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Data Availability Statement: All data in this study were obtained from a third party. Data are available upon request from the National Institute of Statistics (Departamento Administrativo Nacional de Estadística –DANE), and some of the data are available at: (http://formularios.dane.gov.co/Anda 4_ 1/index.php/catalog/MICRODATOS#_r= 1424959387372&collection=&country=&dtype= &from=1973&page=1&ps=&sk=EEV V&sort_by = titl&sort_order=&to=2014&topic=&view = s&vk=). For information about the data, please contact the **RESEARCH ARTICLE**

Years of Life Lost (YLL) in Colombia 1998-2011: Overall and Avoidable Causes of Death Analysis

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Abstract

Objective

Estimate the Years of Life Lost (YLL) for overall and avoidable causes of death (CoD) in Colombia for the period 1998-2011.

Methods

From the reported deaths to the Colombian mortality database during 1998-2011, we classified deaths from avoidable causes. With the reference life table of the Global Burden of Disease (GBD) 2010 study, we estimated the overall YLL and YLL due to avoidable causes. Calculations were performed with the difference between life expectancy and the age of death. Results are reported by group of cause of death, events, sex, year and department. Comparative analysis between number of deaths and YLL was carried out.

Results

A total of 83,856,080 YLL were calculated in Colombia during period 1998-2011, 75.9% of them due to avoidable CoD. The year 2000 reported the highest number of missed YLL by both overall and avoidable CoD. The departments with the highest YLL rates were Caquetá, Guaviare, Arauca, Meta, and Risaralda. In men, intentional injuries and cardiovascular and circulatory diseases had the higher losses, while in women YLL were mainly due to cardiovascular and circulatory diseases.

Conclusions

The public health priorities should focus on preventing the loss of YLL due to premature death and differentiated interventions by sex.

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Introduction

Decision-making in health is challenged to set, predict, and respond to the priorities of diseases prevention and control, ideally, based on summary measures of population health status $[\underline{1}, \underline{2}]$. Deaths accountability is one of the simplest approaches to measure the health problems in a population. Mortality rates (MR) have been widely used to estimate the burden of disease and determine the relative importance of different causes of death $[\underline{3}-\underline{5}]$.

MR play an important role in estimating the health status of populations and prioritizing the public health interventions, however, MR are generally not as sensitive to estimate the burden of premature mortality [6]. In fact, as most deaths occur in the elderly, MR are dominated by diseases of this population group [7]. The analysis of premature mortality involves the estimation of the average time that a person has left to live if death occurs prematurely (i.e. before her life expectancy). This estimation incorporate the age at which death occurs and not only the occurrence of the event [8].

The Years of Life Lost (YLL) is one way to measure the mortality impact, which gives higher weight to deaths at younger ages (premature mortality), and is useful in prioritizing public health interventions as elderly population deaths are less susceptible to decline. YLL, as summary measure of population health, are important to compare the relative importance of different diseases, to track differences in trends across countries and trends over time, and to provide a framework for evaluating the cost-effectiveness of new or better interventions [2]. The aim of this analysis was to estimate the YLL for both overall and avoidable Causes of Death (CoD) in Colombia during period 1998–2011.

Methods

YLL for each death occurred in Colombia during period 1998–2011 were estimated. The National Bureau of Statistics (*Departamento Administrativo Nacional de Estadísticas—DANE*) is in charge to collect the certification of death register of all mortality case in the country. Death certificate is filled by health workers (a physician in most of cases) and includes variables about the individual identification and the basic CoD. *DANE* reviews the completeness and validity of the information and codifies the CoD as the International Classification Disease 10th revision (CIE-10). *DANE* provided the Colombian mortality database for the present analysis. YLLs correspond to the number of years of life expectancy to the age of the death. The reference life expectancy for a single age was extracted from the life table of the Global Burden of Disease (GBD) 2010 Study from the University of Washington [9], and corresponds to a difference between that the expected age of death (*EAoD*) and the age of death (*AoD*).

A half cycle adjusting in the YLL estimation was performed to avoid the overestimation of the lost (i.e. a death occurred at the 11 months of any age). Deaths occurred after the first year of life included an adjusting factor (k) of 0.5 years; for population between two and 11 months, k was 0.42 years; and for children under two months k was zero, considering that the YLL loss was equivalent to life expectancy at birth. We did not use time discounts rate or adjustments for age weighting, according to the University of Washington recommendations [10].

$$YLL_i = EAoD_i - (AoD_i + k) \tag{1}$$

Where:

YLL: Years of Potential Life Lost of the individual *i*

EAoD: Expected Age of Death

AoD: Age of Death

k: half cycle adjustment factor according with the AoD (over one = 0.5; between two months and one year = 0.42, for less than two months = 0)

Avoidable deaths correspond to those deaths potentially preventable by both health system intervention and adjustment of policies pertaining to public health; the classification in Colombia was developed for the National Health Observatory and is published elsewhere [11]. To report the results the disease classification of the 2010 GBD study was implemented. There are 3 main groups: communicable, maternal, perinatal and nutritional diseases (group I); non-communicable diseases (group II); and injuries (group III); these groups are divided into 22 categories and 236 subcategories. Garbage code redistribution according with <u>S1 Table</u> was carried out.

We reported the estimated total annual YLL for both overall and avoidable CoD by sex and Colombian departments (States). In the analysis by department, deaths with no information for this variable were excluded. For overall CoD the analysis was carried out by residence's department, except for dengue, malaria, and injuries, which were carried out by occurrence's department. Data were managed and analyzed in MS Excel 2010 and Stata 12.

Results

In Colombia during period 1998–2011 a total of 83,856,080 YLL for overall CoD were estimated, 76% of them due to avoidable CoD <u>Table 1</u>. The average annual loss was 5,989,720 YLL (rate 141.3 YLLs per 1000 habitants), and 4,548,802 YLL (rate 107.5 per 1000 habitants) for overall and avoidable CoD, respectively. Year 2000 had the higher YLL for both overall and avoidable CoD, with a rate of 163.5 and 130.8 per 1000 habitants, respectively; and the lowest was 2011 with rates of 116.3 and 81.2 per 1000, respectively <u>Table 1</u>.

For overall and avoidable CoD, men were the most affected population group. The 64.7 and 68.4% of YLL for overall, and avoidable CoD occurred in men, respectively. For the total YLL in men, 80.1% were due to avoidable CoD, while in women it represented the 67.6% <u>Table 2</u>. For both sexes, the YLL trend is declining during the period analyzed <u>Table 2</u>.

Year	YL	YLL for overall CoD		for avoidable CoD
	Total	Rate per 1000 habitants	Total	Rate per 1000 habitants
1998	6,078,622	155.1	4,884,699	124.7
1999	6,364,830	160.2	5,108,467	128.6
2000	6,588,808	163.5	5,270,910	130.8
2001	6,632,278	162.5	5,269,116	129.1
2002	6,536,241	158.2	5,160,182	124.9
2003	6,197,433	148.1	4,781,512	114.3
2004	5,954,821	140.5	4,552,901	107.5
2005	5,763,788	134.4	4,318,683	100.7
2006	5,767,529	132.9	4,262,399	98.2
2007	5,710,459	130.0	4,183,692	95.2
2008	5,643,678	127.0	4,101,507	92.3
2009	5,692,451	126.6	4,106,973	91.3
2010	5,570,462	122.4	3,942,282	86.6
2011	5,354,680	116.3	3,739,908	81.2
Total	83,856,080		63,683,232	

Table 1. YLL estimates for overall and avoidable causes of death by year.

Colombia, 1998–2011. CoD: Causes of Death

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Table 2.	YLL	for overall and	l avoidable	causes o	of death b	by year and sex.
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Year	Sex	YL	L for overall CoD	YLL for avoidable CoD			
		Total	Rate per 1000 habitants	Total	Rate per 1000 habitants		
1998	Male	3,971,514	205.4	3,339,020	172.7		
	Female	2,103,931	106.0	1,542,891	77.7		
1999	Male	4,166,215	212.5	3,492,522	178.1		
	Female	2,197,015	109.2	1,614,674	80.2		
2000	Male	4,350,832	218.8	3,649,401	183.5		
	Female	2,236,647	109.6	1,620,336	79.4		
2001	Male	4,392,380	218.1	3,663,452	181.9		
	Female	2,238,898	108.3	1,604,774	77.6		
2002	Male	4,353,839	213.5	3,631,758	178.1		
	Female	2,180,713	104.2	1,527,432	73.0		
2003	Male	4,022,838	194.8	3,278,214	158.7		
	Female	2,172,345	102.5	1,501,551	70.8		
2004	Male	3,842,964	183.8	3,103,761	148.4		
	Female	2,111,319	98.4	1,448,810	67.5		
2005	Male	3,662,776	173.0	2,899,384	137.0		
	Female	2,100,625	96.7	1,418,972	65.3		
2006	Male	3,663,247	171.0	2,867,463	133.8		
	Female	2,103,230	95.7	1,394,000	63.4		
2007	Male	3,630,365	167.0	2,826,738	130.4		
	Female	2,078,241	93.4	1,355,441	60.9		
2008	Male	3,572,671	162.8	2,761,855	125.8		
	Female	2,070,219	92.0	1,339,094	59.5		
2009	Male	3,643,593	164.1	2,808,014	126.5		
	Female	2,048,858	90.0	1,298,958	57.0		
2010	Male	3,547,755	157.9	2,693,827	119.9		
	Female	2,022,347	87.8	1,248,198	54.2		
2011	Male	3,391,902	149.2	2,542,355	111.8		
	Female	1,962,253	84.2	1,197,140	51.4		
Total 1998-	-2011 in Males	54,212,891	184.1	43,557,766	147.9		
	98–2011 in males	29,626,641	98.0	20,112,272	66.5		

Colombia, 1998-2011. CoD: Causes of Death

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Five of the 33 departments (States) contributed with 50% of the total YLL for both overall and avoidable CoD: Antioquia, Bogotá DC (Colombia's capital city), Valle del Cauca, Cundinamarca, and Atlántico <u>Table 3</u>. The departments with less YLL were Guainía, Vaupés, Archipiélago of San Andrés, Providencia and Santa Catalina, Amazonas, and Vichada. Analyzing the relative loss, the top five departments with higher YLL rates per 1000 due to overall CoD were: Caquetá, Risaralda, Caldas, Valle del Cauca, and Quindío; and for avoidable CoD, Caquetá, Guaviare, Arauca, Meta, and Risaralda <u>Table 3</u>.

By main groups, for overall CoD during the period, 46% of YLL were due to noncommunicable diseases, 33% to injuries, and 20% to communicable, maternal, neonatal and nutrition disorders; while for avoidable CoD 43% YLL were due to injury, 33% to noncommunicable diseases, and 24% to communicable, maternal, neonatal and nutrition disorders. At the second aggregation level by sex, in males both overall and avoidable CoD YLL



Table 3. YLL for overall and avoidable causes of death by department.

Department	YLL for overall causes of death	YLL avoidable death	YLL for overall causes death rate per 1000 hab.	YLL avoidable death rate per 1000 hab.
Caquetá	1,108,750	929,920	188.6	158.2
Guaviare	225,576	194,753	169.2	146.1
Arauca	550,926	469,264	171.0	145.6
Meta	1,883,292	1,526,518	173.5	140.6
Risaralda	2,260,559	1,736,022	180.5	138.6
Valle del Cauca	10,200,694	7,984,099	175.9	137.7
Quindío	1,310,766	985,145	175.6	132.0
Antioquia	13,274,744	10,421,089	168.1	132.0
Norte de Santander	2,904,417	2,277,504	167.6	131.4
Caldas	2,383,760	1,772,258	175.9	130.8
Vichada	111,535	91,979	143.9	118.7
Putumayo	591,067	508,794	137.0	117.9
Casanare	575,660	472,299	140.9	115.6
Huila	2,088,410	1,585,811	148.6	112.9
Cesar	1,694,060	1,403,603	134.6	111.5
Tolima	2,865,995	2,120,573	150.5	111.3
Cauca	2,477,878	1,896,069	140.2	107.3
Vaupés	68,423	56,589	126.2	104.4
Guainía	62,487	50,612	128.6	104.1
Magdalena	1,998,742	1,605,757	124.5	100.0
Amazonas	112,466	90,649	120.3	97.0
Santander	3,617,450	2,595,071	132.4	95.0
Atlántico	3,647,665	2,785,226	121.1	92.5
Boyacá	2,319,379	1,608,529	132.4	91.9
Chocó	706,333	581,222	111.4	91.7
Cundinamarca	3,931,350	2,746,858	124.4	86.9
La Guajira	941,137	810,949	100.3	86.4
Córdoba	2,182,121	1,705,642	106.8	83.5
Nariño	2,383,435	1,787,434	111.1	83.3
Bolívar	2,734,946	2,125,443	104.2	81.0
Bogotá, D.C.	11,037,600	7,580,816	116.3	79.8
Sucre	1,067,332	813,786	99.2	75.6
Archipiélago de San Andrés Providencia y Santa Catalina	89,680	68,971	91.3	70.2

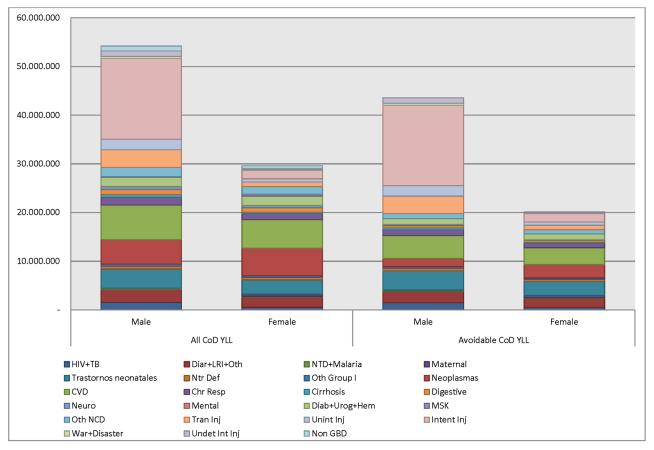
Colombia, 1998-2011. Results sort by YLL avoidable death rate per 1000 habitants. hab: habitants

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were mainly due to self-harm and interpersonal violence (intentional injuries) (31% and 38%, respectively), followed by cardiovascular and circulatory diseases (13% and 11%), and transit injuries (7% and 8%), while in women the higher YLL were due to cardiovascular and circulatory diseases (20% and 17%), and neoplasms (19% and 13%) (Fig 1). In both sexes, losses due to neonatal disorders also represented a significant YLL proportion of both overall and avoidable CoD (Fig 1).

By events the analysis was performed comparing the first and later year of the period for both overall and avoidable CoD, Figs 2 and 3. Comparing overall CoD (Fig 2) it is noted that the assault by firearm was the leading cause of YLL in the two years, but the sharing in the total







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YLL was decreasing from 17.8% to 13.2%. Comparing the top 10 at the start and end of the period it is highlighted that Non-GBD Group raised from 10^{th} place in 1998 to 5th place in 2011, and the absolute value increased from 134,564 YLL to 154,469 YLL; Chronic Obstructive Pulmonary Disease (COPD) changed from 13^{th} to 8th place, varying from 109,545 to 129,000 YLL; and injuries in motorized vehicle with two wheels varied from 16^{th} to 10^{th} place rising from 94,800 to 117,082 YLL. Two events from Group I showed a significant reduction in terms of YLL: Neonatal encephalopathy, jumping from 5^{th} to 24^{th} place and other diarrheal diseases that moved from 8^{th} to 54^{th} place (Fig 2).

A YLL increase was observed for HIV disease resulting in other specified or unspecified disease varying from 64,282 in 1998 (25th place) to 101,344 in 2011 (15th place), other digestive diseases from 43,002 to 66,564 rising from 37th to 21th place, breast cancer from 37,785 to 64,678 changing from 44th to 26th place, and colon and rectum cancers from 31,915 to 60,226 moving from 48th to 28th place. In 2011 only two events from the group communicable, maternal, neonatal and nutritional disorders are among the YLL top 10, while 4 non-communicable diseases, and 3 injuries are in the top ten for overall CoD.

For the avoidable CoD the leading cause of YLL was also the assault by firearm for the start and end of the period, decreasing from 22.2% of total YLL to 19% in 2011, also with a decreasing in the absolute value of the YLL from 1,080,101 to 708,074 (Fig 3). It is highlighted the preterm birth complications of delivery that moved from the 2^{nd} place in 1998 to 3^{rd} in 2011



YLL	Rate	% Event	_	Event	YLL	Rate	
081.076		17,8% 1. Assault by firearm		1. Assault by firearm	708.662	15,4	
867.958	9,4	6,1% 2. Ischemic heart disease		2. Ischemic heart disease	459.624	10,0	
19.646	8,2	5,3% 3. Preterm birth complications		3. Other Lower respiratory infections	178.164	3,9	
271.586	6,9	4,5% 4. Other Lower respiratory infections		4. Preterm birth complications	168.326	3,7	
170.741	4,4	2,8% 5. Neonatal encephalopathy (birth asphyxia and birth trauma)	1	5. Non-GBD	154.469	3,4	
167.345	4,3	2,8% 6. Hemorrhagic and other nonischemic stroke	\land	6. Hemorrhagic and other nonischemic stroke	143.125	3,1	
167.183	4,3	2,8% 7. Assault by sharp object		7. Assault by sharp object	135.484	2,9	
149.434	3,8	2,5% 8. Other diarrheal diseases		8. Chronic obstructive pulmonary disease	129.000	2,8	
136.442	3,5	2,2% 9. Other cardiovascular and circulatory diseases		9. Other cardiovascular and circulatory diseases	120.789	2,6	
134.564	3,4	2,2% 10. Non-GBD		10. Motorized vehicle with two wheels	117.082	2,5	
126.266	3,2	2,1% 11. Pedestrian injury by road vehicle	1 /	11. Other neoplasms	109.777	2,4	
110.084	2,8	1,8% 12. Self-harm		12. Congenital heart anomalies	106.232	2,3	
109.545	2,8	1,8% 13. Chronic obstructive pulmonary disease		13. Self-harm	103.474	2,2	
99.751	2,5	1,6% 14. Congenital heart anomalies		14. Stomach cancer	103.329	2,2	
96.815	2,5	1,6% 15. Injuries with undetermined intent		15. HIV disease resulting in other specified or unspecified diseases	101.344	2,2	
94.800				16. Diabetes mellitus	91.166		
	2,4	1,6% 16. Motorized vehicle with two wheels				2,0	
94.345	2,4	1,6% 17. Diabetes mellitus		17. Injuries with undetermined intent	89.699	1,9	
85.552	2,2	1,4% 18. Stomach cancer		18. Ischemic stroke	83.590	1,8	
83.923	2,1	1,4% 19. Other neoplasms		19. Other congenital anomalies	83.566	1,8	
80.165	2,0	1,3% 20. Drowning		20. Trachea, bronchus and lung cancers	83.205	1,8	
73.859	1,9	1,2% 21. Protein-energy malnutrition		21. Other digestive diseases	66.564	1,4	
73.787	1,9	1,2% 22. Ischemic stroke		22. Leukemia	66.519	1,4	
73.114	1,9	1,2% 23. Other congenital anomalies		23. Hypertensive heart disease	65.887	1,4	
71.035	1,8	1,2% 24. Road injury other		24. Neonatal encephalopathy (birth asphyxia and birth trauma)	64.734	1,4	
64.282	1,6	1,1% 25. HIV disease resulting in other specified or unspecified diseases		25. Sepsis and other infectious disorders of the newborn baby	64.684	1,4	
62.868	1,6	1,0% 26. Other neonatal disorders		26. Breast cancer	64.678	1,4	
59.577	1,5	1,0% 27. Other transport injury		27. Chronic kidney diseases unspecified	63.262	1,4	
59.212	1,5	1,0% 28. Hypertensive heart disease		28. Colon and rectum cancers	60.226	1,3	
56.478	1,4	0,9% 29. Trachea, bronchus and lung cancers		29. Pedestrian injury by road vehicle	57.434	1,2	
56.088	1,4	0.9% 30. Leukemia		30. Cirrhosis of the liver	56.140	1,2	
55.601	1,4	0,9% 31. Other infectious diseases		31. Drowning	55.383	1,2	
			XINAN	-			
54.652	1,4	0,9% 32. Chronic kidney diseases unspecified		32. Brain and nervous system cancers	54.464	1,2	
52.705	1,3	0,9% 33. Motorized vehicle with three or more wheels		33. Road injury other	54.165	1,2	
52.460	1,3	0,9% 34. Cirrhosis of the liver		34. Other neurological disorders	53.974	1,2	
50.280	1,3	0,8% 35. Assault by other means		35. Assault by other means	48.482	1,1	
45.693	1,2	0,8% 36. Cervical cancer	143 X / M/XX	36. Other infectious diseases	45.849	1,0	
43.002	1,1	0,7% 37. Other digestive diseases		37. Protein-energy malnutrition	45.589	1,0	
42.541	1,1	0,7% 38. Tuberculosis		38. Other neonatal disorders	45.072	1,0	
41.149	1,1	0,7% 39. Falls		39. Cervical cancer	44.916	1,0	
41.032	1,0	0,7% 40. Pneumoconiosis		40. Unintentional injuries not classified elsewhere	43.952	1,0	
40.429	1,0	0,7% 41. Sepsis and other infectious disorders of the newborn baby		41. Other musculoskeletal disorders	40.776	0,9	
40.408	1,0	0,7% 42. Other meningitis	V ALCON I	42. Liver cancer	36.560	0,8	
39.706	1,0	0,7% 43. Unintentional injuries not classified elsewhere	XXV \\ \X	43. Falls	34.243	0,7	
37.785	1,0	0,6% 44. Breast cancer	₹/XX \\ X/-	44. Other chronic respiratory diseases	33.698	0,7	
35.840	0,9	0,6% 45. Brain and nervous system cancers	¶//\\ `\X`/ /	45. Other endocrine, nutritional, blood, and inmune disorders	32.094	0,7	
32.906	0,8	0,5% 46. Other neurological disorders		46. Prostate cancer	32.089	0,7	
32.300	0,8	0,5% 47. Other endocrine, nutritional, blood, and inmune disorders		47. Pranceatic cancer	27.804	0,7	
31.915	0,8	0,5% 48. Colon and rectum cancers	T/\ LAN	48. Chronic kidney diseases due to diabetes mellitus	27.804	0,6	
30.765	0,8	0,5% 49. Liver cancer		49. Tuberculosis	27.589	0,6	
23.806	0,6	0,4% 50. Prostate cancer		50. Non-Hodgkin's lymphoma	27.220	0,6	
23.553	0,6	0,4% 51. Chronic kidney diseases due to diabetes mellitus		51. Motorized vehicle with three or more wheels	25.857	0,6	
22.346	0,6	0,4% 52. Other chronic respiratory diseases	$\mathbf{V} \mid \mathbf{Z} \setminus \mathbf{V}$	54. Other diarrheal diseases	21.248	0,5	
20.281	0,5	0,3% 54. Non-Hodgkin's lymphoma	$\mathcal{M} \setminus \mathcal{M}$	67. Other meningitis	13.482	0,3	
18.850	0,5	0,3% 55. Other musculoskeletal disorders		85. Other transport injury	6.778	0,1	
			[/ \				
18.598	0.5	0,3% 57. Pranceatic cancer	V	87. Pneumoconiosis	6.036	0,1	



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declining in 4.5% of its YLL. HIV disease resulting in other specified or unspecified disease was one of the top 10 events of avoidable mortality that report a high rose during the period going from 19th to 10th place (varying from 63,396 to 97,786 YLL). Other diarrheal diseases and neonatal encephalopathy decreased significantly, from 7th and 5th places to 41th and 14th places, respectively. Also decreased pedestrian injury by road vehicle (from 9th to 19th place). In 2011 the top 10 avoidable CoD, according with the YLL, were 4 injuries, 3 of the group I, and 3 noncommunicable diseases.



/LL	Rate	% Event	_	Event	YLL	Rate
80.101		22,2% 1. Assault by firearm		1. Assault by firearm	708.074	15,4
19.646	8,2	6,6% 2. Preterm birth complications		2. Ischemic heart disease	323.282	7,0
91.234	7,4	6,0% 3. Ischemic heart disease		3. Preterm birth complications	168.326	3,7
55.430	6,5	5,2% 4. Other Lower respiratory infections		4. Other Lower respiratory infections	151.226	3,3
70.741	4,4	3,5% 5. Neonatal encephalopathy (birth asphyxia and birth trauma)		5. Assault by sharp object	135.099	2,9
56.826	4,3	3,4% 6. Assault by sharp object		6. Motorized vehicle with two wheels	116.932	2,5
16.509	3,7	3,0% 7. Other diarrheal diseases		7. Hemorrhagic and other nonischemic stroke	112.698	2,4
39.021	3,5	2,9% 8. Hemorrhagic and other nonischemic stroke		8. Congenital heart anomalies	106.131	2,3
23.285	3,1	2,5% 9. Pedestrian injury by road vehicle		-9. Self-harm	102.887	2,2
9.543	2,8	2,3% 10. Self-harm		10. HIV disease resulting in other specified or unspecified diseases	97.786	2,1
9.711	2,5	2,0% 11. Congenital heart anomalies		11. Injuries with undetermined intent	86.382	1,9
95.087	2,4	2,0% 12. Injuries with undetermined intent		12. Chronic obstructive pulmonary disease	67.479	1,5
4.712	2,4	1,9% 13. Motorized vehicle with two wheels		13. Diabetes mellitus	66.812	1,5
80.001						
	2,0	1,6% 14. Drowning		. 14. Neonatal encephalopathy (birth asphyxia and birth trauma)	64.734	1,4
7.888	2,0	1,6% 15. Diabetes mellitus		15. Sepsis and other infectious disorders of the newborn baby	64.684	1,4
5.598	1,9	1,6% 16. Chronic obstructive pulmonary disease		, 16. Trachea, bronchus and lung cancers	64.390	1,4
0.395	1,8	1,4% 17. Road injury other		17. Breast cancer	60.628	1,3
9.304	1,8	1,4% 18. Protein-energy malnutrition		.18. Drowning	55.150	1,2
53.396	1,6	1,3% 19. HIV disease resulting in other specified or unspecified diseases		. 19. Pedestrian injury by road vehicle	54.234	1,2
2.868	1,6	1,3% 20. Other neonatal disorders		. 20. Road injury other	53.495	1,2
9.025	1,5	1,2% 21. Other transport injury		21. Ischemic stroke	51.369	1,1
2.504	1,3	1,1% 22. Motorized vehicle with three or more wheels		22. Colon and rectum cancers	49.344	1,1
1.396	1,3	1,1% 23. Ischemic stroke		23. Chronic kidney diseases unspecified	49.064	1,1
0.145	1,3	1,0% 24. Other cardiovascular and circulatory diseases		24. Assault by other means	48.182	1,0
9.952	1,3	1,0% 25. Assault by other means	XIII	25. Other neonatal disorders	45.072	1,0
8.758	1,2	1,0% 26. Trachea, bronchus and lung cancers		26. Cervical cancer	41.942	0,9
8.057	1,2	1,0% 27. Chronic kidney diseases unspecified		27. Unintentional injuries not classified elsewhere	41.840	0,9
15.537	1,2	0,9% 28. Other infectious diseases		28. Cirrhosis of the liver	39.475	0,9
		0,9% 29. Cervical cancer				
3.075	1,1			29. Protein-energy malnutrition	39.315	0,9
0.660	1,0	0,8% 30. Hypertensive heart disease		- 30. Hypertensive heart disease	36.494	0,8
0.429	1,0	0,8% 31. Sepsis and other infectious disorders of the newborn baby		31. Other infectious diseases	34.043	0,7
9.993	1,0	0,8% 32. Tuberculosis		32. Other cardiovascular and circulatory diseases	32.667	0,7
9.636	1,0	0,8% 33. Pneumoconiosis		33. Leukemia	31.390	0,7
9.582	1,0	0,8% 34. Falls		34. Falls	31.383	0,7
9.040	1,0	0,8% 35. Other meningitis		35. Liver cancer	27.999	0,6
8.811	1,0	0,8% 36. Unintentional injuries not classified elsewhere		36. Other chronic respiratory diseases	26.816	0,6
8.534	1,0	0,8% 37. Cirrhosis of the liver		37. Motorized vehicle with three or more wheels	25.566	0,6
5.540	0,9	0,7% 38. Breast cancer		38. Tuberculosis	25.522	0,6
7.645	0,7	0.6% 39. Leukemia		39. Chronic kidney diseases due to diabetes mellitus	22.511	0,5
7.410	0,7	0,6% 40. Colon and rectum cancers		40. Epilepsy	22.028	0,5
7.009	0,7	0,6% 41. Liver cancer		41. Other diarrheal diseases	19.463	0,4
1.296	0,7	0,4% 42. Chronic kidney diseases due to diabetes mellitus		42. Other digestive diseases	18,243	0,4
0.630	0,5	0,4% 43. Other chronic respiratory diseases		43. Mechanical forces (other)	16.754	0,4
9.118	0,5	0,1% 44. Interstitial lung disease and pulmonary sarcoidosis		44. Collective violence and legal intervention	15.306	0,3
8.595	0,5	0,4% 45. Mechanical forces (other)	-XHHH	45. Other maternal disorders	15.190	0,3
.8.464	0,5	0,4% 46. Other maternal disorders		46. Paralytic ileus and intestinal obstruction without hernia	14.794	0,3
7.705	0,5	0,4% 47. Epilepsy		47. Interstitial lung disease and pulmonary sarcoidosis	14.416	0,3
5.764	0,4	0,3% 48. Asthma	L \/// /	48. Chronic kidney diseases due to hypertension	13.609	0,3
5.628	0,4	0,3% 49. Pedal cycle vehicle		49. Exposure to forces of nature	13.591	0,3
4.134	0,4	0,3% 50. Fire, heat and hot substances		50. Pedal cycle vehicle	12.989	0,3
3.781	0,4	0,3% 51. Peptic ulcer disease		52. Other meningitis	12.590	0,3
13.193	0,3	0,3% 52. Chronic kidney diseases due to hypertension		56. Asthma	7.311	0,2
11.532	0,3	0,2% 56. Paralytic ileus and intestinal obstruction without hernia	-×// X _ \\	57. Peptic ulcer disease	6.842	0,1
8.307	0,2	0,2% 59. Other digestive diseases	$\square / / \land \land$	58. Other transport injury	6.678	0,1
7.728	0,2	0,2% 61. Collective violence and legal intervention		68. Fire, heat and hot substances	4.666	0,1
5.396	0,1	0,1% 68. Exposure to forces of nature	_r ·	69. Pneumoconiosis	4.629	0,1



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Discussion

This is the first Colombian national analysis performed in order to determine the impact of overall and avoidable mortality using YLL, the latter weighing the death for the time of occurrence [11]. In the literature, for Colombia only YLLs estimation to subnational scale or for particular events had been published [12–16]. During the period 1998–2011 in Colombia were estimated about 84 million YLL, 76% due to avoidable CoD, with trend to annual decrease in YLL rates for both overall and avoidable CoD. We found absolute and relative YLL differences by department and sex. The largest losses are concentrated in larger departments, however in the analysis by YLL rates per 1000 population Caquetá, Risaralda and Caldas reported the highest avoidable YLL rates; suggesting YLL rates will be used whenever possible to evidence relatively important health problems in small population. By sex, YLL are higher in Colombia men, similar to the findings from other studies in Colombia [13–15] and in Italy [17, 18] and Spain [19]. Men is the most impacted population groups especially due to intentional injuries, while women is the cardiovascular and circulatory diseases.

The relative importance of non-communicable disease with 46% of YLL in overall CoD, is consistent with findings in other populations, although with a higher values close to 80% of total YLL [19, 20]. However, it is overcome by injuries when only YLL due to avoidable CoD were considered.

Very important differences between sexes are present, with significant implications for public health intervention with a differential approach. In men, for overall CoD, intentional injuries still in first place by YLL, but are cardiovascular and circulatory diseases, which have the highest number of deaths. The opposite occurs when analyzing the percentage proportion of avoidable CoD. In women, it is noteworthy that cardiovascular and circulatory diseases take first place in both the percentage ratio of YLL and deaths.

The events that occur early in life will bring more YLL and their intervention could have a higher avoiding in YLL in the Colombian population. Neonatal disorders and injuries of transport are relevant in both sexes, although the number of deaths is moderately they represent a significant loss of YLL and should be subject to preventive actions that reflect a significant impact on longevity.

These results could have an important impact on public health in Colombia, allowing to guide clear and specific interventions in preventive health care [16], and comparing YLL within the population over the years [21], referring to a normal life expectancy. The YLL is an important measure of population health status, and would be an approach to identify the interventions to implement with a positively affect the health of the population, even in avoidable CoD. The use of such indicators for prioritizing public health interventions requires simultaneous consideration of fairness and justice elements regarding population groups where YLL are not the best indicator of the health impact, but are relevant to advance in an agenda of better health reducing the burden of premature mortality. This study shows the utility of YLL as a measure of impact on life expectancy of the Colombian population; considering the assumption that to removing one of these specific causes that contributes significantly to the weight of the YLL, the population had not died from other causes [6].

This analysis has some limitations. First, there may be validity issues with the analysis depending of the correct identification of the basic CoD, in particular among the elderly people [22], however we use the clean and debugged official mortality database. Second, there are possibilities of classification errors by avoidable deaths, and the concept would need an in depth discussion, due to multiple available approaches. We focused in the avoidable deaths occurred before 75 years old, understand how the death that could not occur with an adequate health attention or a public policy implementation. Third, underreporting adjustment of mortality data was not performed and we only reported the analysis over the official deaths. The DANE coverage in Colombia is high, and the coverage had been identify in remote and small areas. However this analysis has the advantage that it is easy to do and only be requires death with the age of the events, with the population mortality rates or life tables [23].

Conclusions

Cardiovascular and circulatory diseases and intentional injuries are the most relevant causes of YLL for both overall and avoidable death in Colombia. The YLL analysis is a useful tool for to define priorities and development public health policies that promote heath in universal and equitable way. Progress in the promotion and disease prevention can reduce the impact of events that could be avoidable and minimize treatment costs for the health system. Public health efforts and resources allocation in research should be more explicit in preventing premature death and to attain a substantial impact on life expectancy of the population. This type of analysis needs to be complemented with the assessment of the disabling effects of disease to estimate adjusted life years (DALYs), from the perspective of global burden of disease study, to promote informed health decisions.

Supporting Information

S1 Table. Recodification of garbage codes in the GBD 2010 groups. Redistribution of causes of death in ICD-10 garbage codes in the GBD study groups (Washington University), according with the WHO 2008-GBD groups. (PDF)

Author Contributions

Conceived and designed the experiments: LCR DDJ CCO. Analyzed the data: LCR DDJ CCO FDHR. Contributed reagents/materials/analysis tools: LCR DDJ CCO. Wrote the paper: LCR DDJ CCO FDHR. Discussion of results: LCR DDJ CCO FDHR.

References

- 1. Bonita R, Beaglehole R, Kjellström T. Basic epidemiology: World Health Organization. 2nd ed. Washington, D.C: OPS; 2008
- Murray CJ, Salomón JA, Mathers CD, Lopez AD. Summary measures of population health: concepts, ethics, measurement and applications: World Health Organization; 2002. Available: <u>http://whqlibdoc.</u> who.int/publications/2002/9241545518.pdf. PMID: 15386680
- 3. Cajka JC, Cooley PC, Wheaton WD. Attribute assignment to a synthetic population in support of agentbased disease modeling. Methods report (RTI Press). 2010; 19 (1009): 1–14. PMID: 22577617
- World Health Organization. Health statistics and information systems. Health Status Statistics: Mortality. 2012. Available: <u>http://www.who.int/healthinfo/statistics/indunder5mortality/en</u>.
- 5. World Health Organization. Under-five mortality rate. Global Health Observatory (GHO) data. 2012. Available: <u>http://www.who.int/gho/urban_health/outcomes/under_five_mortality_text/en/</u>.
- 6. Organizacion Panamericana de la Salud. Técnicas para la medición del impacto de la mortalidad: Años potenciales de vida perdidos. Boletín epidemiológico. 2003; 24 (2): 1–4.
- Centers for Disease Control. Premature mortality in the United States: public health issues in the use of years of potential life lost. MMWR Morbidity and mortality weekly report. 1986; 35 (2 Suppl): 1S–11S. PMID: 3097485
- Gardner JW, Sanborn JS. Years of potential life lost (YPLL)—what does it measure? Epidemiology. 1990; 1(4): 322–9. PMID: <u>2083312</u>
- Murray CJ, Ezzati M, Flaxman AD, Lim S, Lozano R, Michaud C, et al. GBD 2010: design, definitions, and metrics. Lancet. 2012; 380 (9859): 2063–6. doi: <u>10.1016/S0140-6736(12)61899-6</u> PMID: <u>23245602</u>
- Dempsey M. Decline in tuberculosis; the death rate fails to tell the entire story. American review of tuberculosis. 1947; 56 (2): 157–64. PMID: 20264378
- National Health Observatory Colombia. Third Report NHO: Avoidable mortality in Colombia. 1998–2011. 2014. 11–63. Available from: <u>http://www.ins.gov.co/lineas-de-accion/ons/SiteAssets/Paginas/publicaciones/Informe3-ME-ONS-Definitivo.pdf</u>.

- Vanegas Y, Sánchez MA. Años potencialmente perdidos por accidente de tránsito, Colombia 2010. CES Salud Pública. Julio-Diciembre 2011; 2(2): 159–68.
- Londoño JF, Grisales H, Fernández FY, Agudelo B, Sánchez J. Años potenciales de vida perdidos por la población de Medellín, 1994–1996. Facultad Nacional de Salud Pública. Enero — Junio 1999; 16(2).
- Zuluaga AC, Correa J, Estrada LA, Alvis N. Valoración económica de la mortalidad en la región Caribe de Colombia, 2004–2008. Semestre Económico. 2013; 16(33). PMID: 20672536
- 15. Toro MA, García OH, Sánchez JH, Moreno RJ. Años de vida potencialmente perdidos por la problación del municipio de Itagüí, año 2005. Medellín: CES; 2007. Available: <u>http://bdigital.ces.edu.co:8080/dspace/bitstream/123456789/21/1/Anos_vida_potencialmente_perdidos_poblacion_Municipio_de_Itagui_Ano_2005.pdf</u>.
- Alvis N, De la Hoz F. Tendencias de la mortalidad por enfermedades infecciosas en Cartagena de Indias, Colombia, 1995–2000. Una medida de transición epidemiológica. Revistas de Salud Pública. 2004; 6(3): 235–52.
- Mariotti S, D'Errigo P, Mastroeni S, Freeman K. Years of life lost due to premature mortality in Italy. European Journal of Epidemiology. 2003; 18:513–21. PMID: <u>12908716</u>
- 18. Minerba L, Argiolas F, Scarpa B. Years of potential life lost in the Sardinian population (Italy): limitations and perspectives. Journal of Preventive Medicine and Hygiene. 1999; 40: 99–104.
- Génova R, Catalá F, Fernández N, Álvarez E, Morant C. The burden of premature mortality in Spain using standard expected years of life lost: a population-based study. BMC public health. 2011; 11(1): 787.
- Plass D, Yuen P, Quoc T, Jahn HJ, Chin P, Ming Ch, et al. Quantifying the burden of disease due to premature mortality in Hong Kong using standard expected years of life lost BMC public health. 2013; 13(1): 863.
- Londoño JL. Metodología de la investigación epidemiológica. 1st ed. Medellín: Manual Moderno; 1995.
- Pikala M, Bryla M, Bryla P, Maniecka I. Years of life lost due to external causes of death in the lodz province. Plos One. 2014; 9(5): e96830. doi: 10.1371/journal.pone.0096830 PMID: 24810942
- Arriaga EE. Los años de vida perdidos: su utilización para medir el nivel y cambio de la mortalidad. Bureau of the Census. Available: <u>http://www.cepal.org/publicaciones/xml/0/34410/lcg165_p1.pdf</u>. Accessed 16 June 2014.