Methodology for the calculation of health expectancies

In theory, the probabilities by age come from the entrance and exit incidence rates of each state, in the same way as the calculation of life expectancy probabilities are obtained from the registered number of deaths. Therefore, probabilities are calculated from the movement observed in a defined period and provide information on the number of transitions inside and outside each state.

In practice, the construction of this table is inviable as the transition data between health states is not collected systematically but rather specific surveys are available (health, disability) which are more or less periodic and which reflect a stock, not a movement. Therefore, the incidence of the period, necessary for calculations has to be estimated based on the available information.

1. Methods of calculation

There are three types of method to carry out this estimate: life table methods based on observed prevalence, life table methods with multiple decreases, life table methods with decreases-increases.

LIFE TABLE METHOD BASED ON OBSERVED PREVALENCE. SULLIVAN METHOD.

With respect to health, Sanders proposed a combined model of mortality and morbidity in the same life table (Sanders, 1964). The ideas was carried out finally by Sullivan, who built a life table based on the observed prevalence and calculated the first life expectancy free of disability. The Sullivan method (1971) is today the one used most often to obtain temporary series and international comparisons on health issues.

Construction of the life table

The elaboration process of the life table based on observed prevalence is simple. It consists of modifying in the classical life table the function Lx (the number of years lived in the age interval), multiplying it by 1 - the specific prevalence rate by age (tx). Now you have (1-tx)·Lx which is the number of years lived without disability in the age interval.

To apply this method, data is used from the classical mortality tables and the data relative to the state j observed in a specific population survey. The specific rates by age tx referring to the state of health, disability, etc. are stock data, in other words, observed prevalence.

Advantages and disadvantages of the method.

The main disadvantage of the Sullivan method is the non-observation of transitions between states, but also that they are estimated from observed prevalence. It has been demonstrated that the method produced good estimates when the transition under study is stable over time. With respect to health states, such as disability, changes are sufficiently gradual to ensure that observed prevalence is a good estimator of the changes in a studied period. However, the data must be interpreted with caution, especially in estimating, for example the number of years lived with disability, given that we are dealing with a situation of short duration in a state of relatively low incidence and therefore the imprecisions of the model may have greater impact.

Up to now the Sullivan method has been used to calculate health expectancy and other health indicators in at least 49 countries.

LIFE TABLE METHOD WITH MULTIPLE DECREASES

This model was developed initially by actuaries and insurance companies to calculate pensions and indemnities based on average life expectancy before reaching the state of "insurance beneficiary", in other words, disabled, widow, etc.

The model of multiple decreases does not consider death as the final state on its own but that other life states that may be taken as definitive are also taken into account. In other

words, events that constitute an exit from the life table. In this sense death and disability are considered absorbent states.

Using a continuous study that collects data in various waves, the number of transitions from the initial state to the absorbent state can be evaluated and in this way the specific survival probabilities in the initial state can be estimated. Applying these probabilities to a hypothetical cohort, the life table related to these absorbent events can be obtained.

This method supplies an indicator of the period that correctly reflects the current health conditions of the population.

However, the information that the method requires is impossible to achieve on a large scale, since it is necessary to carry out population surveys more than once on the same sample. Therefore, its use to calculated internationally comparable health expectancy is inviable.

On the other hand, the assumption that the disability or health state considered is absorbent, without possible recovery is not appropriate for health studies since there exist recoverable disabilities and transitory states of health.

LIFE TABLE METHOD WITH DECREASES-INCREASES

In the 1970s other authors started to explore models capable of maintaining not only exit transitions from the initial state, but also the return to that state. The idea that these models developed was to study the effect of a specific health program on the population group that the program was directed at. A life table of increases-decreases based on a Markov chain has been developed.

2. Health expectancy with the Sullivan method.

The main reason for calculating a health expectancy is to combine information on mortality and morbidity in one indicator. This indicator will be useful for obtaining the health of the population and for making comparisons between countries, within a country over time or within population subgroups despite the differences that may exist in the composition by age. Comparability is even greater if calculations are made separately for men and women.

As this method has general use, various points should be borne in mind in order to facilitate comparison.

– The same definitions of state of health must be used

– The general design of surveys from which prevalence is obtained is required to be the same as the estimates of prevalence of states of illness and health are very sensitive to the method of collection: personal interview, telephone, mail…

– Heath expectancies should be calculated on the total population, including residents in group establishments, as omission leads to significant bias in elderly populations.

– It is essential to specify the last age group, the open group, that differs between surveys and may also affect the comparability of the results.

Calculation of Life Expectancy Free of Disability (LEFD) with the Sullivan method

As was commented at the beginning the method consists of modifying the life table multiplying by 1 - the specific prevalence rate by age (tx), by Lx, the number of years lived in the age group.

For each age group the life table provides the columns that are required for the calculation of the LEFD:

l_x Survivors at age x

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

and the Survey on Disabilities, Impairments and State of Health 1999 supplies disability rates by age, t_x.

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

$$\frac{\sum_{x}^{n}(L_x)}{l_n} \qquad \frac{\sum_{x}^{n}((1-t_x)L_x)}{l_n}$$

The calculation of LEFD is illustrated with a numerical example.

Life Expectancy Free of Disability by age calculated with the Sullivan method. National total, men.

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

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

T'_x Future life years without disability from age x

e_x Life expectancy at age x

$LEFD_x$ Life Expectancy Free of Disability at age x

There is a singularity in the first age group in the table, 0 to 5 years. This is due to the disability study that has been carried out in different questionnaires and definitions for the population of 0 to 5 years and those over 6 years old. Therefore this age distribution was used when obtaining these rates.

Health expectancy provided are calculated independently for men and women.

The rates used in the calculation of life expectancy for this study, obtained from the information provided by the Disabilities survey, are the following:

– **LEFCD. Life Expectancy Free of Chronic Disease:** rate of people with at least one chronic disease. This rate has been obtained from the survey health module.

– **LEPH. Life Expectancy in Good Perceived Health:** the state of perceived health has been asked for following WHO recommendations by means of the question'What is your general state of health in your opinion?' with 5 possible answers: very good, good, average, bad, and very bad. The rate of people who have an average, bad or very bad state of health has been used, this also following international recommendations. This rate has been obtained from the survey health module.

Life Expectancy Free of Disability by age calculated with the Sullivan method. National total, men.

Age	L_x	l_x	T_x	t_x	$(1-t_x)\cdot L_x$	T'_x	e_x	$LEFD_x$
0-5	596.631	100.000	7.528.977	0,0217	583.676	6.852.269	75,29	68,52
6-9	397.239	99.358	6.932.346	0,0189	389.727	6.268.593	69,77	63,09
10-14	496.214	99.285	6.535.107	0,0163	488.137	5.878.866	65,82	59,21
15-19	495.202	99.183	6.038.894	0,0221	484.237	5.390.729	60,89	54,35
20-24	493.258	98.869	5.543.693	0,0224	482.225	4.906.492	56,07	49,63
25-29	490.843	98.417	5.050.436	0,0288	476.698	4.424.267	51,32	44,95
30-34	487.781	97.898	4.559.594	0,0395	468.494	3.947.568	46,58	40,32
35-39	483.737	97.182	4.071.813	0,0396	464.603	3.479.074	41,90	35,80
40-44	478.579	96.274	3.588.077	0,0451	456.982	3.014.471	37,27	31,31
45-49	471.375	95.088	3.109.498	0,0547	445.599	2.557.489	32,70	26,90
50-54	460.582	93.342	2.638.124	0,0652	430.532	2.111.890	28,26	22,63
55-59	444.710	90.719	2.177.542	0,0998	400.349	1.681.358	24,00	18,53
60-64	421.045	86.903	1.732.832	0,1522	356.964	1.281.009	19,94	14,74
65-69	385.908	81.133	1.311.788	0,1710	319.931	924.045	16,17	11,39
70-74	335.987	72.737	925.881	0,2195	262.233	604.114	12,73	8,31
75-79	267.269	61.049	589.895	0,3252	180.365	341.881	9,66	5,60
80-84	182.962	45.354	322.626	0,4289	104.483	161.516	7,11	3,56
85+	139.664	27.621	139.664	0,5916	57.033	57.033	5,06	2,06

– **LEFD. Life Expectancy Free of Disability**: rate of general disability (rate of limitations in the case of children 0 to 5 years old).

– **Life Expectancy Free of Severe Disability**: rate of persons with some severe or total disability limitation (categories 3 with serious severity and 4 cannot carry out the severity activity variable.

– **Life expectancy free of disabilities that need assistance**: rate of persons who receive some assistance or who do not receive assistance but who need it

– **Life Expectancy Free of Disabilities for Activities of Daily Living**: rate of persons with some disability in ADLs: carrying out changes in body position; getting up, going to bed, moving within the household, walking without transport, going to the toilet, controlling needs, dressing, eating and drinking, taking care of shopping, meals, cleaning and ironing of clothes and maintenance of the house and well being of members of the family. Children from 0 to 5 have not been included in the calculation of this indicator.

– **Life Expectancy Free of Disabilities of Mobility**: Persons 25 years old and over: rate of persons with a group 5 disability. Getting around (5.1. Changes and maintenance of various body positions, 5.2. Getting up, going to bed, remaining standing or seated and 5.3. moving around within the house) and Moving around outside the house (7.1. Walking without transport, 7.2. Moving around in public transport and 7.3. Driving own vehicle). Children 0 to 5: rate of children with limitation 1. Significant delays to remain seated, standing or starting to walk or difficulties walking or weakness or rigidity in the legs.

– **Life Expectancy Free of Disability in Taking Care of Oneself**: rate of people with a group 8 disability . Taking care of oneself (8.1 Go to the toilet alone: wash and take care of appearance, 8.2 Control of needs and use the toilet alone, 8.3 Dress, undress, dress up and eat and drink). Children 9 to 5 have not been included in the calculation.

– **Life Expectancy Free of Disabilities to carry out Domestic Tasks**: rate of people with a group 9 disability. Carrying out household tasks. (9.1 Taking care of shopping and control of supplies and services, 9.2. Taking care of meals, 9.3. Taking care of cleaning and ironing of clothes, 9.4. Taking care of cleaning and maintenance of the house and 9.5. Taking care of the well being of other members of the family). Children 0 to 5 have not been included in the calculation of this indicator since group 9 disabilities are only considered from the age of 10.

– **Life Expectancy Free of Disability for Seeing**: Persons 25 years old and over: rate of persons with a group 1 disability. Seeing (1.1. Disability for receiving images, 1.2. Disability for visual tasks as a whole and 1.3. Disability for detailed visual tasks). Children 0 to 5: rate of children with limitation 2. Significant difficulties seeing, or 3. Total blindness.

– **Life Expectancy Free of Disabilities Hearing**: Persons 25 years old and over: rate of persons with a group 2 disability . Hearing (2.1. Disability to receive any sound, 2.2. Disability to hear strong sounds and 2.3. Disability for listening to speech). Children 0 to 5: rate of children with limitation 4. Significant difficulties hearing, or 5. Total deafness.

– **Life Expectancy Free of Osteoarticular Deficiencies**: rate of persons with a group 5 impairment . Osteoarticular impairments (5.1. Head, 5.2. Vertebral column, 5.3. Superior extremities and 5.4 Inferior extremities).

The information that is offered on health expectancy calculation methods as well as the methodology used to obtain them have been 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.

The indicators that are presented in the first five sections provide information on the group of people with disability and on people without disability. The ratio between the indicators of both population groups is also offered, resulting in a more specific idea on the relation existing between them. The indicators from point six make a reference to the households in which disabled people live and those where they do not live.

The formulas used for the calculation of each one of the indicators are detailed below.

1. Percentage of people married or living with a partner

$$I_1^D = \frac{D_C}{D} \times 100$$

where:

D_C is the number of disabled people who are married or cohabit with their partner

D is the total number of disabled persons

It is similarly defined:

$$I_1^{ND} = \frac{ND_C}{ND} \times 100$$

, for the non-disabled population

and the ratio between the indicator for the disabled and for the non-disabled:

$$I_{1,RATIO} = \frac{I_1^D}{I_1^{ND}}$$

Each one of these indicators is provided according to age group (20-39, 40-59, 60-79, 80 and + and total) and sex (male, female and both sexes).

2. Percentage of people who live alone

$$I_2^D = \frac{D_S}{D} \times 100$$

where:

D_S is the number of disabled persons who live alone

D is the total number of disabled persons

It is similarly defined:

$$I_2^{ND} = \frac{ND_S}{ND} \times 100$$

, for the non-disabled population

$$I_{2,RATIO} = \frac{I_2^D}{I_2^{ND}}$$

, the ratio between the indicator for the disabled and for the non-disabled:

Each one of these indicators is provided according to age group (20-39, 40-59, 60-79, 80 and + and total) and sex (male, female and both sexes).

3. Standardised literacy and illiteracy percentages

3.1. Standardised illiterates percentage by physical and psychological reasons

$$I_{3,1}^D = \sum_x \frac{d_{AnF,x}}{d_x} \times w_x \times 100$$

where:

$d_{AnF,x}$ is the number of disabled people in age group x (x=10-17, 18-24, 25-34, 35-44, 45-54, 55-64, 65-74, 75 and +) who are illiterate for physical or psychological reasons.

d_x is the number of disabled people in age group x

w_x is the weight of age group x in the Spanish general population 10 years and over

It is similarly defined:

$$I_{3,1}^{ND} = \sum_x \frac{nd_{AnF,x}}{nd_x} \times w_x \times 100$$

, for the non-disabled population

, the ratio between the indicator for the disabled and for the non-disabled:

$$I_{3,1,RATIO} = \frac{I_{3,1}^{D}}{I_{3,1}^{ND}}$$

Each one of these indicators is provided according to age group (10-44, 45-64, 65-79, 80 and + and total) and sex (male, female and both sexes).

3.2. Standardised percentage of illiterates by other reasons

$$I_{3,2}^{D} = \sum_x \frac{d_{AnO,x}}{d_x} \times w_x \times 100$$

where:

$d_{AnO,x}$ is the number of disabled people in age group x (x=10-17, 18-24, 25-34, 35-44, 45-54, 55-64, 65-74, 75 and +) who are illiterate for other reasons.

d_x is the number of disabled people in age group x

w_x is the weight of age group x in the Spanish general population 10 years and over

It is similarly defined:

$$I_{3,2}^{ND} = \sum_x \frac{nd_{AnO,x}}{nd_x} \times w_x \times 100$$

, for the non-disabled population

, the ratio between the indicator for the disabled and for the non-disabled:

$$I_{3,2,RATIO} = \frac{I_{3,2}^{D}}{I_{3,2}^{ND}}$$

Each one of these indicators is provided according to age group (10-44, 45-64, 65-79, 80 and + and total) and sex (male, female and both sexes).

3.3. Standardised literacy percentage

$$I_{3,3}^{D} = \sum_x \frac{d_{Alf,x}}{d_x} \times w_x \times 100$$

where:

$d_{Alf,x}$ is the number of disabled people in age group x (x=10-17, 18-24, 25-34, 35-44, 45-54, 55-64, 65-74, 75 and +) who know how to read and write

d_x is the number of disabled people in age group x

w_x is the weight of age group x in the Spanish general population 10 years and over

It is similarly defined:

$$I_{3,3}^{ND} = \sum_x \frac{nd_{Alf,x}}{nd_x} \times w_x \times 100$$

, for the non-disabled population

$$I_{3,3,RATIO} = \frac{I_{3,3}^{D}}{I_{3,3}^{ND}}$$

, the ratio between the indicator for the disabled and for the non-disabled:

Each one of these indicators is provided according to age group (10-44, 45-64, 65-79, 80 and + and total) and sex (male, female and both sexes).

4. Standardised percentage of people with secondary or higher studies

For the calculation the following levels have been considered as secondary or higher studies: second year general secondary education, higher professional education and university studies or equivalent.

$$I_4^D = \sum_x \frac{d_{Sec,x}}{d_x} \times w_x \times 100$$

where:

$d_{Sec,x}$ is the number of disabled people in age group x (x=18-24, 25-34, 35-44, 45-54, 55-64, 65-74, 75-74, 75 and +) who have finished secondary or higher studies.

d_x is the number of disabled people in age group x

w_x is the weight of age group x in the Spanish general population 18 years and over

It is similarly defined:

$$I_4^{ND} = \sum_x \frac{nd_{Sec,x}}{nd_x} \times w_x \times 100$$

, for the non-disabled population

, the ratio between the indicator for the disabled and for the non-disabled:

$$I_{4,RATIO} = \frac{I_4^D}{I_4^{ND}}$$

Each one of these indicators is provided according to age group (18-44, 45-64, 65-79, 80 and + and total) and sex (male, female and both sexes).

5. Standard employment and unemployment rates of the population from 16 to 64 years old

5.1. Standardised employment rate

$$I_{5,1}^D = \sum_x \frac{d_{E,x}}{d_x} \times w_x \times 100$$

where:

$d_{E,x}$ is the number of people with disability in age group x (x=16-24, 25-34, 35-44, 45-54, 55-64) who have a job (working or with job but temporarily absent)

d_x is the number of disabled people in age group x

w_x is the weight of age group x in the Spanish general population 16 to 64 years old

It is similarly defined:

$$I_{5,1}^{ND} = \sum_x \frac{nd_{E,x}}{nd_x} \times w_x \times 100$$

, for the non-disabled population

, the ratio between the indicator for the disabled and for the non-disabled:

$$I_{5,1,RATIO} = \frac{I_{5,1}^D}{I_{5,1}^{ND}}$$

Each one of these indicators is provided according to age group (16-24, 25-44, 45-64, 80 and + and total) and sex (male, female and both sexes).

5.2. Standardised unemployment rate.

$$I_{5,2}^D = \sum_x \frac{d_{P,x}}{d_{A,x}} \times w_{A,x} \times 100$$

where:

$d_{P,x}$ is the number of people with disability in age group x (x=16-24, 25-34, 35-44, 45-

54, 55-64) who are unemployed (unemployed who are looking for their first job or unemployed who have worked before).

$d_{A,x}$ is the number of people with disability in age group x who are active (with job or unemployed)

w_x is the weight of age group x in the active Spanish general population (with job or unemployed) 16 to 64 years old

It is similarly defined:

$$I_{5,2}^{ND} = \sum_x \frac{nd_{P,x}}{nd_{A,x}} \times w_{A,x} \times 100$$

, for the non-disabled population

, the ratio between the indicator for the disabled and for the non-disabled:

$$I_{5,2,RATIO} = \frac{I_{5,2}^{D}}{I_{5,2}^{ND}}$$

Each one of these indicators is provided according to age group (16-24, 25-44, 45-64, 80 and + and total) and sex (male, female and both sexes).

6. Distribution of households

6.1. Distribution of households according to number of disabled persons who live in them

4 indicators are obtained, one for each variable value NDIS0, which is the number of disabled people who live in the household and takes values 2, 3, 0 and 1 or more: $I^{HT}_{NDIS=0}$, $I^{HT}_{NDIS=1}$, $I^{HT}_{NDIS=2}$, $I^{HT}_{NDIS=3+}$.

$$I_{NDIS=n}^{HT} = \frac{HT_{NDIS=n}}{HT} \times 100$$

where:

$HT_{NDIS=n}$ is the number of households with number of disabled persons equal to n.

HT is the total number of households

Each one of these indicators is provided according to the size of the household (1, 2, 3, 4, 5, 6 or more members and Total).

6.2. Distribution of households according to the size of the household

6 indicators are obtained, one for each of the variables Siz, which is the size of the household and takes the values 1, 2, 3, 4, 5 and 6 or more members: $I^{HT}_{Siz=1}$, $I^{HT}_{Siz=2}$, ., $I^{HT}_{Siz=6+}$.

$$I_{Siz=t}^{HT} = \frac{HT_{Siz=t}}{HT} \times 100$$

where:

$HT_{Siz=t}$ is the number of households with size equal to t.

HT is the total number of households

Each one of these indicators is provided according to the size of the household (1, 2, 3, 4, 5, 6 or more members and Total).

6.3. Distribution of households with people 65 and over according to number of disabled people 65 and over who live in them

4 indicators are obtained, one for each variable value NDIS65, which is the number of disabled people 65 and over who live in the household and takes values 0, 1, 2 and 3 or more: $I^{H65}_{NDIS=0}$, $I^{H65}_{NDIS=1}$, $I^{H65}_{NDIS=2}$, $I^{H65}_{NDIS=3+}$.

$$I_{NDIS65=n}^{H65} = \frac{H65_{NDIS65=n}}{H65} \times 100$$

where:

$H65_{NDIS65=n}$ is the number of households with persons 65 and over where there live a number of disabled people 65 and over equal ton.

H65 is the total number of households with persons 65 and over

Each one of these indicators is provided according to the size of the household (1, 2, 3, 4, 5, 6 or more members and Total).

6.4. Distribution of households with people 65 and over according to size of household

6 indicators are obtained, one for each of the variables Siz, which is the size of the household and takes the values 1, 2, 3, 4, 5 and 6 or more members: $I^{H65}_{Siz=1}$, $I^{H65}_{Siz=2}$, ..., $I^{H65}_{Siz=6+}$.

$$I^{H65}_{Siz=t} = \frac{H65_{Siz=t}}{H65} \times 100$$

where:

$H65_{Siz=t}$ is the number of households with persons 65 and over with size equal to t.

H65 is the total number of households with people 65 and over

Each one of these indicators is provided according to the number of disabled persons 65 and over who are in the household (0, 1, 2, 3 or more disabled and Total).