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Environmental impact on human health: analysis of the global burden of disease in Bogotá D. C.

Impacto ambiental en salud humana: Análisis de la carga global de enfermedad en Bogotá, D. C.

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ABSTRACT

Objective The interplay between the environment and human health is an escalating global concern, particularly in densely populated urban centers like Bogota. This article delves into the global burden of diseases, focusing on how environmental factors shape the health landscape of its populace. Emphasis is placed on comprehending and addressing health hazards linked with the urban landscape and depletion of natural resources within the city.
Methods A quantitative ecological approach was employed, utilizing secondary data from sources such as SALUDATA and the National Data Archive (Archivo Nacional de Datos-ANDA) of the National Administrative Department of Statistics (Departamento Administrativo Nacional de Estadística-DANE). An etiological approach to epidemiological transition was adopted, and theoretical frameworks established by Murray and López were employed to gauge the burden. Analysis was conducted at the level of the city's 20 localities, considering the number of individuals attended to in healthcare institutions per locality.
Results A total of 11,220,420 individuals were identified as receiving care in the year 2022, exhibiting unequal distribution across localities. Diseases influenced by environmental factors were incorporated into the study. Metrics such as years of life lost (YLL), years of life lost due to disability (YLD), and disability-adjusted life years (DALYs) were computed. Findings underscored a substantial burden affirming the influence of environmental impact.
Conclusion The study underscores the imperative of addressing environmental factors to alleviate the burden and enhance the quality of life for the population. Urgency is stressed in implementing efficacious policies and measures to mitigate adverse effects on public health. These insights bear direct implications for shaping public health policies and provide a robust foundation for future investigations into the interplay between burden and environmental determinants within the city.

Keywords: Burden of disease; public health; Bogotá D.C.; environmental impact; environmental epidemiology; respiratory and cardiovascular pathologies (*source: MeSH, NLM*).

RESUMEN

Objetivo La interacción entre el medio ambiente y la salud humana es una preocupación mundial creciente, particularmente en centros urbanos densamente poblados como Bogotá. Este artículo profundiza en la carga mundial de enfermedades, centrándose en cómo los factores ambientales dan forma al panorama sanitario de su población. Se hace hincapié en la comprensión y el tratamiento de los peligros para la salud relacionados con el paisaje urbano y el agotamiento de los recursos naturales dentro de la ciudad.

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Métodos Se empleó un enfoque ecológico cuantitativo, utilizando datos secundarios de fuentes como SALUDATA y el Archivo Nacional de Datos (ANDA) del Departamento Administrativo Nacional de Estadística (DANE). Se adoptó un enfoque etiológico de la transición epidemiológica y se emplearon los marcos teóricos establecidos por Murray y López para medir la carga. El análisis se realizó a nivel de las 20 localidades de la ciudad, considerando el número de personas atendidas en instituciones de salud por localidad.
Resultados Se identificó que un total de 11,220,420 personas recibieron atención en el año 2022, mostrando una distribución desigual entre localidades. Se incorporaron al estudio las enfermedades influenciadas por factores ambientales. Se calcularon métricas como los años de vida perdidos (AVP), los años de vida perdidos debido a una discapacidad (AVP) y los años de vida ajustados por discapacidad (AVAD). Los hallazgos subrayaron una carga sustancial que afirma la influencia del impacto ambiental.
Conclusión El estudio subraya la necesidad imperiosa de abordar los factores ambientales para aliviar la carga y mejorar la calidad de vida de la población. Se hace hincapié en la urgencia de aplicar políticas y medidas eficaces para mitigar los efectos adversos sobre la salud pública. Estos conocimientos tienen implicaciones directas para la configuración de las políticas de salud pública y proporcionan una base sólida para futuras investigaciones sobre la interacción entre la carga y los determinantes ambientales dentro de la ciudad.

Palabras clave: Carga de enfermedad; salud pública; Bogotá D.C.; impacto ambiental; epidemiología ambiental; patologías respiratorias y cardiovasculares (*source: MeSH, NLM*).

The interaction between the environment and human health is an increasingly concerning issue worldwide, particularly in densely populated urban areas such as Bogotá D.C. According to the World Health Organization (WHO), air, water, and soil pollution, among other environmental factors, significantly contribute to the global burden of diseases, posing a substantial risk to public health (1). In this capital, the situation is particularly alarming due to high population density and rapid urban growth, which have increased exposure to various environmental pollutants (2).

In this context, the study of pathologies (both acute and chronic) of any origin is influenced by environmental conditions, which is crucial for understanding and addressing health risks associated with the built environment and the loss of natural capital in the city under study. The burden refers to the total quantity of disease (in terms of mortality, morbidity, and disability) affecting a population over a certain period; in this study, an approach was undertaken to quantify the impacts of environmental conditions on the population's health.

Epidemiological studies have consistently demonstrated that environmental factors play a crucial role in the onset and spread of diseases in urban areas (3,4). Exposure to atmospheric pollutants such as nitrogen dioxide (NO_2), particulate matter ($PM_{2.5}$), carbon monoxide (CO), and ozone (O_3) primarily derived from vehicular traffic and industrial activity has been associated with increased risk of respiratory, cardiovascular, and other chronic conditions in the urban population (5,6). Furthermore, water pollution and lack of access to adequate sanitation services can increase the incidence of waterborne conditions such as diarrhea and cholera (7).

The quality of drinking water and proper waste management are important concerns to ensure the health and well-being of the population. Water pollution from heavy metals, toxic chemicals, and pathogenic bacteria can lead to conditions such as leptospirosis, giardiasis, cryptosporidiosis, schistosomiasis, interstitial nephritis, among others.

Despite the growing awareness of health risks associated with the environment, there is a lack of comprehensive understanding of how these factors affect the burden of disease in specific urban contexts. Existing studies often focus on regions or specific health issues, limiting our ability to comprehend the full scale of environmental impact on urban public health (8,9). Therefore, this study aims to address this gap by examining the etiologies underpinning environmental impact on human health in Bogotá, using a comprehensive approach that considers its interactions with the built and natural environment.

METHODS

A quantitative approach with an ecological descriptive type was conducted, utilizing secondary data sources. The etiological approach of epidemiological transition proposed by Valdéz et al., (10) was adopted.

Morbidity and mortality data were collected from reliable sources, including the Individual Records of Health Services Provision (RIPS) from the Bogotá Epidemiological Surveillance System, as well as records from hospitals and healthcare centers in the 20 localities of the Capital District. The units of analysis included the number of individuals attended and reported in the health information registry system SALUDATA for the year 2022, population projections per locality, and deaths reported in vital statistics from the ANDA of the DANE, with a reference date of October 2023.

To estimate the burden, theoretical foundations proposed by Murray and López, adapted by Grisales-Romero et al., were utilized (11,12). The analysis was conducted by political division, considering the environmental impact on

individuals attended for each of the major disease groups according to the ICD-10, such as cardiovascular, malignant tumors, respiratory, fetal, gastrointestinal infections, traumatic, ocular, heat-related, and heavy metal nephritis.

The burden estimation was performed using indicators such as years of life lost (YLL), years of life lost due to disability (YLD), and disability-adjusted life years (DALY). YLLs were calculated by multiplying the number of deaths by the condition and life expectancy at the time of death. YLDs were estimated from the incidence by grouped cause, disability weight adjusted by locality, and average duration of the condition. DALYs were obtained by summing YLLs and YLDs, with weighted adjustments by sex and age groups, excluding groups under 4 years and over 80 years.

For the geographical description of the indicators, geographical polygons of the localities obtained from the Urban Laboratory through IDECA (Spatial Data Infrastructure of Bogotá) were used. The data were normalized in MapShaper, and heat maps were constructed using choropleth maps using the Matplotlib, Nympy, Pandas, and GeoPandas libraries in Google Colaboratory. Sensitivity analyses were conducted to assess the robustness of the results against different assumptions and analytical approaches.

RESULTS

A total of 11,220,420 individuals were attended to in the year 2022 across the 20 localities of Bogotá D.C., as found in SALUDATA. Regarding the distribution of these individuals by locality, Chapinero, Tunjuelito, and Usaquén were identified with 11.86% (n=1,330,911), 10.48% (n=1,175,550), and 10.11% (n=1,134,130), respectively, as the localities with the highest number of individuals attended (which represents one-third of the total). Additionally, a comparison was made with the population estimated to reside in each of these localities for the year 2022 (Table 1).

Table 1. Distribution of individuals attended by localities for 2022

Localities	Individuals Attended	Proportion (%)	Population 2022
Usaquén	1.134.130	10,11	579.447
Suba	1.090.785	9,72	1.273.909
Barrios Unidos	1.076.960	9,60	150.151
Chapinero	1.330.911	11,86	176.471
Antonio Nariño	488.265	4,35	82.958
Engativá	397.774	3,55	815.262
Fontibón	229.070	2,04	399.020
Kennedy	1.003.871	8,95	1.034.293
Candelaria	23.534	0,21	18.143
Puente Aranda	715.911	6,38	255.123
Teusaquillo	985.963	8,79	167.657
Santa Fe	158.593	1,41	107.630
Los Mártires	162.881	1,45	83.142
Rafael Uribe	350.848	3,13	386.696
San Cristóbal	154.896	1,38	403.674
Usme	103.894	0,93	400.580
Tunjuelito	1.175.550	10,48	181.476
Bosa	358.632	3,20	726.293
Ciudad Bolívar	277.636	2,47	656.015
Sumapaz	316	0,00	3.713

Source: SALUDATA and Population Projections 2022. DANE.

The pathologies included in this study are both acute and chronic, and they are those influenced by environmental impact on human health. The health metric used to identify them was the Population Attributable Fraction (PAF) from the WHO, which represents the fraction of a disease or death attributable to a specific risk factor in a given population (13) (Table 2).

The indicators were calculated by locality as follows: a. Years of Life Lost (YLL) (n=1,037,690). b. Years Lived with Disability (YLD) (n=23,330,307.45). c. Disability-Adjusted Life Years (DALY) (n=45,687 per persons attended). Regarding YLL, it was identified that the localities bearing the highest burden in their healthcare services were Chapinero with 142.30, followed by Usaquén with 123.90, and Suba with 119.22. Conversely, in terms of YLD, the localities with the greatest burden of care were Usaquén with 3,569,165.05, followed by Chapinero with 2,709,142.26, and finally Barrios Unidos with 2,543,142.79 (Table 3 and Figure 1).

Table 2. Disease Groups and Population Attributable Fraction related to Environmental Component

Disease Groups	% PAF (according to WHO for low and middle-income countries)
Cerebrovascular diseases	0,3-0,42
Ischemic heart diseases	0, 28-0,35
Diarrheal diseases	0,57-0,61
Lower respiratory infections	0,35-0,37
Cancers	0,2
Chronic obstructive pulmonary disease (COPD)	0,17-0,35
Traffic accidents on the road	0,39
Neonatal conditions	0,11
Malaria	0,42
Drowning	0,73
Neck and back pain	0,27
Burns, heat, and fire-related injuries	0,76
Falls	0,3
Asthma	0,44
Unipolar depressive disorder	0,11
Dengue fever	0,42-0,95
Upper respiratory infections and otitis	0,24-0,35
Lung cancer in men	0,45
Lung cancer in women	0,48

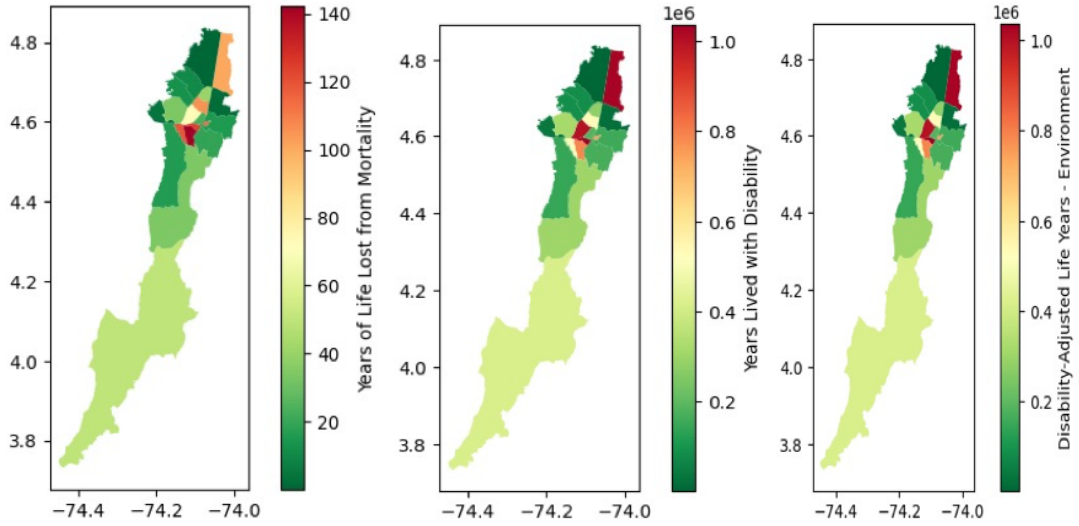
Source: WHO, 2015.

Table 3. Relates Years of life lost, years lived with disability, and disability-adjusted life years for the localities of Bogotá D.C.

	YLL	YLD	DALY by localities	DALY per inhabitants BTA	DALY per Persons Attended
Usaquén	123,90	3.569.155,05	3.569.278,95	0,45	3,15
Suba	119,22	1.304.616,32	1.304.735,55	0,17	1,20
Chapinero	142,30	2.709.142,26	2.709.284,56	0,34	2,04
Barrios Unidos	113,54	2.543.226,79	2.543.340,33	0,32	2,36
Engativá	40,28	969.708,03	969.748,31	0,12	2,44
Teusaquillo	105,56	1.991.044,01	1.991.149,57	0,25	2,02
Puente Aranda	72,35	1.552.351,04	1.552.423,39	0,20	2,17
Fontibón	22,92	667.685,39	667.708,302	0,08	2,91
Antonio Nariño	49,77	1.477.401,19	1.477.450,96	1,87	3,03
Kennedy	100,94	1.886.114,61	1.886.215,56	0,24	1,88
Candelaria	1,87	86.271,078	86.272,94	0,01	3,67
Santa fe	15,09	498.053,57	498.068,66	0,06	3,14
Los mártires	18,98	584.556,72	584.575,70	0,07	3,59
Rafael Uribe	34,35	1.116.458,53	1.116.492,89	0,14	3,18
San Cristóbal	15,93	506.290,47	506.306,41	0,06	3,27
Usme	4,04	143.297,36	143.301,40	0,02	1,38
Tunjuelito	33,55	1.127.667,83	1.127.701,38	0,14	0,96
Bosa	12,84	330.669,77	330.682,61	0,04	0,92
Ciudad Bolívar	10,25	266.143,71	266.153,96	0,03	0,96
Sumapaz	0,02	453,70	453,72	0,0001	1,44
Totals	1.037,70	23.330.307,5	23.331.345,10	4,64	45,69

Source: Created by the authors.

Figure 1. Relates Years of life lost, years lived with disability, and disability-adjusted life years for the localities of Bogotá D.C



Source: Created by the author.

DISCUSSION

This discussion focuses on analyzing the global burden of disease in Bogotá and its relationship with the impact on human health. The collected data indicate that this exposure varies depending on the type and risk factor involved. Global studies estimate that between 25% and 30% of the burden is attributable to the environment by 2004, and by 2019, these risk factors were responsible for nine million deaths worldwide (14). In Latin America, its association with exposure has been more extensively studied, highlighting air pollution and poor water quality as the main factors affecting population health in countries such as Mexico (15).

The results of this study, grounded in previous research, confirm the significant burden of cancers in Bogotá, distributed across its 20 localities (16-18). The variability in prevalence and distribution by age is influenced by local and loco-regional factors, underscoring the need for prevention and treatment strategies tailored to the city's reality (19). Moreover, the persistence of cardiovascular conditions in the population of the twenty localities comprising the Colombian capital is emphasized, related to factors such as air pollution, highlighting the importance of specific measures to reduce cardiovascular risk, considering the city's particular environmental conditions (20-22).

Regarding gastrointestinal and respiratory conditions, this study delves into the urgency of addressing water and air pollution, especially in densely populated urban areas like Bogotá. These findings support the need for policies to improve environmental quality to prevent them (23-26). The variability in the burden related to trauma and accidents also warrants attention, signaling the importance of further research to formulate prevention policies (27).

The results on the burden related to newborn malformations in Bogotá align with existing literature and underscore the importance of efficient prenatal and neonatal services to improve infant health outcomes (28). The application of the Grisales formula provides valuable insight by specifically addressing pathologies affecting the economically active population, reinforcing the importance of considering social and economic implications when developing prevention and treatment strategies (12).

Finally, despite the study's limitations, such as the lack of detailed data on the origin of the individuals served, the need to implement effective preventive measures and health services to comprehensively address the disease burden associated with environmental impact in Bogotá is highlighted. Adherence to preventive policies and specific circumstances may influence the interpretation of results and the effectiveness of proposed interventions.

This study provides insight into the complex interaction between population health and environmental factors impacting the hospital network across the twenty localities of Bogotá. Comparison with existing literature underscores the need for contextualized approaches to address each specific affliction in unique urban settings like this capital. These findings have direct implications for the formulation of public health policies, emphasizing the importance of considering the environment in health promotion and prevention.

This study lays the groundwork for future research to delve deeper into the relationship between disease burden and its determinants supporting the localities of Bogotá. Greater understanding is needed of how environmental, political, social, mobility, and other factors affect the health of the heterogeneous population served in healthcare institutions. This not only reflects the residents but also those from neighboring municipalities, and even other cities and remote areas, who are attended to in this metropolis as the capital of the country. All the above contributes to the development of effective interventions tailored to local needs. Ultimately, this research contributes to bridging the gap in scientific knowledge on urban health to formulate public health policies for this city and other urban populations with similar characteristics ♣

Data and materials availability: The datasets analyzed in this study are available from the corresponding authors upon reasonable request.

Ethics approval and consent to participate: Ethics approval was obtained.

Conflict of interest: None.

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