Original Research Article

SAGE Open Medicine

SAGE Open Medicine
Volume 10: 1–14
© The Author(s) 2022
Article reuse guidelines:
sagepub.com/journals-permissions
DOI: 10.1177/20503121221094688
journals.sagepub.com/home/smo
SAGE

Trends in inequality in the coverage of vitamin A supplementation among children 6–59 months of age over two decades in Ethiopia: Evidence from demographic and health surveys

Betregiorgis Zegeye[1], Comfort Z Olorunsaiye[2], Bright Opoku Ahinkorah[3], Edward Kwabena Ameyaw[3], Abdul-Aziz Seidu[4], Eugene Budu[4] and Sanni Yaya[5]*

Abstract

Objectives: There is a dearth of evidence on inequalities in vitamin A supplementation in Ethiopia. The goal of this study was to assess the magnitude and overtime changes of inequalities in vitamin A supplementation among children aged 6–59 months in Ethiopia.

Methods: We extracted data from four waves of the Ethiopia Demographic and Health Surveys (2000, 2005, 2011, and 2016). The analysis was carried out using the 2019 updated World Health Organization's Health Equity Assessment Toolkit software that facilitates the use of stored data from World Health Organization's Health Equity Monitor Database. We conducted analysis of inequality in vitamin A supplementation by five equity stratifiers: household economic status, educational status, place of residence, child's sex, and subnational region. Four summary measures—population attributable fraction, ratio, difference, and population attributable risk—were assessed. We computed 95% uncertainty intervals for each point estimate to ascertain statistical significance of the observed vitamin A supplementation inequalities and overtime disparities.

Results: The findings suggest marked absolute and relative pro-rich (population attributable fraction = 29.51, 95% uncertainty interval; 25.49–33.53, population attributable risk = 13.18, 95% uncertainty intervals; 11.38–14.98) and pro-urban (difference = 16.55, 95% uncertainty intervals; 11.23–21.87, population attributable fraction = 32.95, 95% uncertainty intervals; 32.12–33.78) inequalities. In addition, we found education-related (population attributable risk = 18.95, 95% uncertainty intervals; 18.22–19.67, ratio = 1.54, 95% uncertainty intervals; 1.37–1.71), and subnational regional (difference = 38.56, 95% uncertainty intervals; 29.57–47.54, ratio = 2.10, 95% uncertainty intervals; 1.66–2.54) inequalities that favored children from educated subgroups and those living in some regions such as Tigray. However, no sex-based inequalities were observed. While constant pattern was observed in subnational regional disparities, mixed but increasing patterns of socioeconomic and urban–rural inequalities were observed in the most recent surveys (2011–2016).

Conclusion: In this study, we found extensive socioeconomic and geographic-based disparities that favored children from advantaged subgroups such as those whose mothers were educated, lived in the richest/richer households, resided in urban areas, and from regions like Tigray. Government policies and programs should prioritize underprivileged subpopulations and empower women as a means to increase national coverage and achieve universal accessibility of vitamin A supplementation.

Keywords

Vitamin A supplementation, health inequalities, global health, demographic and health surveys, Ethiopia

Date received: 9 July 2021; accepted: 30 March 2022

[1]HaSET Maternal and Child Health Research Program, Shewarobit Field Office, Shewarobit, Ethiopia
[2]Department of Public Health, Arcadia University, Glenside, PA, USA
[3]School of Public Health, Faculty of Health, University of Technology Sydney, Sydney, NSW, Australia
[4]Department of Population and Health, University of Cape Coast, Cape Coast, Ghana
[5]Faculty of Medicine, University of Parakou, Parakou, Benin

*Sanni Yaya is also affiliated to School of International Development and Global Studies, University of Ottawa, Ottawa, ON, Canada

Corresponding author:
Sanni Yaya, School of International Development and Global Studies, University of Ottawa, Ottawa, ON K1N 6N5, Canada.
Email: sanni.yaya@gmail.com

Introduction

Vitamins are crucial micronutrients, which are necessary for good health.[1] Vitamin A is one of the essential vitamins that is vital for enhancing reproduction and vision, as well as for preventing blindness and infection.[1,2] Vitamin A has numerous important functions such as preserving the intestinal, respiratory, and urinary tracts and the surface of the eyes, as well as for proper functioning of the immune system.[3] Vitamin A is indispensable for adequate fetal growth during the embryonic phase.[4] On the other hand, absence of sufficient vitamin A, especially in children, increases the risk of illnesses such as blindness, measles, diarrhea, and death.[3,5]

Vitamin A deficiency (VAD) is a major public issue in low- and middle-income countries (LMICs).[6,7] Measles- and diarrhea-related childhood mortality is mainly associated with a deficiency of Vitamin A,[7] and in LMICs, its deficiency is one of the major causes of preventable childhood blindness.[8] Insufficient intake of vitamin A is considered as the key cause of VAD.[8] Children require optimal intake of vitamin A, especially during infections, for reducing VAD-related complications.[8]

Worldwide, nearly 190 million young children are affected by VAD,[9] in which Africa accounts for 56.4% of this global burden.[8] VAD significantly contributes to under-five morbidity and mortality.[10,11] Recent studies in LMICs showed that VAD accounts for 1.7% of the overall under-five mortality in those countries, of which 95% occurs in South Asia and sub-Saharan Africa.[7]

In Ethiopia, based on the 2016 Ethiopia Demographic and Health Survey (EDHS), child mortality is still high. For instance, 48 children per 1000 live births are dying before celebrating their fifth birthday.[1] VAD caused 80,000 deaths in a year and affected 61% of under-five children.[12,13] Approximately, 23% of all causes of child mortality can be averted by adequately supplementing vitamin A, especially for children with VAD, since it can increase their immunity and resistance to diseases.[6,11]

Assuring optimal supplementation coverage is extremely vital, not only for preventing VAD but because it is also one of the utmost cost-effective approaches and fundamental components of the child survival program.[6,9] A recent study in Ethiopia shows that vitamin A supplementation (VAS) has saved between 167,563 to 376,030 child lives between 2005 and 2019.[14]

Hence, many LMICs including Ethiopia have implemented interventions that include routine VAS for children aged 6–59 months. These interventions are constituents of the Integrated Management of Childhood Illness (IMCI) package and provide vitamin supplementation two times per year mainly at the primary health facility level and during other designated campaigns such as the maternal, newborn, and child health (MNCH) weeks and national immunization days.[11,15] VAS is being pragmatic in many LMICs.[16] Although few countries have reported that the coverage of VAS is up to 85%,[9] in many LMICs like Ethiopia, it is below this target.[17]

Based on the recent 2016 EDHS, the coverage of VAS among 6–59 months aged children was 45%.[1] Extant literature showed geographic and socioeconomic variations in VAS coverage.[18–20] However, there is a dearth of evidence on comprehensive assessments of inequalities in VAS in Ethiopia. Thus, the purpose of the present study was to answer two key questions: (1) What is the magnitude of VAS coverage across socioeconomic and geographic subpopulations from 2000 to 2016 in Ethiopia? (2) What are the trends in socioeconomic, demographic and geographic inequalities in vitamin A coverage in Ethiopia from 2000 to 2016?

Recognizing the magnitude of these disparities will uncover some of the underlying risk factors for poor population health outcomes and contribute to policies and programs/interventions to promote health for all.[21] The reduction of these inequalities is also crucial for the achievement of universal health coverage.[22,23] Ongoing monitoring of the magnitude of health inequalities is essential to assure the disadvantaged population groups are prioritized in policy and program interventions.[21]

Methods

Data source

It is a descriptive cross-sectional study and we used data from four waves of EDHSs (2000, 2005, 2011, and 2016). The EDHS is conducted with the financial support of the United State Agency for International Development (USAID) and technical assistance of United Nation International Children's Emergency Fund (UNICEF). The EDHS is a nationally representative survey designed to collect data on various health topics such as nutrition, domestic violence and female genital mutilation, access to mass media, fertility, young child development, breastfeeding and food intake, vaccinations, and treatment of diseases. By providing the government of Ethiopia with valid and up-to-date health indicators on reproductive-aged women (15–49 years of age), men 15–59 years old, and children under 5, the survey aims to monitor and assess the health situation of the population.

Sample size determination

The sample for all the four EDHS was designed to provide population and health indicators at national (urban and rural) and regional levels. The sample design permitted for specific indicators, such as VAS, to be calculated for each of Ethiopia's 11 geographic/administrative regions (the nine regional states and two city administrations).[1,24–26] The 1994 population and housing census, conducted by the Central Statistical Agency (CSA), was provided the sampling frame for the 2000 and 2005 EDHSs, while the 2007 population and housing census used for the 2011 and 2016 EDHSs. Administratively, regions in Ethiopia are divided into zones, and zones into administrative units called *weredas*. Each *wereda* is further subdivided into the lowest administrative unit, called *kebele*. Each *kebele* was subdivided into census enumeration areas (EAs), which were convenient for the implementation of the census. An EA is a geographic area that covers an average of 181 households. All four EDHS samples used a stratified, two-stage cluster sampling design, and EAs were the sampling units for the first stage. Thus, 2348 clusters (672 urban and 1676 rural) were selected from the list of EA using proportional probability sampling (PPS) technique. In the second stage, households from each cluster were then systematically selected for participation in the survey. In all four surveys, a total of 65,112 households were selected for the sample, of which 62,180 were occupied. Of the occupied households, 61,145 were successfully interviewed. A total of 37,625 children aged 6–59 months were included. Detailed description of the sampling design and overall methodology of EDHSs is explained elsewhere.[1,24–26]

Instruments

The EDHS data are collected usually every 5 years with the use of pretested validated quantitative tools and structured methodologies. Specifically for this study, data were collected using a questionnaire that included information on children's identity (age, sex, and relationship to the main caregiver) and VAS coverage during the preceding 6 months. Caregivers were shown samples of VA capsules and were asked about their sociodemographic characteristics and their sources of information on vitamin A. The information is based on mother's recall, health facility information (where available), and the vaccination card (where available). In case of missing information on the day of the supplementation date, we imputed 15 as the probable day. The rationale for selection of day 15 refers to its position in the middle of the month; therefore, it would minimize potential bias referring to the child's age in the date of the supplementation.[1,24–26]

Variables and their measurements

We measured inequality in VAS coverage, which is the primary outcome variable of interest for the study. VAS was assessed among living children aged 6–59 months who received vitamin A capsule or supplement 6 months before the interview.[27] In the EDHS, the mothers or caregivers are questioned on whether their child had received vitamin A capsule or not. If the child received the supplement, we coded the variable as "yes" and if not, we coded it as "no."[27]

We measured inequality in VAS coverage using five equity stratifiers, namely, household's economic status, educational status, child's sex, place of residence, and subnational region. Household economic status was measured using the Demographic and Health Survey (DHS) wealth index, which is customarily calculated by considering the possession of durable goods, household characteristics and availability of basic household facilities following the methodology explained elsewhere.[28] For all the surveys, the commonly used variables took account of possession of a car, motorcycle, bicycle, electricity, television, radio, and material used for constructing wall, roof and floor of household house, water and hygiene and sanitation facilities.[28,29] The constructed wealth index is then divided into five quintiles, namely, wealth quintile 1 (poorest), wealth quintile 2 (poorer), wealth quintile 3 (middle), wealth quintile 4 (richer), and wealth quintile 5 (richest). The other equity stratifiers are maternal education (coded as no education, primary school, secondary school and above), place of residence (coded as rural and urban), child's sex (coded as male and female), and subnational region (coded into nine regions and two city administration: Tigray, Afar, Amhara, Oromiya, Somali, Benishangul-Gumuz, South Nation and Nationalities People (SNNP), Gambela, Harari, Addis Ababa, and Dire Dawa).

Statistical analysis

The analysis was done using HEAT software that is recommended by World Health Organization (WHO) for investigation of health inequalities and it is available offline after installation. The detailed description of the software is available elsewhere.[30,31] In brief, the HEAT is software that enables the examination and analysis of health inequalities across and within countries. The software is valuable for exploring the health disparity situation in a systematic manner. The HEAT software application comprises the WHO Health Equity Monitor (HEM) database.[32] The database has large sets of data from Multiple Indicator Cluster Survey (MICS) and DHS which are carried out in several LMICs including Ethiopia. Currently, the HEM database comprises more than 30 maternal, neonatal, child and reproductive health indicators.

The analysis included two key steps. First, disaggregation of VAS was made using the above-mentioned five equity stratifiers. Following the disaggregation, VAS inequality was further analyzed using the four summary measures, namely, population attributable fraction (PAF), population attributable risk (PAR), difference (D), and ratio (R). The selection of the summary measures for an inequality study should be based on the fact that, the selected summary measures need to be of simple and complex measures.[33] At the same time, summary measures need to be relative and absolute measures to be able to examine inequality from different angles. For our study, we selected measures of inequality by these recommendations. PAF and PAR are complex measures, whereas R and D are simple measures.[33] In addition, PAF and R are relative summary measures, whereas PAR and D are absolute summary measures.

Simple measures make pairwise comparisons of health between two subgroups, such as the most and least wealthy.[33] Simple pairwise comparisons have historically been the dominant type of measurement used in inequality monitoring, as their simplicity makes them intuitive and easily understood. Complex measurements, on the contrary, make use of data from all subgroups to assess inequality.[33] When describing the inequality in a health indicator by region, for instance, pairwise comparisons can be used to describe the inequality between two selected regions—such as worst versus best—whereas complex measures could describe the inequality that exists among all regions. While pairwise comparisons of inequality have certain limitations that complex measures overcome, they will be described here at length as they play an important role in inequality monitoring. Because they are straightforward, and they are preferable over complex measures in situations where complex measures do not present a substantially improved picture of inequality.[33] Detailed description of the calculation of each of the summary measures used in this study is explained elsewhere,[33,34] but we have highlighted here a summary. D is calculated by subtracting two subgroups ($D = Y_{high} - Y_{low}$), where Y_{high} represents richest, secondary school and above, female, and urban and Y_{low} represents poorest, no education, male, and rural for economic, education, sex, and place of residence dimensions, respectively. Similar calculation was applied for subregions (region with highest VAS coverage minus lowest VAS coverage). The calculation of R in all five dimensions of inequalities is similar with D except that R is dividing subgroups with highest VAS coverage with subgroups with lowest VAS coverage as follows: R is calculated by dividing two subgroups ($R = Y_{high}/Y_{low}$), where Y_{high} represents richest, secondary school and above, female, and urban and Y_{low} represents poorest, no education, male, and rural for economic, education, sex and place of residence dimensions, respectively.

PAR was calculated by subtracting the national average of VAS coverage from the reference subgroups. The reference subgroups for economic, education, sex, and place of residence are richest, secondary school and above, female, and urban, respectively. For subnational, the reference subgroups are region with the highest VAS coverage in each survey. PAF is computed by dividing the PAR with the national average of VAS coverage (μ) and multiplied by 100. An inequality in VAS coverage is nonexistent if the D included zero and R included 1. PAF and PAR take the value of zero if no inequalities or same levels are recorded across subgroups. The greater the value of PAF and PAR from zero, the higher the inequality. The value of PAF and PAR indicates the potential improvement in the national coverage of VAS coverage if the VAS coverage reached the same level across subgroups or no inequality across subgroups. A positive value of PAR and PAF indicates higher concentration of coverage of VAS coverage among advantaged subpopulations such as richest, secondary school and above, female children and urban residents as well as regions with the highest VAS coverage. Inequality trends were assessed in caution and by referring to the uncertainty intervals (UI) of each summary measure of different surveys. That means if the UIs did not overlap, there were increasing or decreasing changes, but the overlapping of UIs was considered a constant pattern. However, the small and large overlapping was not treated equally and authors considered this important concept during interpretations of trends. For enabling this study's quality of evidence, we followed the guideline indicated in strengthening Reporting of Observational Studies in Epidemiology (STROBE).[35]

Ethical considerations

For the analysis of this study, ethical approval was not sought for the present study because authors utilized already existing secondary data. All ethical procedures that were followed by the custodians of the data have been reported in the manuscript. In addition, the University of Ottawa's Office of Research Ethics and Integrity stated that "no ethics review is required for the use of previously collected, publicly available, anonymously collected data" (https://research.uottawa.ca/ethics/submission-and-review/types-review).

Results

Sociodemographic characteristics of study participants

In the present study, 37,625 children below 5 years are included. Of them, 18,458 (49%) were females and 33,616 (89.3%) were rural residents. Approximately three-fourth (27,889 (74.1%)) of the respondents (their mothers) had no formal education, while 7851 (20.9%) and 1883 (5.0%) of the respondents attended primary and secondary school, respectively (Table 1).

Coverage of VAS among children 6–59 months of age

The findings show the overall national coverage rates of VAS in 2000, 2005, 2011 and 2016 were 59.9%, 46%, 53.1% and 44.7% respectively. This study also shows marked differences in the coverage of VAS across wealth quintiles, especially between quintile 1 (poorest) and quintile 5 (richest) from 2000 to 2016 survey period. In addition to variation, the coverage of VAS was mixed across economic subpopulations (Figure 1). For instance, among wealth quintile 1 and wealth quintile 5, VAS coverage decreased from 2000 to 2005 and then remained constant until 2016. Among wealth quintile 2, VAS coverage decreased from 2000 to 2005; however, it rose from 2005 to 2011 and decreased from 2011 to 2016.

In this study, we found variations in VAS coverage based on educational status, with higher coverage among secondary

Table 1. Sociodemographic characteristics of study participants: evidence from Ethiopia Demographic and Health Surveys.

Dimension of inequality	Subpopulation	Sampled population				
		2000	2005	2011	2016	Total
Economic status	Quintile 1 (poorest)	2108	1989	2191	2206	8494
	Quintile 2	2048	1892	2165	2106	8211
	Quintile 3	2005	1953	1989	1938	7885
	Quintile 4	1937	1743	1935	1642	7257
	Quintile 5 (richest)	1576	1377	1495	1323	5771
Educational level	No education	7892	7052	6793	6152	27,889
	Primary school	1287	1501	2629	2434	7851
	Secondary school+	497	403	353	630	1883
Place of residence	Rural	8638	8284	8498	8196	33,616
	Urban	1038	672	1278	1021	4009
Sex of child	Female	4775	4450	4775	4458	18,458
	Male	4902	4507	5001	4759	19,169
Subnational region	Tigray	639	590	639	604	2472
	Afar	97	85	97	93	372
	Amhara	2516	2025	2219	1745	8505
	Oromia	3937	3598	4082	4015	15,632
	Somali	114	383	293	420	1210
	Benshangul-gumz	93	83	113	100	389
	South nation Nationality People	2056	1986	2048	1944	8034
	Gambela	22	26	33	22	103
	Harari	20	18	24	21	83
	Addis Ababa	147	130	191	209	677
	Dire Dawa	31	30	32	39	132

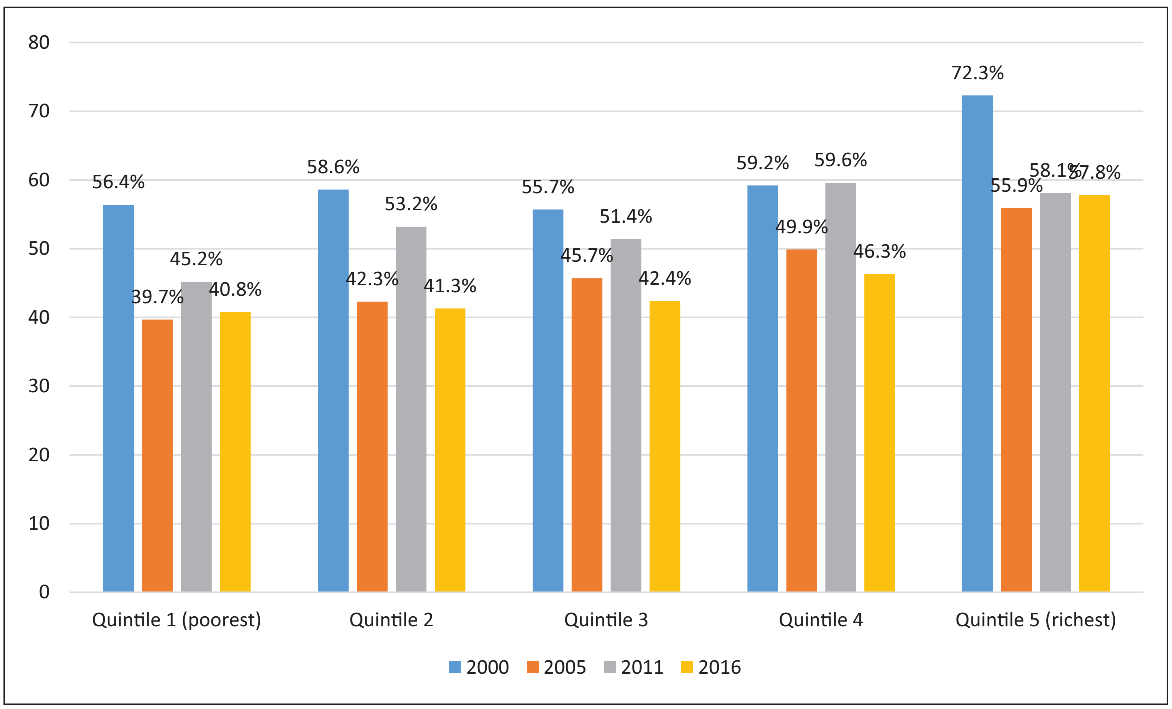

Figure 1. Coverage of vitamin A supplementation among children 6–59 months of age in Ethiopia by household economic status: Evidence from EDHS 2000–2016.

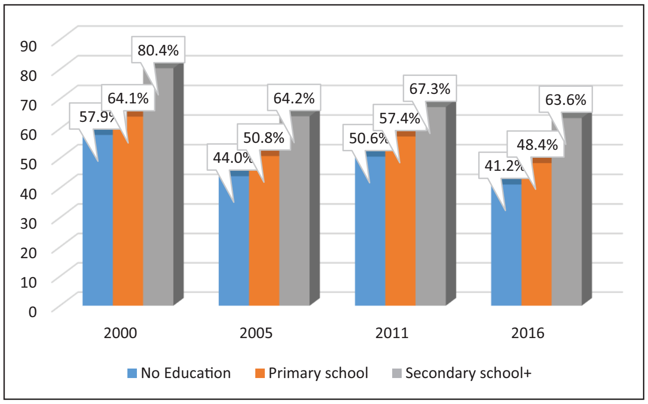

Figure 2. Coverage of vitamin A supplementation among children 6–59 months of age in Ethiopia by maternal educational status: Evidence from EDHS 2000–2016.

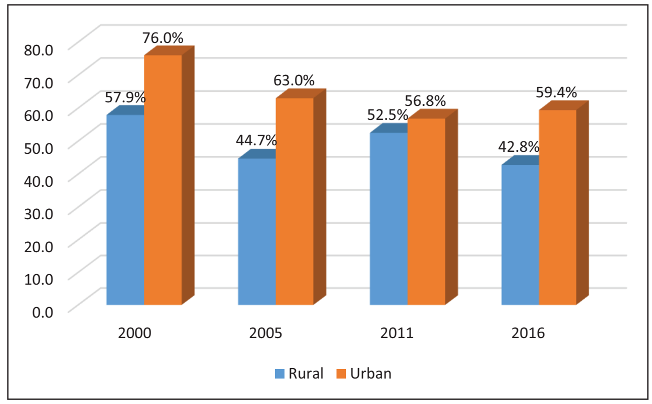

Figure 3. Coverage of vitamin A supplementation among children 6–59 months of age in Ethiopia by place of residence: Evidence from EDHS 2000–2016.

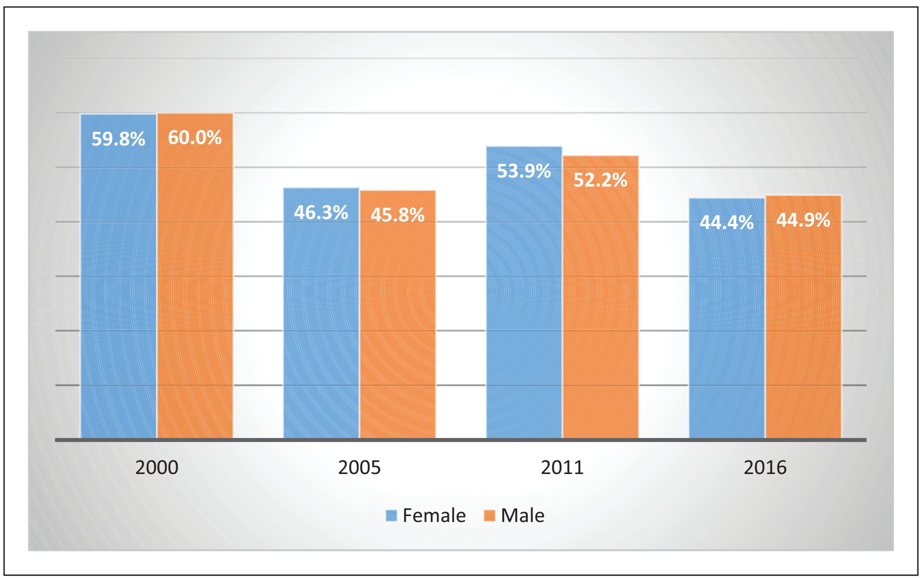

Figure 4. Coverage of vitamin A supplementation among children 6–59 months of age in Ethiopia by child sex: Evidence from EDHS 2000–2016.

school subgroups in all four surveys compared with no education subgroups. The pattern in the coverage of VASs also varied across education subgroups from 2000 to 2016. For instance, among no education subgroups, the VAS decreased from 2000 to 2005, then increased from 2005 to 2011, and again decreased from 2011 to 2016. Among secondary school and above subgroups, the VAS coverage decreased from 2000 to 2005 and then remained constant until 2016 (Figure 2).

This study revealed urban–rural variation in the coverage of VAS, with higher coverage among urban subpopulation especially in three surveys (2000, 2005, and 2016). Generally, the coverage decreased in both subpopulations approximately at a similar rate, which is 1.04 percentage points (pp) and 0.95 pp per year among urban and rural subgroups, respectively (Figure 3).

Regarding sex-based distribution, the coverage of VAS was not varied among male and female children in all four surveys as illustrated in Figure 4.

Another finding from this study is profound variation in the coverage of VAS coverage across subnational regions from 2000 to 2016. Except in Afar and SNNP regions, the coverage decreased from 2000 to 2005 across all regions. Again, except, Somali and SNNP regions, the coverage increased from 2005 to 2011. When we see the first and last surveys, the coverage roughly decreased in most regions, but an increment was seen in Benshangul-Gumuz and Afar regions. The coverage was approximately constant in Tigray, SNNP, and Gambela regions (Figure 5).

For more details about the magnitude and trends in the coverage of VAS coverage, with the corresponding 95% UI,

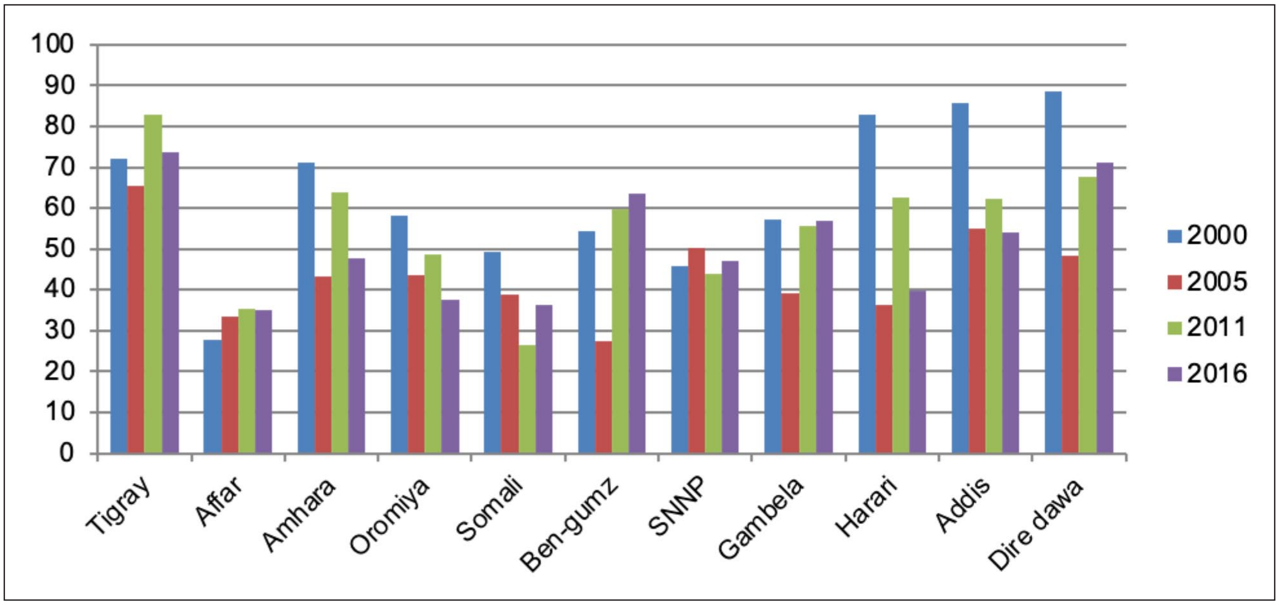

Figure 5. Coverage of vitamin A supplementation among children 6–59 months of age in Ethiopia across subnational regions: Evidence from EDHS 2000–2016.

among children 6–59 months of age across various subpopulation groups, please refer to Table 2.

Magnitude of and trends in inequality

Table 3 shows the magnitude and trends in socioeconomic and geographic related inequalities in VAS among children 6–59 months by four summary measures. We found significant absolute and relative wealth-driven inequalities between the 2000 and 2016 period both by simple (D, R) and complex (PAR, PAF) measures. For instance, in the 2016 survey, based on D measure, the coverage among children in the richest subgroups was higher by 17.1 pp (95% UI: 10.77–23.32) compared with children in the poorest subpopulation. Significant absolute and relative education-related inequalities in VAS coverage were observed both by simple and complex measures. The simple measures indicated constant pattern of inequality over the 16-year survey period. The patterns of both wealth-driven and education-related inequality were constant using the simple measures over the 16 years while mixed using the complex measures.

Except absence of inequality in 2011 by R measure, we found substantial relative and absolute place of residence inequalities in VAS from 2000 to 2016 both by simple and by complex measures. Both simple and complex measures show mixed pattern of urban–rural inequality. No sex-based inequality was seen over the 16-year survey period. We found significant absolute and relative region-related inequality in VAS coverage over the 16-year survey periods both by simple (D, R) and by complex (PAR, PAF) measures. For instance, the coverage of VAS in Tigray region was higher by 38.5 pp (95% UI; 29.57–47.54) compared with the Somali region. Constant patterns in both inequality types were observed using the complex measures and R measure. However, the D measure showed mixed pattern of absolute regional inequality; decrement from 2000 to 2005, then increment from 2005 to 2011 and again decrement from 2011 to 2016.

Discussion

In this study, we examined trends in absolute and relative inequalities in VAS among children 6–59 months using five commonly used inequality dimensions.[36–38] The findings show the overall national coverage rates of VAS coverage in 2000, 2005, 2011 and 2016 were 59.9%, 46%, 53.1%, and 44.7%, respectively. Our finding is lower compared with other African countries such as Senegal (88.4%), Rwanda (86.4%), Sierra Leone (83.2%), and Togo (81.7), respectively. The differences for coverage across countries could partly be due to variations in women's literacy level, place of residence and media exposure.[39]

Significant socioeconomic and geographic-based inequalities in VAS were observed in Ethiopia from 2000 to 2016. The patterns of inequalities varied based on the respective summary measures. The possible justification for the reduction of coverage of VAS coverage from 2000 to 2016 might be due to inequality in maternal healthcare service utilization.[40] Recent studies in Ethiopia shows that compared with 2000, the likelihood of maternal health service utilization significantly increased in 2016 among economically advantaged subpopulation than those who are poor.[40] This widened inequality might be due to fast population growth from 2000 to 2017,[41] which again results to increase healthcare demand

Table 2. Coverage of vitamin A supplementation across different subpopulations in Ethiopia from 2000 to 2016: Evidence from Ethiopia Demographic and Health Surveys.

Dimension of inequality	Subpopulation	2000		2005		2011		2016	
		% (95% UI)	Popn	% (95% UI)	Popn	% (95% UI)	Popn	% (95% UI)	Popn
Economic status	Quintile 1 (poorest)	56.42 (51.59–61.14)	2108	39.73 (35.69–43.91)	1989	45.21 (41.59–48.89)	2191	40.80 (35.93–45.86)	2206
	Quintile 2	58.65 (54.04–63.11)	2048	42.29 (38.06–46.64)	1892	53.16 (48.90–57.38)	2165	41.29 (37.54–45.16)	2106
	Quintile 3	55.69 (51.36–59.95)	2005	45.75 (41.75–49.82)	1953	51.39 (47.08–55.68)	1989	42.37 (38.26–46.59)	1938
	Quintile 4	59.21 (54.77–63.50)	1937	49.92 (44.94–54.89)	1743	59.63 (55.03–64.07)	1935	46.29 (41.57–51.06)	1642
	Quintile 5 (richest)	72.28 (67.67–76.46)	1576	55.95 (50.77–61.01)	1377	58.07 (51.98–63.93)	1495	57.85 (53.97–61.64)	1323
Educational level	No education	57.90 (55.28–60.47)	7892	44.02 (41.10–46.98)	7052	50.61 (47.94–53.28)	6793	41.24 (38.26–44.29)	6152
	Primary school	64.12 (58.47–69.40)	1287	50.77 (45.99–55.55)	1501	57.43 (53.55–61.22)	2629	48.42 (44.64–52.22)	2434
	Secondary school+	80.44 (73.90–85.66)	497	64.27 (58.11–69.99)	403	67.27 (59.54–74.17)	353	63.62 (58.27–68.65)	630
Place of residence	Rural	57.95 (55.30–60.56)	8638	44.68 (41.96–47.45)	8284	52.48 (49.88–55.07)	8498	42.83 (40.22–45.49)	8196
	Urban	75.96 (69.57–81.37)	1038	63.03 (56.41–69.19)	672	56.83 (50.17–63.25)	1278	59.39 (54.69–63.93)	1021
Sex of child	Female	59.78 (56.87–62.62)	4775	46.28 (43.32–49.27)	4450	53.93 (51.19–56.64)	4775	44.41 (41.47–47.39)	4458
	Male	59.99 (57.22–62.69)	4902	45.85 (43.03–48.69)	4507	52.21 (49.29–55.11)	5001	44.91 (42.22–47.62)	4759
Subnational region	Tigray	71.95 (67.77–75.79)	639	65.33 (59.56–70.68)	590	82.78 (78.11–86.62)	639	73.54 (67.20–79.04)	604
	Afar	27.61 (18.77–38.62)	97	33.32 (25.88–41.69)	85	35.32 (29.03–42.17)	97	34.98 (28.54–42.01)	93
	Amhara	71.08 (66.93–74.91)	2516	43.31 (36.75–50.12)	2025	63.76 (57.86–69.28)	2219	47.82 (43.12–52.56)	1745
	Oromia	58.14 (53.49–62.66)	3937	43.43 (38.92–48.06)	3598	48.68 (44.36–53.02)	4082	37.64 (33.18–42.33)	4015
	Somali	49.16 (35.43–63.02)	114	38.82 (31.88–46.24)	383	26.32 (21.05–32.37)	293	36.26 (30.62–42.31)	420
	Benshangul-Gumuz	54.21 (46.12–62.08)	93	27.40 (20.33–35.81)	83	59.89 (51.02–68.16)	113	63.67 (58.35–68.68)	100
	South Nation Nationality People	45.65 (40.70–50.68)	2056	50.19 (46.32–54.07)	1986	43.92 (39.85–48.06)	2048	47.06 (42.93–51.23)	1944
	Gambela	57.31 (46.62–67.35)	22	39.06 (31.91–46.72)	26	55.58 (48.95–62.01)	33	56.77 (49.50–63.75)	22
	Harari	82.99 (78.68–86.58)	20	36.33 (30.07–43.09)	18	62.57 (56.40–68.36)	24	39.63 (32.06–47.74)	21
	Addis Ababa	85.77 (80.83–89.59)	147	54.91 (48.45–61.22)	130	62.34 (55.70–68.56)	191	53.90 (47.78–59.91)	209
	Dire Dawa	88.48 (85.25–91.07)	31	48.18 (43.54–52.86)	30	67.56 (60.54–73.87)	32	71.22 (63.23–78.07)	39
National average		59.88		46.06		53.05		44.67	

UI: uncertainty intervals.

Table 3. Trends in inequalities in the coverage of vitamin A supplementation in Ethiopia from 2000 to 2016: Evidence from Ethiopia Demographic and Health Surveys.

Dimension	Year				
	Measure	2000	2005	2011	2016
		% (95% UI)	% (95% UI)	% (95% UI)	% (95% UI)
Economic status	D	15.85 (9.37–22.33)	16.22 (9.67–22.77)	12.85 (5.84–19.87)	17.05 (10.77–23.32)
	PAF	20.69 (17.57–23.81)	21.46 (17.32–25.61)	9.46 (5.98–12.93)	29.51 (25.49–33.53)
	PAR	12.39 (10.52–14.26)	9.89 (7.98–11.80)	5.01 (3.17–6.86)	13.18 (11.38–14.98)
	R	1.28 (1.14–1.41)	1.40 (1.21–1.60)	1.28 (1.11–1.45)	1.41 (1.22–1.61)
Educational level	D	22.54 (16.15–28.93)	20.24 (13.62–26.87)	16.65 (8.84–24.47)	22.37 (16.36–28.38)
	PAF	34.32 (33.56–35.08)	39.51 (38.33–40.69)	26.80 (25.57–28.04)	42.42 (40.79–44.04)
	PAR	20.55 (20.10–21.01)	18.20 (17.66–18.74)	14.22 (13.56–14.87)	18.95 (18.22–19.67)
	R	1.38 (1.27–1.50)	1.45 (1.29–1.62)	1.32 (1.16–1.49)	1.54 (1.37–1.71)
Place of residence	D	18.01 (11.57–24.45)	18.34 (11.39–25.29)	4.34 (–2.71–11.40)	16.55 (11.23–21.87)
	PAF	26.84 (26.30–27.38)	36.82 (36.16–37.48)	7.12 (6.40–7.84)	32.95 (32.12–33.78)
	PAR	16.07 (15.75–16.40)	16.96 (16.66–17.26)	3.77 (3.39–4.16)	14.72 (14.35–15.09)
	R	1.31 (1.19–1.42)	1.41 (1.24–1.57)	1.08 (0.94–1.21)	1.38 (1.24–1.52)
Sex of child	D	–0.20 (-4.15–3.74)	0.43 (-3.65–4.52)	1.72 (-2.26–5.70)	–0.49 (-4.49–3.51)
	PAF	0 (-1.60–1.60)	0.47 (-1.75–2.69)	1.65 (-0.16–3.48)	0 (-2.19–2.19)
	PAR	0 (-0.96–0.96)	0.21 (-0.80–1.24)	0.87 (-0.08–1.84)	0 (-0.98–0.98)
	R	0.99 (0.93–1.06)	1.00 (0.91–1.09)	1.03 (0.95–1.11)	0.98 (0.90–1.07)
Subnational region	D	60.86 (50.49–71.23)	37.93 (28.40–47.46)	56.46 (49.38–63.53)	38.56 (29.57–47.54)
	PAF	47.74 (32.69–62.79)	41.83 (20.68–62.97)	56.03 (46.58–65.48)	64.62 (42.87–86.38)
	PAR	28.59 (19.57–37.60)	19.27 (9.52–29.01)	29.72 (24.71–34.74)	28.87 (19.15–38.58)
	R	3.20 (2.04–4.36)	2.38 (1.68–3.08)	3.14 (2.44–3.83)	2.10 (1.66–2.54)

UI: uncertainty intervals; PAF: population attributable fraction; PAR: population attributable risk; R: ratio; D: difference.

and imbalanced population to health facility ratio and due to low healthcare forces.[40] A recent study in Ethiopia shows that related to individual, household, and community-level factors, women in Ethiopia are still changing in accessing healthcare services, especially those who are disadvantaged subpopulations.[42] The finding shows more than 71% of married women in Ethiopia encountered at least one type of barrier (i.e. money, distance to a health facility, getting permission to go to a health facility, and going alone) to accessing healthcare services.[42]

Some husbands still do not allow their spouses and children to access and use healthcare services, and this is partly linked to their religious view.[43] As an example, a study in Northeast Ethiopia indicates that societies are articulated that healing, as well as illness and health, is given by God. The healing system takes place through searching for the help of the divine via supplication and scripture-based healing procedures and through nature spirit actors which include "woliy," "wodaja," and "tsebel"/holy water. Every nature spirit agent performs numerous key roles on this process affecting non-secular, mental, and bodily health.[44]

Healthcare utilization can be affected by cultural backgrounds, ideals, norms and values of particular ethnic organizations and faith. Ethnicity and faith are frequent concepts linked to beliefs, norms, and values on the subject of pregnancy, childbirth, and usage of services.[45]

A previous inquiry on Ethiopia's maternal health services utilization suggests that Christian and Muslim women had been more likely to apply maternal health services than conventional and other religions. This result is steady with other studies. This may be because women with traditional religion can be much less modern and greater inclined to standard beliefs. Regarding ethnicity, Wolaita ethnic groups were less probably to use skilled antenatal care and transport care than other ethnic agencies. The reason for the low maternal health service usage by the Wolaita ethnic group can be because of the fact that those ethnic groups culturally might not assist facility delivery due to their cultural ideals and values on maternal healthcare.[46]

Geographic related and socioeconomic inequalities remained high in accessing health services more prevalently in rural settings.[42,47] More precisely, we found pro-rich inequalities, which were comparable with findings of studies in India,[19] Philippines,[48] Cambodia,[49] Bangladesh,[50] Guinea[51] and Ethiopia.[52] In Ethiopia, the report from 2016 EDHS confirmed recent findings of about 17% variation in VAS coverage between children in the poorest households (41%) and children in the richest households (58%).[1] Higher uptake of VAS among children from the wealthier households might partly be due to the fact that better economic status increases healthcare seeking behaviors and access to health information.[53]

Within the Ethiopian health system, a few public health services had been provided to all residents freed from charge irrespective of level of earnings. This has taken place because of the nature of these activities and due to the desire to promote the utilization of certain healthcare services. Although exemption services were extra standardized across regions, some services needed standardization by means of authorities. Services that have been supplied free of price in a few public health centers have been not unfastened in others. Furthermore, there was no clear distinction among the financing and service provision. Health centers were providing free services without budgetary/funding support for these sports.[54]

Ethiopia institutionalized mechanisms for supplying offerings to the bad free of price through a fee-waiver system, as well as through free provision of selected public health services (via exemption) consisting of health education and treatment of tuberculosis patients and through services targeting selected corporations (e.g. immunization of children under the age of 5). However, a sturdy want existed to systematize and standardize those services. For instance, local authorities had been issuing (and continues to be issuing in some areas) price waiver certificates to the negative as verified through local social justice structures at the time of sickness. This led to cumbersome processes that brought on delays in the poor's capability to get entry to care. This changed into now not the case for people in better income classes, and the system therefore created healthcare inequities.[54,55]

We found education-related disparities in VAS coverage that favored children from educated mothers as compared with children from mothers who had no formal education. Similar findings are reported in several previous studies in India,[19] Philippines,[48] Cambodia,[49] Bangladesh,[50] Guinea,[51] Nigeria,[20] Ghana,[18] and Ethiopia.[52] The observed association between VAS coverage and mother's education is not surprising; this relationship has also been reported in association with other child health services such as immunization[36] and nutrition.[56] Better utilization of maternal and child health services has been reported among educated women, likely because education enhances access to opportunities as well as communication capacities with healthcare providers. These could potentially lead to improved understanding of the benefits and schedules of health promotion services.[57–59] Furthermore, disparities in access to health information between educated and non-educated mothers could be reduced through strategies tailored to the local context and suited to non-educated women within communities, as reported in Mali.[60]

A previous study in Sierra Leone showed that extensive and contextual cluster-based social mobilization resulted in increased VAS coverage from 86.7% to 97.8%. This finding suggests that designing contextual-based awareness creation strategies for the improvement of VAS coverage and other child health services is an effective solution to promote healthcare utilization among the poorest individuals, especially within communities with low female literacy rates.[61]

In this study, significant pro-rich disparities in VAS coverage were observed in all four surveys. A study conducted in Kenya also reported comparable findings.[62] One possible justification for poor uptake of VAS coverage among rural residents might be a far distance to health facilities.[62] Unlike children living close to health facilities, poor uptake of VAS coverage is usually seen among children living far from the facilities.[62] This may be explained partly by transport costs needed to reach the health facilities.[62] The other reason might be due to factors such as women's autonomy, societal way of life and perceptions interconnected with the use of maternal and child health services on every occasion they want care. This could be associated with other variables like with schooling of women and urban residence, both of which are factors that boom the chance of the use of maternal and child health services.[46] Our study showed no sex-based disparities in VAS coverage in Ethiopia in all four surveys. No sex-based variation in VAS coverage was reported in several previous studies elsewhere.[19,20,50,63] Furthermore, we found substantial regional disparities in VAS coverage in Ethiopia from 2000 to 2016. The PAF and PAR measures in the 2016 survey, for example, indicated that, if the country avoided relative and absolute disparities in VAS across regions, it was possible to increase the 2016 national VAS coverage approximately by 64.6 pp and 28.8 pp, respectively. The finding showed that the VAS coverage in regions such as Afar and Somali was approximately two times lower than Tigray region. Similar findings are reported in Ethiopia,[64] Nigeria,[20,65,66] Guinea[51] and India.[19] In Afar and Somali regions of Ethiopia, majority of the population are Muslim,[1] and in those communities' religious beliefs and cultural practices are believed to influence the uptake of maternal and child health interventions, similar to findings reported in Nigeria.[20,67,68] Evidence shows fathers' consent in such communities is significantly related to utilization of maternal and child health services including immunization and VAS coverage.[69,70] However, other factors such as unequal distribution of healthcare services across regions within the country may also be possible reasons for the observed disparities.[47]

A previous study in Ethiopia reported inequalities in access and availability, across subnational regions, related to health center–based healthcare services.[47] This may be partly explained by unequal distribution of healthcare providers across regions.[24] A typical example of this is that a previous study in Ethiopia has revealed poor accessibility of health services in Afar region related to a shortage of healthcare providers, in addition to the difficult climate conditions and pastoral life of the communities.[71]

Another study by WHO also confirmed inequalities in the distribution of healthcare providers across regions.[72] Therefore, ensuring equal distribution of human and other resources across regions may reduce disparities in the uptake of health services, including VAS.[47] In addition, regional differences in culture, socioeconomic status, supply or availability, and accessibility of immunization and VAS services might be another possible reason for the disparities assessed.[73] For example, a study conducted on regional economic inequality in Ethiopia shows that though little increment is seen especially after 1994, the dominantly pastoral regions of the country (Afar and Somali) have the lowest socioeconomic status. These regions are not only the most disadvantaged regions in the country in terms of average economic status but also have the lowest intergenerational mobility.[74] Another recent study by Zegeye et al. on barriers of healthcare access in Ethiopia shows huge variations in barriers to accessing healthcare services across regions with more barriers among Oromia, Benshangul-Gumuz, and SNNP regions, respectively.[42] Therefore, all the above-mentioned contexts need to be considered in policies and programs aimed at enhancing VAS coverage in Ethiopia.

Strengths and limitations of the study

The first strength of this study is the use of nationally representative EDHSs to investigate wide-ranging inequalities in VAS coverage through a standardized analytic approach. In addition, incorporating simple and complex as well as absolute and relative summary measures of inequalities has highlighted significant types of inequalities in the coverage of VAS coverage as a first step toward reducing and eliminating these disparities. Despite these strengths, a notable limitation of the current study is that due to the emphasis on the five equality stratifiers included in the WHO's Health Equity Monitor Database, we were not able to include other sociocultural and demographic covariates in the analysis. Therefore, we recommend future studies to address this gap. Finally, since the data in the software are available as 0–59 months, we were unable to use age as a dimension of inequality.

Conclusion and policy implication

In this study, notable socioeconomic, urban–rural, and subnational region inequalities in VAS were observed from 2000 to 2016 in Ethiopia. These disparities favored children from advantaged subpopulations such as those with educated mothers, richest/richer household wealth quintiles, urban residence and regions such as Tigray. However, we did not find sex-based disparities in VAS across all four surveys. The findings suggest mixed patterns of socioeconomic and urban–rural disparities, with overall increases in the recent two surveys (2011–2016). Regional disparities remained constant over the 16 years of surveys. Therefore, prioritizing underprivileged subpopulations could be temporary solution to the observed disparities in VAS. In the long-term, equitable allocation of national economic and development benefits across regions and subpopulations as well as empowering women through education and economic resources may ensure universal health coverage and sustainable health development.

Monitoring health inequality fosters accountability and continuous improvement within health systems. Underprivileged population subgroups can hold back a country's national VAS figures as outliers. Addressing health inequalities such as inequalities in VAS can thus lead to a better national health system, enhancing national coverage of VAS like that of other African countries that have relatively better coverage of VAS, which included Senegal (88.4%), Rwanda (86.4%), Sierra Leone (83.2%) and Togo (81.7). Moreover, it can ensure the principle of health for all.

Acknowledgements

The authors acknowledge WHO for making the HEAT software available to the public domain for free.

Author contributions

S.Y. and B.Z. contributed to the conception and design of the study, interpreted the data, and prepared the first draft manuscript. C.O.Z., B.O.A., E.K.A., A.S., and E.G. helped with data interpretation and critically reviewed the manuscript for its intellectual content. S.Y. had the final responsibility to submit the manuscript for publication. All authors read and revised drafts of the paper and approved the final version.

Data availability

The datasets generated and/or analyzed during the current study are available in the WHO's HEAT version 3.1 [(https://www.who.int/gho/health_equity/assessment_toolkit/en/).

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethical approval

Ethical approval was not sought for the present study because authors utilized already existing secondary data. All ethical procedures that were followed by the custodians of the data have been reported in the manuscript. In addition, the University of Ottawa's Office of Research Ethics and Integrity stated that "no ethics review is required for the use of previously collected, publicly available, anonymously collected data" (https://research.uottawa.ca/ethics/submission-and-review/types-review).

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Informed consent

Informed consent was obtained from all subjects before the study. The DHS Program maintains strict standards for protecting the privacy of respondents and household members in all DHSs. Before each interview or biomarker test is conducted, an informed consent statement is read to the respondent, who may accept or decline to participate. A parent or guardian must provide consent prior to participation by a child or adolescent.

ORCID iD

Sanni Yaya https://orcid.org/0000-0002-6003-139X

References

1. Central Statistical Agency (CSA) [Ethiopia] and ICF. *2016 Ethiopia demographic and health survey key findings*. Addis Ababa, Ethiopia; Rockville, MD: CSA and ICF, 2017.
2. Khillan JS. Vitamin A/retinol and maintenance of pluripotency of stem cells. *Nutrients* 2014; 6: 1209–1222.
3. Smith RG. *The vitamin cure for eye disease: how to prevent and treat eye disease using nutrition and vitamin supplementation*. Laguna Beach, CA: Basic Health Publications, 2012.
4. World Health Organization (WHO). Vitamin A supplementation during pregnancy, 2015, http://www.who.int/elena/titles/vitamina_pregnancy/en/ (accessed 21 October 2021).
5. United Nations Children's Fund (UNICEF). *Vitamin A supplementation 2000–2014*. Geneva: UNICEF, 2015.
6. Imdad A, Mayo-Wilson E, Herzer K, et al. Vitamin A supplementation for preventing morbidity and mortality in children from six months to five years of age. *Coch Datab Syst Rev* 2017; 3: CD008524.
7. Stevens GA, Bennett JE, Hennocq Q, et al. Trends and mortality effects of vitamin A deficiency in children in 138 low-income and middle-income countries between1991 and 2013: a pooled analysis of population-based surveys. *Lancet Glob Health* 2015; 3(9): e528–e536.
8. World Health Organization (WHO). *Global prevalence of vitamin A deficiency in populations at risk 1995-2005: WHO global database on vitamin A deficiency*. Geneva: WHO, 2009.
9. United Nations Children's Fund (UNICEF) Division of Communication. *Tracking progress on child and maternal nutrition: a survival and development priority* (ed. UNICEF), 2009, https://www.unicef.org/publications/index_51656.html (accessed 21 October 2021).
10. World Health Organization (WHO). *The World Health Report 2002: reducing risks, promoting healthy life*. Geneva: WHO, 2002, p. 55.
11. United Nations Children's Fund (UNICEF). *Vitamin A supplementation: a decade of progress United Nations Children's Fund (UNICEF)*. New York: UNICEF, 2007.
12. Robles A. Strengthening the nutrition information and early warning system: rapid social response, 2012, http://documents.worldbank.org/curated/en/675361468024616821/pdf/781600BRI0377328B00PUBLIC00RSR0Story011.pdf (accessed 30 October 2021).
13. Federal Ministry of Health Ethiopia (FMoH). *National nutrition program*. Addis Ababa, Ethiopia: FMoH, 2015.
14. Laillou A, Baye K, Zelalem M, et al. Vitamin A supplementation and estimated number of averted child deaths in Ethiopia: 15 years in practice (2005–2019). *Matern Child Nutr* 2021; 17(3): e13132.
15. United Nations Children's Fund (UNICEF). Evaluation of the maternal, newborn and child health week in Nigeria, 2016, https://www.uniceforg/nigeria/reports/evaluationmaternal-newborn-and-child-health-week-nigeria (accessed 30 October 2021).
16. Bhutta ZA, Chopra M, Axelson H, et al. Countdown to 2015 decade report (2000–10): taking stock of maternal, newborn, and child survival. *Lancet* 2010; 375(9730): 2032–2044.
17. United Nations Children's Fund (UNICEF). Vitamin A deficiency, https://www.unicef.org/specialsession/about/sgreport-pdf/12_VitaminADeficiency_D7341Insert_English.pdf (accessed 30 October 2021).
18. Hadzi D, Asalu GA, Avedzi HM, et al. Vitamin A supplementation coverage and correlates of uptake among children 6–59 months in the South Dayi District, Ghana. *Centr Afr J Publ Health* 2014; 2: 89–98.
19. Agrawal S and Agrawal P. Vitamin a supplementation among children in India: does their socioeconomic status and the economic and social development status of their state of residence make a difference? *Int J Med Public Health* 2013; 3(1): 48.
20. Aghaji AE, Duke R and Aghaji UCW. Inequitable coverage of vitamin A supplementation in Nigeria and implications for childhood blindness. *BMC Public Health* 2019; 19: 282.
21. World Health Organization (WHO). *State of inequality: reproductive, maternal, newborn and child health*. Geneva: WHO, 2015.
22. Hosseinpoor AR, Bergen N, Koller T, et al. Equity-oriented monitoring in the context of universal health coverage. *PLoS Med* 2014; 11(9): e1001727.
23. Saksena P, Hsu J and Evans DB. Financial risk protection and universal health coverage: evidence and measurement challenges. *PLoS Med* 2014; 11(9): e1001701.
24. Central Statistical Agency (CSA) [Ethiopia] ICF. *2011 Ethiopia demographic and health survey key findings*. Addis Ababa, Ethiopia; Rockville, MD: CSA and ICF, 2012.
25. Central Statistical Authority (CSA) [Ethiopia] and ORC Macro. *Ethiopia demographic and health survey 2000*. Addis Ababa, Ethiopia; Calverton, MD: Central Statistical Authority and ORC Macro, 2001.
26. Central Statistical Agency (CSA) [Ethiopia] and ORC Macro. *Ethiopia demographic and health survey 2005*. Addis Ababa, Ethiopia; Calverton, MD: CSA and ORC Macro, 2006.
27. Croft TN, Marshall AMJ, Allen CK, et al. *Guide to DHS statistics*. Rockville, MD: ICF, 2018.
28. Rutstein SO and Johnson K. The DHS wealth index, http://www.measuredhs.com/pubs/pdf/CR6/CR6.pdf (accessed 13 December 2020).
29. Martel P. *Review of options for reporting water, sanitation and hygiene coverage by wealth quintile*. MICS methodological papers, no. 4. New York: Data and Analytics Section, Division of Data, Research and Policy, UNICEF, 2016.
30. World Health Organization (WHO). Global health observatory (GHO) data: health equity assessment toolkit—overview, https://www.who.int/gho/health_equity/assessment_toolkit/en/ (accessed 13 June 2020).
31. Hosseinpoor AR, Nambiar D, Schlotheuber A, et al. Health equity assessment toolkit (HEAT): software for exploring and comparing health inequalities in countries. *BMC Med Res Methodol* 2016; 16: 141.

32. Hosseinpoor AR, Bergen N, Schlotheuber A, et al. Data resource profile: WHO health equity monitor (HEM). *Int J Epidemiol* 2016; 45(5): 1404.e–1405.e.
33. World Health Organization (WHO). *Handbook on health inequality monitoring with a special focus on low- and middle-income countries*. Geneva: WHO, 2013.
34. World Health Organization (WHO). *Health equity assessment toolkit (HEAT): software for exploring and comparing health inequalities in countries*. Builtin database ed. (Version 3.1). Geneva: WHO, 2019.
35. Von Elm E, Altman DG, Egger M, et al. The strengthening reporting of observational studies in epidemiology (STROBE) Statement guidelines for reporting observational studies. *PLoS Med* 2007; 4(10): e296.
36. Shibre G, Zegeye B, Idriss -Wheeler D, et al. Inequalities in measles immunization coverage in Ethiopia: a cross-sectional analysis of demographic and health surveys 2000–2016. *BMC Infect Dis* 2020; 20: 481.
37. Yaya S, Ameyaw EK, Idriss-Wheeler D, et al. Summary measures of socioeconomic and area-based inequalities in fertility rates among adolescents: evidence from Ethiopian demographic and health surveys 2000–2016. *BMC Publ Health* 2021; 21: 763.
38. Shibre G, Zegeye B, Woldeamanuiel GG, et al. Observed magnitude and trends in socioeconomic and geographic area inequalities in obesity prevalence among non-pregnant women in Chad: evidence from three waves of Chad demographic and health surveys. *Arch Publ Health* 2021; 79: 133.
39. Berde AS, Bester P and Kruger IM. Coverage and factors associated with vitamin A supplementation among children aged 6–59 months in twenty-three sub-Saharan African countries. *Public Health Nutr* 2019; 22(10): 1770–1776.
40. Gebre E, Worku A and Bukola F. Inequities in maternal health services utilization in Ethiopia 2000–2016: magnitude, trends, and determinants. *Reproduct Health* 2018; 15: 119.
41. Ethiopia Population, http://worldpopulationreview.com/countries/ethiopiapopulation/ (accessed 28 October 2021).
42. Zegeye B, Adjei NK, Ahinkorah BO, et al. Barriers and facilitators to accessing health care services among married women in Ethiopia: a multi-level analysis of the Ethiopia demographic and health survey. *Int J Transl Med Res Publ Health* 2021; 52: 183–196
43. Jackson R, Tesfay FH, Godefay H, et al. Health extension workers' and mothers' attitudes to maternal health service utilization and acceptance in Adwa Woreda, Tigray region, Ethiopia. *PLoS ONE* 2016; 11(3): e0150747.
44. Kahissay MH, Fenta TG and Boon H. Religion, spirits, human agents and healing: a conceptual understanding from a sociocultural study of Tehuledere community, Northeastern Ethiopia. *J Relig Health* 2020; 59(2): 946–960.
45. Gabrysch S and Campbel O. Still too far to walk: literature review of the determinants of delivery service use. *BMC Pregn Childb* 2009; 9: 34.
46. Tarekegn SM, Lieberman LS and Giedraitis V. Determinants of maternal health service utilization in Ethiopia: analysis of the 2011Ethiopian Demographic and Health Survey. *BMC Pregn Childb* 2014; 14: 161.
47. Woldemichael A, Takian A, Akbari Sari A, et al. Availability and inequality in accessibility of health centre-based primary healthcare in Ethiopia. *PLoS ONE* 2019; 14(3): e0213896.
48. Choi Y, Bishai D and Hill K. Socioeconomic differentials in supplementation of vitamin A: evidence from the Philippines. *J Health Popul Nutr* 2005; 23(2): 156–164.
49. Grover DS, Pee Sd, Sun K, et al. Vitamin A supplementation in Cambodia: program coverage and association with greater maternal formal education. *Asia Pac J Clin Nutr* 2008; 17(3): 446–450.
50. Semba RD, de Pee S, Sun K, et al. Coverage of vitamin A capsule programme in Bangladesh and risk factors associated with non-receipt of vitamin A. *J Health Popul Nutr* 2010; 28(2): 143–148.
51. Bendech MA, Cusack G, Konate F, et al. National vitamin A supplementation coverage survey among 6-59 months old children in Guinea (West Africa). *J Trop Pediatr* 2007; 53(3): 190–196.
52. Semba RD, de Pee S, Sun K, et al. Coverage of the national vitamin A supplementation program in Ethiopia. *J Trop Pediatr* 2008; 54(2): 141–144.
53. Kassa G, Mesfin A and Gebremedhin S. Uptake of routine vitamin A supplementation for children in Humbo district, southern Ethiopia: community-based cross-sectional study. *BMC Publ Health* 2020; 20: 1500.
54. USAID. Health care financing reform in Ethiopia: improving quality and equity. *HealthSystems20/20*, https://www.hfgproject.org/wp-content/uploads/2015/02/Ethiopia_Health_Care_Reform_Brief1.pdf
55. USAID. HSFR Project. *The status of health care financing reform in Ethiopia: synthesis of data collected through supportive supervision in Amhara, Oromia and SNNP regions*. Addis Ababa, Ethiopia, 2010.
56. Zegeye B, Shibre G, Idriss -Wheeler D, et al. Trends in inequalities in childhood stunting in Ethiopia from2000 to 2016; a cross-sectional study. *J Publ Health* 2020; 43: 655–663.
57. Govindasamy P and Ramesh BM. *Maternal Education and the Utilization of Maternal and Child Health Services in India*. National family health survey subject reports no. 5. Calverton, MD: International Institute for Population Sciences Mumbai, India Macro International, 1997.
58. Vikram K, Vanneman R and Desai S. Linkages between maternal education and childhood immunization in India. *Soc Sci Med* 2012; 75(2): 331–339.
59. Landoh DE, Ouro-Kavalah F, Yaya I, et al. Predictors of incomplete immunization coverage among one to five years old children in Togo. *BMC Publ Health* 2016; 13(16): 968al.
60. Ayoya MA, Bendech MA, Baker SK, et al. Determinants of high vitamin A supplementation coverage among preschool children in Mali: the national nutrition weeks experience. *Publ Health Nutr* 2007; 10(11): 1241–1246.
61. Hodges MH, Sesay FF, Kamara HI, et al. High and equitable mass vitamin A supplementation coverage in Sierra Leone: a post-event coverage survey. *Glob Health Sci Pract* 2013; 1(2): 172–179.
62. Christine NK. Vitamin a Dietary Intake and Supplementation among children aged 12 to 59 months in Gatunga Ward, Tharaka Nithi County, Kenya, http://ir-library.ku.ac.ke/handle/123456789/18999 (accessed 21 October 2021).
63. Bishai D, Kumar K C S, Waters H, et al. The impact of vitamin A supplementation on mortality inequalities among children in Nepal. *Health Policy Plan* 2005; 20(1): 60–66.
64. Haile D, Biadgilign S and Azage M. Differentials in vitamin A supplementation among preschool-aged children in Ethiopia:

evidence from the 2011 Ethiopian Demographic and Health Survey. *Publ Health* 2015; 129(6): 748–754.
65. National Population Commission Nigeria. *Nigeria demographic and health survey 2003*. Calverton, MD: National Population Commission and ICF Micro, 2004, p. 705.
66. National Population Commission (NPC) [Nigeria] ICF and Macro. *Nigeria demographic and health survey 2008*. Abuja, Nigeria: National Population Commission and ICF Macro, 2009.
67. Ghinai I, Willott C, Dadari I, et al. Listening to the rumours: what the northern Nigeria polio vaccine boycott can tell us ten years on. *Glob Publ Health* 2013; 8(10): 1138–1150.
68. Ophori EA, Tula MY, Azih AV, et al. Current trends of immunization in Nigeria: prospect and challenges. *Trop Med Health* 2014; 42(2): 67–75.
69. Adamu MD and Muhammad N. Assessment of vitamin A supplementation coverage and associated barriers in Sokoto State, Nigeria. *Ann Niger Med* 2016; 10(1): 16.
70. Monguno AK. Socio cultural and geographical determinants of child immunisation in Borno State, Nigeria. *J Publ Health in Afr* 2013; 4(1): e10.
71. King R, Jackson R, Dietsch E, et al. Utilisation of maternal health services in Ethiopia: a key informant research project. *Dev Pract* 2016; 26(2): 158–169.
72. World Health Organization (WHO). *Primary health care systems (PRIMASYS): case study from Ethiopia*. Geneva: WHO, 2017.
73. Taddege TG, Derseh LG and Negesse AA. Geographical variation and associated factors of childhood measles vaccination in Ethiopia: a spatial and multilevel analysis. *BMC Public Health* 2019; 19: 1194.
74. Bethlehem A and Argaw BA. *Regional inequality of economic outcomes and opportunities in Ethiopia: a tale of two periods*. Helsinki: Unite Nation University, World Institute for Development Economic Research, 2017.