

Evolution of disease mortality burden in Cuba: 1990-2005

Evolución de la carga de enfermedad debido a la mortalidad en Cuba: de 1990 a 2005

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Abstract

The objective of this study was to estimate the evolution of the burden of disease in Cuba for 20 major causes at five year intervals from 1990 to 2005, in terms of mortality and years of life lost due to premature death (YLL), using national mortality registries. Six summary measures were computed for each of the 20 major causes of death which characterized the evolution of the disease burden over the period studied. The 20 causes were then grouped according to their behaviour in these summary measures; hierarchical cluster analysis was used to support this grouping process. We compute YLL results with and without age-weighting and time discounting (3%). The 20 major causes were grouped into 12 subgroups, each with a particular pattern. The burden of disease in Cuba during the period 1990-2005 has a peculiar pattern that does not reproduce the one characteristic of other low- and middle-income countries. The approach used in this study supports a better description of mortality and YLL trends for major causes, for identifying possible explanations, and for supporting public health policy making. It seems convenient to reproduce this analysis using shorter time intervals, e.g. annually.

Potential Years of Life Lost; Illness Behavior; Mortality

Introduction

Several developed and developing countries have conducted national and subnational burden of disease studies^{1,2,3,4}, after the World Bank and the World Health Organization (WHO) introduced, more than 15 years ago, disability adjusted life years (DALYs), a composite health measure which integrates years of life lost due to premature death and a suboptimal quality of life^{5,6}.

The global results of the DALY approach have appeared in several publications, and have attracted wide attention^{7,8,9,10,11,12,13,14,15,16,17}. However, its usefulness in supporting evidence-based public health policy decision making at the national level has yet to be established fully.

The DALY is aggregated from disease-specific mortality and morbidity data. Mortality data is readily available in developed and some developing countries; however, reliable morbidity data is difficult to obtain even in some developed countries. Therefore, in some contexts, burden of disease studies in terms of mortality and years of life lost due to premature death (YLL) have much more credibility and still could be useful.

This study presents estimations of the patterns of evolution of the burden of disease in terms of YLL (which capture the burden of premature deaths) due to 20 major causes in Cuba for the years 1990, 1995, 2000 and 2005. Common patterns of evolution were identified through a cluster analysis of the 20 causes. The main goal

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of this study was to assess the usefulness of this approach in supporting public health policy decision making at the national level in Cuba.

Methods

In general, the methodology used in this paper is similar to the one used in the Global Burden of Disease Study conducted in the 1990s by the WHO^{6,7,8,9,10,11,12,13}. In a previous study¹⁸ we used a list of 20 major causes to estimate the burden of disease in Cuba. That list included 17 causes that appeared in our National Health Statistics Yearbooks from 1995 to 2000, as main causes of death; three additional causes were taken from the Global Burden of Disease Study: neuropsychiatric conditions, digestive diseases, and chronic obstructive pulmonary diseases (COPD). Because bronchitis & emphysema was one of the causes from our yearbooks, we included in our list "COPD excluding bronchitis and emphysema" (Table 1). These 20 causes accounted for

almost 95% of all deaths in Cuba in each of the four years studied, and their International Classification of Diseases (ICD) 9th or 10th revision codes are detailed in Seuc et al.¹⁸.

Mortality data were obtained from the mortality registries of the National Statistics Division of the Cuban Ministry of Public Health. Codes from the ICD-9th revision were used in the registries for the years 1990, 1995 and 2000; for 2005 the registry used the codes of the ICD-10th revision. The ICD-10th revision was introduced in Cuba in 2000 in addition to the ninth revision, and we decided to use the ICD-9th codes for 2000 because they were considered more reliable.

We calculated mortality burden, i.e. YLL using the same methods as in the global burden of disease studies^{6,7}. Life expectancy for men and women, and for each age group (19 age groups were used, from "less than 1" to "80 and above"), were obtained for the year 2000 from the National Statistical Office, and taken as the reference for all the YLL calculations. Life expectancy at birth in Cuba in 2000 was 76 years, 74 for men and 78

Table 1

Description (means and slopes) of mortality and years of life lost due to premature death (YLL) rates (per 100,000 inhabitants) and YLL/death, for each of 20 major death causes. Cuba, 1990, 1995, 2000 and 2005.

Cause of death	Mean			Slope			Cluster *
	Mortality	YLL	YLL/death	Mortality	YLL	YLL/death	
Heart diseases	196	2,584	13.2	-0.6	-18	-0.05	1
Cancer	145	2418	16.7	2.7	38	-0.04	2
Accidents	47	1,310	27.7	-0.8	-54	-0.72	3
Influenza, pneumonia	43	541	13.0	2.4	19	-0.27	4
Sepsis	1	63	43.7	0.0	-3	-0.84	5
Cerebrovascular disease	72	941	13.1	0.8	1	-0.13	6
Neuropsychiatric conditions	25	422	17.5	1.0	6	-0.42	7
COPD excluding bronchitis and emphysema	14	167	12.2	0.9	11	0.01	8
Suicide	17	553	31.4	-0.6	-25	-0.44	9
Arteries, arteriols, capillar vessels	30	298	9.9	0.1	1	0.00	10
Diabetes	19	305	16.2	-0.4	-8	-0.04	10
Cirrhosis	9	177	19.7	0.1	3	0.09	10
Digestive diseases	17	278	16.0	0.0	-3	-0.13	10
Bronchitis emphysema	4	46	11.6	-0.3	-3	0.02	10
Asthma	4	93	26.0	-0.2	-5	-0.04	10
Assaults	6	282	43.4	-0.1	-6	-0.29	11
Meningitis	2	67	38.3	-0.1	-4	-0.51	11
Infectious diseases **	8	215	27.3	-0.2	-9	-0.38	11
Perinatal conditions	5	353	71.8	-0.3	-23	-0.15	12
Congenital diseases	6	339	58.9	-0.3	-18	-0.41	12

COPD: Chronic obstructive pulmonary diseases.

* Death causes are grouped according to cluster analysis technique;

** Excluding meningitis, influenza & pneumonia and sepsis.

for women. Main results were obtained without age-weighting and without time discounting; to assess reliability, results were also computed using age-weighting and 3% time discounting. Different percentages have been used for time discounting, but 3% has become standard for burden of disease studies^{6,7,12}.

Population data by sex and age groups were obtained from the National Statistical Office for the years included in this study.

In Cuba all death certificates are made by qualified medical doctors, who are distributed all over the country in hospitals, policlinics, schools and work places. For this reason, we did not consider it necessary in this study to make any mortality adjustments to account for ill-defined codes or corrections for inadequate coverage of our mortality registries.

For each cause and using the mortality rates (per 100,000 inhabitants) and YLL rates (per 100,000 inhabitants) for each of the four years studied, we computed six summary measures: (1) mean of mortality rates; (2) mean of YLL rates; (3) mean of YLL per death (mean of YLL/death); (4) slope of mortality rates; (5) slope of YLL rates; and (6) slope of YLL per death (slope of YLL/death). Slopes were computed as the average rate of change per year. Mortality and YLL rates were computed using the total Cuban population for each year, and were not standardized. To qualify the numeric results, we divided the range of values for each of the three mean indicators (mean mortality, mean YLL, and mean YLL/death) in five equally distanced parts, corresponding to the categories “very high”, “high”, “medium”, “low”, and “very low”.

For each of the slope indicators (mortality slope, YLL slope, and YLL/death slope) we divided the largest of the ranges (the range for the positive slopes and the range of the negative slopes) in three equal parts, corresponding to the categories “low increase (decrease)”, “medium increase (decrease)”, and “high increase (decrease)”; additionally, we consider a “no change” category formed by slope values around zero within 2% of the largest range mentioned above. As a result, for each slope indicator we considered seven categories.

For some analyses, the 20 death causes were grouped into the traditional three categories used in several global burden of disease studies^{6,7,12,13}: group I (communicable, maternal and perinatal conditions), group II (non-communicable diseases), and group III (injuries).

In order to support the process of identifying groups of homogeneous causes in terms of the above six summary measures, we used hierarchical cluster analysis of the 20 causes. The “be-

tween groups linkage” agglomeration method with the squared Euclidean distance applied on standardized (z-scores) variables, was used. Different solutions with different numbers of clusters were considered. SPSS for Windows version 11.5 (SPSS Inc., Chicago, U.S.A.) was used in all data processing and statistical analyses.

Results

Table 1 shows the six summary measures for each of the 20 major causes (without age-weighting and time discounting), and the results of the grouping of homogeneous causes (supported by the cluster analysis results) for the 12-cluster solution.

Nine of the 20 major causes (cluster 1 to cluster 9) remained as isolated entities with respect to their patterns of evolution, and therefore they deserve to be described one by one. The remaining 11 causes were grouped in three clusters: one cluster (cluster 10) with six causes, another cluster (cluster 11) with three causes, and the last cluster (cluster 12) with two causes. Table 2 shows the “categories” we used to summarize the patterns for each of the 12 clusters, based on the numeric values of the six summary measures on Table 1 (see *Methods* section). These categories made easier the interpretation of results and description of the patterns of each of the clusters during the period studied.

The results show that heart diseases (cluster 1) and cancer (cluster 2) were the two main causes of mortality and YLL during the period, with a tendency for cancer to replace heart diseases in both indicators in the near future (cancer increasing its rates and heart diseases decreasing its rates).

Third place in terms of YLL is occupied by accidents (cluster 3) and in terms of mortality by cerebrovascular diseases (cluster 6); the tendency of accidents during the period is remarkably positive, with the highest decreases in mortality and YLL rates, while cerebrovascular diseases indicators are generally stable during the period.

Influenza and pneumonia (cluster 4) has low or very low mean values in mortality rates, YLL rates, and YLL/death during the period, as the other group I conditions included in this study, but it is the only one in this group with a tendency to increase the first two indicators; the increase in mortality rates is very high, and for YLL rates the increase is the second highest during the period after cancer (Tables 1 and 2).

Sepsis (cluster 5) is characterized by having a remarkably high mean value of YLL/death (third place just after perinatal conditions and congeni-

tal diseases) and the lowest mean mortality rate, for the 1990-2005 period. This is the consequence of very few deaths due to sepsis but occurring very early in life. Fortunately, the YLL/death indicator tended to decrease substantially from 1990 to 2005.

Neuropsychiatric conditions (cluster 7) is seventh place in terms of the mortality rate and YLL rate during the period studied, with a slight tendency to increase. This is a relevant result in the Cuban context because before 2004 these conditions were not reported in the list of the ten major death causes, and because it adds up to the already heavy burden of non-communicable diseases (group II) in our country.

COPD (cluster 8) is one of the five group II diseases that is a cluster in its own. Like neuropsychiatric conditions (cluster 7) it has very low mean mortality rates, mean YLL rates, and mean YLL/death, with the first two indicators slightly increasing during the period; however, YLL/death decreased for neuropsychiatric conditions while for COPD it slightly increased, which shows that the few deaths due to COPD during the period had a slight tendency to occur at earlier ages.

Suicide (cluster 9) and accidents (cluster 3) are the two conditions of group III (injuries) that define a cluster on its own. Like accidents, suicide generally had small values in all indicators with a tendency to improve (reduction of rates) during the period; the main difference was that in Accidents the mean YLL rate was higher than in suicide.

Causes in cluster 10 (arteries, arteriols, capillary vessels; diabetes; cirrhosis; digestive diseases; bronchitis emphysema; and asthma) have all very low and quite stable levels of mortality, YLL and YLL/death during the period 1990-2005 (Table 2).

The causes in cluster 11 (assaults, meningitis and infectious diseases) have very low levels in mortality and YLL, but not such low levels in YLL/death; their tendency during the period is slightly improving, particularly for the last mentioned indicator YLL/death.

The two causes in cluster 12 (perinatal conditions and congenital diseases) have very low levels of mortality and YLL, but (very) high levels for YLL/death; for these causes, all indicators (mortality, YLL and YLL/death) tend to improve (decrease) during the period, particularly YLL (Table 2).

Discussion

Numerous recent studies on the evolution of mortality and burden of disease tend to concen-

trate on specific conditions or specific population subgroups^{19,20,21,22,23,24}; on the other hand, most studies covering a wide range of conditions are usually conducted at specific years^{25,26}. We have not been able to find studies addressing the patterns of evolution of a wide range of conditions at a national or regional level, so the possibilities we have of comparing the results of this study are quite limited.

In a previous study¹⁸ we considered a range of 20 conditions that accounted for about 95% of all deaths in Cuba for the period 1990-2000, but we focused there on how the ranking of conditions according to mortality and according to YLL, in 1990, 1995 and 2000 were quite different in Cuba.

Studies addressing specific conditions^{19,20,21,22} are indeed very useful because, among other things, they allow to identify factors related to, or even explaining the yearly rates of mortality, YLL, years lost due to disability (YLD), or DALYs; however, they tend to overestimate the importance of the specific condition considered⁶.

Studies addressing multiple conditions tend to avoid these biases and are more objective, because the description of any condition is put necessarily into the context of the others; however, the possibly high number of conditions considered can make the analyses too cumbersome. Then, in these cases, reducing the dimensionality of the problem can be very helpful in facilitating the elaboration of the main messages that should be communicated to different audiences, particularly decision-makers.

In this study, with the support of the conglomerate analysis statistical technique²⁵, we were able to reduce the dimension of the problem from 20 to 12; the resulting 12 clusters of conditions were fairly interpretable, which indirectly validated this solution.

Another advantage of the clustering of conditions conducted in this study is that it could suggest a few potential common factors explaining the common pattern of the conditions in the corresponding cluster; one such factor could be "quality of services" for example. On the other hand, the clustering results might suggest specific subdivisions within well established groups; for example, within group II of non-communicable diseases we have found in this study a quite homogeneous subgroup (cluster 10), which might have a common pattern not because of external factors like "quality of services" but because of intrinsic factors related to the etiologies of these conditions.

From 1990 to 2005 in Cuba, mortality and YLL were heavily dominated by heart diseases and cancer; third place in terms of mortality was

Table 2

Qualitative description * of mortality and years of life lost due to premature death (YLL) rates, and YLL/death, for each 20 major death causes. Cuba, 1990, 1995, 2000 and 2005.

Cause of death	Mean			Slope			Cluster **
	Mortality	YLL	YLL/death	Mortality	YLL	YLL/death	
Heart diseases ***	Very high	Very high	Very low	Low decrease	Medium decrease	Low decrease	1
Cancer ***	High	Very high	Very low	High increase	High increase	Low decrease	2
Accidents #	Low	Medium	Low	Low decrease	High decrease	High decrease	3
Influenza pneumonia ##	Low	Very low	Very low	High increase	Medium increase	Low decrease	4
Sepsis ##	Very low	Very low	Medium	No change	Low decrease	High decrease	5
Cerebrovascular diseases ***	Low	Low	Very low	Low increase	Low increase	Low decrease	6
Neuropsychiatric conditions ***	Very low	Very low	Very low	Medium increase	Low increase	Medium decrease	7
COPD excluding bronchitis and emphysema ***	Very low	Very low	Very low	Low increase	Low increase	Low increase	8
Suicide #	Very low	Very low	Low	Low decrease	Medium decrease	Medium decrease	9
Arteries, arteriols, capillar vessels ***	Very low	Very low	Very low	Low increase	Low increase	No change	10
Diabetes ***	Very low	Very low	Very low	Low decrease	Low decrease	Low decrease	10
Cirrhosis ***	Very low	Very low	Very low	Low increase	Low increase	Low increase	10
Digestive diseases ***	Very low	Very low	Very low	No change	Low decrease	Low decrease	10
Bronchitis emphysema ***	Very low	Very low	Very low	Low decrease	Low decrease	Low increase	10
Asthma ***	Very low	Very low	Low	Low decrease	Low decrease	Low decrease	10
Assaults #	Very low	Very low	Medium	Low decrease	Low decrease	Medium decrease	11
Meningitis ##	Very low	Very low	Medium	Low decrease	Low decrease	Medium decrease	11
Infectious diseases ###,###	Very low	Very low	Low	Low decrease	Low decrease	Medium decrease	11
Perinatal conditions ##	Very low	Very low	Very high	Low decrease	Medium decrease	Low decrease	12
Congenital diseases ***	Very low	Very low	High	Low decrease	Medium decrease	Medium decrease	12

* Numeric values are presented in Table 1;

** Death causes are grouped according to cluster analysis technique;

*** Group II: non-communicable diseases;

Group III: injuries;

Group I: communicable, maternal and perinatal conditions;

Excluding meningitis, influenza & pneumonia and sepsis.

occupied by cerebrovascular diseases, and in terms of YLL by accidents. This is a very similar situation to what was found in the US in 1996 with respect to YLL²⁶; on the other hand, our results are rather different to those found in 2001 for “low- and middle-income countries” in terms of DALYs²⁷, where the first three causes were “perinatal conditions”, “lower respiratory infections” and “ischemic heart disease”. The comparison of the main causes of YLL in the US and Cuba up to the 8th or 9th rankings shows that the main differences are concentrated in “HIV” and “homicide and violence”, which in the US have higher burdens than in Cuba. The Cuban policy concerning the HIV/AIDS epidemic, based on intensive HIV testing and tracing of partners, has been considered the main reason for the infection's low burden in this country²⁸.

Since 1999, cancer has been the main source of YLL most affecting Cuban life expectancy at

birth. However, it is true that cancer is a too broad and heterogeneous condition which deserves to be sub-classified into specific types like lung cancer, breast cancer, and colorectal cancer for example, so decision-makers can better use this evidence.

As we mentioned in the *Results* section, neuropsychiatric conditions had a notorious (and to some extent ignored) role concerning mortality and YLL in Cuba from 1990 to 2005. Within neuropsychiatric conditions, “dementia and other degenerative conditions of the central nervous system”, “alcohol use related conditions” and “Parkinson” were the most important. A similar situation occurred at the international level, because the global burden of disease study conducted by WHO in the 90s was one of the first studies alerting about the negative impact of these neglected mental diseases on wide sectors of the world population.

The positive evolution of accidents in Cuba during the period studied was quite remarkable; it could be related to the fact that in 1995 this country implemented a National Program for the Prevention of Accidents.

When we group causes in “communicable, maternal and perinatal” (group I), “non-communicable” (group II), and “injuries” (group III), from Table 2 we see that the first ten causes according to mean mortality rates are dominated by group II conditions (7 out of 10, 70%); only “influenza and pneumonia” from group I, and “accidents” and “suicide” from group III, are in this list of ten major causes. When we rank diseases according to mean YLL rates, non-communicable diseases are still a majority in the first ten causes (6 out of 10, 60%), but now “perinatal conditions” (in addition to “influenza and pneumonia”) from group I is included. These mortality and YLL results are quite different to those for the “low- and middle-income countries” group²⁷, where only three of the first ten causes of mortality and only four of the first ten causes of DALYs, are in the “non-communicable” group II.

In contrast to other non-industrialized countries, Cuba has been prioritizing health for

almost half a century, has an extensive primary health-care network, and has obtained very significant results mainly in the control of infectious diseases and reducing infant mortality^{29,30}. At the same time, the Cuban demographic evolution, characterized by increasing life expectancy and low fecundity, is forcing the Cuban population to an accelerated aging process³¹ for the last 10 or 15 years; almost 14% of the Cuban population in 2005 was over 60 years old (Table 3). The confluence of the above mechanisms could explain why the patterns of mortality and YLL in Cuba during the period studied are closer to the patterns of developed countries (like the US) than to the patterns of low- and middle-income countries.

Some of the criticisms to the DALY approach refer to the age-weighting, the time discounting, and the severity estimations for each of the causes studied^{6,32,33}. As we did not consider in this study the YLD component, i.e. the years of life lost due to living with a suboptimal quality of life, the last criticism is not pertinent for this study.

To address the first two criticisms we conducted a similar analysis including age-weighting and 3% time discounting for computing the

Table 3

Proportions of the Cuban population in age groups above 60 years: 1990, 1995, 2000, 2005.

Sex/Age groups (years)	1990		1995		2000		2005	
	n	%	n	%	n	%	n	%
Males								
60-69	310,664	5.8	330,335	6.0	392,981	7.0	454,378	8.1
70-79	207,860	3.9	224,739	4.1	251,526	4.5	256,297	4.6
80 +	118,331	2.2	127,940	2.3	145,274	2.6	34,747	0.6
Subtotal	636,854	11.8	683,013	12.4	789,780	14.0	745,422	13.2
Total	5,381,198		5,522,120		5,623,066		5,630,428	
population								
Females								
60-69	310,989	5.9	334,590	6.1	398,567	7.1	474,295	8.4
70-79	212,558	4.0	236,908	4.3	251,526	4.5	283,936	5.1
80 +	63,790	1.2	145,996	2.7	162,121	2.9	39,875	0.7
Subtotal	587,336	11.1	717,493	13.1	812,213	14.5	798,106	14.2
Total	5,313,267		5,476,412		5,594,034		5,613,408	
population								
Both sexes								
60-69	621,653	5.8	664,925	6.0	791,548	7.1	928,673	8.3
70-79	420,418	3.9	461,646	4.2	503,051	4.5	540,233	4.8
80 +	182,120	1.7	273,936	2.5	3,073,95	2.7	74,622	0.7
Subtotal	1,224,190	11.4	1,400,506	12.7	1,601,993	14.3	1,543,528	13.7
Total	10,694,465		10,998,532		11,217,100		11,243,836	
population								

YLL, as stated by Murray & Lopez⁶. The results of the cluster analysis were different; in this case the solution with 12 clusters, for example, grouped the 20 conditions as follows: cluster 1 (heart diseases); cluster 2 (cancer); cluster 3 (cerebrovascular diseases); cluster 4 (accidents); cluster 5 (suicide); cluster 6 (influenza pneumonia); cluster 7 (arteries, arteriols, capillary vessels); cluster 8 (congenital diseases); cluster 9 (neuropsychiatric conditions); cluster 10 (sepsis); cluster 11 (diabetes, cirrhosis, digestive diseases, infectious diseases, COPD, bronchitis & emphysema, asthma); cluster 12 (perinatal conditions, aggressions, meningitis).

We think the main reason for this difference is the asymmetrical impact of age-weighting and time discounting on the six summary measures used in the cluster analysis, affecting not the mortality measures but the YLL and the YLL/death measures. Therefore, in future studies similar to this one, special attention should be given to these options as the results may change substantially.

Because we did not standardize rates with respect to age, some of the patterns over time observed for some diseases might be, to some extent, the result of the aging of the Cuban pop-

ulation. To give some perspective on this issue, Table 3 gives the proportion of the population in several age groups above 60 years, in 1990, 1995, 2000 and 2005. In general we consider that the use of crude rates in this study has not significantly affected the results obtained, but this would have to be confirmed.

This study did not include the burden of morbidity in the calculations, mainly because of the uncertainty surrounding current morbidity estimates in Cuba. We indeed consider this burden very important and have been supporting the creation and keeping of the corresponding registries. Meanwhile, in future studies we should use estimates of this morbidity burden based on estimates of YLL for the Latin America region, obtained for example from global burden of disease studies⁶.

We consider that studies similar to this are useful for public health policy making in Cuba, and possibly in some other countries. This usefulness should increase if we address the already mentioned issues of alternatively using age-standardized mortality and YLL rates, age-weighting and time discounting, and the inclusion in the calculations of the burden of disease associated to morbidity.

Resumen

El objetivo fue estimar la evolución de la carga de enfermedades en Cuba para 20 enfermedades a intervalos de 5 años desde 1990 al 2005, en términos de años de vida perdidos por muerte prematura (YLL), usando los registros de mortalidad nacionales. Se obtuvieron seis indicadores resúmenes para cada enfermedad, que caracterizaban su evolución en el periodo de estudio 1990-2005. Las 20 enfermedades se agruparon según su comportamiento en estos seis indicadores, usando un análisis de conglomerados jerárquico. Los YLL se obtuvieron con y sin descuento en el tiempo (3%) y ponderación por edad. Se agruparon las 20 enfermedades en 12 subgrupos, cada uno con un patrón par-

ticular. El patrón de evolución observado es peculiar y no reproduce el patrón típico de los países de medio y bajo ingreso en el mundo. El enfoque adoptado en este trabajo permite una mejor descripción de la evolución de la carga por mortalidad para un grupo grande de enfermedades, desarrollar posibles explicaciones para el comportamiento identificado, y apoyar la toma de decisiones en salud pública. Sería conveniente reproducir este análisis para periodos de tiempo más cortos, por ejemplo, anualmente.

Años Potenciales de Vida Perdidos; Conducta de Enfermedad; Mortalidad

Contributors

Both authors contributed equally to the preparation of this manuscript.

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