

METHODOLOGY FOR THE CALCULATION OF HEALTH EXPECTANCIES

The calculation of life expectancy in a specific state of health is based on techniques for obtaining life expectancy. Basically, the population in each age range is partitioned in accordance with the specific likelihood due to age of being in each of the possible states.

In theory, the likelihood by age is derived from the rates of incidence start and finish for each state, in the same way that in calculating life expectancy, the likelihood is obtained from the number of deaths registered. Therefore, the likelihood is calculated taking the flow observed in a specific period and provides information regarding the number of transitions within and outside each state.

In practice, the construction of the aforementioned table is unfeasible, since the transition data between the states of health is not collected in a systematic way, but rather, there are only specific, more or less periodic surveys available (health, disabilities, etc.), reflecting a stock, not a flow. Therefore, the incidence for the period, needed for calculations, should be estimated depending on the information available.

1. Methods of calculation

There are three families of methods for carrying out this estimate: life table methods based on the observed prevalence, life table methods with multiple decreases, life table methods with decreases-increases.

LIFE TABLE METHOD BASED ON THE OBSERVED PREVALENCE. SULLIVAN METHOD

In the health field, Sanders suggested a model combining mortality and morbidity in the same life table (Sanders, 1964). The idea was finally implemented by Sullivan, who constructed a life table based on the observed prevalence and calculated the first disability-free life expectancy. The Sullivan method (1971) is today the one used the most for obtaining time series and international comparisons on health matters.

Construction of the life table

The process of compiling the life table based on the observed prevalence is straightforward. It consists of amending in the classic life table the function L_x (number of years lived in the age range), multiplying it by $1 - tx$ - the specific rate of prevalence by age (tx). Thus we have $(1-tx) \cdot L_x$, which is the **number of years lived without disabilities** in the age range.

In order to apply this range, data is used from the classic mortality tables as well as data relating to state j observed in a specific population survey. The

specific rates by age, sex, referring to state of health, disabilities, etc., are stock data, in other words, observed prevalence.

Advantages and disadvantages of the method.

The main drawback of the Sullivan method resides in the absence of observed transitions between states, with them being estimated taking the observed prevalence. It has been shown that the method produces good estimates when the transition studies are stable over time. As far as states of health are concerned, such as disabilities, changes are gradual enough to be able to ensure that the observed prevalence is a good estimator of changes in the period studied. Nevertheless, caution should be exercised when interpreting the data, particularly when estimating, for example, the number of years lived with disabilities, since it involves a short duration situation in a state of relatively low incidence, and therefore imprecisions in the model may have a greater impact.

To date, the Sullivan method has been used to calculate health expectancies and other health indicators in at least 49 countries.

LIFE TABLE METHOD WITH MULTIPLE DECREASES

This model was initially developed by actuaries and insurance companies in order to calculate pensions and compensation payable based on the average duration of life before reaching the state of "insurance beneficiary", in other words, with disabilities, widowed, etc.

The multiple decrease model not only considers death as a final state, it also takes into account other states of life which may be regarded as permanent, in other words, events constituting leaving the life table. In this sense, death and disabilities are considered absorbent states.

Using an ongoing study, which collected data, in several waves, it would be possible to assess the number of transitions from the initial state to the absorbent state, and thereby estimate the specific likelihood of survival in the initial state. By applying these probabilities to a hypothetical cohort, we will be given the life table in relation to those absorbent events.

This method provides an indicator of the period, which suitably reflects the current health conditions of the population.

Nevertheless, the information required by the method is impossible to obtain on a large scale, since it would require the carrying out of surveys over and over again on the same sample, in order to obtain the transition likelihood. Therefore, its use for calculating health expectancies comparable internationally is unfeasible.

Conversely, the assumption that disabilities or state of health considered are absorbent, with no possibility of recovery, is inappropriate for health studies, since there are disabilities from which there may be recovery and transitory states of health.

LIFE TABLE METHOD WITH DECREASES-INCREASES

In the 1970s, several authors began exploring models capable of handling not only transitions out of the initial state, but also transitions back to the state. The idea driving these models was to study the effect of a specific health programme on the population group at which the programme was aimed. A life table has been developed of increases-decreases on the basis of a Markov chain.

2. Health expectancies with the Sullivan method.

The main reason for calculating a health expectancy is to combine information regarding mortality and morbidity in a single indicator. The aforementioned indicator would be useful in order to ascertain the health of the population and draw comparisons between countries, within a country over time or between population subgroups, despite any existing differences in age composition. Comparability is greater still if calculations are made separately for men and women.

Since this method is for general use, in order to enable comparison of its results, several points must be borne in mind:

- The same definitions of state of health must be used
- The general design of surveys from which prevalences are obtained must also be the same, since estimates regarding prevalences of illness and health are highly sensitive to the collection method: personal, telephone and postal interviews etc.
- It is essential to specify the last age group, the open group, which differs between surveys and may also affect comparability of results.

In view of the fact that the methodology for disability surveys used for persons resident in Households and resident in Centres are not uniform, and that the remaining surveys will only be aimed at the population resident in Households, only the rates for the latter group have been applied for calculating Disability-free Life Expectancy. In this way, comparability is also guaranteed with data for 1999.

Calculation of Disability-free Life Expectancy (DFLE) with the Sullivan method

As commented from the outset, the method consists of amending the life table by multiplying $1 -$ the specific rate of prevalence by age (tx), by L_x , the number of years lived in the age range.

For each age range, the mortality table for the mortality rates of the population of Spain used is the one for 2007 (the latest one available), which provides the columns needed for calculating the DFLE:

lx Survivors aged x

L_x Number of years lived in the age group $x, x+n$

and the Disabilities, Independence and Dependency Situations Survey aimed at households (DIDSS-h 2008) provides the disability rates by age, t_x .

This way, life expectancy and the DFLE are obtained from these functions:

$$EV_x = \frac{\sum_{i=x}^{90} (L_i)}{l_x} \quad EVLD_x = \frac{\sum_{i=x}^{90} ((1-t_i)L_i)}{l_x}$$

The calculation of DFLE is illustrated with a numerical example.

Disability-free Life Expectancy by age calculated with the Sullivan method. National total. Both sexes.

Edad	L_x	l_x	T_x	t_x	$(1-t_x) \cdot L_x$	T'_x	EV_x	$EVLD_x$
0	597.654	100.000	8.094.292	0,0215	584.802	7.249.307	80,94	72,49
6	398.152	99.558	7.496.638	0,0174	391.223	6.664.505	75,30	66,94
10	497.459	99.520	7.098.486	0,0192	487.926	6.273.283	71,33	63,04
15	496.909	99.456	6.601.027	0,0165	488.734	5.785.357	66,37	58,17
20	495.967	99.290	6.104.118	0,0166	487.759	5.296.623	61,48	53,35
25	494.940	99.094	5.608.151	0,0174	486.332	4.808.864	56,59	48,53
30	493.731	98.876	5.113.211	0,0261	480.821	4.322.532	51,71	43,72
35	492.029	98.604	4.619.480	0,0328	475.884	3.841.711	46,85	38,96
40	489.117	98.166	4.127.451	0,0447	467.231	3.365.827	42,05	34,29
45	484.597	97.433	3.638.334	0,0612	454.958	2.898.596	37,34	29,75
50	477.728	96.328	3.153.738	0,0730	442.838	2.443.638	32,74	25,37
55	467.537	94.635	2.676.010	0,1026	419.576	2.000.801	28,28	21,14
60	452.824	92.208	2.208.472	0,1249	396.264	1.581.225	23,95	17,15
65	432.019	88.691	1.755.648	0,1558	364.730	1.184.961	19,80	13,36
70	400.504	83.776	1.323.629	0,2182	313.098	820.230	15,80	9,79
75	351.414	75.861	923.125	0,3089	242.866	507.132	12,17	6,68
80	277.934	63.914	571.711	0,4265	159.383	264.266	8,94	4,13
85	180.076	46.324	293.777	0,5745	76.625	104.883	6,34	2,26
90	113.701	25.988	113.701	0,7515	28.258	28.258	4,38	1,09

L_x Number of years lived in the age group $x, x+n$

l_x Survivors at age x

T_x Future life years from age x

L_x Disability rate in the age group $x, x+n$

$(1-t_x) \cdot L_x$ Number of years lived without disability in the age group $x, x+n$

T_x Future life years without disability from age x

LE_x Life expectancy at age x

$DFLE_x$ Disability-free Life Expectancy at age x

There is a singularity in the first age group in the table, 0 to 5 years. This is due to the fact that the disability study has been carried out using different questionnaires and definitions for the population aged 0 to 5 years old and

aged 6 years old and over. Therefore, obtaining these rates was subject to this age distribution.

The life expectancies provided are calculated for both sexes, and for men and women.

The rates used in calculating the life expectancies in this study are obtained from the information provided by the DIDSS-h 2008, except for the Life Expectancy Free of Chronic Illness and in Perceived Good Health in which the information provided by the National Health Survey 2006 has been used. These rates are as follows

- LEFCI. Life Expectancy Free of Chronic Illness: rate of persons with at least one chronic illness. This rate has been obtained from the Health Module of the National Health Survey 2006. Chronic illnesses taken into account differ to persons aged less than 16 years old and for persons aged 16 years old or over. These are considered to be illnesses diagnosed by a doctor.

- LEPGH. Life Expectancy in Perceived Good Health: perceived state of health has been asked via the question 'Would you say that, the last 12 months, your state of health has been very good, good, fair, poor or very poor?'. The rate has been used for persons whose state of health is fair, poor or very poor, thereby also following international recommendations. This rate has been obtained from the Health Module of the National Health Survey 2006.

- DFLE. Disability-free Life Expectancy: general disability rate (rate of limitations in the case of children between the ages of 0 to 5 years old).

- DFLE1. Life Expectancy Free of Severe Disability: rate of persons with a severe or total disability or impairment when they do not receive person assistance or use technical assistance (categories 3 'With severe difficulty' and 4 'Cannot carry out the activity' of the variable severity of disability without assistance).

- DFLE2. Disability-free Life Expectancy requiring Assistance: rate of persons receiving assistance or not receiving but needing it.

- DFLE3. Disability-free Life Expectancy for Basic Everyday Activities: rate of persons with a disability called ADL (corresponding to the following activities from the DIDSS-2008 survey: 27. *Washing oneself*; 28. *Caring for body parts*; 29. *Personal hygiene related to urination*; 30. *Personal hygiene related to defecation*; 31. *Personal hygiene related to menstruation*; 32. *Dressing and undressing*; 33. *Eating and drinking*; 34. *Looking after one's health: following medical prescriptions*; 35. *Looking after one's health: avoiding dangerous situations*; 36. *Acquisition of goods and services*; 37. *Preparing meals*; 38. *Performing housework*; 18. *Changing basic body postures*; 19. *Maintaining the*

position of the body; 20. Getting around inside the home; 21. Getting around outside the home; 14. Intentional use of the senses (watching, listening); 16. Undertaking simple tasks.) When calculating this indicator, children between the ages of 0 and 5 years old have not been included.

- **DFLE4. Disability-free Life Expectancy affecting Mobility: Persons aged 6 years old and over:** rate of persons with a disability affecting mobility (corresponding to the following activities from the DIDSS-2008 survey: 18. *Changing basic body postures, 19. Maintaining the position of the body; 20. Getting around inside the home; 21. Getting around outside the home, 22. Getting around via passenger transport 23. Driving vehicles, 24. Picking up and carrying objects, 25. Moving objects with the upper limbs or 26. Fine hand use).* **Children between the ages of 0 and 5 years old:** rate of children with the following limitations from the DIDSS-2008 survey: 1. *Difficulty remaining seated without aid, 2. Difficulty remaining standing without aid, 3. Difficulty walking unaided, 8. Difficulty moving his or her arms due to weakness / rigidity in his or her arms or 9. Weakness or stiffness in the legs.*

- **DFLE5. Disability-free Life Expectancy affecting Self Care:** rate of persons with a disability affecting Self Care (corresponding to the following activities from the DIDSS-2008 survey: 27. *Washing oneself, 28. Caring for body parts, 29. Personal hygiene related to urination, 30. Personal hygiene related to defecation, 31. Personal hygiene related to menstruation, 32. Dressing and undressing, 33. Eating and drinking, 34. Looking after one's health: following medical prescriptions or 35. Looking after one's health: avoiding dangerous situations.* When calculating this indicator, children between the ages of 0 and 5 years old have not been included.

- **DFLE6. Disability-free Life Expectancy for performing Household Chores:** rate of persons with a disability affecting home life (corresponding to the following activities from the DIDSS-2008 survey: 36. *Acquisition of goods and services, 37. Preparing meals or 38. Doing housework.* When calculating this indicator, children between the ages of 0 and 5 years old and the ages of 6 and 9 years old have not been included, since disabilities in this group are only considered from the age of 10 years old.

- **DFLE7. Disability-free Life Expectancy affecting Sight: Persons aged 6 years old and over:** rate of persons with a disability affecting sight (corresponding to the following activities from the DIDSS-2008 survey: 1. *Perceiving any image, 2. Overall visual tasks, 3. Detail visual tasks or 4. Other visual problems.* **Children between the ages of 0 and 5 years old:** rate of children with the following limitations from the DIDSS-2008 survey: 4. *Total blindness or 5. Severe difficulty in seeing.*

- **DFLE8. Disability-free Life Expectancy affecting Hearing: Persons aged 6 years old and over:** rate of persons with a disability affecting hearing (corresponding to the following activities from the DIDSS-2008 survey: 5. *Receiving any sound, 6. Hearing loud sounds or 7. Hearing speech.* **Children between the ages of 0 and 5 years old:** rate of children with the following limitations from the DIDSS-2008 survey: 6. *Total deafness or 7. Severe difficulty in hearing.*

- DFLE9. Life Expectancy Free of Osteoarticular Impairments: Persons aged 6 years old and over: rate of persons with an impairment from group 5. Osteoarticular impairments from the DIDSS-2008 survey: (5.1. Head, 5.2. Spinal column, 5.3. Upper limbs and 5.4. Lower limbs). . **Children between the ages of 0 and 5 years old**: rate of children with an impairment from the osteoarticular impairments group from the DIDSS-2008 survey: (5.3. Upper limbs, 5.4. Lower limbs and 5.9. Other osteoarticular impairments).

The information offered regarding methods of calculation of health expectancies, as well as the methodology used for obtaining them extracted from 'Selection of a Coherent Set of Health Indicators. Final draft. A First Step Towards A User's Guide to Health Expectancies for the European Union' , J-M Robine, C. Jagger and V. Egidi. Montpellier (France), Euro-REVES, June 2000.