



Burden Disease of COVID-19: Disability-Adjusted Life Years (DALYs) in Bogota, Colombia

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Abstract

Background: Disability-adjusted life years (DALYs) are a synthetic health indicator used to measure the burden of disease at the population level, which provides joint information on the fatal and non-fatal consequences of diseases, injuries and risk factors. This indicator as the number of years of healthy life lost uses both to describe the epidemiological situation in different countries or regions and to estimate the population impact of different interventions. The World Health Organization as a public health emergency of international importance (ESPII) classified the new coronavirus (COVID-19). In December 2019, an association of pneumonia cases emerged in Wuhan (Hubei province, China), with a sample common to a wholesale market for seafood, fish, and live animals. On January 7, 2020, the Chinese authorities established a new virus of the Corona viridae family as the agent promoting the outbreak, which was later designated SARS-COV-2 1. The Chinese authorities shared the genetic sequence on January 12. The disease caused by this new virus by international consensus COVID-19. The Emergency Committee of the International Health Regulations (IHR, 2005) declared the outbreak as a PHEIC at its meeting on January 30, 2020. Subsequently, the WHO considered it a global pandemic on March 11, 2020 ISCH. Cases on all continents and on March 6 the first case in Colombia and the National Institute of Health (INS) notifies the Ministry of Health daily of the figures of accumulated confirmed cases of COVID-19, as follows: total of cases, cases in hospitalizations, ICU admissions, deaths and recovered cases. The objective of this work was to estimate the burden of disease due to COVID-19 in Bogotá for the years 2020 and 2021 in order to establish the burden of disease due to this pathology.

Methods: We conducted an ecological study between Jan 1, 2020, and Dec 31, 2021. We used final prevalence estimates and disability weights to estimate years lived with disability and disability-adjusted life-years (DALYs) for COVID-19 in Bogotá.

Findings: The public data on COVID 19 published on the Salud-data website of the Bogotá Health Center, available at <https://saludata.saludcapital.gov.co/osb/>. A total of 13,428 deaths and 482,346 laboratory-confirmed cases of COVID 19 in the study period. The discount rate that evaluates what benefits they prefer in the present and not in the future into account, so it is necessary to introduce this correction factor for future benefits, which is a procedure commonly used in economics. This same

situation occurs in health, because the value given to a year of healthy life gained in the present is different and superior to that given to a year of healthy life gained in the future. The discount weight into account in the calculation as a correction since societies tend to value a year of life lost or gained differently during young adulthood than during early childhood or old age. This discount model allows the time lived at different ages to be valued using an exponential function. The burden of disease is the gap between existing health conditions and an ideal health situation. Life expectancy to calculate based on the assumption that someone is currently living and in the future to current mortality rates for each age group (42). In this case, the life table with the highest life expectancy at birth in the world used, which is that of Japan, with 80 years for men and 82.5 years for women, in addition to allowing us to compare ourselves with studies that use this value (43). This pandemic has created a greater urgency to strengthen health systems in most countries and the burden of disease must know in order to know the possible economic impact.

Interpretation: This pandemic has created an increased urgency to strengthen health systems in most countries. Taking no action to address the burden of COVID-19 should not be an option.

Keywords: SARS-CoV-2; Measles; Attenuation; Physical Distancing; Vaccination

Abbreviations: DALYs: Disability-Adjusted Life Years; IHR: International Health Regulations; YLDs : Years Lived With Disability; ICU: Intensive Care Units.

Introduction

GBD 2020 is in the process of estimating the burden of 370 diseases and injuries 88 risk factors in 204 countries and territories. GBD 2020 is quantifying the burden using disability-adjusted life years (DALYs), which represent the number of years of healthy life lost due to mortality or disability. Here, we quantify the impact of COVID-19 on prevalence and burden by location, age, and sex in 2020 and 2021 in Bogotá, Colombia [1,2]. COVID-19 continues to spread across most of the world's populations with significant health consequences and mortality among those who become infected. In addition to the direct effects of COVID-19, the pandemic has created an environment in which many determinants of mental health are also affected. Social restrictions, lockdowns, school and business closures, loss of livelihood, decreases in economic activity, and shifting priorities of governments in their attempt to control COVID-19 outbreaks all have the potential to affect the mental health of the population. The need for up-to-date information on the global prevalence and burden of COVID-19 in a way that informs health system responses has never been more urgent.

Methods

Overview

First, we conducted a systematic literature review to assemble data from surveys measuring the effect of COVID-19

on the incidence and mortality for COVID-19 and translate changes in prevalence to corresponding changes in burden estimates as years lived with disability (YLDs) and DALYs.

Type of Study

An ecological study exploratory conducted described the burden disease of COVID 19 infections in Bogotá, Colombia in 2020 and 2021, in which the methodology of Murray and López described in 1994 and perfected in 2016 and 2020 has been followed.

Reference Population

In this case, reference to some characteristics of Bogotá, which is the population of this study. It is the capital of the Colombia. It is the geographical, political, industrial and economic center of the country. The city had a population of 7,363,782 people in the year 2018, of which 3,815.0. It has an administrative division of 20 localities or districts to offer citizens networks of public services such as road infrastructure, entertainment and supply of products and, each has its own mayor and, that can resemble states.

Information Sources

Mortality databases generated by the National Administrative Department of Statistics (DANE) for the years 2020-2022 and deaths associated with COVID-19 corresponding to the ICD-10 codes:

- U07.1. COVID-19 laboratory confirmed virus
- U04.9: Severe acute respiratory syndrome
- U07.2: COVID-19 virus confirmed by clinic and images or medical criteria

This search on the basic cause of death, in order to collect all cases whose cause was COVID 19, including those that not confirmers by laboratory, but were confirmed by clinical and imaging, in addition, by medical criteria. Records of population estimates and projections generated by the National Administrative Department of Statistics (DANE) by age groups and simple ages for the years 2020 and 2021 based on the 2018 census [3]. Databases of the COVID-19 Epidemiological Surveillance System (SIVIGILA) generated by the District Health Secretary of Bogotá to obtain the number of reports of laboratory-confirmed cases of COVID-19.

Statistical Analysis

- **Descriptive analysis of cases of illness and mortality from COVID 19:** A descriptive analysis of the COVID-19 cases reported in the city of Bogotá in the period 2020 and 2022 by sex, age groups and locality. With the deaths, the mortality rates per 1.000 inhabitants per year, by sex, age groups and locality, were calculated.

Standard Life Expectancy

In this case, the life table with the highest life expectancy at birth in the world uses, which is that of Japan, with 80 years for men and 82.5 years for women (43).

Discount Rate

The discount rate for the uncertainty of future benefits recommended by the World Bank Disease Control Priorities Study and the Global Burden of Disease Project is 3% per year (41). The discount make following a continuous model of the form: $d - rt$

Where (d) is the value of the time lived in the different ages, (r) is the discount rate that, in the case of individual decision making, coincides with the interest rate and (t) the number of periods (years) elapsed from the present moment to the moment you became ill.

Weights By Age

A correction implies within the calculation since societies tend to value a year of life lost or gained differently during young adulthood than during early childhood or old age. This discount model allows the time lived at different ages to values using an exponential function expressed:

$$C e^{\beta x}$$

Being β a constant that allows having a pattern with respect to the weights for age that can take values from 0.03 to 0.05 and that in the methodology assumed by Murray and

Lopez takes a value of 0.04. The constant C chose so that the introduction of unequal weights for age does not change the estimation of the burden of disease compared to the burden that estimates if there are equal weights for age, in this case it takes a value of 0.1658 [4].

Disability Weights

The weight of disability is the comparison between the time lived with disability and the time lost due to mortality. A value of zero implies that the state of health is equivalent to excellent health, and a value of one implies that the state of health is equivalent to death. In this case, and given that no references, three disability scenarios takes: zero= without disability, 0.5 with moderate disability and one= as death or complete disability.

$$YLL = \sum_{i=1}^I D_i \times \left[C \times \frac{e^{r m_i}}{(\beta + r)^2} \right] \\ \times \left\{ \left[e^{-(\beta+r)(L_i+m_i)} \times (-(\beta+r) \times (L_i+m_i) - 1) \right] \right. \\ \left. - \left[e^{-(\beta+r)m_i} \times (-(\beta+r) \times m_i - 1) \right] \right\}$$

Years Lived with Disability:

They were estimated from the cases of attempted for each age group, taking into account aspects such as: average duration of the disease (in this case a value of 0.5 is taken since there is no reference from the average duration of disabilities generated by COVID-19) and the discount rate of years for future benefits. DALYS Calculate:

$$DALY = YLL + YLD$$

Finally, obtaining DALYs gives by the following equation:

YLL: Years of life lost due to premature death (YLL).

YLD: Years of life lost due to disability (YLD).

DALY: Disability Adjusted Life Years (DALY).

The following YLL formula uses to estimate the years of life lost associated with the acute respiratory infection:

$$YLL = \frac{K C e^{r a}}{(r + \beta)^2} \left[e^{-(r + \beta)(L + a)} \left[-(r + \beta)(L + a) - 1 \right] - e^{-(r + \beta)a} \left[-(r + \beta)a - 1 \right] \right] + \frac{1 - k}{r} (1 - e^{-rL})$$

Where a is the age of death; r is the social discount rate; β is the age weighting constant; K is the age weighting modulation constant; C is the adjustment constant for age-weights; and L is the standard life expectancy at age of death.

The following YLD formula uses to estimate the years lost due to disability associated with the acute respiratory infection:

$$YLD = DW \left\{ \frac{KCe^{ra}}{(r+\beta)^2} \left[e^{-(r+\beta)(L+a)} [-(r+\beta)(L+a)-1] - e^{-(r+\beta)a} [-(r+\beta)a-1] \right] + \frac{1-k}{r} (1-e^{-rl}) \right\}$$

Where a is the age of death; r is the social discount rate; β is the age weighting constant; K is the age weighting modulation constant; C is the adjustment constant for age-weights; and L is the duration of disability; and DW is the disability weight.

Bias

Consistent with GBD methods, we followed ICD rules for determining the underlying cause of death. DALYs for COVID-19 were composed entirely of YLDs, which meant that, despite potential excess deaths. We first estimated sequela-specific YLDs by multiplying sequela-specific prevalence by their respective disability weights. We then corrected the specific YLDs for comorbidities to adjust for the co-occurrence of causes of YLDs within GBD 2020; these methods describes in detail elsewhere. Therefore, we calculated baseline burden estimates by adjusting GBD 2020 burden estimates by the ratio between baseline prevalence and adjusted prevalence. p values of less than 0.05 considers to significant. We did all analyses using DisMod MR-2.1, MR-BRT, and R (version 3.6.3).

Results

From January 2020 to December 2021, 29.2% of the Covid-19 cases reported in Colombia are in Bogotá D.C., 1,009,351 confirmed cases of COVID-19, and 25,534 deaths.

Of the total cases, 52.4% of the cases occurred in women and in the case of deaths, 64.1% occurred in men. The highest concentration of cases according to age is between 20 to 49 years old with a percentage weight of 60.6% [4]. The localities with the highest number of positive cases are Suba with 15.9% of the cases in the city ($n=160.487$), followed by Kennedy with 12.6% ($n=127.178$), Engativá with 11.0% ($n=111.029$), Usaquén with 8.8% ($n=88.823$) and Bosa with 7.1% ($n=71.664$). These five localities contribute 55.8% of the confirmed cases in the District. 0.386% of the cases are in a mild state, 0.018% moderate, and 0.002% in a serious state. 1,760,672 people (97.6%) have recovered and 29,557 (1.6%) have died. 99.98% of the cases are found at home, 0.018% in general hospitalization and 0.002% in Intensive Care Units-ICU.

Bogotá has 92.7 active cases of Covid-19 per 100,000 inhabitants and a mortality rate in men of 458.7 per 100,000 and in women 297.8 per 100,000. When comparing Bogotá with Miami, New York, Madrid, London and the main cities of Latin America, the Colombian capital ranks eighth according to the number of cases per million inhabitants (231,824).

In 2020, it that for every 100.000 inhabitants of Bogotá, 87,5 DALYs were lost in men and 95,9 in women. In the year 2021, 91,7 DALYs were lost in men and 111,8 in women. By age, a greater burden of disease in the group between 30 and 60 years of age, with 390,6 per hundred thousand inhabitants (Table 1).

Age	2020			2021		
	Males DALYs 100.000	Females DALYs 100.000	Total DALYs 100.000	Males DALYs 100.000	Females DALYs 100.000	Total DALYs 100.000
0-4	13,9	26,4	18,0	12,2	24,6	16,3
5-14	34,6	36,2	35,4	41,1	43,4	42,2
15-29	88,7	103,9	96,3	93,5	114,9	104,1
30-44	122,6	126,2	124,5	125,6	136,8	131,4
45-59	116,0	110,1	112,7	127,3	132,1	130,0
60-69	111,0	88,7	98,4	120,2	137,7	129,2
70-79	117,4	84,5	98,1	110,2	121,5	116,0
80+	128,4	119,9	123,4	107,0	154,8	130,3
Total	87,5	95,8	91,7	91,8	111,8	101,8

Table 1: DALYs in Bogota, Colombia. 2020 y 2021.

By locality, a higher burden of disease in Suba with 118,2 x 100.000 inhabitants, Kennedy with 104.1, Engativá with 93.4, Usaquén with 43.4 and Bosa with 34.6.

Discussion

The current study provides the panorama of global disease burden with DALYs metric due to COVID-19 from January 2020 until December 2021 in Bogotá, Colombia.

Global health loss due to COVID-19 after translating these DALYs estimates per capita into the corresponding DALYs (thousands) based on the actual global population gives 31,930 x 100,000 inhabitants. The estimated DALYs figures increased with time and the study period (2020-2021).

In a short period of 1 year, the COVID-19 pandemic has emerged as the largest-ever health crisis globally, nationally, and locally. Despite several measures to contain the spread of the virus, the infection has intensified the disease burden, increased premature mortality, increased short- and long-term morbidity, raised health care costs, reduced income, increased unemployment, and above all, generated a psychological scare worldwide. The second and the third waves of COVID-19 infection are underway in many of the worst affected countries. The geographical spread of the COVID-19 infection and the associated mortality has largely been uneven. Its impact varies across and within the countries.

In Bogotá, a disease burden similar to that reported in the study by Gianino MM, et al. [5], was found where countries such as Denmark (116 x 100,000 inhabit), Slovakia (101) and Malta (178); and it was much lower than that of countries such as Czechia (534), Italy (650), Netherlands (429) among others. The burden of disease found in our study for Bogotá differs substantially from that of the United States, which according to the same study found 4,354 per 100,000 inhabitants.

In a study by Fan C, et al. [6], global DALYs (in 100,000) incurred by COVID-19 were estimated to be 427.4 from January 2020 to April 2021. The global health loss due to COVID-19 after translating these estimates of DALYs per capita in corresponding DALYs (miles) based on actual world population gives 31,930 from period I to period IV. Our study showed a load expressed in DALYs much lower than that reported in this study.

According to the global burden of disease study, the leading causes of DALYs are no communicable diseases, and communicable diseases such as HIV/AIDS, malaria, and tuberculosis were ranked 13th, 14th, and 20th for women and 13th for women, 15 and 14 for men, respectively. According to study by Fan C, et al. [6] the differences in the burden of disease measured with DALYs is associated with the total population of the country, which may explain the differences found between Bogotá and countries such as the US, Italy, and Spain.

In Mexico, Salinas EG, et al. [7] estimated 1,384,227.4 DALYs resulted. The total DALYs were highest in the 50–59 year age group but were higher in the 60–69 year group when applying the discount rate. Similar to year's group with

major DALYs in Bogotá, Colombia. Likewise, in Saudi Arabia, Asdaq S, et al. [8] a greater burden of disease was found as age increased, the DALYs/100,000 inhabitants increased progressively as the age of the population increased, and the highest value was found for those over 70 years old (25.73 ± 2.09). Bogotá also took measures to restrict social activities and the vast majority of people respected the contact restriction; which can influence the value of the burden of disease found.

Although it is difficult to make comparisons with other disease burdens, this study focused on DALYs due to COVID-19 in Bogotá. For comparison, the global disease burden from May 2020 to April 2021 was estimated at 29,232 DALYs (thousands), which was only slightly less than 45,000 (thousands) for TB and malaria. The results of our study supported the effects of the restrictions imposed by the Mayor of Bogotá and contributed to a completely different burden of disease from COVID-19. Early preparation and adequate resources for testing and isolation eased the impacts of COVID-19.

The COVID-19 epidemic hit Bogotá in a scenario of unemployment, impoverishment and other risk factors related to the spread of the disease. The individual and collective conditions (socioeconomic and demographic) to face the public health crisis caused by COVID-19 were different by locality. In localities such as Usaquén, Suba, and Chapinero, where most of the specialized human resources and hospitals with intensive care units are proportionally concentrated, it could affect the fatality rates of COVID-19 and explain the difference in DALYs with the other localities. The literature on estimates of the global burden of disease emphasizes the importance of the DALY indicator to measure mortality and morbidity in the same metric. Even the component that measures temporary and permanent disabilities represents the strategic axis to support planning, programming and measuring the economic impact on the health system.

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