Measuring the Economic Costs of Diarrheal Diseases in Nigeria: A 2021 GBD Study

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Abstract

Background: This study aims to quantify the economic burden of diarrheal diseases in Nigeria considering the year 2021.

Methods: The study considered the value of life-year (VLYs) approach using the World Health Organization (WHO) and Lancet commissions' recommendations, which assigns a monetary value to each life-year for sub-Saharan Africa. The economic burden was calculated by multiplying the GDP per capita and disability-adjusted life years (DALYs) by 4.2. The cost of illness (COI) analysis considered direct healthcare costs, non-healthcare costs, and indirect costs from morbidity and mortality. The COI values are calculated by adding the total direct medical costs (DMCs), direct non-medical costs (DNMCs), and indirect costs (morbidity and mortality). The study utilized data from the IHME Global Burden of Disease (GBD) 2021 website, the World Bank Database, and the ILO data explorer.

Results: Using the approach of the WHO, the value of life lost due to diarrheal illnesses in Nigeria in 2021 was 8.3 trillion Naira (56.7 billion US$) at one-times the GDP per capita and 24.9 trillion Naira (170 billion US$). The COI analysis revealed an economic burden of 109 billion Naira (744 million US$), with productivity loss from mortality contributing the most to the economic burden at 74%, followed by productivity losses from morbidity at 19%, with 7% attributed to direct medical and non-medical costs.

Conclusions: This study reveals a need to implement and strengthen existing actions to ensure a drastic reduction in the economic burden of diarrheal diseases. By implementing targeted interventions, preventing and controlling diarrheal disease and improving the well-being of communities in Nigeria is feasible.

Keywords: Diarrheal Diseases; Health Economics; Economic Burden; Public Health; Nigeria

1. Background

Diarrheal diseases remain a major global health concern, particularly in low-income countries where the provision of safe drinking water and adequate sanitation facilities is often lacking (1). Diarrheal diseases not only affect public health but also have significant economic implications, encompassing direct costs, such as medical expenses, and indirect costs, including lost income and reduced economic productivity due to illness and caregiving responsibilities (2). These diseases rank as the third leading cause of death among children under five years old, manifesting through the passage of three or more loose or liquid stools per day (1). Diarrhea is usually a symptom of an infection in the intestinal tract, which can be caused by a variety of bacterial, viral, and parasitic organisms. These pathogens are often transmitted via the fecal-oral route, underscoring the critical importance of handwashing and general hygiene to prevent infections.

In Nigeria, the primary risk factors contributing to the prevalence of diarrheal diseases include deficiencies in water, sanitation, and hygiene (WASH), malnutrition in all forms (including wasting, stunting, and underweight), non-exclusive breastfeeding, and air pollution (3). Diarrheal diseases present a significant burden in Nigeria. According to the Nigeria National Demographic and Health Survey 2018, the national prevalence of diarrheal diseases is 13%, with higher rates observed in the northern states where the issue is endemic (4). Diarrheal diseases were identified as the fifth leading cause of death in Nigeria, according to the Global Burden of Disease (GBD) study, with a death rate of 54.53 per 100,000 population, showing a gender disparity of 64.56 deaths per 100,000 males and 45.32 per 100,000 females (3). Historically, these

diseases were the leading cause of death in 1990, with a death rate of 225.55 per 100,000 population. Despite a significant 76% reduction in mortality by 2021, attributable to substantial public health efforts, the burden remains considerable (3). However, disability-adjusted life years (DALYs) rates per 100,000 population from diarrheal diseases in Nigeria for both sex groups in 2021 is 4361.11 DALYs per 100,000 population (males 7023.38; females 5858.78), and ranked as the 4th cause of DALYs in 2021 (3). Diarrheal diseases were ranked as the 1st leading cause of DALYs in 1990 (17,780.9 DALYs per 100,000 population). Although the DALYs rates have decreased by 75.47% when compared to 2021, it is still a significant health issue in Nigeria (3).

Understanding the economic impact of diarrheal diseases is crucial for policymakers, healthcare providers, and development agencies to prioritize interventions and allocate resources effectively.

2. Objectives

This study aims to quantify the economic burden of diarrheal diseases in Nigeria considering the year 2021.

3. Methods

The direct valuation of DALYs was done using the recommendations of the World Health Organization (WHO) commission on macroeconomics and health (5). It recommends valuing DALYs at between one- and three-times GDP per capita (referred to as CMH1 and CMH3, respectively) (6). Constructing the CMH1 and CMH3 estimates/projections involved multiplying DALYs from diarrheal diseases in 2021 obtained from the IHME GBD 2021 website by the relevant multiple (1 or 3) of GDP per capita in 2021. The GDP per capita for Nigeria was sourced from the World Bank Database (7). The DALYs were sourced from GBD 2021 (3). All conversions of the international dollars (I$) to Nigerian Naira (NGA) were done using the 2021 purchasing power parity (PPP) conversion factor obtained from the World Bank database (7).

Further, to assess the economic burden of diarrheal diseases, the value of life-year (VLYs) approach presented by the Lancet commission on investing in health that assigns a monetary value to each life-year was also adopted (8). For sub-Saharan Africa, the value of one life-year is equivalent to 4.2 times the per capita GDP at a 3% discount rate. Thus, the economic burden of diarrheal disease was calculated by multiplying the GDP per capita (2021) and DALYs by 4.2 (Formula 1).

$$Economic\ Burden\ (VLYs) = GDP\ per\ capita \times DALYs \times 4.2$$

A cost of illness (COI) analysis, which takes into account the various costs associated with a disease, including direct healthcare costs, direct non-healthcare costs, and indirect costs from morbidity, mortality, and disability, was also conducted (9). The values for direct medical costs (DMCs), direct non-medical costs (DNMCs), and indirect costs (productivity loss due to morbidity) in this analysis were obtained from the study by Salihu et al. (10), adjusted to the 2021 values using the GDP deflators for 2016 and 2021 obtained from the World Bank Database, and multiplied by the prevalence values obtained from the IHME GBD 2021 website (Formula 2). The DMCs in the study by Salihu et al. covered medical consultations, laboratory tests and investigations, hospital admissions, card purchases, pharmaceuticals, and medical consumables, which were summed up to give a total value (10). The DNMCs consisted of transport costs, and indirect costs (from morbidity) consisted of sick leave and help accepted due to illness.

$$Costs\ in\ 2021 = Costs\ in\ 2016 \times \frac{GDP\ deflator\ of\ country\ in\ year\ 2021}{GDP\ deflator\ of\ country\ in\ year\ 2016}$$

The productivity loss from mortality (indirect costs) considered the entire period of life lost and was calculated by multiplying the Period Expected Years of Life Lost (PEYLL) by the Working Years Lost (WYL) and the Average Annual Gross Salary (AAGS). The PEYLL (discounted by 3%) was calculated by multiplying the life expectancy at the average age of death obtained from the GBD 2021 by the number of deaths due to diarrheal diseases in 2021 (obtained from the GBD 2021). The WYL were calculated by multiplying the calculated discounted PEYLL by the employment-to-population ratio for 2021 obtained from the World Bank Database. The AAGS of employees by sex in 2021 was obtained from the ILO data explorer (11). Thus, the COI values were obtained by adding the total DMCs, DNMCs, and indirect costs (morbidity and mortality; Formula 3).

$$COI = DMC + DMNC + Indirect\ cost\ from\ morbidity + (PEYLL \times WYL \times AAGS)$$

All data was analyzed using Microsoft Excel version 16.

4. Results

The GDP per capita in Nigeria in 2021 was 5,623.7 US$ (825,096.23 Naira). The total DALYs from diarrheal diseases in Nigeria in 2021 from the IHME website were 10,081,391.8 (males = 5,783,644.5; females = 4,297,747.3). Using the approach of the WHO commission on macroeconomics and health, the value of life lost due to diarrheal diseases in Nigeria in 2021 was 8.3 trillion Naira (56.7 billion US$) at one-time the GDP per capita and 24.9 trillion Naira (170 billion US$) at three-times the GDP per capita, as shown in Table 1. Quantifying the economic burden using the Lancet commission on investing in health approach reveals a value of life lost due to diarrheal diseases amounting to 35 trillion Naira (238.1 billion US$).

Table 1. Value of Statistical Life Using the World Health Organization CMH and the Lancet Approaches

Variables	VSL-WHO CMH Approach				VSL; The Lancet Commission on Investing in Health Approach	
	Income Lost Due to Disease Billions I$ Males (CMH1)	Income Lost Due to Disease Billions I$ Males (CMH3)	Income Lost Due to Disease in Trillion NGA Males (CMH1)	Income Lost Due to Disease in Trillion NGA Males (CMH3)	Income Lost Due to Disease Males (Billion I$)	Income Lost Due to Disease Males (Trillion NGA)
Males	32.52548	97.57644	4.772063	14.31619	136.607	20.04267
Females	24.16924	72.50772	3.546055	10.63817	101.5108	14.89343
Total	56.69472	170.0842	8.318118	24.95436	238.1178	34.9361

z Abbreviations: WHO, World Health Organization; I$, international dollars; NGA, Nigerian Naira.

The DNMCs and indirect costs (productivity loss due to morbidity) per case of diarrheal disease in 2016 from Salihu et al. were 917 Naira, 294.8 Naira, and 3,889 Naira, respectively. The 2021 values for DNMCs and indirect costs (productivity loss due to morbidity) per case after adjustments were 1,472.6 Naira, 634 Naira, and 6,245.3 Naira, respectively (10). The employment-to-population ratio in Nigeria in 2021 was 55.51%. The AAGS was 54,057.3 Naira for males and 34,042.3 Naira for females.

According to the COI analysis, the DMCs of diarrheal diseases in 2021 were 4.9 billion Naira (33.7 million US$), with DNMCs of 2.1 billion Naira (14.5 million US$). Diarrheal diseases cost 81.2 billion Naira (553.3 million US$) in lost productivity from early death in 2021 (Table 2). Productivity loss from morbidity of diarrheal diseases amounted to 29.6 billion Naira (142.9 million US$) in 2021. The total burden of diarrheal diseases in 2021 in Nigeria using the COI analysis is 109 billion Naira (744 million US$).

Table 2. Cost-of-Illness Analysis for Diarrheal Diseases in Nigeria in 2021 a

Variables	Total Cost Mil $	Total Cost 2021 Bln NGA
DMCs	33.70093 (5)	4.944523 (5)
DNMCs	14.50941 (2)	2.128787 (2)
Indirect morbidity costs	142.9258 (19)	20.96974 (19)
Mortality costs	553.2972 (74)	81.17848 (74)
COI	744.4333 (100)	109.2215 (100)

z Abbreviations: NGA, Nigerian Naira; DMCs, direct medical costs; DNMCs, direct non-medical cost; COI, cost of illness.
a Values are expressed as No (%).

5. Discussion

This is the first study considering, as part of the economic burden, the productivity loss from mortality of diarrheal diseases in Nigeria. This study reveals a high economic burden considering the WHO commission on macroeconomics and health's approach, ranging from 8.3 to 24.9 trillion Naira (56.7 to 170 billion US$). The economic burden using the Lancet commission's approach was even higher. This study further highlights a high economic burden from the COI analysis at 744 million US$ (109 billion Naira). This result is similar to a study in Burundi, which revealed an estimated economic cost of 534 million US$ from diarrheal diseases in 2018 with considerations for productivity loss from mortality (12). Furthermore, a study in Bangladesh highlighted similar results with an economic burden of 769 million US$ from under-five diarrheal diseases in 2018 (13).

Further considering the COI analysis in this study, productivity loss from mortality contributed the most to the economic burden of diarrheal diseases in Nigeria at 74%, followed by productivity loss from morbidity at 19%, with

7% attributed to direct medical and DNMCs. This is similar to the study by Sin et al. in Bangladesh, which revealed that productivity loss from mortality remained the greatest economic cost (13). Considering only DMCs, DNMCs, and productivity loss from morbidity in this study, diarrheal diseases cost 189 million US$ in 2021. Studies in Bangladesh have shown similar trends with the economic burden of diarrheal diseases ranging from 79 to 172 million US$ (14, 15). However, a study in Indonesia reveals a lower economic burden with costs of about 30 million US$ annually, which can be attributed to immense public health efforts in the country (16). The economic burden of diarrheal diseases in Nigeria reveals a need to implement and strengthen existing actions to ensure a drastic reduction.

This study has several limitations which should be taken into consideration when interpreting the results. The productivity loss from mortality used in the COI assumes that individuals in the working population cannot be replaced and thus may overestimate the value of

forgone production (9). Uncertainty analysis was also not performed for DALY or VLY calculations. Additionally, the estimates used for the COI may not reflect the individual costs of diarrheal treatment in Nigeria, considering that the existing COI study utilized was conducted in Northern Nigeria and may not apply to all the regions and states in Nigeria. However, this study is informative for policymakers and health managers for planning health interventions, especially for diarrheal diseases, and to achieve better and sustained health outcomes.

5.1. Recommendations for Reducing the Burden of Diarrheal Diseases

Diarrheal diseases are a multifaceted problem that requires coordinated efforts from governments, international organizations, civil society, communities, and groups. These coordinated efforts involve not only health policies but also economic and social strategies.

First, addressing WASH, which is the main risk factor for diarrheal diseases, is sacrosanct. There is a need for increased access to clean and potable water, and sanitation, especially in Northern Nigeria. This can be achieved through intersectoral collaborations involving the Ministry of Water Resources, National Orientation Agency (NOA), Ministry of Health and Social Welfare, Ministry of Education, Ministry of Finance, and other parastatals.

Second, promoting zinc and oral rehydration therapy (ORT) as first-line treatment for diarrheal diseases, especially among children under five, is important. ORT is a simple, cost-effective treatment that can significantly reduce mortality from diarrheal diseases and is recommended alongside zinc by the WHO. Efforts should be made to increase awareness and usage of ORT, especially in rural areas where access to healthcare facilities may be limited. A cost-effectiveness study in Burundi revealed that an ORT program can save about 37 billion US dollars considering a 100% coverage and effectiveness (12).

Third, strengthening the healthcare system, particularly in rural areas, can ensure timely and effective treatment. This includes training healthcare workers, especially on Integrated Management of Childhood Illnesses (IMCI), improving supply chains for essential medicines through the drug revolving funds in most states, and enhancing disease surveillance systems.

Fourth, nutrition and immunization should be prioritized. Malnutrition can increase the severity of diarrheal diseases and make children more susceptible to infections. Ensuring children receive adequate nutrition and are fully immunized can help reduce the burden of these diseases. Vaccines are available for certain diarrheal pathogens, such as rotavirus and cholera. Vaccination programs targeting high-risk populations, such as infants and travelers, can reduce the incidence and severity of diarrheal diseases.

Lastly, risk communication and sensitization should be implemented at all levels. Since the burden of diarrheal diseases is higher in Northern Nigeria, especially in the Northeast and Northwest geopolitical zones, community and religious leaders should be involved in sensitization efforts to ensure positive and sustained results.

5.2. Conclusions

Diarrheal diseases pose a significant public health burden worldwide, particularly in Nigeria, where poor sanitation and limited access to healthcare resources prevail. This results in a significant economic burden on individuals, communities, and the country at large. Understanding the risk factors and prevention strategies for diarrheal illnesses is crucial for reducing their impact on global health. By addressing underlying risk factors, promoting hygiene and sanitation practices, and implementing targeted interventions, preventing and controlling diarrheal diseases and improving the well-being of communities in Nigeria is feasible.

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