, Ottawa, (Reves paper n°86).

Robine JM, Mormiche P (1993) L'espérance de vie sans incapacité augmente. *INSEE Première* 281.

Robine JM, Mormiche P (1994) Estimation de la valeur de l'espérance de vie sans incapacité en France en 1991. *Solidarité Santé* (1):17-36.

Robine JM, Ritchie K (1991) Healthy life expectancy: evaluation of a new global indicator of change in population health. *Br Med J* **302**:457-460.

Robine JM, Colvez A, Bucquet D, Hatton F, Morel B, Lelaidier S (1986) L'espérance de vie sans incapacité en France en 1982. *Population* 41:1025-1042.

Robine JM, Romieu I, Cambois E, van de Water HPA, Boshuizen HC, Jagger C (1994) Global Assessment in Positive Health: Contribution of the Network on Health Expectancy and the Disability Process to the World Health Report 1995 'Bridging the Gaps'. Montpellier: Laboratoire d'Epidémiologie et d'Economie de la Santé.

Robine JM, Mormiche P, Cambois E (1996a) Evolution des courbes de survie totale, sans maladie chronique et sans incapacité en France de 1981 à 1991: application d'un modèle de l'OMS. *Annales de Démographie Historique*:99-115

Robine JM, Romieu I, Cambois E (1997a). Health expectancies and current research. *Rev Clinical Gerontol* **7**:73-81.

Robine JM, Brouard N, Jagger C, Ritchie K, van de Water HPA (1997b) Euro-REVES, a concerted action in support of harmonization of health expectancy calculations in Europe. Montpellier, INSERM (Final activity report).

Robine JM, Mormiche P, Sermet C (1998a) Examination of the causes and mechanisms of the increase in disability-free life expectancy. *J Aging Health* **10**:171191

Robine JM, Cambois E, Romieu I, Mormiche P (1998b) Variations régionales de l'espérance de vie sans incapacités entre 1982 et 1990. Note au Haut Comité de Santé Publique. Janvier.

Roelands M, van Oyen H, Baro F (1994) Dementia free life expectancy in Belgium. *European J Public Health* **4**:33-37.

Roelands M, Van Oyen H (1995) *L'espérance de vie sans invalidité des personnes âgées : une méthode de planning et de prise de décision dans le secteur des soins de santé*. Bruxelles: Services fédéraux des affaires scientifiques, techniques et culturelles. 142p.

Rogers A, Rogers RG, Branch LG (1989) A multistate analysis of active life expectancy. *Public Health Rep* **104**:222-225.

Rowe JW (1990) *Toward successful aging: Limitation of the morbidity associated with 'normal' aging*. In: Principles of geriatric medicine and gerontology (2nd ed :138-141) New York: McGraw Hill.

Rowe JW, Kahn RL (1987) Human aging: usual and successful. *Science* **237**:143-149.

Rowe JW, Kahn RL (1997) Successful aging. *The Gerontologist* **37**(4):433-440.

Sanders BS (1964) Measuring community health levels. *Am J Public Health* **54**:1063-1070.

Schatzkin A (1980) "How long can we live ? A more optimistic view of potential gains in life expectancy". *Am J Public Health* **70**(11):1199-1200.

Sihvonen AP (1994) *Suomalaisten toimintakykyiset elinvuodet. Metodinen tarkastelu ja mittaaminen* (Health expectancy in Finland. Methodological considerations and measurement). Helsinki: STAKES. (Report n°148)

Sociedad Espanola de Salud Pùblica y Administracion Sanitaria (1993). *Informe SESPAS 1993: La salud y el sistema sanitario en Espana*. Barcelona: SG Editores

Spuhler T, Bisig B et al (1991) *Disability free life expectancy in Switzerland*. In: 4th Work-group meeting REVES, International Research Network for Interpretation of Observed Values of Healthy Life Expectancy, Noordwijkerhout, June.

Strehler BL (1975) Implications of aging research for society. in: Theoretical concepts of developmental and age changes. *Federation Proceedings* 34(1):5-8.

Sullivan DF (1971) A single index of mortality and morbidity. HSMHA *Health Rep* **86**:347-354.

Sweden's Public Health Report 1997. National Board of Health and Welfare, Stockholm, 1998

Tsai SP, Lee ES, Hardy RJ (1978) The effect of a reduction in leading causes of death: potential gains in life expectancy. *Am J Public Health* **68**(10):966-971.

United Nations (1946) *Constitution of the World Health Organization.* UN, New York.

Vademecum gezondheidsstatistiek Nederland 1994 / Vademecum of health statistics of the Netherlands 1994 (1994) Voorburg: Netherlands Central Bureau of Statistics, p 158.

Valkonen T (1994) *Country report*. In: Robine JM, Mathers C, Stevenson C, d'Espaignet ET. General report of the 7th meeting of the International Network on Health Expectancy / Rapport général de la 7ème réunion internationale du Réseau Espérance de Vie en Santé. Canberra, Australia, 23-25 February.

Valkonen T, Sihvonen AP, Lahelma E (1994). *Disability-free life expectancy by level of education in Finland.* In: Mathers CD, McCallum J, Robine JM, (Eds). Advances in health expectancies. Canberra: Australian Institute of Health and Welfare, AGPS.

van de Water HPA, Boshuizen HC, Perenboom RJM (1992) *Gezonde levensverwachting: een integrale indicator*. Poster op het STG-symposium 'Zorg voor chronisch zieken in de toekomst'. Utrecht, April 2.

van de Water HPA, Boshuizen HC, Perenboom RJM (1995) *Health expectancy of the Dutch population*. Leiden: TNO, 21p.

van den Bos GAM, van der Maas PJ (1993) *Social inequalities in the basic indicators of health expectancy: chronic morbidity, disability and mortality.* In: *Calculation of health expectancies: harmonization, consensus achieved and future perspectives*. Montrouge: John Libbey Eurotext.

van der Maas PJ, Kramers PGN (Eds) (1997) Volksgezondheid Toekomst Verkenning 1997. III Gezondheid en levensverwachting gewogen. Bilthoven : RIVM, Elsevier, 225p.

van Ginneken JK, Bonte JT (1989) *Sex differentials in life expectancy free of disability in the Netherlands in 1981-1985*. In: International Population Conference, International Union for Scientific Study of Population, New Delhi.

van Ginneken JKS, Dissevelt AG, van de Water HPA, van Sonsbeek JLA (1991) Results of two methods to determine health expectancy in the Netherlands in 1981-1985. *Soc Sci Med* **32**:1129-1136.

van Ginneken JKS, van de Water HPA, van Sonsbeek JLA (1992) *Gezonde levensverwachting: betekenis en resultaten*. In: Gunning-Schepers LJ., Mootz M (Eds). Gezondheidsmeting. Houten. Bohn Stafleu Van Loghum.

Van Herten LM, Boshuizen HC, Perenboom RJP, van de Water HPA (1997). *Gezonde levensverwachting naar sociaal-economische status*. In: van der Maas PJ, Kramers PGN (Eds). Volsgezondheid toekomst verkenning 1997. III Gezondheid en levensverwachting gewogen. Bilthoven: RIVM, Elsevier, 225p.

van Oyen H, Tafforeau J, Roelands M (1994). *Regional inequities in health expectancy in Belgium.* In: Mathers CD, McCallum J, Robine JM, (Eds). Advances in health expectancies. Canberra: Australian Institute of Health and Welfare, AGPS.

Wilkins R, Adams OB (1983a) Health expectancy in Canada, late 1970s: demographic, regional and social dimensions. *American J Public Health* **73**, 9: 1073-1080.

Wilkins R, Adams OB (1983b) *Healthfulness of life: a unified view of mortality, institutionalization and non-institutionalized disability in Canada, 1978*. Montréal: Institut de recherches politiques, 162 p.

Wilkins R, Chen J, Ng E (1994) *Changes in health expectancy in Canada from 1986 to 1991.* In: Mathers CD, McCallum J, Robine JM, Eds. Advances in health expectancies. Canberra: Australian Institute of Health and Welfare, AGPS:115-132.

Wolfson MC (1996) Health-adjusted life expectancy. *Rapports sur la santé* **8**(1):41-46.

World Health Organization (1980) *International classification of impairments, disabilities and handicaps*. Geneva: WHO.

World Health Organisation (1984) *The uses of epidemiology in the study of the elderly : Report of a WHO scientific group on the epidemiology of aging*. Geneva: WHO (Technical Report Series 706).

World Health Organisation (1985) *Targets for health for all: Targets in support of the European regional strategy for Health For All*. Copenhagen : WHO Regional Office for Europe.

World Health Organization (1992) *International statistical classification of diseases and related health problems: tenth revision*. Geneva: WHO.

World Health Organization (1997a) The World Health Report 1997, Conquering suffering, Enriching humanity. World Health Organization, Geneva.

World Health Organization (1997b) *ICIDH-2: International classification of impairments, activities, and participation. A Manual of dimensions of disablement and functioning. Beta-1 draft for field trials*. World Health Organization, Geneva.

World Health Organisation Regional Office for Europe (1988) *Consultation to develop common methods and instruments for health interview survey*. Voorburg: NCBS, 82p.

World Health Organisation Regional Office for Europe (1996) *Health interview surveys: Toward international harmonization of methods and instruments*. WHO Regional Publications European Series 58, 161p.

Annex 1

Health expectancy indicators: Definitions and classification

1. Definition of the main health expectancy indicators

The first indicator proposed was disability-free life expectancy [Sullivan, 1971], followed by active life expectancy [Katz et al., 1983]. The introduction of concepts from the International Classification of Impairments, Disabilities, and Handicaps (ICIDH) [WHO, 1980] enables us to differentiate among impairment-free, disability-free, and handicap-free life expectancies. Until now, disability-free life expectancy (DFLE) has been the most frequently used expression, often without explicit reference to the WHO-ICIDH concepts and sometimes as the generic term for health expectancies.

Health expectancy is a general term referring to the entire class of indicators expressed in terms of life expectancy in a defined state of health. Health expectancies are hypothetical measures and indicators of the current health and mortality conditions. Health expectancies include both "positive" and "negative" health states, which may be defined in terms of impairment, disability, handicap, self-rated health, or other concepts. The sum of health expectancies in a complete set of complementary health states should always equal to total life expectancy [Mathers et al., 1994].

The REVES classification system is based on the concepts principally relating to (a) the ICD framework, (b) the consequences of diseases (ICIDH framework) with subdivisions as proposed by the REVES committee on conceptual harmonization, (c) perceived health and (d) quality-adjustment.

According to the ICD framework:

- *Disease-free life expectancy*, the average number of years an individual is expected to live free of disease if current patterns of mortality and morbidity continue to apply. A well known example of a specific disease-free life expectancy is dementia-free life expectancy.

- *Dementia-free life expectancy* is a specific disease-free life expectancy, as dementia is a medical diagnosis. It reflects the average number of years an individual is expected to live without senile dementia if current patterns of mortality and morbidity continue to apply. A calculation using the loss of cognitive function would of course result in an impairment-free life expectancy.

According to the ICIDH framework, health expectancies are differentiated into:

- *Impairment-free life expectancy*, the average number of years an individual is expected to live free of impairment if current patterns of mortality and impairment continue to apply.

- *Disability-free life expectancy*, the average number of years an individual is expected to live free of disability if current patterns of mortality and disability continue to apply.

- *Handicap-free life expectancy*, the average number of years an individual is expected to live free of handicap if current patterns of mortality and handicap continue to apply. The ICIDH distinguishes between seven main dimensions of handicap: orientation, physical independence,

mobility, occupation, social integration, economic self sufficiency and other handicaps. The REVES classification system distinguishes independent life expectancy, mobility handicap-free life expectancy and occupational handicap-free life expectancy. When the handicap is assessed in a global manner, the indicator is reported as a general handicap-free life expectancy. However, one should realize that handicap is - next to the presence of disabilities - to a large extent determined by the environment one lives in. Therefore differences in (cultural) environment will always have to be taken into account when making geographical (for instance international) comparisons.

According to the REVES committee on conceptual harmonization [Chamie, 1990], the ICIDH disability-free life expectancy should be differentiated into:

- *Functional limitation-free life expectancy*, the average number of years an individual is expected to live free of functional limitation if current patterns of mortality and disability continue to apply. Functional limitations mean restrictions in abilities, for instance, to bend forward and pick up something, or the ability to walk.

- *Activity restriction-free life expectancy*, the average number of years an individual is expected to live free of activity restriction if current patterns of mortality and disability continue to apply. Activity restrictions mean problems in the performance of complex normal human activities like cooking and dressing.

According to Katz et al. [Katz et al., 1983] and subsequent authors:

- *Active life expectancy* was built to measure independence through the calculation of the average number of years an individual is expected to live without restrictions in a number of activities of daily living (ADL) or instrumental activities of daily living (IADL) if current patterns of mortality and ADL/IADL problems continue to apply. So, given the intention of these authors, active life expectancy is an example of a specific handicap-free life expectancy. Although meant to be an indicator of independent life, the fact that active life expectancy is built with activity restriction data, will always make it difficult to classify. Dependency is not necessarily reflected by the number of inabilities. One could imagine more direct assessments of dependency through one or two general questions leading to other indicators of independent life expectancy.

Perceived health expectancy is a generic term for health expectancies calculated for health states defined using population data on perceived health status [Mathers et al., 1994]. So:

- *healthy life expectancy*, or life expectancy in good health, is the average number of years an individual is expected to live in a health state defined as the "favourable part" part of the distribution of perceived health status (usually self-rated on a scale of the form *excellent/good/fair/poor*, or alternatively, *very good/good/fair/bad/very bad*).

Health-adjusted life expectancy is a generic term for a weighted expectation of life summed over a complete set of health states. Weights for health states typically range from zero (death) to unity (optimal health). Health-adjusted life expectancy is a statistical abstraction based on health expectancies in a number of discrete health states and explicit weights for each of those health states. The weights may be empirically derived, based on expert opinion, or arbitrarily chosen [Mathers et al., 1994].

Historic indicators without any explicit reference to the WHO - ICIDH conceptual framework and which cannot be classified according to classification system are referred to as "unclassified disability"-free life expectancy. Thus:

- "*Unclassified disability*"-free life expectancy is the average number of years an individual is expected to live free of "disability" (generic or historic term) if current patterns of mortality and "unclassified disability" continue to apply. This indicator is a combination of mortality and morbidity data without reference to any distinguishable section of the ICIDH.

The REVES classification system is summarized in table 1. Because some conceptual points need more clarification and because ICIDH is currently being revised, a further evolution of it is expected.

Table 1 : Classification system of health expectancies developed by REVES, 1994

	Concepts	**Health expectancies...**
ICD-10	Disease	With or without disease - With or without dementia
ICIDH	Impairment	With or without impairment
	Disability	With or without functional limitation With or without activity restriction
	Handicap	With or without handicap With or without physical independence handicap - (Independent) Active life expectancy With or without mobility handicap With or without occupational handicap With or without other handicap
	Perceived health	In good health / in bad health
	Health-adjusted	Health-adjusted

Source: Robine et al., 1994

Annex 2

Health expectancies: methods of calculation

The principle of the calculation of health expectancy was postulated as early as 1964 [Sanders, 1964] and a first method of calculation was proposed in 1971 by Sullivan [Sullivan, 1971]. Three different methods of calculation of health expectancies exist: (i) the observed prevalence life table method (the Sullivan method); (ii) the double decrement life table method; (iii) and the multistate life table method.

The main advantage of the *observed prevalence life table method* (the Sullivan method) lies in the separate collection of mortality and disability data and in the ready availability of the data necessary for the calculation. Basic cross-sectional surveys are sufficient to collect the observed prevalence of disability within the population; however the indicator obtained is not really a period indicator. The problem with this method lies in approximating the period prevalence by the observed prevalence of disability.

The *double decrement life table method* is based on the observation, during the study period, of the occurrence of two events corresponding to two possible outcomes: mortality and disability. The simplified method used by Katz et al. [Katz et al., 1983] results from using the probabilities of survival without disability directly observed at the end of the study period. This implies that the two outcomes studied are irreversible. The advantage of this method is that it really provides a *period indicator* based on data that are not too difficult to collect. The main drawback lies, as for the method following, in the non-separated collection of the mortality and disability data; the accuracy of the mortality data depending on the size and the representativeness of the study sample.

The *multistate life table method* has been proposed by Rogers et al. [Rogers et al., 1989] in order to take *the recovery of lost functions* into account and return to a state of good health. The advantage of this method - based on transitions between states of health - is that it gives a period indicator that takes the *reversibility of disability* into account. The specific drawback of the multistate life table method arises from the scarceness of adequate data. Data requirements for multistate methods are considerable and there are very few countries where national data are available or likely to be available for some time. Biases are introduced when the gaps between successive waves of longitudinal studies are too long, thus failing to capture a part of the flows between health states during the inter-survey period. Some researchers are developing discrete-time Markov chain models and microsimulation techniques to compute active life expectancy. These new methods aim in particular to accommodate different time intervals between interviews for the different respondents [Laditka and Wolf, 1995]

The observed prevalence life table method uses cross-sectional disability and mortality data, whereas the double decrement and multistate life table methods depend upon longitudinal data sets. There are enormous financial and political implications in the choice between these two data collection strategies, with cross-sectional being much more likely to have been conducted in most countries. However, longitudinal data and multistate methods are essential for projecting the health of populations.

The Sullivan method is very simple and has been discussed by many authors [Robine, 1989]. The years lived between the various ages by the population of a life table are qualified on the basis of the institutionalization rate (generally provided by a census) and the prevalence rate of permanent and temporary limitation of activity (from national health or disability surveys). Once the table is modified, the period life expectancy is calculated in the traditional manner, according to various states of functional disability. So, one can obtain a series of health expectancy values including *disability-free life expectancy* and *life expectancy with disability*.

Taking the survivors (b) in a life table (see Table 1), the number of years lived between two ages (c) is first calculated. Rates of prevalence of disability (d) are then used to calculate the number of years lived with disability. By substracting these from the number of years lived between two ages (c), the number of years lived without disability is obtained (e). The cumulative total of these years (f) is then computed from any given age x (a) and related to the total number of survivors (b) at that age to obtain disability-free life expectancy (g). For example, the total number of years without disability from age 65 upwards is thus 1,153,013.2 in Table 1. This total is divided by the number of survivors aged 65 to estimate DFLE at age 65: 1,153,013.2 (f) divided by 89,347 (b), i.e. 12.9 years.

Table 1: Disability-free life expectancy by the Sullivan method: France, 1991, female (simplified estimation computed with long term disability only).

Age x (a)	Survivors Sx (b)	Years lived between x and x+a (c)	Prevalence of disability between x and x+a (d)	Years lived without disability between x and x+a (e)	Years lived without disability from x (f)	Long term DFLE from x (g)
0	100,000	496,176.5	0.0097	491,366.7	7,075,234.3	70,8
5	99,242	496,287.5	0.0242	484,295.5	6,583,867.6	66.3
10	99,158	495,323.9	0.0253	482,791.8	6,099,572.1	61.5
15	99,076	495,697.5	0.0419	474,927.3	5,616,780.3	56.7
20	98,911	493,614.3	0.0358	475,933.2	5,141,853.0	52.0
25	98,685	492,480.1	0.0631	461,390.7	4,665,919.8	47.3
30	98,401	491,880.8	0.0395	472,470.2	4,204,529.1	42.7
35	98,051	488,648.7	0.0548	461,869.0	3,732,058.8	38.1
40	97,583	486,446.6	0.0632	455,709.6	3,270,189.9	33.5
45	96,876	481,630.4	0.0867	439,895.1	2,814,480.3	29.1
50	95,854	476,093.8	0.1068	425,246.1	2,374,585.2	24.8
55	94,400	467,568.3	0.1221	410,472.8	1,949,339.2	20.6
60	92,336	454,383.5	0.1508	385,853.2	1,538,866.4	16.7
65	89,347	436,686.7	0.1885	354,389.6	1,153,013.2	12.9
70	84,952	408,481.5	0.2740	296,546.1	798,623.6	9.4
75	78,000	363,545.5	0.3455	237,955.9	502,077.5	6.4
80	66,522	290,185.4	0.4675	154,519.8	264,121.6	4.0
85	48,434	297,869.1	0.6320	109,601.8	109,601.8	2.3

Source: Robine and Mormiche, 1994

In 1991, Mathers proposed a method to calculate the confidence intervalle of the estimated health expectancy [Mathers, 1991]. In the framework of Euro-REVES, Jagger produced a practical guide

in which numerous different examples can be found [Jagger, 1997]. In 1973, it was proposed that a weight be introduced in the calculation in order to obtain a single value, the weighted life expectancy [Berg, 1973] or the value-adjusted life expectancy [Bush et al., 1973], which should make it possible to measure the social value of future gains in life expectancy [Robine, 1992].

A first calculation of health expectancy has now been carried out for nearly 50 countries [REVES, 1997a], principally using the Sullivan method. The limits of this method are increasingly well understood and simulations provide a useful means of assessing its imprecision [Mathers and Robine, 1997]. Even if calculation methods are no longer a problem, it would obviously be preferable that all calculations be made with the multistate method. This will naturally occur as period data estimates become available and up till this time, the Sullivan method will provide a useful indicator which can be used, as long as its limitations are understood.

Annex 3

Results of reclassified national health expectancy calculations

1: Health expectancies according to the International Classification of Diseases (ICD-10)

1-1 Disease-free life expectancy

	At birth				At age 65			
	Male		Female		Male		Female	
Countries	LE	HE	LE	HE	LE	HE	LE	HE
Life expectancy without chronic disease								
France, 1991 [1]	72,9	48,7	81,2	49,0	-	-	-	-
Norway, 1985 [2]	72.6	38.9	79.0	37.9	14.3	3.8	18.2	3.7
Life expectancy free from major coronary event and cancer (fatal diseases)								
Italy, 1990 [3]	74.1	70.8	80.7	77.0	-	-	-	-
Life expectancy free from fatal and chronic non fatal disease								
Italy, 1990 [3]	74.1	56.1	80.7	55.9	-	-	-	-

Sources: [1] Robine et al., 1996 ; [2] Grotvedt L and Viksand G, 1994 ; [3] Egidi and Frova, 1997

1-2 Dementia-free life expectancy

	At age 65				At age 85			
	Male		Female		Male		Female	
Countries	LE	HE	LE	HE	LE	HE	LE	HE
Belgium, 1991 [1]	14.0	13.1	18.3	16.1	4.5	3.3	5.6	3.3
France, 1988-90 [2]	15.4	14.8	19.7	18.8	-	-	-	-
Netherlands, 1993 [3]	14.5	14.0	19.0	17.7	4.6	3.7	5.8	3.3

Sources: [1] Roelands et al., 1994; [2] Ritchie et al., 1994b; [3] Perenboom et al., 1996

2: Health expectancies according to the framework of the ICIDH

	At birth				At age 65			
	Male		Female		Male		Female	
Countries	LE	HE	LE	HE	LE	HE	LE	HE
	General handicap-free life expectancy							
Finland, 1986 [1]	-	-	-	-	13.4	4.3	17.4	5.6
France, 1991 [2]	72.9	63.8	81.1	68.5	15.7	10.1	20.1	12.1
Netherlands, 1991-92 [3]	74.2	61.4	80.2	63.5	-	-	-	-
United Kingdom, 1994 [4]	74,2	59.2	79.6	62,2	14.8	8,5	18.6	9.8
	Independent life expectancy							
Finland, 1986 [5]	-	-	-	-	13.4	2.5	17.4	2.4
Norway, 1985 [6]	-	-	-	-	14.4	13.3	18.2	16.9
United Kingdom, 1994 [7]	-	-	-	-	14.8	13.5	18.6	15,6
	Mobility handicap-free life expectancy							
France, 1991 [8]	72.9	71.7	81.1	78.8	15.7	14.8	20.1	18.1
United Kingdom, 1994 [9]	-	-	-	-	14.8	12,9	18.6	14,0
	Occupational handicap-free life expectancy							
Germany*, 1995 [10]	73,8	64,2	80,0	73,2	14,9	12,2	18,7	14,9
	Activity restriction-free life expectancy							
Austria, 1992 [11]	72.9	69.0	79.4	72.4	14.9	11.5	18.3	12.3
Italy, 1990 [12]	73.5	70.6	80.0	76.2	14.9	13.5	18.8	16.8
Netherlands, 1990 [13]	73.9	60.4	80.1	59.9	14.4	9.0	19.0	8.0
Switzerland, 1988-89 [14]	74.0	67.1	80.9	72.9	15.4	12.2	19.6	14.9
	Functional limitation-free life expectancy							
Denmark, 1994 [15]					14.3	9.9	17.8	9.7
Netherlands, 1986-88 [16]	73.5	64.1	79.9	65.1	-	-	-	-
Spain, 1986 [17]	73.2	61.6	79.6	63.6	15.0	7.0	18.4	6.9
United Kingdom, 1985 [18]	71.7	63.6	77.5	66.5	-	-	-	-
	"Unclassified disability"-free life expectancy							
Bulgaria, 1996 [19]	-	-	-	-	12.6	6.9	15.2	7.1
Poland, 1988 [20]	67.1	59.8	75.7	62.6	-	-	-	-

*For ex Federal Republic of Germany.

Author's denominations and sources:

[1] *Life expectancy without limiting or extremely limiting long-standing illness*, Valkonen, 1994

[2] *Espérance de vie sans incapacité,* Robine and Mormiche, 1993

[3] *General handicap-free life expectancy (Including "intermittently"),* Boshuizen and van de Water, 1994

[4] *Healthy life expectancy calculated from GHS (Long standing illness question),* Bebbington and Darton, 1996

[5] *Life expectancy free of ADL-Index #3 (all items),* Valkonen, 1994

[6] *Able to dress, undress etc.,* Grotvedt and Viksand, 1994

[7] *Life expectancy independent in ADLs,* Bebbington and Darton, 1996

[8] *Espérance de vie sans incapacité sévère*, Robine and Mormiche, 1993

[9] *Life expectancy mobile outdoors unaided,* Bebbington and Darton, 1996

[10] *Disability-free life expectancy*, Brückner, 1997

[11] *Disability-free life expectancy*, Kytir, 1994

[12] *Speranza de vita senza limitazioni temporanee;* Burratta and Crialesi, 1993

[13] *Activity restriction-free life expectancy*, Boshuizen and van de Water, 1994

[14] *Disability free life expectancy,* Spuhler et al., 1991

[15] *Expected life time without long-term disability*; Bronnum-Hansen, 1998

[16] *Gezonde levensverwachting*, van Ginneken et al.,1992

[17] *Esperanza de vida libre de incapacidad*, Sociedad Espanola de Salud Pùblica y Administracion Sanitaria, 1993

[18] *Expectation of life without disability,* Bebbington, 1992

[19] *Disability-free life expectancy,* Mutafova, 1997

[20] *Disability-free life expectancy,* Haber and Dowd, 1994

3: Health expectancies according to the concept of perceived health

	At birth				At age 65			
	Male		Female		Male		Female	
Countries	LE	HE	LE	HE	LE	HE	LE	HE
Belgium, 1989-90 [1]	-	-	-	-	14.2	12.4	18.4	15.7
Finland, 1986 [2]	-	-	-	-	13.4	9.6	17.4	11.6
Germany, 1995 [3]	73.8	62.4	80.0	64.2	14.9	9.4	18.7	10.5
Italy, 1990 [4]	73.5	58.6	80.0	58.4	14.9	6.1	18.8	6.5
Netherlands, 1990 [5]	-	-	-	-	14.4	9.3	19.0	9.1
Netherlands, 1994 [6]	74.6	60.1	80.3	60.3	-	-	-	-
Norway, 1985 [7]	72.6	69.0	79.0	74.1	14.3	12.4	18.2	15.2
Spain, 1991 [8]	73.3	54.5	80.5	53.3	15.4	6.9	19.2	7.1

Author's denominations and sources:

[1] *Espérance de vie en bonne santé*, Roelands and Van Oyen H, 1995

[2} *Life expectancy without self-rated poor or very poor health.* Valkonen, 1994.

[3] *Healthy life expectancy.* Brückner, 1997

[4] *Speranza di vita in buona salute*, Buratta and Crialesi, 1993

[5] *Life expectancy in good self-reported health,* Vademecum gezondheidsstatistiek Nederland 1994, 1994

[6] *Levensverwachting in goed ervaren gezondheid*, Perenboom et al., 1997

[7] *Life expectancy with very good, good or fair health,* Grotvedt and Viksand, 1994

[8] *Esperanza de vida en buena salud,* Regidor et al., 1995

4: Health-adjusted life expectancies

4-1 Disability-adjusted life expectancy, both sexes

	At birth		At age 65	
Countries	LE	HE	LE	HE
Netherlands, 1990s [1]	73.5	64.7	14.3	9.5

Author's denominations and sources:

[1] *Disability-Adjusted life expectancy*, Barendregt et al., 1998

4-2 Health-adjusted life expectancy

	At birth				At age 65			
	Male		Female		Male		Female	
Countries	LE	HE	LE	HE	LE	HE	LE	HE
Netherlands, 1990s [1]	74.6	69.4	80.3	73.2	-	-	-	-
United Kingdom, 1994 [2]	-	-	-	-	14.8	11.2	18.6	12.6

Author's denominations and sources:

[1] *Gezonde levensjaar-equivalenten*, Perenboom et al., 1997

[2]*Quality adjusted life years*, Bebbington and Darton, 1996

Annex 4

Health expectancies by region

Health expectancies by regions

	At birth				At age 65			
	Male		Female		Male		Female	
Countries	LE	HE	LE	HE	LE	HE	LE	HE
General handicap-free life expectancy								
United Kingdom, Standard regions, 1991 [1]								
North	72.3	61.2	77.8	65.5	13.6	7.5	17.3	9.3
Yorks & Humberside	72.7	62.2	78.3	66.0	13.9	7.8	17.8	9.4
East Midlands	73.5	63.7	78.9	67.4	14.3	8.5	18.1	10.1
East Anglia	75.0	66.2	80.1	69.5	15.1	9.5	18.8	11.2
South East	74.7	66.4	79.9	69.6	15.0	9.5	18.7	11.2
Greater London	73.1	63.9	79.3	67.7	14.5	8.9	18.6	10.7
South West	74.6	65.6	80.2	69.4	15.1	9.5	19.0	11.3
West Midlands	73.0	63.3	78.5	66.8	14.0	8.2	18.0	9.9
North West	72.1	61.2	77.7	65.2	13.6	7.6	17.3	9.3
Wales	73.1	60.4	78.9	64.9	14.1	7.4	18.1	9.4
France, Regions, 1990 [2]								
ZEAT* 1	73.1	63.2	81.0	67.0	-	-	-	-
ZEAT 2	72.2	65.4	80.7	70.9	-	-	-	-
ZEAT 3	69.8	62.5	78.8	69.6	-	-	-	-
ZEAT 4	72.0	63.6	80.0	69.5	-	-	-	-
ZEAT 5	72.6	63.9	81.1	69.0	-	-	-	-
ZEAT 7	73.8	64.1	81.4	68.1	-	-	-	-
ZEAT 8	73.1	65.1	81.3	70.6	-	-	-	-
ZEAT 9	73.1	65.8	81.1	71.1	-	-	-	-
Functional limitation-free life expectancy								
Spain, autonomous communities, 1986 [3]								
Spain	73.2	60.8	79.6	62.6	-	-	-	-
Andalucia	71.8	59.1	78.7	60.0	-	-	-	-
Aragon	73.9	62.0	79.7	61.4	-	-	-	-
Asturias	72.3	62.3	79.7	66.9	-	-	-	-
Baleares	71.2	61.9	78.6	65.7	-	-	-	-
Canarias	72.5	60.8	78.7	61.1	-	-	-	-
Cantabria	73.5	61.3	80.4	64.4	-	-	-	-
Castilla-La Mancha	74.6	60.8	79.4	61.1	-	-	-	-
Castilla y Leon	75.0	63.4	78.9	65.9	-	-	-	-
Cataluna	73.8	61.3	80.1	62.2	-	-	-	-
Comunidad Valenciana	72.9	61.2	78.8	63.7	-	-	-	-
Extramadura	72.8	60.7	79.0	61.4	-	-	-	-
Galicia	72.6	61.9	79.4	65.4	-	-	-	-
Madrid	74.2	59.9	81.3	60.2	-	-	-	-
Murcia	72.9	61.9	78.6	66.9	-	-	-	-
Navarra	73.9	62.7	79.8	65.2	-	-	-	-
Pais Vasco	72.4	60.7	78.1	61.4	-	-	-	-
La Rioja	73.0	57.8	79.6	51.8	-	-	-	-

*ZEAT = Zone d'Etude et d'Aménagement du Territoire. France is divided into 8 large regions or ZEAT.

Health expectancies by regions, continued

	At birth				At age 65			
	Male		Female		Male		Female	
Countries	LE	HE	LE	HE	LE	HE	LE	HE
	Healthy life expectancy							
Italy, Regions, 1990 [4]								
Italia Settentrionale	71.7	58.2	79.0	57.9	13.8	6.1	18.0	6.8
Italia centrale	73.1	59.0	79.4	59.2	14.3	5.9	18.1	6.3
Italia meridionale	72.7	57.3	78.1	57.4	14.4	5.3	17.2	5.3
Belgium, 1989-90 [5]								
Flemish region	-	-	-	-	14.3	13.3	18.5	16.1
Walloon region	-	-	-	-	13.2	9.2	17.7	14.4

Author's denominations and sources:

[1] *Healthy life expectancy;* Bone et al., 1995

[2] *Espérance de vie sans incapacité*; Robine et al., 1998b

[3] *Esperanza de vida libre de incapacidad*; Regidor et al., 1995

[4] *Speranza di vita in buina salute;* Buratta and Crialesi, 1993

[5] *Healthy life expectancy*; van Oyen et al., 1994

Annex 5

Chronological series of health expectancy

Chronological series

	At birth				At age 65			
	Male		Female		Male		Female	
Countries	LE	HE	LE	HE	LE	HE	LE	HE
Denmark	**Functional limitation-free life expectancy, 1987-1994 [1]**							
1987	-	-	-	-	14.1	8.8	17.9	9.8
1994	-	-	-	-	14.3	9.9	17.8	9.7
Finland	**General handicap-free life expectancy, 1978-1986 [2]**							
1978	-	-	-	-	12.4	4.4	16.2	5.1
1986	-	-	-	-	13.4	4.3	17.4	5.6
Finland	**Healthy-life expectancy, 1978-1986 [2']**							
1978	-	-	-	-	12.4	8.2	16.2	9.7
1986	-	-	-	-	13.4	9.6	17.4	11.6
France	**Chronic disease-free life expectancy, 1981-1991 [3]**							
1981	70,4	48,3	78,6	49,1	-	-	-	-
1991	72,9	48,7	81,2	49,0	-	-	-	-
France	**General handicap-free life expectancy, 1981-1991 [4]**							
1981	70.4	60.8	78.6	65.9	14.1	8.8	18.3	9.8
1991	72.9	63.8	81.1	68.5	15.7	10.1	20.1	12.1
France	**Mobility handicap-free life expectancy, 1981-1991 [4']**							
1981	70.4	68.9	78.6	76.3	14.1	13.1	18.3	16.5
1991	72.9	71.7	81.1	78.8	15.7	14.8	20.1	18.1
Germany	**Healthy life expectancy, 1986-1995 [5]**							
1986	71.8	63.7	78.3	67.1	13.8	10.2	17.6	12.1
1989	72.5	-	79.0	-	14.2	-	18.0	-
1992	73.2	64.0	79.6	66.0	14.7	9.9	18.5	11.0
1995	73.8	62.4	80.0	64.2	14.9	9.4	18.7	10.5
Germany	**Occupational handicap-life expectancy, 1986-1995 [5']**							
1986	71.8	62.2	78.3	72.6	13.8	7.7	17.6	14.5
1989	72.5	62.7	79.0	73.1	14.2	7.8	18.0	14.8
1992	73.2	63.3	79.6	72.9	14.7	8.2	18.5	14.6
1995	73.8	64.2	80.0	73.2	14.9	8.7	18.7	14.6
Netherlands	**Healthy life expectancy, 1981-1990 [6]**							
1981	72.7	56.9	79.3	58.0	14.0	8.1	18.5	7.8
1982	72.8	56.0	79.4	58.9	14.0	7.1	18.5	8.6
1983	72.9	58.6	79.5	60.9	14.0	8.4	18.6	9.5
1984	73.0	58.3	79.6	59.8	14.0	7.9	18.7	8.6
1985	72.9	59.0	79.6	60.9	14.0	8.4	18.6	10.0
1986	73.2	59.8	79.7	60.7	14.1	8.4	18.8	9.4
1987	73.5	59.8	80.0	61.5	14.3	8.5	19.0	10.0
1988	73.6	60.3	80.2	61.8	14.4	8.6	19.0	9.3
1989	73.7	59.5	80.0	60.8	14.4	8.3	18.9	8.9
1990	73.9	60.0	80.1	60.2	14.4	9.3	19.0	9.1
Netherlands	**Activity restriction-free life expectancy, 1983-1990 [6']**							
1983	-	-	-	-	14.0	8.0	18.6	7.4
1984	-	-	-	-	14.0	7.7	18.7	5.7
1985	-	-	-	-	14.0	7.6	18.6	6.8
1989	-	-	-	-	14.3	9.1	18.9	7.5
1990	-	-	-	-	14.4	9.0	19.0	8.0

Chronological series, continued

	At birth				At age 65			
	Male		Female		Male		Female	
Countries	LE	HE	LE	HE	LE	HE	LE	HE
Netherlands	**Healthy life expectancy, 1983-1994 [7]**							
1983	72.9	56.7	79.5	61.2	-	-	-	-
1984	73.0	58.3	79.6	60.1	-	-	-	-
1985	72.9	59.1	79.6	61.	-	-	-	-
1986	73.2	59.9	79.7	61.2	-	-	-	-
1987	73.5	59.9	80.0	62.0	-	-	-	-
1988	73.6	60.5	80.2	62.4	-	-	-	-
1989	73.7	59.6	80.0	61.3	-	-	-	-
1990	73.8	60.0	80.0	60.6	-	-	-	-
1991	74.1	58.8	80.2	60.8	-	-	-	-
1992	74.2	59.4	80.2	62.1	-	-	-	-
1993	74.0	59.4	80.0	60.1	-	-	-	-
1994	74.6	60.1	80.3	60.3	-	-	-	-
Netherlands	**Health adjusted life expectancy, 1983-1994 [7']**							
1983	72.9	67.8	79.5	73.0	-	-	-	-
1984	73.0	67.7	79.6	72.6	-	-	-	-
1985	72.9	68.0	79.6	73.1	-	-	-	-
1986	73.2	68.4	79.7	73.0	-	-	-	-
1987	73.5	68.7	80.0	73.5	-	-	-	-
1988	73.6	39.0	80.2	73.8	-	-	-	-
1989	73.7	68.6	80.0	73.4	-	-	-	-
1990	73.8	68.9	80.0	73.1	-	-	-	-
1991	74.1	68.7	80.2	73.3	-	-	-	-
1992	74.2	69.0	80.2	73.7	-	-	-	-
1993	74.0	68.7	80.0	72.9	-	-	-	-
1994	74.6	69.4	80.3	73.2	-	-	-	-
Netherlands	**Activity restriction-free life expectancy, 1989-1994 [7'']**							
1989	73,7	60.8	80,0	61,6	-	-	-	-
1990	73.8	61,2	80,0	61,3	-	-	-	-
1991	74,1	62,0	80,2	60,7	-	-	-	-
1992	74,2	61.3	80,2	61,8	-	-	-	-
1993	74,0	61,1	80,0	60,2				
1994	74,6	62,7	80,3	60,8	-	-	-	-
Norway	**Chronic disease-free life expectancy, 1975-1985 [8]**							
1975	71,9	39,1	78,0	39,6	14.0	3,8	17.2	3,7
1985	72,6	38,9	79,0	37,9	14.3	3,8	18.2	3,7
Norway	**Independent life expectancy, 1975-1985 [8']**							
1975	-	-	-	-	14.0	13.3	17.2	16.1
1985	-	-	-	-	14.4	13.3	18.2	16.9
Spain	**Healthy life expectancy, 1986-1991 [9]**							
1986	73.2	54.0	79.6	51.4	15.0	6.4	18.4	5.8
1991	73.3	54.5	80.5	53.3	15.4	6.9	19.2	7.1

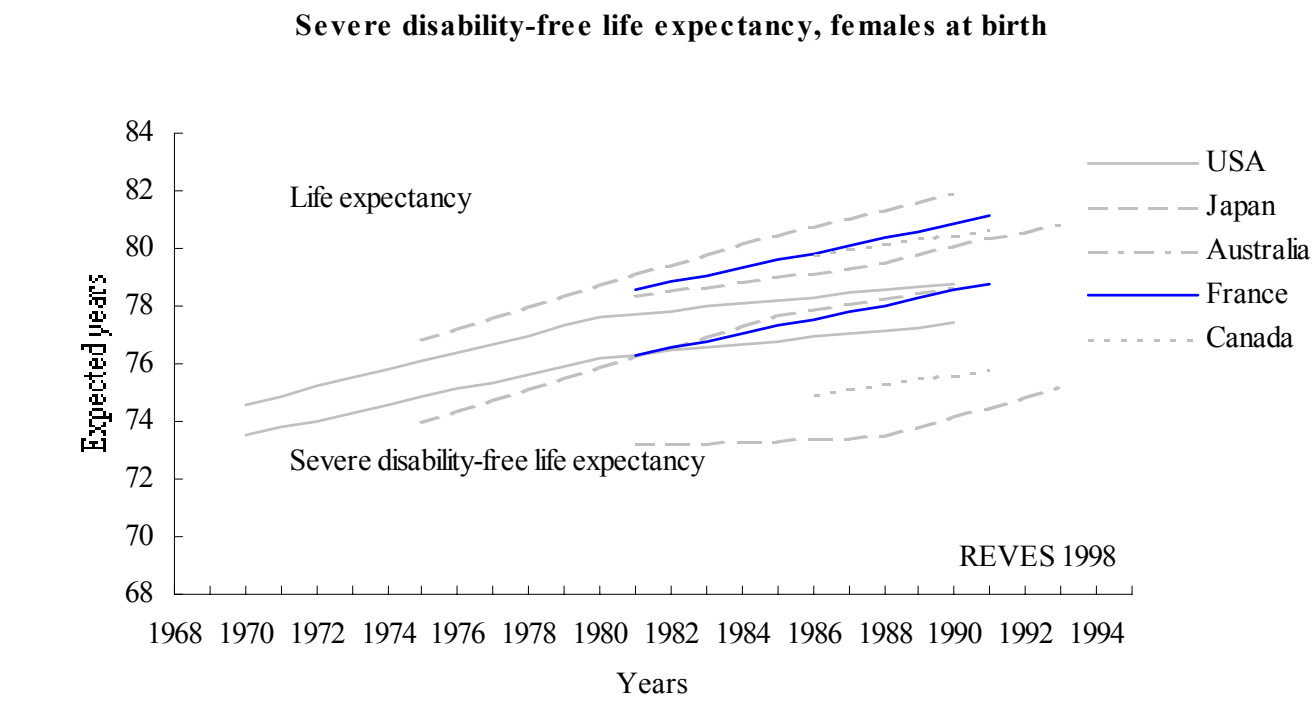
Chronological series, continued

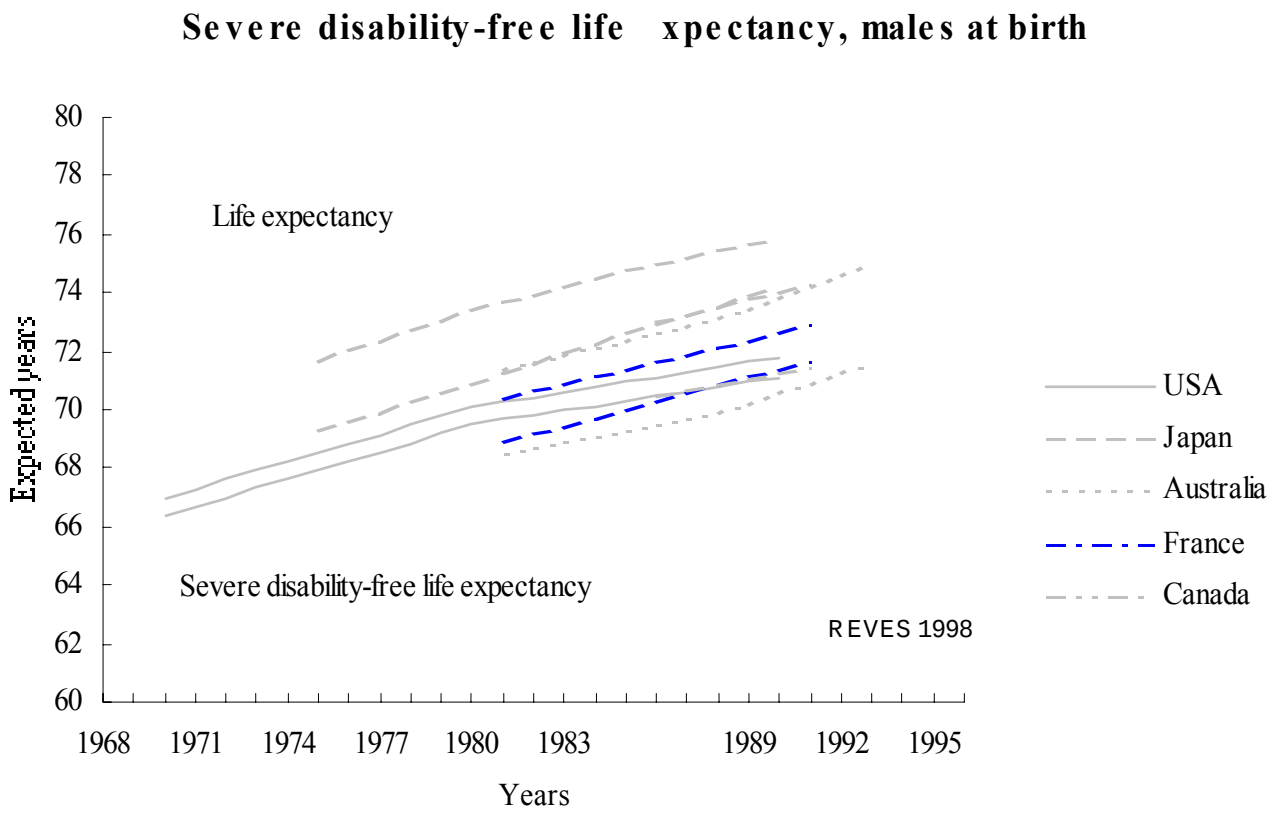
	At birth				At age 65			
	Male		Female		Male		Female	
Countries	LE	HE	LE	HE	LE	HE	LE	HE
United Kingdom	**General handicap-free life expectancy, 1976-1994 [10]**							
1976	70.0	58.3	76.1	62.0	12.5	7.1	16.6	8.6
1981	71.1	58.7	77.1	61.0	13.1	7.9	17.1	8.5
1985	71.9	58.8	77.7	61.9	13.4	7.8	17.3	9.2
1988	72.4	58.5	78.1	61.2	13.7	7.5	17.6	8.7
1991	73.2	59.9	78.7	63.0	14.2	7.9	17.9	9.8
1992	73.7	59.7	79.2	61.9	14.5	7.9	18.3	9.5
1994	74.2	59.2	79.6	62.2	14.8	8.5	18.6	9.8
United Kingdom	**Functional limitation-free life expectancy, 1980-1994 [10']**							
1980	-	-	-	-	12.9	11.9	16.9	14.7
1985	-	-	-	-	13.3	12.4	17.3	14.7
1994	-	-	-	-	14.8	13.8	18.6	15.8
United Kingdom	**Mobility handicap free life expectancy, 1980-1994 [10'']**							
1980	-	-	-	-	12.9	11.6	16.9	13.3
1985	-	-	-	-	13.3	12.0	17.3	13.3
1994	-	-	-	-	14.8	12.9	18.6	14.0
United Kingdom	**Independent life expectancy, 1980-1994 [11]**							
1980	-	-	-	-	12.9	11.6	16.9	14.4
1985	-	-	-	-	13.3	12.1	17.3	14.2
1994	-	-	-	-	14.8	13.5	18.6	15.6

Author's denominations and sources:

[1] *Expected life time without long term disability*; Bronnum-Hansen, 1998
[2] *Life expectancy without limiting or extremely limiting long-standing illness*, Valkonen, 1994
[2'] *Life expectancy in good self-assessed health*, Valkonen, 1994
[3] *Espérance de vie sans maladie chronique*, Robine et al., 1996
[4] *Espérance de vie sans incapacité*, Robine and Mormiche, 1994
[4'] *Espérance de vie sans incapacité sévère*, Robine and Mormiche, 1994
[5] *Healthy life expectancy*, Brückner, 1997.
[5'] *Life expectancy free of severe handicap*, Brückner, 1997.
[6] *Healthy life expectancy*, Perenboom et al., 1993
[6'] *Disability-free life expectancy*, Perenboom et al., 1993
[7] *Levensverwachting in goed ervaren gezonheid*, Perenboom et al., 1997
[7'] *Gezonde levensjaar-equivalent*, Perenboom et al., 1997
[7''] *Levensverwachting zonder beperkingen,* Perenboom et al., 1997
[8] *Life expectancy without chronic disease*, Grotvedt and Viksand, 1994
[8'] *Life expectancy able to dress/undress etc*., Grotvedt and Viksand, 1994
[9] *Esperanza de vida en buena salud*, Regidor et al., 1995
[10] *Healthy life expectancy*, Bebbington and Darton, 1996
[10'] *Life expectancy able to go up and down stairs unaided*, Bebbington and Darton, 1996
[10''] *Life expectancy mobile outdoors unaided,* Bebbington and Darton, 1996
[11] *Life expectancy independent in ADLs*, Department of Health, 1997

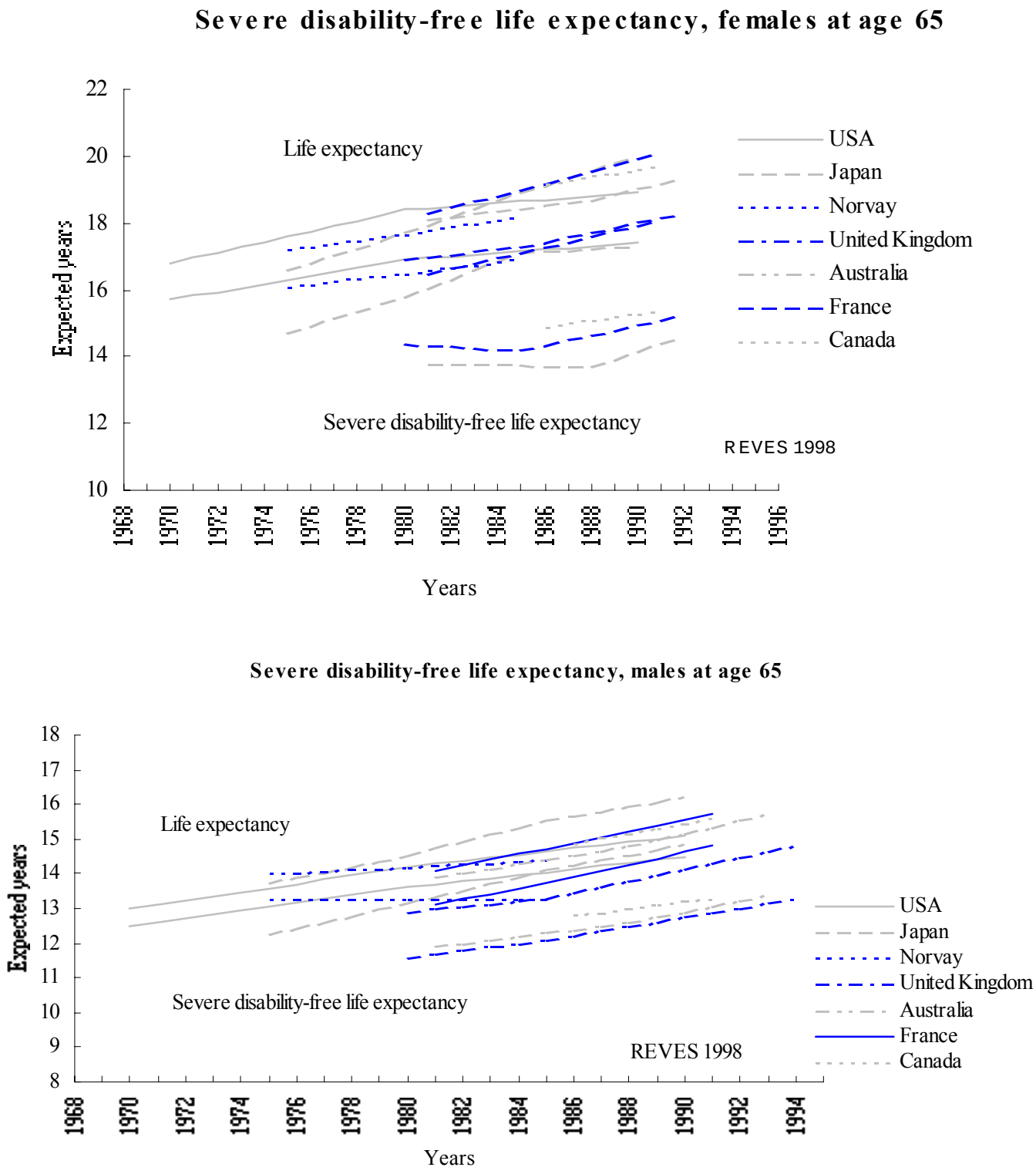
Graph 1:





Sources: Crimmins et al., 1989, 1997 ; Inoue et al., 1997 ; Mathers, 1991, 1996 ; Robine and Mormiche, 1994 ; Wilkins et al., 1994;

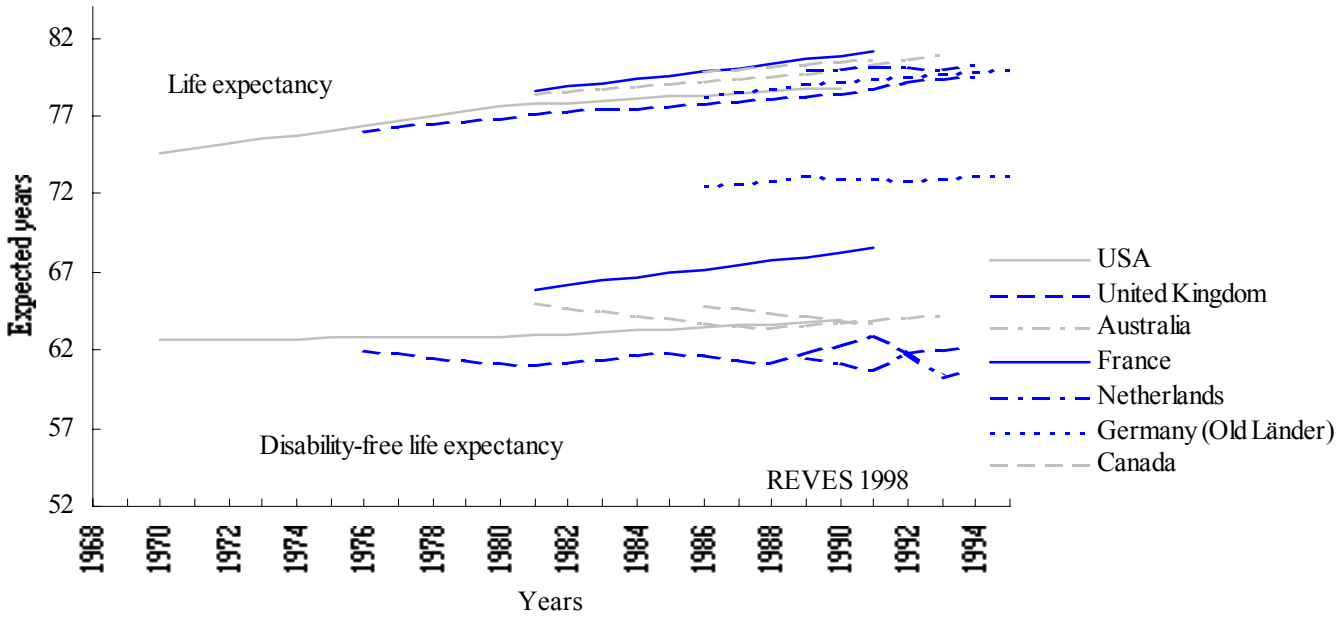
Graph 2:



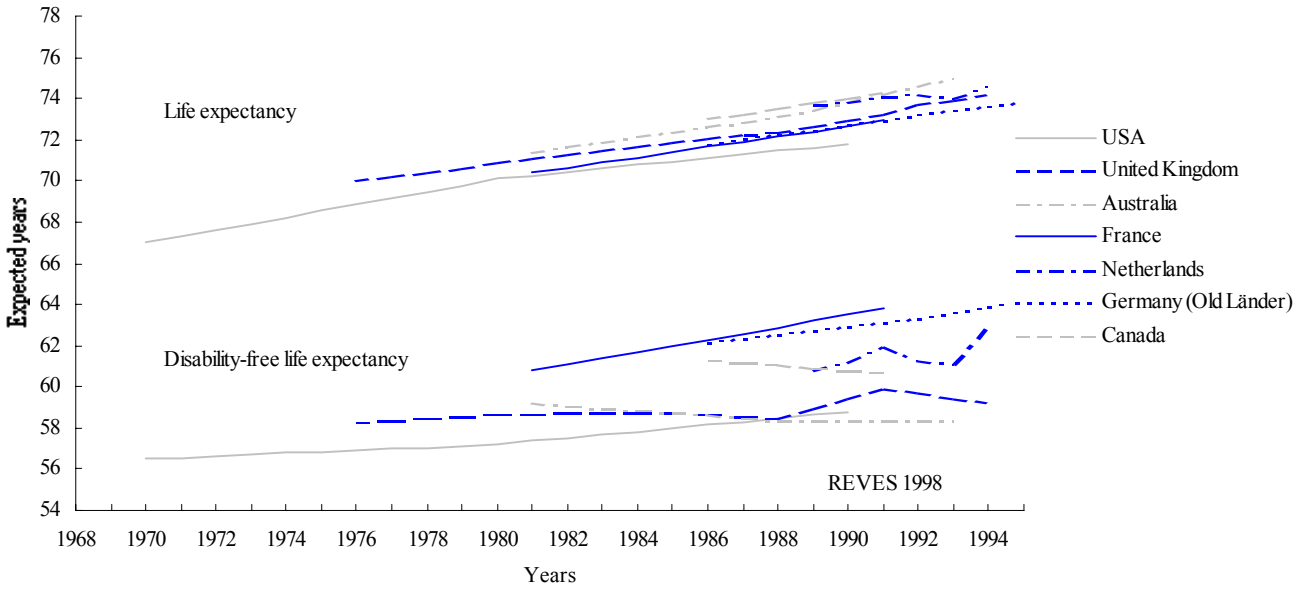
Sources: Crimmins et al., 1989, 1997 ; Inoue et al., 1997 ; Grotvedt and Viksand, 1994 ; Bebbington and Darton, 1996 ; Mathers, 1991, 1996 ; Robine and Mormiche, 1994 ; Wilkins et al., 1994;

Graph 3:

Disability-free life expectancy, all levels combined, females at birth



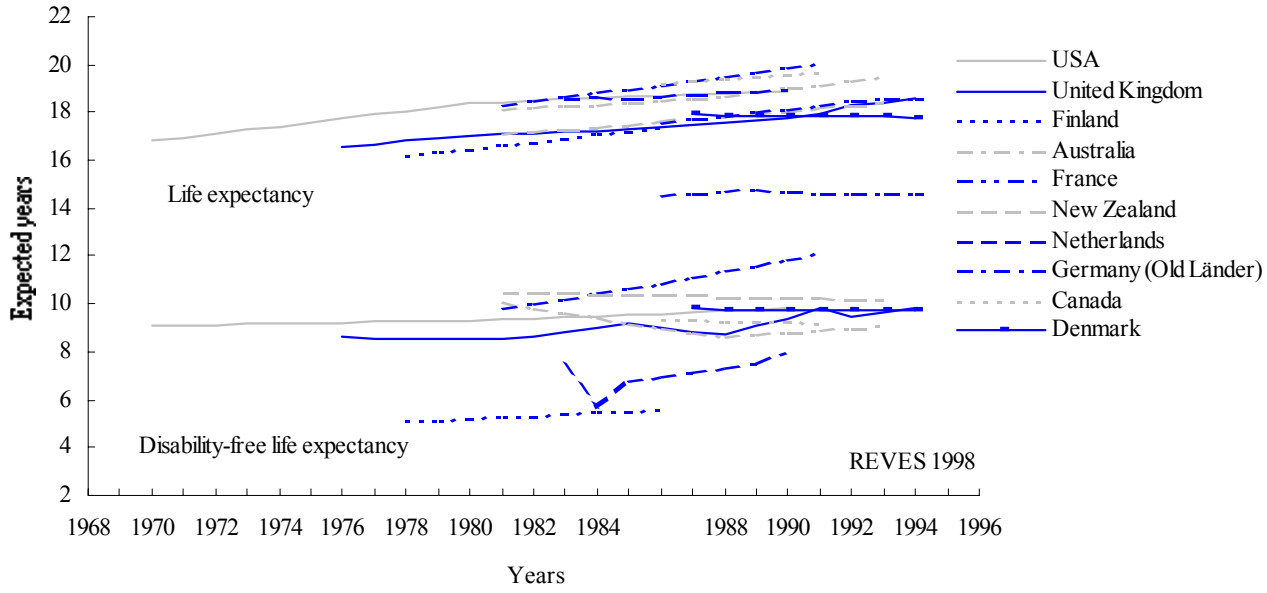
Disability-free life expectancy, all levels combined, males at birth



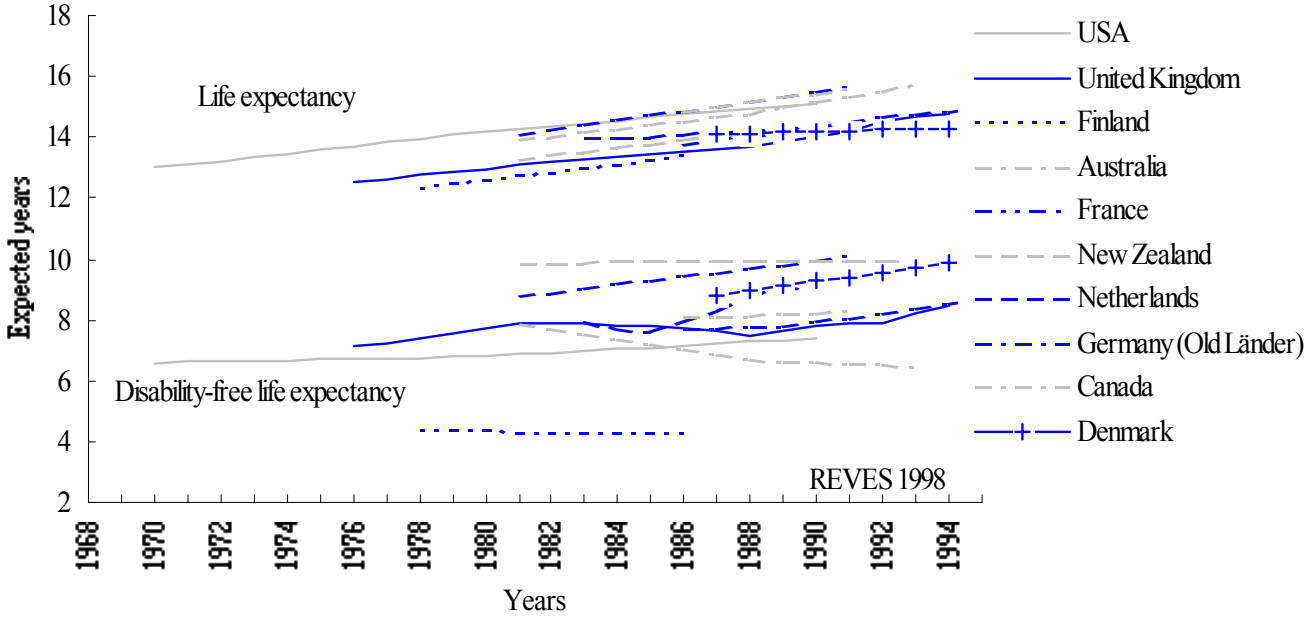
Sources: Crimmins et al., 1989, 1997 ; Bebbington and Darton, 1996 ; Mathers, 1991, 1996 ; Robine and Mormiche, 1994 ; Perenboom et al., 1997 ; Brückner, 1996 ; Wilkins et al., 1994;

Graph 4:

Disability-free life expectancy, all levels combined, females at age 65



Disability-free life expectancy, all levels combined, males at age 65



Sources: Crimmins et al., 1989, 1997 ; Bebbington and Darton, 1996 ; Sihvonen, 1994 ; Mathers, 1991, 1996 ; Robine and Mormiche, 1994 ; Graham and Davis, 1997; Perenboom et al., 1997 ; Brückner, 1997 ; Wilkins et al., 1994 ; Bronnum-Hansen, 1998.