

Diarrheal Disease Incidence and Associated Mortality in Ethiopia: A Systematic Subnational Analysis in Global Burden of Disease Study, 1990-2019

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Abstract

Background: A diarrheal disease prevalent in low and middle-income countries, it majorly affects children and elders. In Ethiopia, where there is a disparity in health service access, sanitation, and safe water across regions, there is a lack of evidence on diarrheal disease incidence and mortality rate and trends at national and regional levels for Ethiopia. This study aims to provide national and regional diarrheal disease incidence and associated mortality trends from 1990-2019 to inform policy and practice in Ethiopia.

Methods: The stated analysis is a component of the GBD-2019 study, a collaborative effort between the Ethiopian Public Health Institute (EPHI) and the Institute for Health Metrics and Evaluation (IHME). It aims to evaluate the extent of diarrheal disease burden in Ethiopia, along with its regional states and chartered cities, by examining specific locations and age groups. This study provides comprehensive data on the incidence and mortality trends of diarrheal diseases at national and regional levels, standardized for age, from 1990 to 2019. The results are presented along with 95% uncertainty intervals (UI) to account for the inherent uncertainty in the findings.

Results: The national age-standardized diarrheal disease incidence rate was 122,781.8 [95% Uncertainty Interval (UI): 113,245.4-132,880.6] per 100,000 populations in 2019. It declined by an annual rate of 16.43% [95% UI: 12.26%-20.58%] from 1990 to 2019. It was higher among under-5 children (186,732.2 [95% UI: 153,251.4–226,075.6]) and older than 70-year adults 244.2 [95% UI: 289,749.3 –324,673.4]). The national age-standardized diarrheal disease-associated mortality was 76.4 [95% UI: 45.1-112.2] per 100,000 populations in 2019. Nationally, it was declined by an annual rate of 74.99% between 1990 and 2019. The findings indicate that the national age-standardized life years lost due to diarrheal disease declined by 76.30 % [95% UI: 53.90%, 85.29%] between 1990 and 2019.

Conclusion: Diarrheal disease has remained a public health problem by affecting a large number of the population in Ethiopia. The youngest and elder populations were disproportionately affected by diarrheal disease incidence and associated mortality. This result may call the attention of Primary Public Health Services to revisit universal health coverage in Ethiopia. Moreover, prevention and management modalities need the community's and other stakeholders' engagement and participation. Equal attention needs to be given to older adults as of under-five children. [*Ethiop. J. Health Dev.* 2023;37 (SI-2)]

Keywords: diarrheal disease, incidence, morbidity, mortality, Ethiopia

Introduction

Living in extreme poverty where primary disease prevention (vaccination) is very low, inadequate sanitation, and lack of safe water and latrine access, diarrheal disease becomes an important cause of illness and death (1–3). Diarrhoeal diseases are caused by a host of bacterial, viral, and parasitic organisms that are mostly spread by contaminated food and water sources. Rotavirus and *Escherichia coli* are the most common etiological agents of diarrhea in developing countries, whereas pathogens like cryptosporidium and shigella species also have an important role (3,4). Rotavirus was the leading etiology for diarrhea mortality among children younger than five years (5). The common reasons for diarrhea in the elderly are stratified infectious, osmotic, secretory, inflammatory, and malabsorptive (6,7).

Diarrheal disease affects all ages, particularly the young and the elderly (5,8). Globally there are nearly 1.7 billion cases of childhood diarrheal disease every year, and in low-income countries, children under three years old experience, on average, three episodes of diarrhoea yearly (3). In 2016, globally, diarrheal disease was the 8th leading cause of death among all

ages, the 5th leading cause of death among children younger than five years, and the 1st leading cause of death for under-five children in Ethiopia. Diarrhea is responsible for more than 1.6 million deaths; the overall diarrheal mortality was 22.4 deaths per 100,000 population, and about 90% of diarrhea deaths occurred in low and middle income countries (2,5,9,10).

This disease affects the nation's productivity and has intergenerational consequences leading to chronic disability (5). Globally, the total number of Disability Adjusted Life Years (DALYs) due to diarrhea could increase by up to 40%. Prevention of wasting in 1762 children could avert one death from diarrhea (11).

Diarrheal disease can be prevented by expanding access to the rotavirus vaccine, improving child growth and well-being, and providing universal access to safe water and sanitation (12–14). Ethiopia has envisioned promoting the society's health and well-being through providing and regulating a comprehensive package of health services of the highest possible quality equitably. It is targeted to prevent diarrheal-associated death through early treatment, vaccination, availing basic sanitation, hand washing facility, and latrine

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access of household. Health extension workers have taken the mandate to facilitate the intervention at the community level (15–18). Regions in Ethiopia may lack equal access to basic and essential health services. Disparity in health service access, sanitation, and safe water may lead to uneven distribution of diarrheal diseases. Ethiopia is still challenged with a weak health system, cholera and other outbreaks, and drought that worsen the population's health condition (19–21).

In parallel to providing essential health services, the country needs to track the progress of diarrheal disease reduction against the target set. This would help the policymakers and health service providers revise their programs and practice against their goals. Thus, we tried to systematically analyze national and regional data for 30 years in Ethiopia to track progress and the burden of diarrheal disease in Ethiopia. This result portrayed the national and regional diarrheal disease incidence and associated mortality trends from 1990 to 2019.

Methods

Study setting

With a population of about 107 million in 2019, Ethiopia is the second most populous country in Africa, next to Nigeria. Ethiopia has a high total fertility rate of 4.6 births per woman (2.3 in urban areas and 5.2 in rural areas) and a crude birth rate of 32 per 1000 in 2016. The average household size is 4.6 (22). The country is administratively divided into 11 regional states and two chartered cities. Over 80% of the population resides in rural areas with limited access to basic health care and sanitation facilities (23,24). Our analysis reported Sidama and South West Ethiopia Regions under the South Nations Nationalities and Peoples (SNNP) Regional State (25).

Data Source and Analysis

This analysis is part of the GBD 2019 study, a collaborative study between the Ethiopian Public

Health Institute (EPHI) and the Institute for Health Metrics and Evaluation (IHME) for Ethiopia and its regional states and chartered cities to quantify the diarrheal disease burden by location, sex and age group (25). The metrics and approaches used in the GBD 2019 to investigate diarrheal disease burden have been comprehensively described elsewhere (26).

In this paper, we presented national and sub-national diarrheal disease incidence and associated mortality results to show trends and rate changes by age group and location from 1990 to 2019. Both crude and age-adjusted diarrheal disease incidence and associated mortality rates were computed with 95% uncertainty intervals (UI). Findings were summarized and presented using tables and figures.

Ethics Statement

This study was produced as part of the GBD Collaborator Network and following the GBD Protocol (IHME ID 4239-GBD2019-042022). For GBD studies, a waiver of informed consent was reviewed and approved by the Institutional Review Board of the University of Washington (<https://www.healthdata.org/gbd/2019>).

Results

Diarrheal Disease Incidence

Nationally 2019, about one hundred sixteen million 116,711,440.6 [95% UI: 105,398,946.7–127,689,400.6] diarrheal diseases occurred among all age groups. The national age-standardized diarrheal disease incidence rate (ASIR) was 122,781.79 [95% UI: 113,245.39–132,880.57] in 2019 (Table 1). The national diarrheal disease incidence per 100,000 populations was 186,732.2 [95% UI: 153,251.4–226,075.6] among older adults, and 312,244.2 [95% UI: 289,749.3 – 324,673.4] among under-5 children in 2019. Compared to the general population, diarrheal disease was more prevalent in children under five and older than 70 years adults (Figure 1).

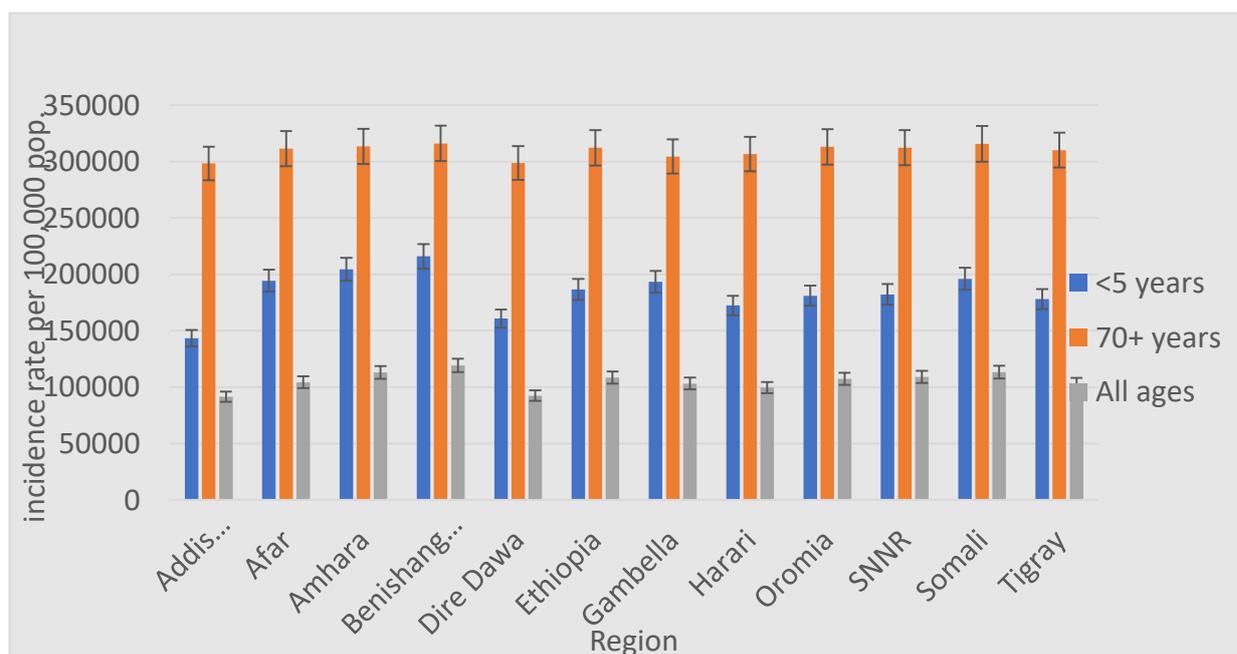


Figure 1. National and sub-national diarrheal disease incidence rate per 100,000 Populations by age group in 2019

Diarrheal Disease Incidence Rate Trends

The national age-standardized incidence rate (ASIR) of diarrheal disease declined by an annual rate of 16.43% [95% UI: 12.26%-20.58%] from 1990-2019. In 30 years, the incidence of diarrheal disease declined in all regions, and their annualized rate of change in ASIR did not significantly differ from the national annual rate of change (Table 1). The highest annual reduction

rate, 24.3 [95% UI: 19.4-29.2], was observed in Gambella region, whereas the lowest, 12.3 [95% UI: 6.7-17.7], was exhibited in the Tigray region. The incidence rate of diarrheal disease annually declined among children under five, but it annually increased among elderly people from 1990-to 2019 across all regions (Table 1, Figure 2).

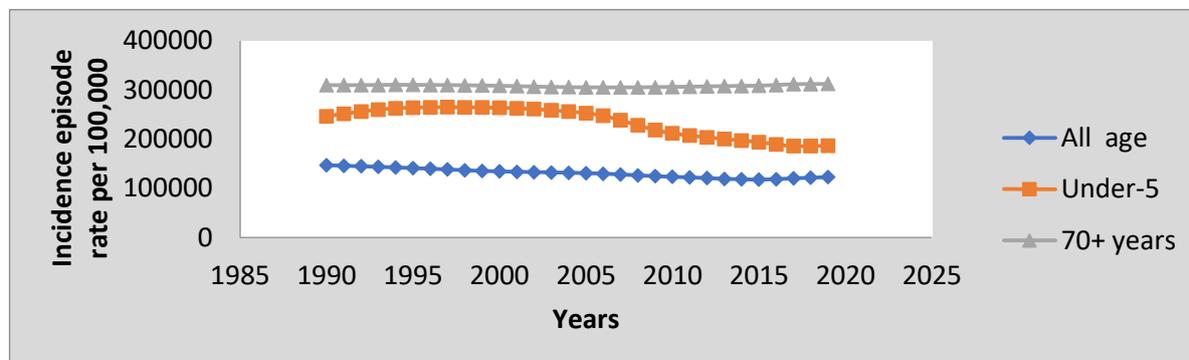


Figure 2. National diarrheal disease incidence rate trend per 100,000 populations by age group from 1990-2019

Table 1. National and sub-national age-standardized diarrheal disease incidence rate per 100,000 population and an annual rate of change by age group from 1990-2019.

Region	Incidence Rate per 100,000 population in 2019 for both sexes (95% UI)	Percentage annual change in rate from 1990-2019 for both sexes (95% UI)		
	ASIR in 2019 (95% UI)	percentage change in rate for all ages 1990 -2019	percentage change in rate for < 5 years 1990 - 2019	percentage change in rate for 70+ years 1990 -2019
Ethiopia	122781.79(113245.39,132880.57)	-0.16 (-0.21, -0.12)	-0.24 (-0.31, -0.17)	0.01 (-0.03, 0.04)
Addis Ababa	105243.37(95514.58,115230.19)	-0.17 (-0.22, -0.11)	-0.36 (-0.43, -0.27)	0.01 (-0.05, 0.08)
Afar	120319.02(109556.32,131837.38)	-0.22 (-0.27, -0.15)	-0.21 (-0.30, -0.13)	0.01 (-0.08, 0.07)
Amhara	124858.52(114073.51,136582.65)	-0.13 (-0.18, -0.07)	-0.15 (-0.26, -0.05)	0.01 (-0.04, 0.06)
Benishangul	135755.36(123403.96,149038.63)	-0.18 (-0.22, -0.12)	-0.16 (-0.24, -0.06)	0.004 (-0.04, 0.05)
Dire dawa	108118.42(99254.26,118184.28)	-0.20 (-0.25, -0.14)	-0.28 (-0.36, -0.20)	-0.02 (-0.11, 0.04)
Gambelia	123365.45(113117,134997.73)	-0.24(-0.29, -0.19)	-0.21 (-0.30, -0.11)	-0.06 (-0.12, -0.02)
Harari	115323.4(104715.01,125732.53)	-0.21 (-0.27, -0.15)	-0.26 (-0.34, -0.18)	-0.03 (-0.11, 0.05)
Oromia	121634.65(111642.1,132610.4)	-0.19 (-0.25, -0.13)	-0.30 (-0.39, -0.19)	0.01 (-0.05, 0.06)
Somali	127784.3(116757.62,139555.2)	-0.14 (-0.20, -0.08)	-0.21 (-0.29, -0.11)	0.001 (-0.05, 0.06)
SNNPR*	126151.96(115223.47,137235.95)	-0.17 (-0.23, -0.10)	-0.24 (-0.31, -0.16)	0.002 (-0.05, 0.06)
Tigray	116418.51(106658.08,126704.22)	-0.12 (-0.18, -0.07)	-0.24 (-0.31, -0.16)	0.03 (-0.04, 0.09)

Diarrheal Associated Mortality Trends

Nationally, in 2019, 50,773.3 [95% UI: 34,603.1-71,122.5] deaths occurred due to diarrheal diseases. National age-standardized diarrheal disease-associated mortality rate (ASMR) was 76.4 [95% UI: 45.1-112.2] per 100,000 populations in 2019, and all regions' ASMR fell within the national uncertainty interval,

except Addis Ababa City Administration (24.42 [95% UI: 9.55-44.34]) with lower mortality rate (Table 2). The mortality rate per 100,000 population among elderly people was much higher than the general population and under-five children across all regions of Ethiopia (Figure 3).

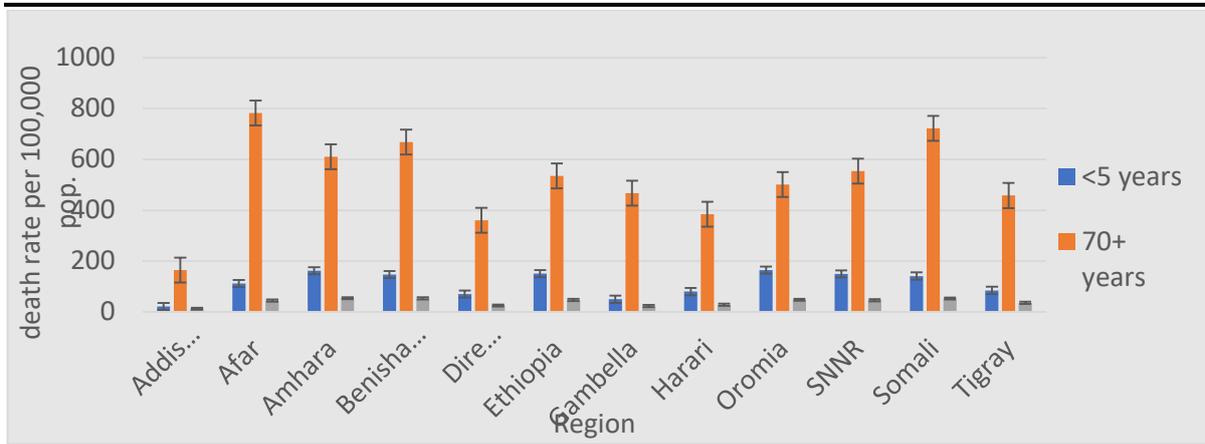


Figure 3. **National and sub-national diarrheal disease-associated mortality rate per 100,000 populations by age group in 2019.**

Between 1990 and 2019, the national diarrheal disease-associated mortality declined by an annual rate of three-fourths (74.99% [95% UI: 43.06%-86.99]) (Figure 4). All regions and the two city administrations

showed a similar decline trend of ASMR in 30 years period, which ranged from 70% [95% UI: 19%-84.6%] in Somali Region to 85.7% [95% UI: 52.1%-92.9%] in Harari region (Table 2).

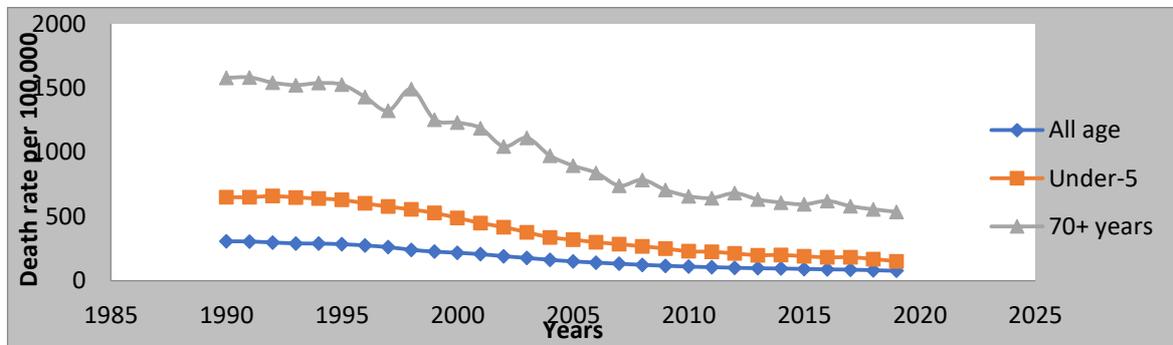


Figure 4. **National diarrheal disease associated mortality rate trend per 100,000 populations by age group from 1990-2019.**

Table 2: National and sub-national age-standardized diarrheal disease-associated mortality and YLL rate per 100,000 population and annual rate of change by age group from 1990-2019

Region	Mortality Rate per 100,000 population for both sexes (95% UI)				YLL Rate per 100,000 population for both sexes (95% UI)			
	ASMR in 2019	percentage change in rate for all ages 1990 -2019	percentage change in rate for < 5 years 1990 -2019	percentage change in rate for 70+ years 1990 -2019	AS YLL Rate in 2019	percentage change in rate for all ages 1990 -2019	percentage change in rate for < 5 years 1990 -2019	percentage change in rate for 70+ years 1990 -2019
Ethiopia	76.45(45.12,112.15)	-0.75 (-0.87, -0.43)	-0.77 (-0.86, -0.61)	-0.66 (-0.86, -0.05)	2679.41(1823.93,3760.22)	-0.76 (-0.85, -0.54)	-0.77 (-0.86, -0.61)	-0.71 (-0.88, -0.20)
Addis Ababa	24.42(9.55,44.34)	-0.85 (-0.92, -0.71)	-0.91 (-0.96, -0.82)	-0.83 (-0.93, -0.63)	706.94(346.09,1160)	-0.87 (-0.92, -0.77)	-0.91 (-0.96, -0.82)	-0.85 (-0.94, -0.65)
Afar	101.11(55.82,151.57)	-0.82 (-0.91, -0.38)	-0.77 (-0.89, -0.57)	-0.75 (-0.90, 0.06)	3028.74(1858.68,4359.95)	-0.83 (-0.91, -0.53)	-0.77 (-0.89, -0.57)	-0.81 (-0.91, -0.19)
Amhara	83.64(42.9,130.29)	-0.71 (-0.84, -0.43)	-0.80 (-0.90, -0.58)	-0.57 (-0.80, 0.03)	2872.53(1619.57,4669.36)	-0.75 (-0.86, -0.52)	-0.80 (-0.90, -0.58)	-0.63 (-0.83, -0.12)
Benishangul	106.56(58.68,168.74)	-0.78 (-0.91, -0.35)	-0.77 (-0.90, -0.52)	-0.73 (-0.90, -0.01)	3468.05(2075.83,5236.29)	-0.79 (-0.89, -0.46)	-0.77 (-0.90, -0.52)	-0.77 (-0.92, -0.14)
Dire dawa	49.08(26.15,79.26)	-0.82 (-0.90, -0.53)	-0.87 (-0.95, -0.70)	-0.77 (-0.90, -0.13)	1527.28(863.89,2479.98)	-0.84 (-0.92, -0.65)	-0.87 (-0.95, -0.70)	-0.79 (-0.90, -0.22)
Gambelia	66.2(31.72,106.05)	-0.83 (-0.93, -0.43)	-0.91 (-0.96, -0.79)	-0.80 (-0.92, 0.06)	1765.71(941.39,2671.89)	-0.87 (-0.94, -0.64)	-0.91 (-0.96, -0.79)	-0.82 (-0.93, -0.00)
Harari	52.24(26.81,86.27)	-0.86 (-0.93, -0.52)	-0.87 (-0.95, -0.71)	-0.82 (-0.93, 0.25)	1696.78(949.97,2706.74)	-0.86 (-0.92, -0.66)	-0.87 (-0.94, -0.71)	-0.85 (-0.94, 0.14)
Oromia	71.44(43.92,110.98)	-0.78 (-0.89, -0.36)	-0.77 (-0.87, -0.49)	-0.69 (-0.88, 0.08)	2636.66(1799.45,3752.16)	-0.78 (-0.87, -0.44)	-0.77 (-0.87, -0.49)	-0.74(-0.90, -0.09)
Somali	99.69(55.99,155.16)	-0.70 (-0.85, -0.19)	-0.53 (-0.77, -0.08)	-0.70 (-0.87, 0.14)	3189.06(2085.43,4620.42)	-0.67 (-0.81, -0.24)	-0.53 (-0.77, -0.08)	-0.74 (-0.89, 0.03)
SNNPR*	83.72(51.2,124.32)	-0.75 (-0.87, -0.36)	-0.74 (-0.87, -0.51)	-0.68 (-0.87, 0.07)	2883.22(1933.89,4093.83)	-0.75 (-0.87, -0.52)	-0.74 (-0.86, -0.51)	-0.72 (-0.89, -0.05)
Tigray	61.69(32.58,98.04)	-0.73 (-0.81, -0.58)	-0.82 (-0.91, -0.67)	-0.61 (-0.76, -0.30)	1885.83(1160.09,2787.08)	-0.77 (-0.85, -0.64)	-0.82 (-0.91, -0.67)	-0.68 (-0.81, -0.42)

Diarrheal Disease Associated Premature Mortality Rate and Trends

In 2019, more than three million years of life lost (YLL) occurred due to diarrheal diseases (3, 094,569.8 [95% UI: 2,135,894.6-4,510,290.4]) with the age-standardized YLL rate of 2,679.4 [95% UI: 1,823.9-3,760.2] per 100,000 populations (Table 2). Between 1990 and 2019, nationally, the age-standardized YLL

rate declined by more than three-fourths (76.30 % [95% UI: 53.90%, 85.29%]). In 30 years, all regions experienced an age-standardized YLL rate that falls within the national uncertainty interval. Nationally, in the 30 years years, YLL declined by an annual rate of 76.81% [95% UI: 60.65%, 85.81%] among under five children and 70.87% [95% UI: 19.86%-88.18 %] among older than 70-year adults (Table 2, Figure 5).

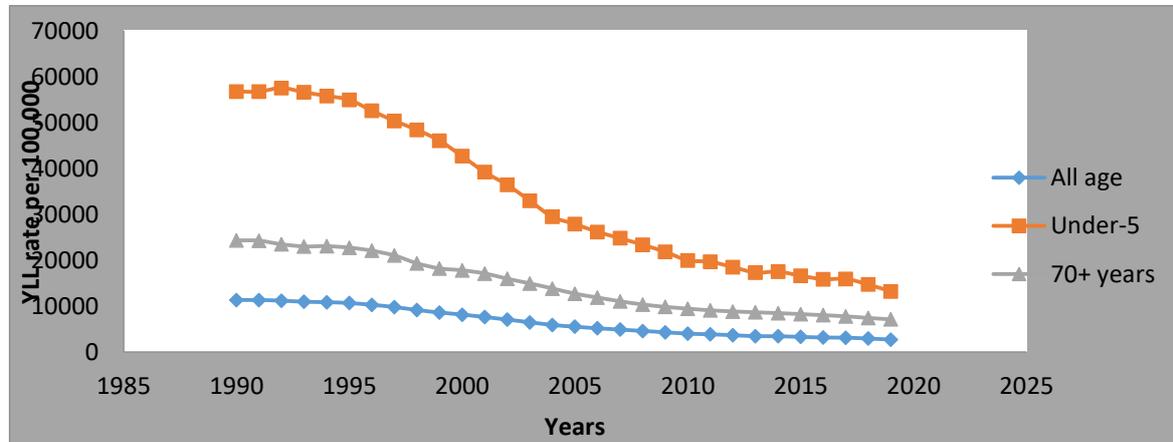


Figure 5. National diarrheal disease associated years of life lost rate trend per 100,000 populations by age group from 1990-2019

Discussion

In this study, age-standardized findings showed that 1 in 10 individuals suffered from diarrheal disease in 2019. This implies that diarrheal disease affects the lives of many Ethiopian populations. It is a major public health problem in poor settings, and has undesirable effects other than health issues. It significantly affects the quality of life of poor households (26). Lack of running water and hygienic material has imposed a psychological burden on the caregivers and sick individuals. While the rotavirus vaccine is available for children in Ethiopia, a significant number of children under five suffer from diarrheal diseases (7,15,18). This calls for evaluating vaccine accessibility and acceptability in the country. Moreover, diarrhoea imposes direct and indirect costs that fuel the existing poverty (1). This finding is similar to other studies conducted in low and middle income countries (27,28).

In this study, children under-five and elderly people (70+ years old) were more severely affected by diarrheal disease than the general population from 1990 to 2019. This is because these groups are prone to malnutrition, infectious, immune suppression, osmotic, secretory, inflammatory, and mal-absorptive absorption problems (4,8,29). In this study, the distribution of diarrheal disease is evenly distributed among regions. The uniformity would be justified by access to safe water, hygienic practices, and utilization of the rotavirus vaccine in the region. This finding suggests similar prevention modalities used across the regions (30–32).

This study also revealed that death due to diarrheal disease was more common in older population groups than in other age group. This fact may show that this group of people might be neglected from available intervention modalities in the country. Economic

problems could also deter elders from basic health care services. The finding informs the need to target those segments of the population, considering them even more vulnerable than children for diarrheal disease morbidity and mortality. This study also showed a similar decreasing rate of diarrheal-associated mortality nationally and sub-nationally among children under five and older than 70-year adults from 1990 to 2019. Generally, diarrheal-related death rate declined regardless of variability in age groups and regions.

This study also showed a high rate of premature mortality due to diarrheal disease at national and regional levels in the year of 2019. The rate of premature mortality showed a declining trend throughout all regions. This could be because of a similar intervention taken against diarrheal disease throughout the country. However, from all regions, Addis Ababa City showed a higher declining trend of YLL rate compared to the national rate; probably this is due to the accessibility of better health promotive, preventive, and curative care in Addis Ababa City. Age-wise comparison also revealed statistically similar YLL rates among under five children and older than 70 year adults. This could indicate that a higher death rate among the elder population than among children under 5 contributed to higher cumulative YLL in older ages, compensating for the cumulative effect of large YLL per death among children under 5.

The Overall limitation of GBD 2019 study has been published elsewhere (26). As a strength, this study utilized all available data sources in Ethiopia that could be accessed by the GBD 2019 study in estimating diarrheal disease incidence and associated mortality.

Conclusion

This study concludes that diarrheal disease incidence and associated mortality remained a significant public health problem at both national and regional levels. Diarrheal diseases mostly affect children and elderly people. Therefore, diarrheal disease prevention strategies, care, and treatment may need to focus on both extreme age group populations. Context-specific intervention needs to be devised through community participation and engagement.

Acronyms

ASIR-Age Standardized Incidence Rate,
 ASMR-Age Standardized Mortality Rate,
 EDHS-Ethiopian Demographic Health Survey,
 EPHI- Ethiopian Public Health Institute,
 GBD- Global Burden of Disease,
 IHME-Institute of Health Metrics and Evaluation,
 NDMC- National Data Management and Analytics Center,
 ORT-Oral Rehydration Therapy,
 SDG-Sustainable Developmental Goal,
 SNNPR-South Nation and Nationalities Peoples Region
 UI- Uncertainty interval,
 WASH- Water Sanitation and Hygiene,
 YLL- Years of Life Lost

Consent for publication

Not applicable

Availability of data and materials

The datasets used for the study are found in the IHME data repository, which can be accessed via <http://ghdx.647healthdata.org/gbd-results-tool>

Competing interests

The authors declare that they have no competing interests.

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Contribution of Authors: GTG, JB conceptualize and drafted the manuscript; SM, SB, TMB, MA, MD, FG, GW, AH, AM revised it critically for important intellectual content.

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