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Mortality Analysis - Some New Uses for Old Indicators

Death itself cannot be prevented. It can, however, be postponed. The public health importance of this fact has long ago motivated the development of measures for the analysis of mortality statistics, traditionally one of the main tools of public health planners and administrators for assessment of health status, definition of priorities and allocation of resources, and surveillance of specific health problems.

It is equally recognized that nonviolent death is but the last event in a continuum of progressively worse health; mortality statistics tell a very incomplete story about disease and suffering, and even less about individual and societal determinants of ill health. However, up to now a satisfactory operational definition of "good" health does not appear to exist, neither at the individual nor at the community level. Nor is it clear whether such a definition would be at all feasible, and if so, whether it would be the same for all members of a community and communties everywhere [1]. Furthermore, those variables that have been accepted as being both sensitive and specific enough to contribute to the assessment of health status are usually difficult to document and much too expensive to obtain for population-wide use.

Accordingly, and without giving up the search for appropriate indicators of positive health, increased efforts are being devoted to the development of indicators based on death statistics, thus acknowledging that the potential information on health status to be extracted from mortality data is still far from exhausted. Mortality rates specific for sex, age, cause, place of residence and other social and economic characteristics of the decedent continue to be the cornerstone of this information, but specific rates are cumbersome to analyze. Crude and age-adjusted (standardized) mortality rates, however, share the major shortcoming of being dominated by mortality at old ages, at which most deaths occur and disease is harder to prevent. Summary measures are needed that, while assessing the impact of mortality as a whole will better reflect changes in those problems that exact their toll at an early age, and highlight the age groups in which this impact is felt the most. Woolsey [2] and Uemura [3] in their search for achievable target rates for the United States of America (USA) and worldwide, respectively, have discussed numerous approaches and have given abundant references to this effect. They provided both background and stimulus for the discussion presented here.

IN THIS ISSUE...

This renewed interest in mortality statistics can only be welcomed, as, in the words of Shapiro [4]:

> ...they represent the only continuous source of information on an unequivocal manifestation of health status that dates back many years and is assured of continuity into the foreseeable future, and the data can be examined on a geographically disaggregated level often down to subareas within a city, for example, or aggregated across civil subdivisions...

According to this author, the challenge of "how to maximize the utility of this resource" is of special relevance to public health officials in developing countries, who are understandably reluctant to use scarce resources for the gathering of additional information on health problems, rather than for their prevention or alleviation.

Objective

This paper will present a discussion of the scope and limitations of some simple procedures to analyze usually available data for (a) estimating gains in mortality from all causes assessed against a country's own past experience, and (b) quantifying the gap between the country's current mortality situation and one observed in a more developed country.

Procedures

Excess mortality will be defined empirically; to estimate it two indicators will be used: the standardized mortality ratio (SMR), and the ratio of observed over expected years of potential life lost (RYPLL). Premature mortality will be defined as that occurring under 65 years of age. Both indicators will be computed for each sex; the SMR will be computed for premature mortality and for all ages. To compute age-specific frequencies age groups are defined as follows: under 1 year of age, 1-4 years, 10-year groups from 5 to 64 years, and 65 years and above.

Data from Argentina and Mexico will be used to illustrate the proposed procedures. These two countries have been chosen as examples because their population size prevents excessive instability of observed frequencies, and mortality data by age and sex are available for more than two decades.

To analyze past experience each country's data for 1982 will be compared to its own data 20 years earlier. As reference for a more favorable situation the 1982 data for the largest developed country in the Region, i.e. the United States of America (USA) will be used.

As the analysis will be centered on the year 1982, both to assess progress against the past as well as to size up the challenges still ahead, the reference population will be the mid-year population estimate for 1982 for Argentina and Mexico. To stabilize the data the number of deaths for each of the years to be studied will be estimated to be the 3-year average centered in that year. Thus, deaths for 1982 and 1962 will be understood to be the average number of deaths occurring in the years 1981-1982-1983 and 1961-1962-1963 respectively, as shown in Table 1.

Table 1. Midyear population and number of deaths Argentina and Mexico, 1982.

Age groups	Argentina				Mexico			
	Population[a]		Deaths[b]		Population[a]		Deaths[b]	
	M	F	M	F	M	F	M	F
Under 1	353	339	11,702	9,127	1,198	1,152	45,548	35,494
1-4	1,346	1,308	1,954	1,665	4,849	4,676	11,897	10,898
5-14	2,743	2,666	1,439	972	10,595	10,237	8,148	5,434
15-24	2,410	2,347	2,784	1,602	7,479	7,295	17,371	6,854
25-34	2,170	2,116	3,658	2,376	4,823	4,836	18,309	7,325
35-44	1,729	1,712	6,469	3,825	3,070	3,187	18,640	9,054
45-54	1,534	1,566	14,227	6,891	2,109	2,239	20,729	12,146
55-64	1,166	1,268	23,787	11,872	1,346	1,492	23,774	16,706
Under 65	13,451	13,322	66,020	38,330	35,469	35,114	164,416	103,911
65+	1,050	1,333	67,868	64,100	1,178	1,424	68,274	69,885
All ages	14,501	14,655	133,888	102,430	36,647	36,538	232,690	173,796

(a) Midyear population estimate for 1982, in thousands.
(b) Average of the deaths registered for 1981, 1982 and 1983. Excludes a yearly average of 2,541 deaths of unknown sex and 7,647 of unknown age in Mexico, as well as 297 deaths of unknown sex and 5,479 of unknown age in Argentina.
Source: PAHO technical data base.

Computation of expected mortality will vary according to the purpose of the analysis. For evaluation of gains achieved, expected deaths will be those that would have occurred if the 1982 population had been subjected to the 1962 age- and sex-specific rates of the same country. To compare with a more favorable health situation, expected deaths will be computed applying the 3-year 1982-centered age and sex-specific death rates of the USA to the 1982 population of Argentina and Mexico. Specific rates are shown in Table 2; expected numbers of deaths are shown in Table 3 for each sex and both sexes combined, the latter obtained by addition of male and female deaths.

The overall SMR is computed by dividing total observed by total expected deaths; the SMR for mortality under 65 is restricted to the ratio of observed and expected deaths below that age limit; and the RYPLL is the ratio of the observed YPLL and those expected. The last column of Table 3 shows age-specific YPLL per death, i.e. the average YPLL for each death in every age group, obtained by subtracting the mid-point of the age interval from 65, the upper limit. Observed and expected YPLL are computed by multiplying (weighting) these age-specific YPLL per death by the observed and expected number of deaths respectively, and adding over all age groups up to but not including 65.

Results

In accordance with the purpose of this paper, presentation of results will focus on the indicators rather than on the health situation of the two countries chosen as examples.

The SMR for all ages, the SMR for deaths occurring before age 65, and the RYPLL, also for deaths prior to age 65 are compared in Table 4. The interpretation of these indicators is simple enough to use them for conveying messages to the general public or authorities not trained in public health: in Argentina the number of male deaths observed in 1982 represents 80.4% of those which would have been expected if the 1962 rates had prevailed; i.e. 19.6% of expected male—and 21.4% of expected female—deaths were avoided due to the reduction in mortality rates experienced since 1962. Similarly, there were savings of 38.5 and 51.2% of expected deaths for men and women in Mexico. Under age 65, the observed savings for each 100 deaths expected were 28.2% for men and 36.8% for women in Argentina and 45.4 and 59.7% respectively in Mexico.

With respect to the RYPLL, for each 100 YPLL expected in the 1982 population if 1962 rates had prevailed, observed data show a reduction of 41.2 and 47.2%, and 54.3 and 64.8% for men and women in Argentina and Mexico respectively. In this example it is clear that the SMR under 65 is more sensitive to rate changes than the SMR for all ages, and the RYPLL is the most sensitive of all.

Table 2. Mortality rates by age and sex Argentina and Mexico, 1962 and 1982; USA, 1982.

Age groups	Argentina				Mexico				USA	
	1962		1982		1962		1982		1982	
	M	F	M	F	M	F	M	F	M	F
Under 1	6,774.5	5,760.7	3,315.0	2,692.3	8,489.1	7,234.2	3,802.0	3,0781.1	1,271.0	1,018.4
1-4	348.7	346.3	145.2	127.3	1,178.1	1,260.7	245.3	233.0	64.8	51.1
5-14	83.1	62.2	52.5	36.5	201.2	188.8	76.9	53.1	34.0	22.0
15-24	172.0	115.9	115.5	68.3	278.8	227.1	232.3	94.0	149.7	52.3
25-34	243.5	164.4	168.6	112.3	477.7	359.9	379.6	151.5	181.1	71.1
35-44	431.1	269.9	374.1	223.4	740.2	537.0	607.1	284.1	275.7	145.4
45-54	1,014.5	530.0	927.4	440.0	1,165.7	825.2	982.9	542.5	720.2	393.8
55-64	2,452.2	1,245.1	2,040.1	936.3	2,206.5	1,807.4	1,766.3	1,119.7	1,741.4	921.3
65+	7,112.9	5,242.2	6,463.6	4,808.7	6,564.0	6,870.2	5,795.8	4,907.7	6,156.4	4,380.0
All ages	1,005.9	706.3	923.3	698.9	1,129.6	1,017.1	634.9	475.7	943.2	777.0

Note: Rates per 100,000 population were computed using as numerator one third of the deaths registered for 1961, 1962, 1963, and for 1981, 1982, 1983 respectively, and as denominator the midyear population for the middle year, i.e. 1962 and 1982 respectively.

Source: PAHO technical data base.

Table 3. Deaths expected in 1982 population of Argentina and Mexico according to country's 1962 rates and US rates for 1982.

Age groups	M		F		T		YPLL for each age group
	E(62)	E(USA)	E(62)	E(USA)	E(62)	E(USA)	
Argentina							
Under 1	23,914	4,487	19,529	3,452	43,443	7,939	64.5
1-4	4,694	872	4,530	668	9,224	1,540	62.0
5-14	2,279	933	1,658	587	3,937	1,520	55.0
15-24	4,145	3,608	2,720	1,227	6,865	4,835	45.0
25-34	5,284	3,930	3,479	1,504	8,763	5,434	35.0
35-44	7,454	4,767	4,621	2,489	12,075	7,256	25.0
45-54	15,562	11,048	8,300	6,167	23,862	17,215	15.0
55-64	28,593	20,305	15,788	11,682	44,381	31,987	5.0
Under 65	91,925	49,950	60,625	27,776	152,550	77,726	**
65 +	74,685	61,884	69,879	51,831	144,564	113,715	**
All ages	166,610	111,834	130,504	79,607	297,114	191,441	**
Mexico							
Under 1	101,699	15,227	83,338	11,732	185,037	26,959	64.5
1-4	57,126	3,142	58,950	2,389	116,076	5,531	62.0
5-14	21,317	3,602	19,327	2,252	40,644	5,854	55.0
15-24	20,851	11,196	16,567	3,815	37,418	15,011	45.0
25-34	23,039	8,734	17,405	3,438	40,444	12,172	35.0
35-44	22,724	8,464	17,114	4,634	39,838	13,098	25.0
45-54	24,585	15,189	18,476	8,817	43,061	24,006	15.0
55-64	29,699	23,439	26,966	13,746	56,665	37,185	5.0
Under 65	301,040	88,993	258,143	50,823	559,183	139,816	**
65+	77,324	71,017	97,832	56,081	175,156	127.098	**
All ages	378,364	160,010	355,975	106,904	734,339	266,914	**

Table 4. Comparison of standardized mortality ratios for all ages and under 65 years and ratio of years of potential life lost Argentina and Mexico, 1982.

Indicators		M	F	T
Argentina				
Past experience (1962)	SMR all ages	80.4	78.6	79.6
	SMR under 65	71.8	63.2	68.4
	RYPLL	58.8	52.8	56.2
Future reference (USA)	SMR all ages	119.7	128.8	123.5
	SMR under 65	132.2	138.0	134.3
	RYPLL	157.4	187.7	168.4
Mexico				
Past experience (1962)	SMR all ages	61.5	48.8	55.4
	SMR under 65	54.6	40.3	48.0
	RYPLL	45.7	35.2	40.8
Future reference (USA)	SMR all ages	145.4	162.6	152.3
	SMR under 65	184.8	204.5	191.9
	RYPLL	235.0	263.9	245.8

Note: All ratios multiplied by 100.

Source: Tables 1 and 3.

The greater sensitivity to change of the RYPLL can also be appreciated when a more favorable set of sex- and age-specific rates—such as those of the USA—is used for comparison. Under these reference rates the YPLL observed exceed those expected far more than the deaths did, as evidenced by the magnitude of the RYPLL in comparison to that of the SMRs.

It should be kept in mind that SMRs and RYPLLs of different countries should be compared only to the extent that one would compare crude rates, as the population of each country is used in both numerator and denominator [5]. By the same token this simplifies interpretation, since the only difference in numerator and denominator of each ratio derives from the mortality rates used.

Discussion

Indicators for excess and premature mortality can be computed for any age-specific subgroup of the population, and there has been much discussion about how they should be defined. But, as Haenszel [6] says, the problem

> ...is not on the mechanics of rate construction but in definition of terms and deciding what is to be measured. The choice of a rate under one criterion would not necessarily preclude the use of another rate under different circumstances...

This statement applies equally to age-limits and reference rates, the selection of which should be guided by the purpose of the analysis.

All three indicators presented here, namely the SMR for all ages and for deaths occurring prior to age 65 and the ratio of observed over expected YPLL were selected because they are simple to use for the purpose at hand. This is the main reason why YPLL were given preference over indicators derived from life tables; the fact that they use observed data was an added consideration.

In their excellent discussion of the main issues involved in the construction and use of the YPLL, the Centers for Disease Control point out that instead of using a common fixed limit the life expectancy remaining for each age group could be used as that group's upper limit [7]. It is felt, however, that this would detract from one of the main appeals of this indicator, namely its simplicity.

The 65-year age limit was chosen in this paper because, on a population-wide basis, mortality at 65 years and above appears to be more difficult to postpone; it should not be interpreted to imply a limit to economically active or potentially productive life. However, this cut-off point can be varied according to a country's circumstances and the purpose of the analysis.

Another choice involves the reference rates to be used, especially when assessing the gap between what is and what could be. Again, this choice is entirely dependent on the purpose and intentionality of any given analysis, and the decisions to be based on it.

An important application of these indicators would be their use to highlight differentials and inequalities within a country. Thus, on a subnational level, the reference rates could be those of that region or area in the country exhibiting the least unfavorable sanitary conditions, as Farr proposed over 150 years ago. This idea is especially attractive since in almost all countries of the Americas there exist mortality statistics of sufficient completeness to do this comparative analysis for mortality from all causes. The SMR under age 65 or the RYPLL should be excellent evaluation tools, since they use a country's or area's own population and thus assess the health status from within that area and in regard to itself.

The ratios discussed are not meant to be used instead of the more traditional indicators, but as their complement. The level of mortality is still best measured by mortality rates. When comparisons over time or among countries or different areas within any one country are desired, rates adjusted for age (by the so-called direct method) will still be the indicator of choice. However, the RYPLL will be an excellent complement for the assessment of differentials and inequalities, of gains achieved and challenges ahead. But, since ratios only express the relation between two numbers, saying nothing about the size of either one, they should not be used without an indicator providing a yardstick for the size of at least one of the ratio's components.

The procedures presented are geared towards analyses to be used by a country or subnational area for its own benefit. It is hoped that countries in the Americas and elsewhere will replicate this exercise and enrich it with their own perspectives and experience.

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Chronic Disease Reports in the Morbidity and Mortality Weekly Report (*MMWR*)

Introduction

In 1986, 1.58 million people in the United States of America (USA) died from six major chronic diseases: cardiovascular and cerebrovascular diseases, chronic obstructive pulmonary disease, chronic liver disease and cirrhosis, malignant neoplasms, and diabetes. These deaths accounted for 75% of all USA deaths [1]. In comparison, unintentional injuries, suicides, and homicides accounted for 7% of mortality, acquired immunodeficiency syndrome for 0.5%, and other infectious diseases for an additional 8%. For many chronic diseases, means of primary, secondary, or tertiary prevention are well known [2,3]. It has been estimated that many deaths caused by these six chronic diseases could have been prevented by various means, for example, by effective control of smoking, blood pressure, diet, and alcohol consumption [2,3].

From January 1989, the *MMWR* publishes monthly Chronic Disease Reports (CDR) to provide basic information on chronic disease mortality, associated risk factors, and preventive measures.

Table 1. Topics included in the MMWR CDR with ICD codes where appropriate.

Topic	ICD code-Mortality	ICD code-Hospital discharge
Years of potential life lost		
Chronic disease mortality trends		
Stroke*	430-434, 436-438	430-434, 436-437
Coronary heart disease*	410-414, 429.2	410, 411, 413, 429.2
Diabetes	250	250
Smoking-related obstructive pulmonary disease*	491, 492, 496	491-493, 496
Lung cancer	162	162
Female breast cancer*	174	174
Cervical cancer	180	180
Colorectal cancer	153-154	153-154
Cirrhosis	571	571
Preventable chronic disease mortality		

*CDR groupings of ICD codes differ from groupings used by NCHS and WHO.