Impacts of diabetes and homicide mortality on life expectancy in Mexico

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Abstract: Mexico presents sharp contrasts on the evolution of the level of mortality. On one hand, chronic degenerative diseases, especially those related to diabetes, are in an alarming increase. On the other, different criminal groups associated with drug trafficking has increased the number of violent deaths. This has resulted in the decline of life expectancy in certain regions. For example, in regard to the death rate from diabetes mellitus, while in 2000 this figure reached 47.8 per hundred thousand for 2011 was 71.0 per hundred thousand. Meanwhile, in regard to the mortality rate from homicide, while in 2007 it amounted to 8.2 per hundred thousand in 2010 had increased to 22.9 per hundred thousand. In this paper we estimate years of life lost (Arriaga, 1996) for these two causes of death, analyze their trends and relate this indicator with temporary life expectancies. Information from vital statistics, available for 2000 and 2010 at national level is used. The estimations may provide clues to the Mexican authorities to formulate population, health and social policies that help to increase the limits of life expectancy in our country.
Keywords: demographic analysis, mortality by cause, years of life lost, temporary life expectancy.

1 Introduction

In Mexico the epidemiological transition has followed the expected pattern. That is, there has been a relative increase of chronic-degenerative diseases. Accordingly, in the last decade it has been observed a rise in diabetes mortality, but to levels above those of most developed countries. Apart from bad habits of diet and sedentarism, it seems there is a genetic factor affecting adversely the Mexican population. Therefore, unlike for developed countries, diabetes mellitus has been the first or the second cause of death in Mexico in recent years. For example, according to figures from World Health Organization (WHO, 2011), from a total of 192 countries, Mauritius was the country with the highest diabetes mortality rate in the world (176 per hundred thousand), Mexico

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occupied the sixth place (83.8 per hundred thousand), above of countries like Portugal (19.3 per hundred thousand), the United States (15.2 per hundred thousand), Canada (13.4 per hundred thousand) and Japan (4.5 per hundred thousand).

Another problem facing Mexican population is the mortality associated with violence which has also presented a rising trend. The so called "war against narco" launched by former president Calderón, provoked a spiral of violence that made increase the number of deaths due to homicide from 8,868 in 2007 to 27,213 2011.

In this paper we estimate the years of life lost (Arriaga, 1996) by two causes of death: diabetes and homicide. As it is known, demographic analysis of mortality often has used different kind of indicators such as crude death rates, specific mortality rates and life expectancies at birth. These indicators aim at portraying the levels and trends of the phenomenon. Nonetheless, each of these indexes present advantages and pitfalls. Thus, for instance, it is known that crude death rates are influenced by age structure, even when the inputs for its calculation are easily available. The years of life lost is an index that not only reflects the number of deaths occurring by each cause. It also takes into account the timing of the deaths.

Information from vital statistics, available for 2000 and 2010, at national level, is used. The estimations may provide clues to the Mexican authorities to formulate population, health and social policies that help to increase the limits of life expectancy in our country.

2 Methodology

One way to look at the impact of a certain cause of death on life expectancy is through the years of life lost (YLL). This methodology originally proposed by Arriaga (1996) consists on calculating the years that persons who die before certain age lose in comparison to the hypothesis that they had reached that age. The assumptions to calculate YLL are: The mortality should be null between two ages chosen for the analysis, i.e. those who die should have lived until the upper limit of the interval considered for the analysis. Assuming the analysis is made between the ages a and v (v – a = u). It is also assumed that there is a life table available that reflects the mortality of the population studied. If the distribution of deaths by cause in the life table is equal to the distribution in the deaths registered, then:

$$ndx,j = ndx \ (nDx,j / nDx)$$

where:

ndx,j : is the number of deaths due to cause j, between ages x and x+n from the life table

ndx : is the number of deaths between ages x and x+n from the life table

nDx : is the number of deaths registered between ages x and x+n

nDx,j is the number of deaths registered between ages x and x+n , due to cause j

the volume of YLL by people who die by cause j in the interval of ages between x and x+n is:

$$u,nAPx,j = ndx,j\ [\ (n - nkx) + (v - x - n)\ ]$$

where

nkx : is the average part of the interval [x , x+n] lived by those who die in that interval among those who have survived to age a, the average of YLL is given by the expression:

$$u,napx,j = ndx,j\ [\ (v - nkx - x\ )\ ] / la \qquad (1)$$

It is possible to add the years of life lost in each interval of ages comprised within the large interval of ages between a and v:

$$_{u}ap_{.,j} = \sum_{x=a}^{v} {}_{u,n}ap_{x,j}$$

This is the formula we applied for most results presented in this paper considering an initial age a = 20 and the final age v = 80. The causes of death (j) included are diabetes mellitus and homicide.

On the other hand, expression (1) can be added for different causes of death. Considering m causes of death with no intersection and that those m causes comprise all possible causes of death, one can calculate the YLL for an age interval [x, x+n] and for all the causes:

$$_{n}ap_{x,.} = \sum_{j=1}^{m} {}_{u,n}ap_{x,j}$$

If in turn, this last expression can be added for all ages between a and v, and in this way we can get the years of life lost between a and v by those who die by any cause. We also analyze those results for 2000 and 2010 and for males and females.

Another index we use in this paper to contrast with the years of life lost, is the temporary life expectancy which can be defined as the average number of years the survivors at certain age (a) are going to live between that age and another age (v). If u = v – a, between the ages a and v, people might live (in theory) a maximum of u years. However, considering mortality they live on average:

$$_{u}e_{a} = \frac{T_a - T_{a+u}}{l_a}$$

i.e., the person years lived by the cohort between the ages a and v, divided by the number of those that survived t age a.

3 Results

We applied the methodology to calculate YLL in the Mexican population between ages 20 and 80 due to diabetes mellitus, homicide, and for all the causes, for the years 2000 and 2010 and by sex (Table 1 and 2). The inputs were life tables by sex for the years 2000 and 2010 and registered deaths by sex, age group and cause (Table 3).

We can see some general results when we considered the YLL by all causes:

1. Men lose more than two additional years than women.
2. The trend over time is to the reduction of YLL. Between 2000 and 2010

   YLL reduced around one year for each sex. For men the reduction was from 6.503 to 5.440, whereas for women from 4.222 to 3.340 years of life lost.

Table 1. Mexico, 2000. Deaths by sex, age group and cause (Total, diabetes and homicide).

Age	Total			Diabetes			Homicide		
group	Males	Females	Both	Males	Females	Both	Males	Females	Both
0	21,793	16,769	38,621	3	2	5	49	38	87
1-4	3,726	3,236	6,963	6	4	10	61	47	108
5-9	2,025	1,432	3,457	4	9	13	66	27	93
10-14	2,252	1,466	3,718	11	20	31	152	45	197
15-19	5,106	2,282	7,389	30	47	77	833	140	973
20-24	7,388	2,606	9,995	60	66	126	1,407	147	1554
25-29	8,380	2,911	11,291	133	104	237	1,438	139	1577
30-34	8,737	3,271	12,009	198	135	333	1,233	128	1361
35-39	9,848	4,107	13,956	359	250	609	1,046	115	1161
40-44	10,387	5,109	15,496	650	500	1150	777	87	864
45-49	11,455	6,603	18,061	1,071	984	2055	651	72	723
50-54	12,574	8,493	21,068	1,622	1,677	3299	432	55	487
55-59	14,839	10,653	25,494	2,286	2,485	4771	375	44	419
60-64	17,100	13,747	30,849	2,834	3,399	6233	264	51	315
65-69	19,510	16,467	35,978	3,036	3,999	7035	195	38	233
70-74	20,865	18,506	39,371	2,987	3,804	6791	135	34	169
75-79	21,513	19,424	40,938	2,603	3,393	5996	110	22	132
80-99	44,356	53,462	97,822	2,928	4,769	7697	92	43	135
100+	1,023	1,952	2,975	8	35	43	1	2	3
N. S.	1,425	757	2,216	34	69	103	127	19	146
Total	222,509	176,484	399,046	20,863	25,751	46,614	9,444	1,293	10,737

Source: Elaborated from SINAIS (2013).

When specific causes of death are considered, the panorama changes. The sex differential for homicide mortality is very important. In terms of YLL, men lose about seven times more years than women. As to deaths due to diabetes, in 2000

male mortality was 2% higher than female mortality. In 2010 it was 24% higher. Unlike mortality by all causes, the years of life lost due to homicide rose between 2000 and 2010 for both sexes. In the case of men it went from 0.239 to 0.296: an increase of 24%; for women, at much lower level, went from 0.036 to 0.041: an increase of 14%.

Table 2. Mexico, 2010. Deaths by sex, age group and cause (Total, diabetes and homicide).

Age	Total			Diabetes			Homicide		
group	Males	Females	Both	Males	Females	Both	Males	Females	Both
0	16,148	12,637	28,785	nd	nd	nd	nd	nd	nd
1-4	3,075	2,576	5,651	1	4	5	66	51	117
5-9	1,603	1,276	2,882	8	4	12	41	31	73
10-14	2,126	1,482	3,609	9	19	28	168	72	241
15-19	7,100	2,801	9,902	27	37	64	1,977	318	2,296
20-24	10,197	3,015	13,216	85	99	184	3,492	362	3,855
25-29	11,229	3,168	14,401	135	145	280	3,822	318	4,140
30-34	12,228	3,723	15,955	335	193	528	3,742	302	4,046
35-39	13,446	4,838	18,292	576	384	960	3,176	230	3,409
40-44	13,723	6,202	19,926	1,132	792	1,924	2,116	189	2,306
45-49	15,704	8,867	24,575	1,973	1,511	3,485	1,429	168	1,597
50-54	18,385	11,685	30,076	3,150	2,588	5,738	1,003	102	1,106
55-59	20,786	14,799	35,590	4,359	3,870	8,230	604	67	671
60-64	23,443	18,371	41,818	5,104	5,225	10,329	378	54	432
65-69	26,005	21,237	47,247	5,412	5,820	11,232	269	42	311
70-74	29,572	25,484	55,065	5,471	6,248	11,720	174	43	217
75-79	31,559	29,218	60,783	4,878	5,988	10,868	114	19	133
80-99	71,869	85,025	156,912	6,975	10,227	17,202	102	28	130
100+	1,634	2,806	4,440	27	79	106	1	0	1
N. S.	2,195	459	2,813	35	33	68	635	38	708
Total	332,027	259,669	592,018	39,692	43,266	82,963	23,309	2,434	25,789

Source: SINAIS (2013).

For diabetes mellitus there were mixed results in the trends of YLL. For males the YLL rose from 0.816 in 2000 to 0.927 in 2010; i.e. a 14% increase. For females a reduction took place between 2000 and 2010, from 0.797 to 0.747, a fall of 7%.

The years of life lost is an index that not only reflects the number of deaths occurring by each cause. It also takes into account the timing of the deaths. An early death produces more YLL than a late death. This explains the apparent paradox of having (for the Mexican population) higher mortality rates due to diabetes for women on one hand, and on the other more YLL for men. This is produced because there are more premature male deaths.

Table 3. Mexico: YLL between ages 20 and 80. Males 2000. Homicide.

Age	${}_nd(x)^1$	${}_nD_x$	${}_nD_{x,j}$	${}_nD_{x,j}/{}_nD_x$	${}_nd_{x,j}$	${}_nk_x$	${}_{u,n}AP_{x,j}$	$u,n,ap_{x,j}$
0	4062	21793				0.41		
1	591	3726	61	0.0164	9.6755	1.92	745.7893	0.0079
5	130	2025	66	0.0326	4.237	2.5	307.1852	0.0032
10	135	2252	152	0.0675	9.1119	2.5	615.0533	0.0065
15	190	5106	833	0.1631	30.9969	2.5	1937.3042	0.0204
20	254	7388	1407	0.1904	48.3728	2.5	2781.4341	0.0293
25	289	8380	1438	0.1716	49.5921	2.5	2603.5865	0.0274
30	412	8737	1233	0.1411	58.1431	2.5	2761.7958	0.0291
35	517	9848	1046	0.1062	54.9129	2.5	2333.7972	0.0246
40	822	10387	777	0.0748	61.4897	2.5	2305.8655	0.0243
45	1336	11455	651	0.0568	75.9263	2.5	2467.6054	0.026
50	2273	12574	432	0.0344	78.0926	2.5	2147.5457	0.0226
55	3569	14839	375	0.0253	90.1931	2.5	2029.3441	0.0214
60	5310	17100	264	0.0154	81.9789	2.5	1434.6316	0.0151
65	7893	19510	195	0.01	78.8895	2.5	986.1193	0.0104
70	12292	20865	135	0.0065	79.5313	2.5	596.4845	0.0063
75	17961	21513	110	0.0051	91.838	2.5	229.5949	0.0024

[1/] This data come from Mina´s (2001) mortality table.
Source: Elaborated from Mina (2001) and SINAIS (2013).

Temporary life expectancies between ages 20 and 80 are about two years higher for females than for males (Table 6). During the first decade of the XXI century they rose one year. The differences mentioned above are almost the same as the differences existing in the YLL (Table 4) both by sex and between 2000 and 2010, namely, a sex differential of two years, and an improvement of one year in 2010, in comparison with 2000. This means that reduction in years of life lost have a close relationship with life expectancies.

As it was said, the total of years of life lost is equal to the sum of the YLL by each cause. Therefore any reduction in the YLL by each cause will contribute to

the reduction of the total YLL and thereby to almost the same increase in the life expectancy.

Table 4. México. YLL 20-80 by causes and sex, 2000 and 2010

	2000		2010	
	Males	Females	Males	Females
Total	6.503	4.222	5.44	3.34
Diabetes	0.816	0.797	0.927	0.747
Homicide	0.239	0.036	0.296	0.041

Source: Estimate.

Table 5. México. Mortality rate by causes and sex, 2000 and 2010(per hundred thounsand people)

	2000		2010	
	Males	Females	Males	Females
Diabetes	43.8	51.6	72.4	75.3
Homicide	19.8	2.6	42.5	4.2
Total*	4.68	3.54	6.1	4.5

* This rate is by thousand

Source: Estimate.

Table 6. México. Temporary life expectancies ${}_{60}e_{20}$

Sex	2000	2010
Males	53.5	54.56
Females	55.78	56.66

References

1. Aguirre, Alejandro and Fortino Vela, "Una mirada retrospectiva a la evolución de la mortalidad y sus vínculos con la política de población en la materia en México, en los últimos 50 años". 50 años del Centro de Estudios Demográficos, Urbanos y Ambientales, El Colegio de México, in press (2014).

2. Arriaga, Eduardo, “Commments on some indexes to measure the level and change of mortality”. Estudios Demográficos y Urbanos, 11, 5-30 (1996).
3. Bocco, Mónica, “La relación entre los años de vida perdidos y la esperanza de vida: aplicaciones para el análisis de la mortalidad”. Notas de Población, junio, 39-60 (1996).
4. Mina, Alejandro, “Funciones de sobrevivencia empleadas en el análisis demográfico”. Papeles de Población, 28:131-154 (2001).
5. WHO, Global status report on noncommunicable diseases 2010, Italy (2011).