

Health-Adjusted Life Expectancy

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Abstract

In 1991, the National Task Force on Health Information recommended that in order to assess the health of Canadians, the health information system should include an aggregate index of population health. This article presents such an index—Health-Adjusted Life Expectancy (HALE)—as one possibility in a range of indicators.

In contrast to conventional life expectancy, which considers all years as equal, to calculate HALE, years of life are weighted by health status. To measure health status, the Health Utility Index, obtained from 1994-95 National Population Health Survey data, was used. Traditional life expectancy and HALE figures are compared to estimate the burden of ill health.

The societal burden of ill health is higher for women than for men, and is highest among those in “early” old age, not among the most elderly. The data further indicate that sensory problems and pain comprise the largest components of the burden of ill health, and that higher socioeconomic status confers a dual advantage—longer life expectancy and a lower burden of ill health.

Keywords: *aging, life expectancy, health status indicators, Health Utility Index*

Introduction

There is increasing interest in population health outcomes. This interest relates to changes in the orientation of health policies and has important implications for health information.¹ A recent milestone was the National Task Force on Health Information, jointly sponsored and supported by the Chief Statistician of Canada, the National Health Information Council, and the Conference of Deputy Ministers of Health. “The mission of the Task Force

was to make strategic planning recommendations toward the development of effective health information systems for Canada.”²

In its final report, the Task Force noted problems with the country’s health information system, in particular, how the health status of the population is measured. “The most common [health] measures ... are actually based on death status—infant mortality and life expectancy. There is very little measurement of health status and function while people are alive.”² The Task Force recommended that “the health information system should include an overall aggregate index of population health—some sort of GDP [Gross Domestic Product] or CPI [Consumer Price Index] of health—which would be the culmination or aggregation of a coherent family of health status indicators.”²

This article presents initial estimates of one such index, and several closely related indicators. This index family, and its measure of health status, is one possibility in a range of indicators. It is advanced as part of an on-going research effort at Statistics Canada. While promising, it is not the only, nor necessarily the most appropriate, measure to meet the needs highlighted by the Task Force.

Building upon life expectancy

One approach to creating a summary health measure is to build upon the concept of life expectancy. But life expectancy estimates are insensitive to the health status of the population. They provide no indication of the quality of life, only the quantity. For example, the past few decades have seen a considerable increase in life expectancy in Canada.³ However, the net benefit

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Methods

To estimate HALE, mean Health Utility Index scores were tabulated for the population by sex, age group, and place of residence (household or institution). The mean scores (by sex and age group) for the population residing in households were multiplied by the proportion living there. For the population in institutions, the scores were multiplied by the proportion residing there. The resulting two figures were summed to provide overall Health Utility Index scores by sex and age group (see *Appendix*).

Next, a cross-sectional life table was constructed in the traditional manner. Then, the years of life lived in each age group were multiplied by the corresponding mean Health Utility Index score. The resulting health-adjusted years of life lived were summed and divided by the total number of persons surviving at given ages to provide the HALE estimate.

The Health Utility Index

The Health Utility Index, developed at McMaster University, focuses on the functional aspects of health and includes a valuation of health.⁴ The functional component was determined by asking survey respondents about eight areas of their personal health: vision, hearing, speech, mobility, emotional state, thinking and memory, dexterity, and level of pain and discomfort. In this article, the data were aggregated to form six attributes. Vision, hearing and speech were combined in one category: sensory. These data were obtained from the 1994 National Population Health Survey (NPHS). (For a description of the survey, see "Sample design of the National Population Health Survey" in *Health Reports* Vol. 7, No. 1, Statistics Canada, Catalogue 82-003.)

The valuation component of the Health Utility Index was derived from another survey that asked respondents to rank preferences for various health conditions. This was a survey of approximately 200 individuals, conducted at McMaster University in Hamilton.

The two components were combined to produce an overall Health Utility Index for each NPHS respondent. The index ranges from 0.00 to 1.00, with 1.00 representing full health.

Disability-free life expectancy

Disability-free life expectancy (DFLE) is an "intermediate" health-adjusted life expectancy measure.⁵ It differs from the measure used in this article by the way years of life lived are treated. DFLE defines a threshold according to disability status. Years of life lived with health above this threshold are counted fully, those below the threshold are not counted. The method used in this article counts all years of life, but with a weight that varies with how ill or disabled an individual is in each year (Chart 1).

Limitations

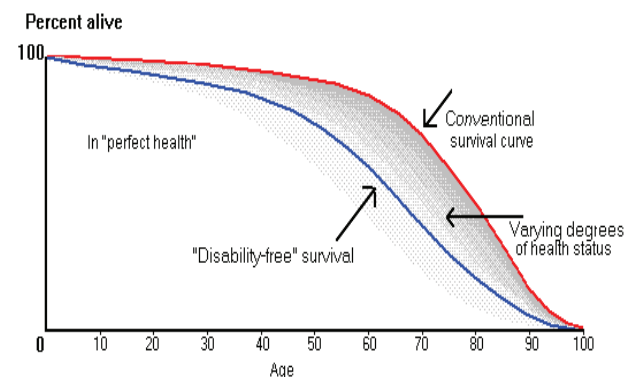
The estimation of HALE embodies judgments. For example, the Health Utility Index underlying HALE estimates is based on asking individuals their personal preferences between health states. Recent research suggests that considerably different results would be obtained if individuals were asked how they would view spending public money to cure the same health problems.⁶ Further, individuals who have suffered from a specific health problem tend to value it differently than people who are unaffected. And among those for whom the health state is hypothetical, there appear to be systematic variations in health preferences by socioeconomic status.⁷

associated with this change is debatable. Although we would all prefer long lives, at older ages people are often frail and plagued by chronic disease. Additional years of life may be years lived in illness. Life expectancy estimates do not provide this information. However, new indicators expand upon the concept of life expectancy and take account of health status. These measures are generically referred to as Health-Adjusted Life Expectancy (HALE).⁸

Life expectancy estimates are calculated from data on deaths and population counts. Based on these data, the survivorship of a hypothetical birth cohort is estimated over time. When graphed, the area under a survivorship curve represents the total person-years of life lived for a cohort (Chart 1). The sum of these years divided by the number of individuals in the cohort is their life expectancy. HALE estimates in this article do not treat each of these years equally, but instead weight them according to health status. Years lived in good health are given higher weights than those in poor health. That is, the years in good health "count for more" (see *Methods*).

Data from the 1994 National Population Health Survey (NPHS) were used to quantify the health status of the population. The measure used—the Health Utility Index—yields values (weights) from 0 to 1.⁹ For instance, an individual who is near-sighted, yet fully healthy in all other respects, scores 0.95 or 95% of full health. Health Utility Index figures were used in conjunction with 1990-1992 life table elements to calculate HALE.

Chart 1
Stylized survivorship curve



The burden of ill health

The difference between life expectancy and HALE estimates represents the burden of ill health. The magnitude of this gap differs by sex. At age 15, the difference between life expectancy and HALE estimates is 14% for women and 11% for men (Table 1). In other words, the burden of ill health is higher among women. Women's longevity is one factor behind this disparity. Since the prevalence of chronic conditions increases with age and women live longer, they spend a longer period with chronic conditions.¹⁰ Also, at age 65 and over, women tend to be in notably poorer health than men the same age.

Health problems

The measure of health status underlying HALE estimates is based on six distinct health attributes: sensory, mobility, emotion, cognition, dexterity, and pain. It is, therefore, possible to ascribe differences between HALE and life expectancy to each of these attributes. To do this, HALE is recalculated under the assumption that everyone is in perfect health for one attribute, but at their actual levels for the other five. This is called attribute-deleted HALE, and is analogous to cause-deleted life expectancy.¹¹

Sensory problems (for example, poor vision or hearing) are the largest source of diminished health, accounting for over one-quarter of the burden of ill health (Table 2). Pain is the second largest source of diminished health. The high ranking of sensory problems is largely due to vision problems, such as near- or far-sightedness. Individuals with somewhat less than perfect vision score only marginally lower on the Health Utility Index than their perfect-sighted counterparts. But these vision problems are very common, and because HALE is calculated for the entire population, common conditions, even though they have a modest effect on health status, can have large effects on HALE.

Sources of poor health by age

It is also possible to decompose the difference between HALE and life expectancy by age group (Table 3). In this case, everyone in a 10-year age group is theoretically given perfect health, while all other age groups are exactly as observed. This calculation shows for which age group in the hypothetical life table population the societal burden of ill health is highest.

Though health status generally declines with age, so do the number of people in a cohort. Consequently, the oldest age group does not represent the greatest societal burden of ill health. For example, among men, those aged 55 to 64 years constituted the highest burden of ill health. For women, the highest burden was 65- to 74-year-olds.

Table 1

Life expectancy and HALE, by sex and age, Canada, 1990-1992

At age	Life	HALE	Difference	
	expectancy		Years	%
	Years	Years		
Both sexes				
15	63.4	55.6	7.8	12
25	53.8	46.7	7.1	13
35	44.3	37.9	6.4	14
45	34.8	29.2	5.6	16
55	25.9	21.3	4.6	18
65	17.9	14.3	3.6	20
75	11.2	8.5	2.7	24
85	6.3	4.4	1.9	30
Men				
15	60.3	53.7	6.6	11
25	50.9	44.9	6.0	12
35	41.5	36.1	5.3	13
45	32.1	27.5	4.6	14
55	23.4	19.6	3.8	16
65	15.7	12.9	2.9	18
75	9.6	7.5	2.1	22
85	5.4	3.8	1.6	29
Women				
15	66.6	57.4	9.2	14
25	56.8	48.4	8.4	15
35	47.0	39.4	7.6	16
45	37.4	30.7	6.8	18
55	28.3	22.7	5.6	20
65	19.9	15.4	4.5	23
75	12.5	9.0	3.5	28
85	6.9	4.4	2.5	36

Source: Social and Economic Studies Division

Table 2**Attribute-deleted HALE at age 25, by sex, Canada, 1990-1992**

Attribute	Attribute-deleted HALE	HALE	Difference	
	Years	Years	Years	%
Men				
Overall			6.0	100.0
Sensory	46.7	44.9	1.8	30.0
Pain	46.4	44.9	1.5	25.0
Emotion	46.0	44.9	1.1	18.3
Cognition	45.7	44.9	0.8	13.3
Mobility	45.2	44.9	0.3	5.0
Dexterity	45.0	44.9	0.1	1.7
Residual [†]	0.4	6.7
Women				
Overall			8.4	100.0
Sensory	50.8	48.4	2.4	28.6
Pain	50.7	48.4	2.3	27.4
Emotion	49.7	48.4	1.3	15.5
Cognition	49.5	48.4	1.1	13.1
Mobility	49.2	48.4	0.8	9.5
Dexterity	48.6	48.4	0.2	2.4
Residual [†]	0.3	3.6

Source: Social and Economic Studies Division

Note: Percent differences are based on unrounded numbers. Percentages may not sum to total because of rounding.

[†] Because the Health Utility Index is a multiplicative function, there is a residual, which is not the result of any attribute, but which is the combination of many attributes.

Table 3**Age-deleted HALE at age 15, by sex, Canada, 1990-1992**

Age group	Age-deleted HALE	HALE	Difference	
	Years	Years	Years	%
Men				
Overall			6.7	100.0
15-24	54.4	53.7	0.7	10.4
25-34	54.4	53.7	0.7	10.4
35-44	54.4	53.7	0.8	11.9
45-54	54.7	53.7	1.0	14.9
55-64	54.8	53.7	1.1	16.4
65-74	54.8	53.7	1.1	16.4
75-84	54.5	53.7	0.8	11.9
85+	54.1	53.7	0.4	6.0
Women				
Overall			9.2	100.0
15-24	58.2	57.4	0.8	8.7
25-34	58.2	57.4	0.9	9.8
35-44	58.3	57.4	0.9	9.8
45-54	58.7	57.4	1.3	14.1
55-64	58.7	57.4	1.3	14.1
65-74	58.9	57.4	1.5	16.3
75-84	58.9	57.4	1.5	16.3
85+	58.4	57.4	1.0	10.9

Source: Social and Economic Studies Division

Note: Percent differences are based on unrounded numbers. Percentages may not sum to total because of rounding.

Education and health

HALE estimates can also be broken down for population subgroups, provided data on both health status and life expectancy are available. One important breakdown is by educational attainment, which is widely used as an indicator of socioeconomic status. Because Canada life tables by educational attainment are not available, these estimates were based in part on special analyses of the Manitoba 1986 Census linkage project.¹² Linked census and vital statistics data were used to derive mortality patterns by educational attainment, age and sex for Manitoba residents.¹³ These results were combined with NPHS data on health status (by educational attainment, sex and age) to generate national HALE estimates by level of education. Age 30 was chosen as the starting point for these HALE estimates because most education is completed by this age, but most illness has not yet occurred.

The data corroborate other research that shows a relationship between health and socioeconomic status.^{4,8} Life expectancy and HALE generally increase with educational attainment. However, the difference between these measures diminishes as education level rises (Table 4). Therefore, less highly educated people are doubly worse off. Not only do they have shorter life expectancies, but they also shoulder a higher burden of ill health during their shorter lifetimes than their more highly educated counterparts.

Table 4**Life expectancy and HALE at age 30, by sex and educational attainment, Canada, 1990-1992**

Educational attainment	Life expectancy	HALE	Difference	
	Years	Years	Years	%
Men				
Lowest quartile	44.5	37.5	7.0	16
Second quartile	45.2	39.5	5.7	13
Third quartile	47.6	41.8	5.8	12
Highest quartile	47.7	42.8	4.9	10
Women				
Lowest quartile	51.0	41.0	10.0	20
Second quartile	52.0	44.1	7.9	15
Third quartile	52.2	44.5	7.7	15
Highest quartile	53.2	46.3	6.9	13

Source: Social and Economic Studies Division

Concluding remarks

The data presented show that HALE can serve as the kind of aggregate index of population health called for by the National Task Force on Health Information. The breakdowns further show that HALE can be extended into a coherent family of health status indicators.

Of great interest is the future trend in HALE. There is a continuing debate over whether a compression of morbidity is occurring, that is, if our years of increasing life span have been generally healthy or burdened by illness. The National Population Health Survey will help provide answers to this question, with new data every two years. Analysts will be able to track the health status of respondents over time, estimate HALE, and monitor changes in HALE compared with changes in life expectancy. To the extent that HALE increases more rapidly than life expectancy, it would be a good indication that not only are Canadians adding years to life, but they are also adding life to years.

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Appendix

Calculation of HALE at age 15, by sex, Canada, 1990-1992

	Mean Health Utility Index		Residing in institutions	Overall Health Utility Index	Years of life	Health-adjusted years
	Households	Institutions				
			%			Years '000
Men[†]						
15-24	0.93	0.75	0.25	0.93	984.8	915.1
25-34	0.93	0.58	0.16	0.93	973.6	902.1
35-44	0.92	0.66	0.23	0.92	959.1	883.3
45-54	0.89	0.66	0.21	0.89	931.6	832.3
55-64	0.87	0.62	0.45	0.87	861.6	749.2
65-74	0.85	0.55	1.34	0.85	700.6	593.8
75-84	0.82	0.51	5.27	0.81	420.4	338.8
85+	0.74	0.52	15.03	0.71	136.7	96.6
Life expectancy					60.33	53.69
Women[‡]						
15-24	0.91	0.74	0.06	0.92	989.9	906.0
25-34	0.92	0.56	0.18	0.92	986.0	905.9
35-44	0.91	0.54	0.13	0.91	979.2	890.1
45-54	0.87	0.59	0.19	0.87	962.6	835.3
55-64	0.86	0.57	0.36	0.86	921.0	790.2
65-74	0.84	0.52	1.48	0.83	826.0	686.7
75-84	0.79	0.50	7.47	0.76	619.1	473.0
85+	0.74	0.47	35.75	0.64	316.3	202.6
Life expectancy					66.56	57.38

Source: Social and Economic Studies Division

[†] Based on 98,930 survivors at age 15.

[‡] Based on 99,163 survivors at age 15.