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The coexistence of stunting and overweight or obesity in Ethiopian children: prevalence, trends and associated factors

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Abstract

Background Double burden of childhood malnutrition is a condition where undernutrition (stunting) along with overweight and obesity coexist within individuals, households, and populations. It reflects a new layer of malnutrition and an understudied phenomenon in many low-income settings. To date, the prevalence and factors that are associated with concurrent stunting and overweight or obesity (overweight/obesity) (CSO) in the same children have not been well researched in Ethiopia. Hence, this study aimed to assess the prevalence, trends, and factors associated with the coexistence of stunting and overweight or obesity among children aged 0–59 months in Ethiopia.

Methods Pooled data from 2005, 2011 and 2016 Ethiopian Demographic and Health Survey (EDHS) were used. A total of 23,756 (weighted sample) children aged 0–59 months were included in the study. Height-for-age z-scores (HAZ) less than – 2 SD and weight-for-height z-scores (WHZ) above 2 SD were calculated, and children were classified as stunted and overweight/obese, respectively. A child who is simultaneously stunted and overweight/obese was considered as having HAZ below – 2 SD and WHZ above 2 SD computed into a variable named CSO, and reported as a binary outcome (yes or no). Multilevel logistic regression analysis that adjusts for sampling weights and clustering was used to identify factors associated with CSO.

Results The prevalence of stunting, overweight or obesity, and CSO among under-five children was 43.12% [95% CI: (42.50, 43.75%)], 2.62% [95% CI: (2.42, 2.83%)], and 1.33% [95% CI: (1.18, 1.48%)], respectively. The percentage of CSO children was reported to have declined from 2.36% [95% CI: (1.94–2.85)] in 2005 to 0.87% [95% CI: (0.07–1.07)] in 2011, and the same appeared to have increased slightly to 1.34% [95% CI: (1.13–1.59)] in 2016. Children who were currently breastfeeding [AOR: 1.64, 95% CI: (1.01–2.72)], born to an overweight mother [AOR: 2.65, 95% CI: (1.19–5.88)], and lived in families with 1–4 household members [AOR: 1.52, 95% CI: (1.02–2.26)] were significantly associated with CSO. At the community level the odds of having CSO were higher among children included from EDHS-2005 [AOR: 4.38, 95% CI: (2.42–7.95)].

Conclusion The study revealed that less than 2% of children had CSO in Ethiopia. CSO was linked to factors at both the individual (i.e. breastfeeding status, maternal overweight, and household size) and community-levels. Overall, the study findings indicated the necessity of focused interventions to simultaneously address double burden of

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Page 2 of 16

childhood malnutrition in Ethiopia. To further combat the double burden of malnutrition, early identification of atrisk children, including those born to overweight women and children living with multiple household members, is indispensable.

Keywords Double burden, Malnutrition, Concurrent stunting and overweight or obesity, Ethiopia

Introduction

Childhood malnutrition remains a serious public health challenge in low-income countries. Malnutrition in children refers to deficiencies or excesses in nutrient intake, imbalance of essential nutrients, or impaired nutrient utilization [1]. Children can also experience two contrasting forms of malnutrition, a condition termed the double burden of malnutrition (DBM), which has become a growing global challenge [2–4]. According to the World Health Organization (WHO) the double burden of malnutrition (DBM) is "characterized by the coexistence of undernutrition (stunting) along with overweight/obesity, and may lead to diet-related non-communicable diseases, within individuals, households, and populations, and across the life course" [2, 5]. For DBM to occur at the household level, at least one member in the household may be undernourished (i.e. stunted, wasted, or underweight) and at least one member is overweight/obese [6]. In contrast, at the individual level, the DBM is expressed when an individual is stunted during early life and may be overweight later in life; or an individual may have a coexistence of micronutrient deficiencies with overweight or obesity at the same time [6]. At the individual level, it has increasingly been observed that children can be overweight and stunted simultaneously (CSO) [7]. Evidence indicates that the best-targeted age to address childhood malnutrition is the first 1000 days of life as this window period is ideal for intervention implementation and tracking for the improvement of child growth and development [8].

Stunting is the most prevalent form of childhood growth failure across all years and countries. In 2019, 155 million children under 5 years of age were stunted [1] and 38.2 million were overweight or obese globally [9]. The concurrence of undernutrition and overweight has been increasing in the poorest low and middle-income countries (LMICs) due to changes that have been termed as the nutrition transition [4], resulting from lifestyle preferences, environmental factors, and cultural determinants [10]. In Africa, the number of overweight children has increased by nearly 24% since 2000 [9]. Conversely, stunting prevalence reduced from 34.5 to 31.1% between 2012 and 2019, but not sufficiently enough to reach the worldwide target [11]. The average prevalence of stunting in sub-Saharan Africa (SSA) was estimated to be 41% [12]. In the Eastern African region where Ethiopia is located, stunting continues to be a rampant public health concern. The region also bears the greatest proportion of under-five stunting and overweight or obese reported be 33.3% [13] and 4.59% [14], respectively.

Studies in different LMICs so far have focused on DBM of various forms of malnutrition in mother-child pairs residing in the same household [15-17]. Some studies have also investigated the co-morbid anemia and stunting among children aged 6-59 [18-21], and others have focused on concurrent stunting and wasting [22-25]. However, few studies have focused on the co-occurrence of stunting and overweight/obesity (CSO) in the same children [7, 26-30]. For instance, Fongar et al. (2019) conducted a study on the coexistence of overweight/obesity and undernutrition in under-fives in western Kenya and reported the prevalence of DBM to be 1.1% [27]. In a Vietnamese study that CSO was reported to be 2.7% in 2013 and 1.4% in 2016 [31], while in Ghana the CSO among Ghanaian children was stated to be 1.2% [26]. Previous studies have identified factors associated with CSO: including breasting feeding for less than 6 months [32], maternal age [28], socio-economic status [28, 29], wealth status [26], maternal education [29], shorter maternal height [28], and large household size [28].

In Ethiopia, the prevalence of stunting has decreased considerably from 51% in 2005 [33] to 37% in 2019 [34], has continued to decline at an average of more than 1 percentage point per year. Despite these reported improvements, stunting among children is substantially high and remains endemic. At the same time, there is an overall increment in the prevalence of overweight among children in Ethiopia [34, 35]. According to the 2019 Ethiopia Mini Demographic and Health Survey (EMDHS), the prevalence of overweight was 2% and increased from the 2016 EDHS report by 1% [34]. Recent primary studies have also revealed that childhood overweight/or obesity is emerging as a significant childhood public health issue and is consistently increasing in magnitude in Ethiopia [36, 37]. For example, a systematic review by Gebrie and colleagues in 2018, revealed that the combined pooled prevalence of overweight and obesity among children and adolescents in Ethiopia was 11.30% [38].

Although previous studies in Ethiopia have determined the different forms of DBM at the household level [17, 21, 39–41], only a few studies focused on CSO at the individual level [7, 42] and these studies explored CSO using a single snapshot survey. This study builds upon the drawback of the Farah et al. [7] study by combining three EDHSs to examine trends and associated factors of CSO. Hence, this present study aimed to investigate the prevalence, trends, and individual and community-level factors associated with concurrent stunting and overweight or obesity (CSO) among children aged 0–59 months in Ethiopia.

Methods

Study setting and data sources

Ethiopia is situated in the Horn of Africa $(3^{\circ}-14^{\circ} \text{ N} \text{ and } 33^{\circ}-48^{\circ} \text{ E})$. Amhara, Oromia, Tigray, Benishangul-Gumuz, Somali, Afar, Harari, Southern Nations Nationalities and Peoples (SNNP), Gambella, and two city administration councils (Addis Ababa and Dire Dawa) make up Ethiopia's administrative structure. The study was based on the combined datasets from three consecutive Ethiopia Demographic and Health Surveys (EDHSs) conducted in 2005, 2011 and 2016, a representative sample of the entire population in Ethiopia [33, 35, 43].

Study design and sampling

The EDHS is a cross-sectional study, which provides a comprehensive overview of population, maternal, and child health issues in Ethiopia with similar sampling methodology applied during data collection in 2005, 2011 and 2016. The EDHS sample was stratified and selected in two stages. In the first stage, enumeration areas (EA) were selected with probability proportional to EA size, with independent selection in each sampling stratum. In the second stage, a fixed number of households per cluster were selected with an equal probability of systematic selection from the newly created household listing [33, 35, 43]. For this study, a total weighted sample of 23,756 children aged 0-59 months were extracted from three surveys and included in the current analysis. The EDHS collected data on the nutritional status of children by measuring the weight and height of children under-five years of age in all sampled households. Children younger than the age of 24 months were measured lying down on the board (recumbent length), while standing heights were measured for older children. These methods have previously been described in the literature [35].

Variables

Outcome variable

The outcome variable was a concurrence of stunting and overweight/obesity (CSO) within the same child. Stunting was defined as height-for-age Z-score (HAZ) below -2SD and overweight/obesity was defined as weight-for-height (or length) z-score (WHZ) above 2 SD from the respective World Health Organization (WHO) 2006 growth standards reference [44] and was dichotomized as co-existence of overweight/obesity and stunting as "Yes", otherwise, "No".

Independent variables

Potential factors of CSO in children were selected based on previous studies [45–48]. The identified factors were categorized into individual/household and community level factors (Supplementary 1).

Data analysis

All analyses were carried out using STATA/MP version 14.1 (StataCorp, College Station, TX, USA). Sampling weighting was applied to all descriptive statistics to compensate for the disproportionate allocation of the sample across regions of Ethiopia. The weighting technique is explained in full in the EDHS reports [35]. Given the hierarchical nature of the EDHS data, multilevel logistic regression models were used to determine community and individual-level factors associated with CSO. A multilevel bivariable logistic regression analysis was performed to identify factors associated with the outcome variable. Variables in bivariable multilevel logistic regression analyses with a p-value < 0.2 were entered into the multilevel multivariable logistic regression models. The EDHS employed a multistage cluster sampling technique with hierarchical data (i.e., children and mothers were nested within households, and households were nested within clusters). Accordingly, four models were fitted: firstly, the empty model without any explanatory variables was run to detect the presence of a possible contextual effect (*model 1*); the second model was run with individual-level variables (model II), the third with community-level variables (model III), and the fourth with both individual/ household and community-level variables (model IV). The intraclass correlation coefficient (ICC) was computed for each model to show the number of variations explained at each level of modeling. An ICC equal or greater than 2% is an indicative of significant grouplevel variance which is a minimum precondition for a multilevel study design [49]. Model comparisons were performed using the deviance information criterion (DIC) [50, 51]. The model with the lowest DIC was considered the best fit model. Moreover, Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC) were used as diagnostics to determine the goodness of fit [52]. Odds ratio (OR) along with 95% confidence interval (CI), were used to estimate the strength of the association. A statistical significance was declared at *p*-value of less than 0.05.

Operation definition

Concurrent stunting and overweight/obesity (CSO): Children were classified as CSO if they had a HAZ value of <-2SD and their WHZ> + 2SD simultaneously.

Results

Socio-demographic and economic characteristics of the sample

A total of 23,756 children who were born in the last five years preceding the survey were included in the study (4,290 in EDHS-2005; 9,987 in EDHS-2011, and 9,479 in EDHS-2016). Almost half of these children were males (51.1%), and 41.1% of children were in the age group of 36–59 months. Almost three-fourths of the children (73.3%) were currently breastfeeding. Of all the study participants, 69.3% of children were born to mothers with no education, and most children were from rural areas (89.0%) (Table 1).

Prevalence of stunting, overweight or obesity, and CSO

The prevalence of stunting and overweight/ obesity among under-five children was found to be 43.12% [95% CI: (42.50, 43.75)] and 2.62% [95% CI: (2.42, 2.83)], respectively. The prevalence of coexistence of stunting and overweight/obesity (CSO) was found to be 1.33% [95% CI: (1.18, 1.48)] (Fig. 1 and Supplementary file 2).

Trends of stunting, overweight or obesity, and CSO (2005–2016)

The prevalence of CSO was found to be 2.36% [95% CI: (1.94, 2.85)] in 2005, 0.87% [95% CI: (0.7, 1.07)] in 2011, and 1.34% [95% CI: (1.13, 1.59)] in 2016. There was a significant decrement in CSO prevalence between 2005 and 2016 (Fig. 1). The percentage of stunted children has declined consistently since 2005, from 50.8% [95%CI: (49.3-52.3)] to 38.4% [95%CI: 37.4-39.4)]. The prevalence of overweight/obesity has decreased from 4.2% [95%CI: (3.63-4.84)] to 2.81% [95%CI: 2.49-3.16)] (Supplementary file 2). This decrease is statistically significant because the confidence intervals are not overlapping (Fig. 1). Children in rural areas were more likely than those in urban areas to have CSO throughout the survey years (2.38% versus 2.06% in EDHS-2005, 0.88% versus 0.71% in EDHS-2005, and 1.39% versus 0.89% in EDHS-2016) (Fig. 2). Similarly, between 2005 and 2016, the percentage of male children with CSO was frequently larger than that of females (Fig. 3). Stunting for children under age 5 sharply increases between age 6 and 35 months, and peaks at age 24-35 months. While **Table 1** Characteristics of the study participants included in the analysis by the individual- and community-level characteristics, EDHS (2005–2016, *n*=23,756)

| Variables | Category | Total weighted frequency (n) | Weighted percent (%) |
|---------------|-------------------------------|---------------------------------|-------------------------|
| Individual-le | evel characteristics | | |
| Child facto | ors | | |
| Sex | | | |
| | Male | 12,141 | 51.1 |
| | Female | 11,616 | 48.9 |
| Age (mo | onths) | | |
| | <6 | 2,470 | 10.4 |
| | 6–11 | 2,515 | 10.6 |
| | 12-23 | 4,524 | 19.0 |
| | 24–35 | 4,489 | 18.9 |
| | 36–59 | 9,758 | 41.1 |
| Birth or | der | | |
| | First born | 4,228 | 17.8 |
| | 2–4 | 10,324 | 43.5 |
| | 5 or higher | 9,204 | 38.7 |
| Birth int | erval | | |
| | <33 months | 16,550 | 69.7 |
| | ≥33 months | 7,206 | 30.3 |
| Size of c | child at birth | | |
| | Larger | 7,478 | 31.6 |
| | Average | 9,593 | 40.5 |
| | Small | 6,601 | 27.9 |
| Current | ly breastfeeding | | |
| | Yes | 17,421 | 73.3 |
| | No | 6,335 | 26.7 |
| Receive | d measles (<i>n</i> = 19,543 | 3) | |
| | Yes | 8,174 | 41.8 |
| | No | 11,369 | 58.2 |
| Full vac | cination ($n = 19,226$) | | |
| | Yes | 4,216 | 21.9 |
| | No | 15,010 | 78.1 |
| Diarrhea | a(n=23,722) | | |
| | Yes | 3,319 | 14.0 |
| | No | 20,403 | 86.0 |
| Fever | | | |
| | Yes | 3,965 | 16.7 |
| | No | 19,751 | 83.3 |
| Childrer | n received deworming | g medication | |
| | Yes | 2,985 | 14.0 |
| | No | 18,301 | 86.0 |
| Parental f | actors | | |
| Mother' | 's age | 475 | 0.7 |
| | < 18 | 1/5 | 0./ |
| | 18–24 | 5,329 | 22.4 |
| | 25-34 | 12,359 | 52.0 |
| | ≥ 35 | 5,893 | 24.8 |

Table 1 (continued)

| Mother's education16,46969.3Primary6,06425.5Secondary8513.6Higher3731.6Mother's occupation (n =23,657)Xon agriculture5,179Non agriculture5,17921.9Agriculture5,73324.2Antenatal care (ANC) visitXon agriculture5,733None8,28250.81-34,17125.64-73,47421.38+3622.2Matemal BMI (kg/m²)Xon7.74<18.5 to 24.917,62974.825+1,1815.0Any anemiaXon7.73Yes5,75724.9No17,39375.1Matemal Stature (n =23,598)*XonNormal5122.2Short8,24534.9Very short14,84062.9Listening to radioXonXonYes9,06038.2Not at all18,41677.6Household factorsWealth indexXonYes5,32422.4Not at all8,41677.6Household size14Poor10,76245.3Middle4,96420.9Rich8,03033.8Household size21.7Soli fuels2.873.6Type of cooking fuelXon1.7Soli fuels2.90489.7Source of drinking water <th>Variables</th> <th>Category</th> <th>Total weighted frequency (n)</th> <th>Weighted percent (%)</th> | Variables | Category | Total weighted frequency (n) | Weighted percent (%) |
|--|------------|--|---------------------------------|-------------------------|
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| Secondary 851 3.6 Higher 373 1.6 Mother's occupation (n = 23,657) 3.9 Not working 12,744 53.9 Not agriculture 5,173 24.2 Agriculture 5,173 24.2 Antenatal care (ANC) visit 25.6 4.7 1-3 4,171 25.6 4-7 3,474 21.3 8+ 362 2.2 Matemal BMI (kg/m ²) | | Primary | 6,064 | 25.5 |
| Higher3731.6Mother's occupation (n = 23,67)5.3.9Non agriculture5,7321.9Agriculture5,7324.2Antenatal care (ANC) visit5.7324.2Antenatal care (ANC) visit5.7325.64.733,47421.33.4744.743,47421.33.4748.436.22.2Maternal BMI (kg/m²)7.482.021.8.5 to 24.917,62974.825.41,1815.0Any anemia7.7324.9No17,39375.1Maternal Stature (n=23,598)*7.13Maternal stature (n=23,598)*7.13Maternal stature (n=23,598)*7.14Normal5.122.2Short14,84062.9Listening to radio1.4Yes9,06038.2Not at all14,68961.8Watching television7.6Yes5,32422.4Not at all14,68961.8Watching television7.6Yealth index7.6Household factors7.6Yealth index7.3Household factors7.1Solid fuels2.2,873Solid fuels2.2,873Solid fuels2.2,873Solid fuels2.2,873Solid fuels2.2,873Solid fuels2.2,873Solid fuels2.2,873Solid fuels2.4,17Listenfuelt1.03Jype of c | | Secondary | 851 | 3.6 |
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| Agriculture 5,733 24.2 Antenatal care (ANC) visit | | Non agriculture | 5,179 | 21.9 |
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| None 8,282 50.8 1-3 4,171 25.6 4-7 3,474 21.3 8+ 362 2.2 Maternal BMI (kg/m²) | Antenat | al care (ANC) visit | | |
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| 25+1,1815.0Any anemiaYes5,75724.9No17,39375.1Maternal stature ($n=23,598$) ^a 2.2Short8,24534.9Very short14,84062.9Listening to radioYes9,060Yes9,06038.2Not at all14,68961.8Watching televisionYes5,324Yes5,32422.4Not at all18,41677.6Household factorsWealth indexYesPoor10,76245.3Middle4,96420.9Rich8,03033.8Household sizeYes18,114Type of cooking fuelYes22,873Qiela fuels20,287398.3Toilet facilityYes10,0681Minproved2,100489.7Source of drinking waterYen10,681Improved12,73454.4 | | 18.5 to 24.9 | 17,629 | 74.8 |
| Any anemiaYes5,75724.9No17,39375.1Maternal stature ($n = 23,598$) ^a 2.2Short8,24534.9Very short14,84062.9Listening to radioYes9,06038.2Not at all14,68961.8Watching televisionYes5,32422.4Not at all18,41677.6Household factorsWealth indexPoor10,76245.3Middle4,96420.9Rich8,03033.8Household size1-45,64223.7 ≥ 5 18,11476.3Type of cooking fuelClean fuels4051.7Solid fuels22,87398.3Toilet facilityImproved21,00489.7Source of drinking waterImproved10,68145.6Unimproved12,73454.4 | | 25+ | 1,181 | 5.0 |
| Yes5,75724.9No17,39375.1Maternal stature ($n = 23,598$) ^a 2.2Short8,24534.9Very short14,84062.9Listening to radio14,84062.9Listening to radioYes9,06038.2Not at all14,68961.8Watching televisionYes5,32422.4Not at all18,41677.6Household factorsWealth indexYes5,32420.9Rich8,03033.833.8Household sizeYes10,76245.3Middle4,96420.938.2Solid fuels22,87398.3Toilet facilityYes1.7Improved21,00489.7Source of drinking waterYes10,681Improved12,73454.4 | Any ane | mia | | |
| No17,39375.1Maternal stature (n =23,598) ^a 2.2Normal5122.2Short8,24534.9Very short14,84062.9Listening to radio $Very$ short14,840Yes9,06038.2Not at all14,68961.8Watching television $Very$ 22.4Not at all18,41677.6Household factorsWealth index $Very$ Poor10,76245.3Middle4,96420.9Rich8,03033.8Household size $Very$ $Very$ 1-45,64223.7 \geq 518,11476.3Type of cooking fuel $Very$ $Very$ Clean fuels4051.7Solid fuels22,87398.3Toilet facility $Very$ $Very$ Improved21,00489.7Source of drinking water $Very$ $Very$ Improved12,73454.4 | | Yes | 5,757 | 24.9 |
| Maternal stature $(n = 23,598)^a$ 2.2 Normal 512 2.2 Short 8,245 34.9 Very short 14,840 62.9 Listening to radio Yes 9,060 38.2 Not at all 14,689 61.8 Watching television Yes 5,324 22.4 Not at all 18,416 77.6 Household factors Wealth index Poor 10,762 45.3 Middle 4,964 20.9 Rich 8,030 33.8 Household size 1-4 5,642 23.7 ≥ 5 18,114 76.3 Type of cooking fuel Clean fuels 405 1.7 Solid fuels 22,873 98.3 Toilet facility Improved 2,417 10.3 Unimproved 21,004 89.7 Source of drinkin | | No | 17,393 | 75.1 |
| Normal5122.2Short8,24534.9Very short14,84062.9Listening to radioYes9,06038.2Not at all14,68961.8Watching televisionYes5,32422.4Not at all18,41677.6Household factorsWealth indexPoor10,76245.3Middle4,96420.9Rich8,03033.8Household size1-45,64223.7 \geq 518,11476.3Type of cooking fuelClean fuels4051.7Solid fuels22,87398.3Toilet facilityImproved2,41710.3Unimproved21,00489.7Source of drinking waterImproved10,68145.6Unimproved12,73454.4 | Materna | Il stature (<i>n</i> = 23,598) ^a | | |
| Short 8,245 34.9 Very short 14,840 62.9 Listening to radio 9,060 38.2 Not at all 14,689 61.8 Watching television 22.4 Not at all 18,416 77.6 Household factors 22.4 Not at all 18,416 77.6 Household factors 22.4 Wealth index 45.3 Poor 10,762 45.3 Middle 4,964 20.9 Rich 8,030 33.8 Household size 23.7 25 1-4 5,642 23.7 ≥ 5 18,114 76.3 Type of cooking fuel 22,873 98.3 Clean fuels 405 1.7 Solid fuels 22,873 98.3 Toilet facility 10,04 89.7 Source of drinking water 10,681 45.6 Unimproved 10,681 45.6 Unimproved 12,734 54.4 | | Normal | 512 | 2.2 |
| Very short 14,840 62.9 Listening to radio 9,060 38.2 Not at all 14,689 61.8 Watching television 22.4 Not at all 18,416 77.6 Household factors 22.4 Not at all 18,416 77.6 Household factors 20.9 Wealth index 4,964 20.9 Rich 8,030 33.8 Household size 23.7 25 1-4 5,642 23.7 ≥ 5 18,114 76.3 Type of cooking fuel 22.873 98.3 Toilet facility 1.7 Solid fuels 22,873 98.3 Toilet facility Improved 2,417 10.3 1.7 Source of drinking water Improved 21,004 89.7 Source of drinking water Improved 10,681 45.6 Unimproved 12,734 54.4 | | Short | 8,245 | 34.9 |
| Listening to radio Yes 9,060 38.2 Not at all 14,689 61.8 Watching television 22.4 Yes 5,324 22.4 Not at all 18,416 77.6 Household factors Wealth index 77.6 Household factors Ves 45.3 Wealth index 8,030 33.8 Household size 33.8 33.8 Household size 23.7 25 1-4 5,642 23.7 \geq 5 18,114 76.3 Type of cooking fuel 22,873 98.3 Clean fuels 405 1.7 Solid fuels 22,873 98.3 Toilet facility 10.4 89.7 Source of drinking water 10,681 45.6 Unimproved 10,681 45.6 Unimproved 12,734 54.4 | | Very short | 14,840 | 62.9 |
| Yes 9,060 38.2 Not at all 14,689 61.8 Watching television 22.4 Yes 5,324 22.4 Not at all 18,416 77.6 Household factors 77.6 Wealth index 45.3 Poor 10,762 45.3 Middle 4,964 20.9 Rich 8,030 33.8 Household size 23.7 25 1-4 5,642 23.7 \geq 5 18,114 76.3 Type of cooking fuel 22.873 98.3 Clean fuels 405 1.7 Solid fuels 22.873 98.3 Toilet facility 10,04 89.7 Source of drinking water 10,0681 45.6 Unimproved 12,734 54.4 | Listenin | g to radio | | |
| Not at all 14,689 61.8 Watching television 7 Yes 5,324 22.4 Not at all 18,416 77.6 Household factors Wealth index 7 Poor 10,762 45.3 Middle 4,964 20.9 Rich 8,030 33.8 Household size 23.7 25 1-4 5,642 23.7 ≥ 5 18,114 76.3 Type of cooking fuel 7 5 Clean fuels 405 1.7 Solid fuels 22,873 98.3 Toilet facility 10,04 89.7 Source of drinking water 10,681 45.6 Unimproved 10,681 45.6 Unimproved 12,734 54.4 | | Yes | 9,060 | 38.2 |
| Watching televisionYes5,32422.4Not at all18,41677.6Household factorsWealth index70010,76245.3Wealth index4,96420.9Rich8,03033.8Household size71.45,64223.72<518,11476.3Type of cooking fuel71.7Clean fuels4051.7Solid fuels22,87398.3Toilet facility71.03Unimproved2,41710.3Source of drinking water71.045.6Improved10,68145.6Unimproved12,73454.4 | | Not at all | 14,689 | 61.8 |
| Yes 5,324 22.4 Not at all 18,416 77.6 Household factors Wealth index 77.6 Poor 10,762 45.3 Middle 4,964 20.9 Rich 8,030 33.8 Household size 76.3 31.8 I -4 5,642 23.7 \geq 5 18,114 76.3 Type of cooking fuel 76.3 77.6 Clean fuels 405 1.7 Solid fuels 22,873 98.3 Toilet facility 10.3 97.5 Source of drinking water 10,04 89.7 Improved 21,004 89.7 Source of drinking water 10,681 45.6 Unimproved 12,734 54.4 | Watchin | g television | | |
| Not at all 18,416 77.6 Household factors 10,762 45.3 Wealth index 4,964 20.9 Poor 10,762 45.3 Middle 4,964 20.9 Rich 8,030 33.8 Household size 23.7 25 1-4 5,642 23.7 ≥ 5 18,114 76.3 Type of cooking fuel 22,873 98.3 Clean fuels 405 1.7 Solid fuels 22,873 98.3 Toilet facility 10.3 10.3 Unimproved 21,004 89.7 Source of drinking water Improved 10,681 45.6 Unimproved 12,734 54.4 | | Yes | 5,324 | 22.4 |
| Household factors Wealth index 10,762 45.3 Poor 10,762 45.3 Middle 4,964 20.9 Rich 8,030 33.8 Household size 23.7 ≥ 5 18,114 76.3 Type of cooking fuel 76.3 Clean fuels 405 1.7 Solid fuels 22,873 98.3 Toilet facility 10,417 10.3 Unimproved 2,417 10.3 Unimproved 21,004 89.7 Source of drinking water Improved 10,681 45.6 Unimproved 12,734 54.4 | | Not at all | 18,416 | 77.6 |
| Wealth index Poor 10,762 45.3 Poor 4,964 20.9 Rich 8,030 33.8 Household size 23.7 ≥ 5 18,114 76.3 Type of cooking fuel 76.3 Clean fuels 405 1.7 Solid fuels 22,873 98.3 Toilet facility 10,417 10.3 Unimproved 2,417 10.3 Unimproved 21,004 89.7 Source of drinking water Improved 10,681 Unimproved 12,734 54.4 | Household | l factors | | |
| Poor 10,762 45.3 Middle 4,964 20.9 Rich 8,030 33.8 Household size 23.7 $1-4$ 5,642 23.7 ≥ 5 18,114 76.3 Type of cooking fuel 20.9 Clean fuels 405 1.7 Solid fuels 22,873 98.3 Toilet facility 10.3 98.3 Unimproved 2,417 10.3 Unimproved 21,004 89.7 Source of drinking water Improved 10,681 Improved 10,681 45.6 Unimproved 12,734 54.4 | Wealth i | ndex | | |
| Middle4,96420.9Rich8,03033.8Household size23.7 ≥ 5 18,11476.3Type of cooking fuel76.3Clean fuels4051.7Solid fuels22,87398.3Toilet facility21,00489.7Source of drinking water10,68145.6Unimproved12,73454.4 | | Poor | 10,762 | 45.3 |
| Rich 8,030 33.8 Household size 1-4 5,642 23.7 ≥ 5 18,114 76.3 Type of cooking fuel 76.3 Clean fuels 405 1.7 Solid fuels 22,873 98.3 Toilet facility 10.3 Unimproved 2,417 10.3 Source of drinking water 10,681 45.6 Unimproved 12,734 54.4 | | Middle | 4,964 | 20.9 |
| Household size 1-4 5,642 23.7 ≥ 5 18,114 76.3 Type of cooking fuel 76.3 Clean fuels 405 1.7 Solid fuels 22,873 98.3 Toilet facility 10.3 97.5 Source of drinking water 10,681 45.6 Unimproved 12,734 54.4 | | Rich | 8,030 | 33.8 |
| $1-4$ 5,642 23.7 ≥ 5 18,114 76.3 Type of cooking fuel 76.3 Clean fuels 405 1.7 Solid fuels 22,873 98.3 Toilet facility 10.3 Unimproved 2,417 10.3 Unimproved 21,004 89.7 Source of drinking water Improved 10,681 45.6 Unimproved 12,734 54.4 | Househ | old size | | |
| $ ≥ 5 		18,114 		76.3 \\ Type of cooking fuel 																																				$ | | 1-4 | 5,642 | 23.7 |
| Type of cooking fuel Clean fuels 405 1.7 Solid fuels 22,873 98.3 Toilet facility Improved 2,417 10.3 Unimproved 21,004 89.7 Source of drinking water Improved 10,681 45.6 Unimproved 12,734 54.4 | | ≥5 | 18,114 | 76.3 |
| Clean fuels4051.7Solid fuels22,87398.3Toilet facility10.3Improved2,41710.3Unimproved21,00489.7Source of drinking waterImproved10,681Improved10,68145.6Unimproved12,73454.4 | Type of | cooking fuel | | |
| Solid fuels22,87398.3Toilet facilityImproved2,41710.3Unimproved21,00489.7Source of drinking waterImproved10,68145.6Unimproved12,73454.4 | | Clean fuels | 405 | 1.7 |
| Toilet facilityImproved2,41710.3Unimproved21,00489.7Source of drinking waterImproved10,681Improved10,68145.6Unimproved12,73454.4 | | Solid fuels | 22,873 | 98.3 |
| Improved2,41710.3Unimproved21,00489.7Source of drinking waterImproved10,68145.6Unimproved12,73454.4 | Toilet fac | cility | | |
| Unimproved21,00489.7Source of drinking waterImproved10,68145.6Unimproved12,73454.4 | | Improved | 2,417 | 10.3 |
| Source of drinking water Improved 10,681 45.6 Unimproved 12,734 54.4 | | Unimproved | 21,004 | 89.7 |
| Improved 10,681 45.6 Unimproved 12,734 54.4 | Source of | of drinking water | | |
| Unimproved 12,734 54.4 | | Improved | 10,681 | 45.6 |
| | | Unimproved | 12,734 | 54.4 |

Table 1 (continued)

| Variables | Category | Total weighted frequency (n) | Weighted percent (%) |
|---------------------|--------------------------|---------------------------------|-------------------------|
| Househ | old flooring | | |
| | Improved | 2,214 | 9.3 |
| | Unimproved | 21,535 | 90.7 |
| Time to | get a water source | | |
| | On-premise | 1,752 | 7.4 |
| | \leq 30 min | 13,241 | 55.7 |
| | 31–60 min | 5,021 | 21.1 |
| | >60 min | 3,742 | 15.8 |
| Communi | ty-level characteristics | ; | |
| Residen | се | | |
| | Urban | 2,618 | 11.0 |
| | Rural | 21,138 | 89.0 |
| Region ^b | 1 | | |
| | Large central | 21,789 | 91.7 |
| | Small peripherals | 1,384 | 5.8 |
| | Metropolis | 584 | 2.5 |
| Ecologia | cal zone | | |
| | Tropical zone | 3,580 | 15.1 |
| | Subtropical zone | 16,703 | 70.3 |
| | Cool zone | 3,473 | 14.6 |
| Survey y | /ear | | |
| | EDHS-2005 | 4,289 | 18.1 |
| | EDHS-2011 | 9,987 | 42.0 |
| | EDHS-2016 | 9,479 | 39.9 |

^a Normal/Tall (155 to < 200 cm); Short (145 to < 155 cm), and Very short (<145 cm); ^b#: The geographical region of Ethiopia where household heads live. Tigray, Amhara, Oromia, and Sothern Nations Nationalities and Peoples Region (SNNPRs) were categorized under larger central regions; Afar, Somali, Benishangul, and Gambella were under Small peripherals, while Metropolis include Harari, Dire Dawa, and Addis Ababa regions

both overweight/obesity and CSO was prevalent in the first 6 months of age (Fig. 4).

Factors associated with CSO

In the multilevel bivariable logistic regression analysis, individual-level factors associated with CSO were the age of the child, a child currently breastfeeding, vaccination status, children who received deworming medication, maternal history of ANC visit, watching television, source of drinking water, household flooring, and time to get to the water source. At the community-level, contextual region was associated with CSO (*p*-value of < 0.05) (Table 2).

Table 3 presents the multivariable multilevel logistic regression analysis results. The odds of having CSO was higher among children who were currently breastfeeding [AOR: 1.64, 95%CI: (1.01–2.72)], children born of an overweight mother [AOR: 2.65, 95%CI: (1.19–5.88)], children living in families having 1–4 household members



Stunting Overweight/obesity CSO

Fig. 1 The prevalence and trends of stunting, overweight/obesity and CSO among under-five children in Ethiopia (2005–2016)



Fig. 2 The trend of CSO among under-five children by residence in Ethiopia, EDHS (2005–2016)

[AOR: 1.52, 95%CI: (1.02–2.26)], and those included from EDHS-2005 [AOR: 4.38, 95%CI: (2.42–7.95)].

Discussion

In this study, we estimated the prevalence and factors associated with childhood (0–59 months) concurrent stunting and overweight/or obesity (CSO) using data

from the three waves of EDHS. Our results suggested that the overall prevalence of CSO was 1.33% over the period 2005 to 2016. Based on the full multilevel analysis model, children breastfeeding status, maternal BMI, and household size were identified factors associated with CSO.

The observed prevalence of CSO may have been driven by a rise in children being overweight, coupled



Fig. 3 The trends of CSO among under-five children by gender in Ethiopia, EDHS (2005–2016)



with stagnant rates of child stunting in Ethiopia. The prevalence of CSO determined by the current study was in agreement with previous report among Ghanaian children, with a relatively low prevalence of 1.2% [26] and the mother–child pair DBM study from Ethiopia at 1.6 [17]. Additionally the current study indicates a much

 Table 2
 Bivariable
 multilevel
 logistic
 regression
 analysis
 of
 individual and
 community-level
 factors
 associated
 with
 concurrent

 overweight/obesity
 and
 stunting (CSO)
 among
 children 0–59
 months
 in
 Ethiopia, EDHS (2005–2016, n = 23,756)

| Variables | Number with CSO, % | Unadjusted OR, 95%CI | <i>p</i> -value ^a |
|----------------------------------|--------------------|----------------------|------------------------------|
| Individual-level characteristics | | | |
| Child factors | | | |
| Sex | | | |
| Male | 187 (1.25) | Ref | |
| Female | 128 (1.01) | 0.80 (0.62–1.03) | 0.091 |
| Age (months) | | | |
| < 12 | 127 (1.97) | Ref | |
| 12–23 | 43 (0.09) | 0.46 (0.31–0.67)** | p<0.001 |
| 24–59 | 144 (0.09) | 0.45 (0.34–0.59)** | p<0.001 |
| Birth order | | | |
| First born | 77 (1.33) | Ref | |
| 2-4 | 139 (1.09) | 0.82 (0.59–1.13) | 0.225 |
| 5 or higher | 98 (1.07) | 0.80 (0.57-1.23) | 0.206 |
| Birth interval | | | |
| < 33 months | 245 (1.16) | 1.09 (0.83–1.45) | 0.524 |
| \geq 33 months | 70 (1.06) | Ref | |
| Size of a child at birth | | | |
| Larger | 121 (1.20) | Ref | |
| Average | 115 (1.16) | 0.96 (0.71-1.29) | 0.797 |
| Small | 77 (1.02) | 0.85 (0.61–1.18) | 0.342 |
| Currently breastfeeding | | | |
| Yes | 249 (1.26) | 1.51 (1.12–2.03)* | 0.007 |
| No | 65 (0.84) | Ref | |
| Full vaccination | | | |
| Yes | 42 (0.82) | Ref | |
| No | 229 (1.36) | 1.67 (1.17–2.38)* | 0.005 |
| Diarrhea | | | |
| Yes | 40 (0.90) | 0.77 (0.52–1.14) | 0.190 |
| No | 275 (1.17) | Ref | |
| Fever | | | |
| Yes | 42 (0.85) | 0.71 (0.49–1.03) | 0.075 |
| No | 273 (1.19) | Ref | |
| Children received deworming me | dication | | |
| Yes | 17 (0 39) | Ref | |
| No | 201 (1 02) | 2 60 (1 41–4 80)* | 0.002 |
| Parental factors | 201 (1.02) | 2.00 (1.00) | 0.002 |
| Mother's age | | | |
| < 18 | 6 (1 86) | 1 65 (0 51–5 34) | 0.401 |
| 18-24 | 114 (1 36) | 1 20 (0.85–1 70) | 0.296 |
| 25-34 | 133 (1 01) | 0.89 (0.65–1.22) | 0.477 |
| > 35 | 61 (1 14) | Ref | 0.477 |
| Mother's education | | ner | |
| No education | 210 (1 17) | 1 09 (0 83-1 44) | 0.507 |
| Primary and above | 105 (1.06) | Ref | 0.507 |
| Mother's occupation | 105 (1.00) | i ver | |
| Not working | 174 (1 19) | 1 30 (0 93-1 83) | 0178 |
| Agriculture | 86 (1 22) | 1.34 (0.89–2.01) | 0.120 |
| Non agriculture | 54 (0.91) | Ref | 0.157 |
| ANC Visit | JT (0.71) | i ver | |
| None | 140 (1 47) | 1 54 (1 06–2 22)* | 0.022 |
| | | | 0.022 |

Table 2 (continued)

| Variables | Number with CSO, % | Unadjusted OR, 95%Cl | <i>p</i> -value ^a |
|--------------------------------|--------------------|----------------------|------------------------------|
| 1–3 | 73 (1.15) | 1.20 (0.78–1.86) | 0.405 |
| 4+ | 41 (0.96) | Ref | |
| Maternal BMI (kg/m²) | | | |
| < 18.5 | 54 (0.95) | Ref | |
| 18.5 to 24.9 | 232 (1.16) | 1.22 (0.89–1.66) | 0.216 |
| 25+ | 22 (1.35) | 1.44 (0.86–2.40) | 0.162 |
| Any anemia | | | |
| Yes | 78 (1.13) | 1.02 (0.77–1.34) | 0.911 |
| No | 218 (1.11) | Ref | |
| Maternal stature | | | |
| Normal | 188 (1.14) | Ref | |
| Short | 109 (1.06) | 0.93 (0.70–1.22) | 0.593 |
| Very short | 10 (1.47) | 1.29 (0.56–2.94) | 0.540 |
| Listening to radio | | | |
| Yes | 101 (0.94) | Ref | |
| Not at all | 213 (1.23) | 1.31 (0.99–1.72) | 0.057 |
| Watching television | | | |
| Yes | 53 (0.78) | Ref | |
| Not at all | 261 (1.22) | 1.55 (1.11–2.19)* | 0.011 |
| Household factors | | | |
| Wealth index | | | |
| Poor | 156 (1.21) | 1.07 (0.81–1.41) | 0.621 |
| Middle | 46 (0.90) | 0.79 (0.53–1.20) | 0.286 |
| Rich | 112 (1.12) | Ref | |
| Household size | | | |
| 1-4 | 99 (1.30) | 1.22 (0.92–1.60) | 0.158 |
| ≥5 | 216 (1.09) | Ref | |
| Type of cooking fuel | | | |
| Clean fuels | 6 (0.08) | Ref | |
| Solid fuels | 307 (1.15) | 1.33 (0.59–3.01) | 0.492 |
| Toilet facility | | | |
| Improved | 36 (1.15) | Ref | |
| Unimproved | 276 (1.16) | 0.96 (0.68–1.36) | 0.859 |
| Source of drinking water | | | |
| Improved | 162 (1.34) | Ref | |
| Unimproved | 150 (1.02) | 0.72 (0.56–0.93)* | 0.013 |
| Household flooring | | | |
| Improved | 14 (0.64) | Ref | |
| Unimproved | 301 (1.22) | 2.30 (1.41–3.78)* | 0.001 |
| Time to get a water source | | | |
| On premise | 17 (0.79) | Ref | |
| ≤ 30 min | 193 (1.25) | 1.58 (0.98–2.54)* | 0.057 |
| 31–60 min | 57 (0.97) | 1.22 (0.71–2.10) | 0.458 |
| >60 min | 47 (1.18) | 1.49 (0.88–2.51) | 0.132 |
| Community-level characteristic | | | |
| Residence | | | |
| Urban | 24 (0.97) | Ref | |
| Rural | 289 (1.16) | 1.19 (0.83–1.69) | 0.345 |
| Region | | | |
| Large centrals | 292 (1.12) | 1.53 (1.01–2.34)* | 0.048 |
| Small peripherals | 19 (1.40) | 1.39 (0.89-2.18) | 0.142 |

| Variables | Number with CSO, % | Unadjusted OR, 95%CI | <i>p</i> -value ^a |
|------------------|--------------------|----------------------|------------------------------|
| Metropolis | 4 (0.81) | Ref | |
| Ecological zone | | | |
| Tropical zone | 34 (0.91) | 0.88 (0.54–1.46) | 0.634 |
| Subtropical zone | 241 (1.30) | 1.28 (0.80–2.06) | 0.298 |
| Cool zone | 40 (1.02) | Ref | |
| Survey year | | | |
| EDHS-2005 | 101 (2.46) | 2.73 (2.01–3.70)* | <i>p</i> < 0.001 |
| EDHS-2011 | 86 (0.83) | 0.92 (0.67–1.26) | 0.620 |
| EDHS-2016 | 127 (0.91) | Ref | |

Table 2 (continued)

** *p*-value < 0.001, **p*-value < 0.05, ^aThe Chi-squared test

lower CSO prevalence than reported in previous studies about household-level double burden of malnutrition (DBM) in Ethiopia at 9% [40] and individual level institutional-based study finding in Addis Ababa (Capital city of Ethiopia) at 5.1% [42], 6.6% in Nepal [15], 19.57% in Kenya [53], and 4.7% in Bangladesh [54]. The observed discrepancy may be explained by the study population (as some included mother-child pairs), differences in socio-demographics, and the prevalence of malnutrition between nations. Additionally, our results on CSO at the individual level contradict those of other studies, which took into account the household-level coexistence of an obese mother and a child who is stunted. The occurrence of CSO in Ethiopia is indicative of the nutrition transition that the nation has been going through as a result of changes in eating patterns, high in energy density food intakes, and a decrease in physical activity [14, 55, 56], which has similarly been reported as a global public health problem [56, 57]. The recent evidence from the 2019 Ethiopian Mini Demographic and Health Survey (EMDHS) showed that the prevalence of overweight was 2%, an increase from 1% reported from the 2016 EDHS [34, 35]. Further analysis of EMDHS conducted in 2022 by Gebremichael et al. reported that the overall prevalence of overweight/obesity among under-five children to be 2.14% (95% CI: 1.74–2.53) [58].

The observed prevalence of overweight/obesity among under-five children was lower than the East African regional estimate of 4.59% [14] as well as the prevalence (6.8%) reported in SSA [55]. The current study finding indicate that overweight/obesity was also lower than studies reported in Cameroon (8%) [59], Sierra Leone (16.9%), Comoros (15.9%), and Malawi (14.5%) [55]. This could be because Ethiopia has experienced severe food security issues for many years and is more susceptible to food shortages, disallowing excesses food consumptions that cause overweight and obesity. Moreover, the disparate impacts of the poverty level, lifestyle, socioeconomic status, and food consumption habits of these countries may explain the observed difference. The prevalence of this study, however, was comparable to Senegal (2.0%) in 2011 and Togo (2.6%) in 2014 [55].

The prevalence of stunting in children under five years was very high (43.1%) in Ethiopia between 2005 and 2016. The prevalence of stunting reported in this study is higher than what had been estimated in Rwanda 38% in 2015 [60], Congo 35.2% in 2014 [61], Nigeria 36.7% in 2013 [62], and the East African countries pooled estimate of stunting (33%) [13]. According to the World Health Organization (WHO), the observed prevalence of stunting in Ethiopia is very high (\geq 30%) [63]. This level of childhood stunting should serve as a trigger point for public health intervention.

In this study, children born to overweight/obese mothers were positively associated with CSO. This study found that the odds of CSO was two times higher when mothers were overweight or obese, implying that maternal overweight is associated with poor child health outcomes [64]. Biological, behavioral, environmental, socioeconomic, and demographic factors, and the nutrition transition that has been observed over the past few years in many LMICs, including Ethiopia, may also contribute to the observed association. These changes in dietary patterns seem to be the underlying cause of DBM, where a child could be stunted during the early years and became obese at a later age [5]. Studies have suggest that maternal overweight/obesity is related to having children with higher birth weights [29] and may be linked to child overweight and possible CSO. Evidence suggests that the drivers of these types of malnutrition are shared by biological, environmental, and socioeconomic factors that contribute to the risk of co-occurring conditions [65]. Several pathways could have contributed to and explain these links. Maternal weight gain was significantly higher in households with better food supply and nutrition, which in some cases may well contribute to excessive energy intake and child obesity. Additional, if mothers were exposed to complex factors that contributed significantly to their

 Table 3
 Multivariable multilevel logistic regression analysis of factors associated with concurrent overweight/obesity and stunting (CSO) among children 0–59 months in Ethiopia, EDHS (2005–2016)

| AOR (95%CI) AOR (95%CI) AOR (95%CI) Individual-Level factors Child factors Sex Male Ref Ref Ref Female 0.94 (0.61–1.37) 0.95 (0.55–1.63) 0.95 (0.55–1.63) A_2-59 Ref Ref Ref Ref Turently breastfeeding 1.24 (0.75–2.35) 1.64 (1.01–2.27)* No Ref Ref Ref Ref Jager Ref Ref Ref Ref Auerage 0.83 (0.54–1.29) 0.86 (0.51–1.33) Scal (0.41–1.49) Full vacination Ref < | Variables | Null Model (Model I) | Model II ^a | Model III ^b | Model IV ^c |
|--|-----------------------------------|----------------------|---------------------------------------|------------------------|---------------------------------------|
| Individual-Level Factors Child actors Sex Nale Ref Ref Male Ref Ref Ref Fernale 0.94 (0.24-13) 0.35 (0.24-138) Age (months) Ref Ref Ref Ref Ref 12-23 0.98 (0.57-167) 0.95 (0.55-163) 24-93 1.34 (0.76-230) 1.39 (0.76-21) Currently breastfeeding IE IE Yes 1.63 (1.01-2.60)* I.64 (1.01-2.72)* No Ref Ref Ref Average 0.83 (0.34-1.20) 0.88 (0.21-1.30) 0.68 (0.41-1.40) Full vaccination Ref Ref Ref No 0.83 (0.32-1.30) 0.83 (0.21-1.20) 0.88 (0.21-1.30) Diarbes Ref Ref Ref No 0.88 (0.32-1.30) 0.84 (0.31-1.30) Diarbes Ref Ref Ref No Ref Ref Ref No 2.93 (0.25-163) <th< th=""><th></th><th></th><th>AOR (95%CI)</th><th>AOR (95%CI)</th><th>AOR (95%CI)</th></th<> | | | AOR (95%CI) | AOR (95%CI) | AOR (95%CI) |
| GivenSectionSectionRefRefMadeRefRefFemale0.90 (0.97-167)0.95 (0.95-1.63)2-2-300.96 (0.97-1.67)0.96 (0.97-1.67)2-2-300.96 (0.97-1.67)0.96 (0.97-1.67)2-2-300.96 (0.97-1.67)0.90 (0.97-1.67)Currently breastfeeding1.62 (0.10-2.60)RefVis0.83 (0.30-1.62)0.81 (0.30-1.62)NoRefRefRefSection Hild at birthRefRefLargerRefRefRefAverage0.83 (0.30-1.62)0.86 (0.81-1.82)Small0.83 (0.30-1.92)0.86 (0.81-1.82)Small0.83 (0.30-1.92)0.86 (0.81-1.82)Small0.83 (0.30-1.92)0.86 (0.81-1.82)No0.83 (0.37-1.91)0.86 (0.81-1.82)No0.83 (0.37-1.91)0.84 (0.91-1.92)No0.85 (0.37-1.91)0.84 (0.91-1.92)No0.87 (0.37-1.91)0.85 (0.91-1.92) <td< td=""><td>Individual-Level Factors</td><td></td><td></td><td></td><td></td></td<> | Individual-Level Factors | | | | |
| SetSetSetMaleRefRefFinale04(04-137)05(05(-138)Age (months)SetSet (05(-138))12-230.98(05/-16/)05(052-16)2-4-590.98(05/-16/)05(052-16)Currently breastreedingSet (05(-238))164(101-229)No0.83(05(-129))0.68(051-30)Size of child at birthSet (05(-238))0.68(051-30)Size of child at birthSet (05(-238))0.68(051-30)Yes0.63(038-1.09)0.68(051-139)Average0.63(038-1.09)0.68(051-139)No0.63(038-1.09)0.68(051-139)PiarthaeFitRefNo0.93(057-1.51)0.64(051-137)No0.64(051-137)0.64(051-137)No0.64(051-137)0.64(051-137)No0.64(051-137)0.64(051-137)No0.64(051-137)0.64(051-137)No0.64(051-137)0.64(051-137)No0.64(051-137)0.64(051-137)No0.64(051-137)0.64(051-137)No0.64(051-137)0.64(051-137)No0.64(051-137)0.64(051-137)No0.64(051-137)0.64(051-137)No0.64(051-137)0.64(051-137)No0.64(051-137)0.64(051-137)No0.64(051-137)0.64(051-137)No0.64(051-137)0.64(051-137)No0.64(051-137)0.64(051-137)No0.64(051-137)0.64(051-137)No0.64(051-137) | Child factors | | | | |
| MalePerPerFemale0.94(0.64-1.37)0.95(0.64-1.36)Age imorbs/1212Per12-730.98(0.75-1.07)0.95(0.55-1.36)24-591.34(0.76-2.53)1.19(0.67-2.11)Currently breastfeeding164(1.01-2.56)*Yes6.81(0.10-2.66)*1.64(1.01-2.57)*No0.81(0.51-1.26)*1.64(1.01-2.56)*Size of hild at birb86LargerRefRefAverage0.83(0.51-1.29)0.68(0.51-1.31)Small0.83(0.51-1.29)0.68(0.51-1.32)Small0.83(0.51-1.51)0.68(0.51-1.32)Darreha861.02(0.51-1.32)Darreha861.02(0.51-1.32)Darreha861.02(0.51-1.32)Darreha811.02(0.51-1.32)Darreha811.02(0.51-1.32)NoRefRef86No0.39(0.51-1.51)0.84(0.51-1.32)Darreha1.17(0.65-1.59)1.02(0.62-0.52)Parental fortor811.02(0.22-0.42)NoScaupation1.52(0.22-2.42)1.52(0.22-2.42)NoRef1.12(0.02-2.42)1.22(0.22-2.42)NoRef1.12(0.02-2.42)1.22(0.22-2.42)NoRef1.12(0.02-2.42)1.22(0.22-2.42)NoRef1.12(0.02-2.42)1.22(0.22-2.42)NoRef1.12(0.02-2.42)1.22(0.22-2.42)NoRef <t< td=""><td>Sex</td><td></td><td></td><td></td><td></td></t<> | Sex | | | | |
| Female0.94 (0.64–1.37)0.95 (0.64–1.38)Age (months)RefRef<12 | Male | | Ref | | Ref |
| <table-container>Age months)RefMedia<12</table-container> | Female | | 0.94 (0.64-1.37) | | 0.95 (0.64-1.38) |
| *12PerPerPer12-230.98 (0.57-1.67)0.95 (0.55-1.63)2-4:591.44 (0.76-2.35)1.110 (0.67-2.11)Currently breastfeedingKoVis1.63 (1.01-2.60"RefSize of child at birthKoLargerRefRefAverage0.83 (0.54-129)0.86 (0.55-133)Size of child at birthKoLargerRefFull vaccinationKoYes0.83 (0.54-129)0.86 (0.55-133)Size of child at birthKoYesRefRefNo0.83 (0.54-129)0.86 (0.55-139)DiarbesKoYesRefNoRefNo0.86 (0.55-139)No0.86 (0.55-139)No0.86 (0.55-139)NoRefNoRefNoRefNoRefNoRefNoRefNoRefNoRefNo <td>Age (months)</td> <td></td> <td></td> <td></td> <td></td> | Age (months) | | | | |
| 12-230.98 (0.57-1.67)0.97 (0.35-1.63)24-591.40 (0.62-23)1.01 (0.67-21)Currently breastreedingKerKerYes1.63 (1.01-2.60)*1.64 (1.01-2.72)*NoRefRefRefSize of hild at birthKerKerLargerRefRefRefAverage0.63 (0.05-1.03)0.68 (0.57-1.33)Small0.63 (0.03-1.05)0.68 (0.47-1.40)Full vaccinationKerRefNo0.88 (0.55-1.39)0.81 (0.51-1.29)DiarrhesKerRefYes9.39 (0.57-1.51)0.81 (0.51-1.37)NoRefRefNo0.84 (0.51-1.37)No (0.64-0.51)NoRefRefNo2.47 (1.07-5.72*1.79 (0.76-4.25)Parental factorKerRefNo1.57 (0.85-2.88)1.57 (0.84-2.94)AgricultureRefRefNorworking1.57 (0.85-2.88)1.57 (0.84-2.94)None1.52 (0.26-2.81)1.59 (0.84-2.46)AgricultureRefRefAgricultureRefRefAgricultureRefRefAgricultureRef1.32 (0.72-2.44)None1.32 (0.72-2.81)1.29 (0.68-2.46)AgricultureRefRefAgricultureRefRefNotarent EMI (Kg/m²)1.55 (0.97-2.91)1.55 (0.97-2.91)AgricultureRefRefAgricultureRefRefAgricultureR | <12 | | Ref | | Ref |
| 24-591.34 (0.76-235)1.19 (0.67-211)Currently breastieedingYes1.63 (1.01-2.60*1.41 (1.01-2.72*NoRefRefSize of child at birthLargerRefRefAverage0.83 (0.84-1.29)0.86 (0.85-1.38)Small0.83 (0.88-1.05)0.86 (0.41-1.4)Full vaccinationRefRefNo0.88 (0.55-1.39)0.86 (0.41-1.4)DiarrheaRefRefYesRefRefNo0.93 (0.57-1.51)0.84 (0.51-1.37)NoRefRefChildren received deworming medicationRefYes0.93 (0.57-1.51)0.94 (0.51-1.37)NoRefRefNo0.93 (0.57-1.51)0.94 (0.51-1.37)NoRefRefChildren received deworming medicationRefYesRefRefNo2.93 (0.57-1.51)0.94 (0.51-1.37)NoRef1.97 (0.85-2.88)1.97 (0.86-2.94)AgricultureRefRefNorregricultureRefRefAgricultureRefRefAgricultureRefRefAgricultureRefRefNorregricultureRefRefAgricultureRefRefAgricultureRefRefNorregricultureRefRefNorregricultureRefRefAgricultureRefRefNorregricultureRefRef <td>12-23</td> <td></td> <td>0.98 (0.57-1.67)</td> <td></td> <td>0.95 (0.55-1.63)</td> | 12-23 | | 0.98 (0.57-1.67) | | 0.95 (0.55-1.63) |
| Iverset/seeding Use u | 24–59 | | 1.34 (0.76–2.35) | | 1.19 (0.67–2.11) |
| Yes1.63 (1.01–2.60)*1.64 (1.01–2.72)*NoRefRefSize of hil at birthRefRefLargerRefRefAverage0.83 (0.54–1.29)0.86 (0.55–1.33)Small0.63 (0.38–1.05)0.86 (0.45–1.34)Full vaccinationRefRefYesRef 0.03 (0.57–1.51)0.81 (0.51–1.29)DiarrheaRefRefYes0.93 (0.57–1.51)0.84 (0.51–1.37)NoRefRefChildren received deworning medicationRefYesRefRefNo1.97 (1.05–5.72)*1.97 (0.76–8.28)Parental factorsI1.97 (0.68–1.99)Non-agricultureRefRefNon-agricultureRef1.97 (0.68–2.88)Non-agriculture1.57 (0.85–2.88)1.57 (0.84–2.94)Non-agricultureRef1.92 (0.68–2.83)Agriculture1.51 (0.83–2.94)1.32 (0.72–2.44)1–31.65 (0.93–2.94)1.32 (0.72–2.44)1–31.65 (0.93–2.94)1.32 (0.72–2.44)1–31.65 (0.93–2.94)1.32 (0.72–2.44)1–31.65 (0.93–2.94)1.92 (0.68–2.45)Katerial BMI (kg/m²)I.92 (0.68–2.13)1.92 (0.68–2.16)Katerial BMI (kg/m²)I.92 (0.68–2.16)1.92 (0.68–2.16)Katerial BMI (kg/m²)I.92 (0.63 (0.81–1.44)1.92 (0.72–2.44)1–31.33 (0.84–2.09)1.93 (0.82–2.16)Katerial BMI (kg/m²)I.92 (0.65–1.64)1.92 (0.65–1.64)Katerial BMI (kg/m²)I.9 | Currently breastfeedi | ng | | | |
| ΝοRefRefJizer of Int bit bithLagrRefAverage0.83 0.54-1.29)Average0.83 0.38+1.05)Small0.83 0.38+1.05)Jiu vaccinationRefWet optimizedRefNo0.80 (0.55-1.39)DiarrhenRefYes0.93 0.57-1.51)No0.84 (0.51-1.32)No0.84 (0.51-1.32)No0.84 (0.51-1.32)No0.84 (0.51-1.32)No0.84 (0.51-1.32)No0.84 (0.51-1.32)No0.84 (0.51-1.32)No0.84 (0.51-1.32)No0.84 (0.51-1.32)AgricultareRefNo0.93 (0.57-1.51)AgricultareRefNo0.84 (0.51-1.32)AgricultareRefNo0.84 (0.51-1.32)AgricultareRefNon-agricultareRefNone1.17 (0.68-1.99)1.30.19 (0.63-1.80)AgricultareRefNone1.29 (0.68-2.80)1.30.29 (0.24-20)1.4Ref1.51.29 (0.62-2.80)1.61.29 (0.62-2.80)1.61.29 (0.62-2.80)1.61.29 (0.62-2.80)1.61.29 (0.62-2.80)1.61.29 (0.62-2.80)1.61.29 (0.62-2.80)1.61.29 (0.62-2.80)1.61.29 (0.62-2.80)1.61.29 (0.62-2.80)1.61.29 (0.62-2.80)1.61.29 (0.62-2.80)< | Yes | | 1.63 (1.01-2.66)* | | 1.64 (1.01–2.72)* |
| Size of child at birthKefRefLargerRefRefRefAverage0.63 (0.54-1.29)0.68 (0.61-1.43)Small0.63 (0.38-1.05)0.68 (0.41-1.41)Full accinationRefRefNo0.81 (0.55-1.39)0.81 (0.51-1.51)DiarrheaURefVes0.91 (0.57-1.51)0.41 (0.51-1.51)No201 (0.57-1.51)RefChildren received deworning medicationRefYes241 (107-52)*1.91 (0.64-2.52)Portati factorsU1.92 (0.65-2.58)Portati factorsU1.92 (0.63-2.58)Agriculture1.57 (0.85-2.88)1.57 (0.84-2.94)None-griculture1.57 (0.85-2.83)1.57 (0.84-2.94)None-griculture1.57 (0.85-2.83)1.57 (0.84-2.94)Agriculture1.57 (0.52-2.83)1.57 (0.84-2.94)Agriculture1.57 (0.52-2.83)1.57 (0.84-2.94)None-griculture1.57 (0.52-2.83)1.57 (0.84-2.94)Agriculture1.57 (0.52-2.84)1.57 (0.84-2.94)Agriculture1.57 (0.52-2.84)1.59 (0.72-2.94)1-31.57 (0.54-2.94)1.59 (0.72-2.94)1-41.65 (0.93-2.94)1.32 (0.72-2.94)1-51.57 (0.54-2.93)1.57 (0.94-2.94)1-61.57 (0.54-2.94)1.57 (0.94-2.94)1-71.55 (0.74-1.94)1.59 (0.74-1.94)1.57 (0.54-2.95)1.57 (0.94-2.94)1.56 (0.94-2.94)1.57 (0.54-2.95)1.57 (0.94-2.94)1.56 (0.94-2.94)1.57 (0.54-2.95)< | No | | Ref | | Ref |
| largerRefRefAverage0.83 (0.54-1.29)0.86 (0.55-1.33)Average0.68 (0.81-1.09)0.68 (0.41-1.4)Valo0.83 (0.81-0.5)0.68 (0.41-1.4)ValoRefRefNo0.88 (0.55-1.39)0.81 (0.51-1.29)Diarrhea | Size of child at birth | | | | |
| Average0.83 (0.54-1.29)0.86 (0.55-1.38)Small0.63 (0.38-1.05)0.68 (0.41-1.14)Full vaccinationKefRefNo0.88 (0.55-1.39)0.81 (0.51-1.29)DiarrheaW0.88 (0.57-1.51)0.84 (0.51-1.32)DiarrheaRefRefYesRefRefChildren received deworning medicationKefRefYesRefRefRefNo247 (107-572)*1.79 (0.76-425)Parental factorsKefRefMother's occupationKefRefNo working1.17 (0.68-1.99)1.09 (0.63-1.88)Agriculture1.57 (0.85-288)1.57 (0.84-2.94)Non-agricultureRefRefAkt VisitKefRefKusternal Bill (kg/m²)1.29 (0.68-2.38)1.32 (0.72-2.44)1-31.27 (0.68-2.38)1.32 (0.72-2.44)1-31.27 (0.68-2.38)1.32 (0.72-2.44)1-4KefRefRefRefRefReternal Bill (kg/m²)1.29 (0.68-2.38)1.29 (0.68-2.42)4.4RefRefRefSto 24.91.41 (0.73-1.79)1.09 (0.69-1.73)25.424.91.41 (0.73-1.79)1.09 (0.69-1.73)25.424.91.41 (0.73-1.79)1.09 (0.69-1.73)25.424.91.56 (0.97-2.49)1.56 (0.97-2.49)Motat all1.33 (0.84-2.09)1.56 (0.97-2.49)Not at all8.6RefRefNot at all1.30 (0.85-1.94)0. | Larger | | Ref | | Ref |
| Small0.63 (0.38-1.05)0.68 (0.41-1.14) <i>Full vaccination</i> RefVesRefRefNo0.88 (0.55-1.39)0.81 (0.51-1.29) <i>Diarthea</i> 0.93 (0.57-1.51)0.84 (0.51-1.37)NoRefRefChildren received deworning medicationRefYesRefRefNo1.07 (0.65-1.29)Ref <i>Notworking</i> 1.07 (0.65-1.29)1.09 (0.65-1.38)AdricultureRef1.09 (0.65-1.38)Advorking1.07 (0.65-1.29)1.57 (0.85-2.90)Non-agricultureRefRefANC VisitI1.29 (0.68-2.30)1.57 (0.85-2.90)Atternal Buf (kg/m ³)1.51 (0.85-2.39)1.52 (0.25-2.48)Atternal Buf (kg/m ³)RefRefKitsing1.65 (0.39-2.94)1.29 (0.68-2.40)Atternal Buf (kg/m ³)I.14 (0.73-1.79)1.09 (0.69-1.73)Zis-5Sc (1.1-5.56)*2.65 (1.1-5.58)*Listening to radioRefRefNot at all1.30 (0.84-2.09)1.56 (0.97-2.49)Not at all1.30 (0.84-2.09)1.56 (0.97-2.49)Not at all1.30 (0.85-1.49)1.56 (0.97-2.49)Not at allRefRefNot at allRef <th< td=""><td>Average</td><td></td><td>0.83 (0.54-1.29)</td><td></td><td>0.86 (0.55-1.33)</td></th<> | Average | | 0.83 (0.54-1.29) | | 0.86 (0.55-1.33) |
| Full vaccinationFull vaccinationYesRefNo088 (055-139)Diarrhea | Small | | 0.63 (0.38-1.05) | | 0.68 (0.41-1.14) |
| YesRefRefNo0.88 (0.55–1.39)0.81 (0.51–1.29)DiartheaYes0.93 (0.57–1.51)0.94 (0.51–1.37)NoRefRefChildren received deworming medicationYesRefRefNo1.07 (0.75–7.2)*Porental factorsMother's occupation1.77 (0.68–1.99)1.09 (0.63–1.88)AgricultureRefRefNot working1.07 (0.68–1.99)1.09 (0.63–1.88)AgricultureRefRefNon-agricultureRefRefNone1.57 (0.85–2.88)1.57 (0.85–2.88)AgricultureRefRefAthernal BMI (kg/m²)1.29 (0.68–2.38)1.29 (0.69–1.78)4.4Sci (0.19–5.83)1.29 (0.69–1.78)5.51.48 (0.51–1.91)1.29 (0.69–1.78)4.51.53 (0.85–2.89)1.29 (0.69–1.78)5.51.55 (0.85–2.88)1.59 (0.69–1.78)4.4RefRefMaternal BMI (kg/m²)1.51 (0.72–2.49)4.51.40 (0.73–1.79)1.69 (0.69–1.73)2.5.42.55 (1.17–5.56)*2.65 (1.19–5.88)1.54 (0.54)1.50 (0.82–1.91)1.65 (0.19–5.19)1.55 (0.51)1.50 (0.82–1.91)1.65 (0.19–5.18)1.55 (0.51)1.50 (0.82–1.91)1.65 (0.19–5.19)1.55 (0.51)1.50 (0.82–1.91)1.65 (0.19–5.19)1.55 (0.51)1.50 (0.51–1.91)1.65 (0.19–5.19)1.55 (0.51)1.50 (0.55–1.94)1.65 (0.19–5. | Full vaccination | | | | |
| No088 (055-1.39)081 (051-1.29)DiarheaVes093 (057-1.51)084 (051-1.37)NoRefRefChildren received deworning medicationYesRefRefNo247 (107-57.27)*RefDarental factorsMother's occupation1.17 (068-1.99)1.09 (063-1.88)Agriculture1.57 (085-2.88)1.69 (063-1.88)AgricultureRefRefNon-agricultureRefRefNon-agricultureRefRefAmerical factorsUse (1000)RefNon-agricultureRefRefSone1.29 (086-2.38)1.29 (086-2.49)Agriculture1.29 (086-2.49)1.29 (086-2.49)AgricultureSone1.29 (086-2.49)AgricultureSone1.29 (086-2.49)AgricultureRefRefMore1.32 (072-24)1.29 (086-2.49)AgricultureSone1.29 (086-2.49)AgricultureRefRefMore1.29 (086-2.49)1.29 (086-2.49)AgricultureRefRefMoreRefRefMoreRefRefMoreRefRefMoreRefRefMoreRefRefMoreRefRefMoreRefRefMoreRefRefRefRefRefRefRefRefRefRefRefNot at all <td>Yes</td> <td></td> <td>Ref</td> <td></td> <td>Ref</td> | Yes | | Ref | | Ref |
| DiartheaYes0.93 (0.57-1.51)0.64 (0.51-1.32)No0.84 (0.51-1.32)0.84 (0.51-1.32)NoRefRefNo2.47 (1.07-5.72)*1.79 (0.76-4.25)Parental factorsU1.79 (0.76-4.25)Parental factorsU1.99 (0.63-1.88)Ayriculture1.17 (0.68-1.99)1.09 (0.63-1.88)Ayriculture1.57 (0.85-2.88)1.57 (0.84-2.94)Non-agricultureRefRefANC VisiU1.29 (0.62-2.38)1.29 (0.62-2.94)1-31.29 (0.62-2.38)1.29 (0.62-2.94)1-31.27 (0.68-2.38)1.29 (0.62-1.73)2-41.85 for 24-91.41 (0.73-1.79)1.99 (0.69-1.73)2-5 12-55 (1.17-5.5)*2.65 (1.17-5.68*Itstening to radio1.14 (0.73-1.79)1.99 (0.69-1.73)2-5 42-55 (1.17-5.5)*2.65 (1.17-5.68*Itstening to radio1.51 (0.62-2.94)1.56 (0.97-2.49)Marchal BMI (kg/m?)U1.51 (0.51-5.89*YesRefRefRefNot at all0.60 (0.58-1.94)0.80 (0.59-1.94)YesRefRefRefNot at all0.60 (0.58-1.94)0.80 (0.59-1.94)Not at all0.60 (0.58-1.94)0.80 (0.59-1.94)Not at all0.60 (0.58-1.94)0.80 (0.58-1.94)Not at all0.60 (0.58-1.94)0.80 (0.58-1.94)Not at all0.60 (0.58-1.94)0.80 (0.58-1.94)Not at all0.60 (0.58-1.94)0.80 (0.58-1.94)Not at all0.60 | No | | 0.88 (0.55-1.39) | | 0.81 (0.51-1.29) |
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| № 247 (1.07–5.22* 1.79 (0.76–4.25) <i>Parental factors</i> | Yes | | Ref | | Ref |
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| Agriculture 1.57 (0.85–2.88) 1.57 (0.84–2.94) Non-agriculture Ref Ref ANC Visit 1.32 (0.72–2.44) 1.32 (0.72–2.44) 1–3 1.27 (0.68–2.38) 1.29 (0.68–2.46) 4+ Ref Ref Maternal BMI (kg/m ²) Ref Ref <18.5 | Not working | | 1.17 (0.68-1.99) | | 1.09 (0.63-1.88) |
| Non-agriculture Ref Ref ANC Visit | Agriculture | | 1.57 (0.85-2.88) | | 1.57 (0.84–2.94) |
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| 4+ Ref Ref Maternal BMI (kg/m²) <18.5 | 1–3 | | 1.27 (0.68–2.38) | | 1.29 (0.68–2.46) |
| Maternal BMI (kg/m²) Ref < 18.5 | 4+ | | Ref | | Ref |
| <18.5 | Maternal BMI (kg/m ²) | | | | |
| 18.5 to 24.9 1.14 (0.73–1.79) 1.09 (0.69–1.73) 25 + 2.55 (1.17–5.56)* 2.65 (1.19–5.88)* Listening to radio 2.55 (1.17–5.56)* 2.65 (1.19–5.88)* Ves Ref Ref Not at all 1.33 (0.84–2.09) 1.56 (0.97–2.49) Watching television 1.33 (0.84–2.09) 1.56 (0.97–2.49) Ves Ref Ref Not at all 1.06 (0.58–1.94) 0.86 (0.45–1.64) Household factors Ref Ref Household size 1.46 (0.98–2.17) 1.52 (1.02–2.26)* | < 18.5 | | Ref | | Ref |
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| Household factors 1.46 (0.98–2.17) 1.52 (1.02–2.26)* | Not at all | | 1.06 (0.58–1.94) | | 0.86 (0.45-1.64) |
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| | 1-4 | | 1.46 (0.98-2.17) | | 1.52 (1.02-2.26)* |
| >5 Ref Ref | > 5 | | Ref | | Ref |

Table 3 (continued)

| Variables | Null Model (Model I) | Model II ^a | Model III ^b | Model IV ^c |
|----------------------------|----------------------|-----------------------|------------------------|-----------------------|
| | | AOR (95%CI) | AOR (95%CI) | AOR (95%CI) |
| Toilet facility | | | | |
| Improved | | Ref | | Ref |
| Unimproved | | 0.78 (0.42-1.45) | | 0.70 (0.37-1.33) |
| Source of drinking water | | | | |
| Improved | | Ref | | Ref |
| Unimproved | | 0.50 (0.33-0.74)* | | 0.83 (0.53-1.30) |
| Household flooring | | | | |
| Improved | | Ref | | Ref |
| Unimproved | | 1.78 (0.75-4.17) | | 1.74 (0.68–4.45) |
| Time to get a water source | | | | |
| On-premise | | Ref | | Ref |
| ≤ 30 min | | 1.49 (0.62–3.57) | | 1.34 (0.53–3.34) |
| 31–60 min | | 1.52 (0.59–3.93) | | 1.49 (0.55-4.00) |
| >60 min | | 1.95 (0.75-5.05) | | 1.93 (0.72–5.19) |
| Community-Level Factors | | | | |
| Residence | | | | |
| Urban | | | Ref | Ref |
| Rural | | | 0.98 (0.67-1.45) | 0.94 (0.42-2.09) |
| Region | | | | |
| Large central | | | 1.45 (0.92–2.31) | 0.99 (0.49–2.00) |
| Small peripherals | | | 1.82 (1.09-3.03)* | 1.64 (0.75–3.58) |
| Metropolis | | | Ref | Ref |
| Ecological zone | | | | |
| Tropical zone | | | 0.99 (0.55–1.77) | 0.75 (0.31–1.84) |
| Subtropical zone | | | 1.50 (0.93–2.43) | 1.80 (0.88–3.69) |
| Cool zone | | | Ref | Ref |
| Survey year | | | | |
| EDHS-2005 | | | 2.68 (1.96-3.66)** | 4.38 (2.42–7.95)** |
| EDHS-2011 | | | 0.92 (0.67–1.26) | 1.42 (0.80–2.52) |
| EDHS-2016 | | | Ref | Ref |
| Random effect | | | | |
| Variance (SE) | 0.1179 (0.0400) | 0.2239 (0.0932) | 0.1613 (0.0306) | 0.2859 (0.0783) |
| ICC (%) | 3.46 | 6.37 | 4.67 | 7.99 |
| Model comparison | | | | |
| LL | -1374.017 | -600.17 | -1341.17 | -578.30 |
| Deviance | 2,748.03 | 1,200.34 | 2,682.34 | 1,156.60 |
| AIC | 2752.034 | 1252.344 | 2700.35 | 1222.601 |
| BIC | 2768.048 | 1442.109 | 2772.41 | 1463.456 |

NB: *Significant at *p*-value 0.05, **Significant at *P*-value 0.001, *CI* Confidence Interval, *AOR* Adjusted Odds Ratio, *ICC* Intraclass Correlation, ^aAdjusted for individual level variables, ^bAdjusted for community-level variables, ^cAdjusted for individual and community level variables

own weight gain, their children are likely to be exposed to the same complex factors that exacerbate the obesity predisposition during childhood. For instance, a recent metaanalysis identified that maternal pre-pregnancy obesity was significantly associated with child overweight/obesity combined (OR 2.69, 956% CI 2.10–3.46) [66].The impact of maternal obesity extends beyond intrauterine and neonatal life to childhood, adolescence, and adulthood [67]. A cohort study indicated that infants born to obese mothers had a double rate of obesity at age 2 years [68].

The odds of CSO were relatively higher in children living in families with 1–4 household members than those children living in households having five and more 5 household members. It is believed that the size of a family influences the opportunities and resources a child could and received, which in turn could affect the child's nutrition and development. Studies that have specifically focused on undernutrition have shown the household family size as a major factor associated with child malnutrition [69–71]. A study conducted in eleven Asian countries revealed that the predictive value of householdlevel factors is much more important for DBM than previously thought [72]. Unlike this study, other studies on concurrent forms of malnutrition have found no links between household size and malnutrition [41]. Thus, more research on CSO in LMICs is needed to determine how CSO relates to the number of household members.

The odds of developing CSO were higher in this study among children currently breastfed. The observed association between breastfeeding patterns and CSO in infants and young children is one of the factors that need to be investigated further to understand better such an association, which is beyond the scope of this study. One probable explanation is that breastfed newborns rely on maternal breastfeeding; under circumstances where food insecurity is a problem as is in Ethiopia, if the mother does not consume enough food and nutrients, her infant may suffer from inadequate milk supply and low-nutrient foods. Because the baby is not getting enough milk, poor milk production can cause problems with nutrients intake, weight gain and poor growth leading to stunting. In addition, if the mother consumes highenergy foods but low-nutrient foods, this may explain the observed association with overweight and obesity in these populations.

In the current study, children from the EDHS-2005 had nearly four times the odds of having CSO than those from the 2016 survey. This finding could be attributed to the difference in the prevalence of stunting and over-weight/obesity over the study periods. In our descriptive analysis of CSO, the prevalence was relatively higher in EDHS-2005 than in 2016 (2.36% versus 1.34%). In addition, other factors, such as lifestyle differences across survey periods, may explain the observed finding, due to increasing patterns of nutrition transition over time. For example, the prevalence of stunting was 51% (EDHS-2005), while the prevalence dropped to 38% (EDHS-2016), and the prevalence of severe stunting decreased by more than half (from 28 to 12%) during the period interval of the two surveys [35].

As the study strength, the use of information from a nationally representative population-based survey with a high response rate gave it a stronger statistical power to infer the features of the study population. In addition, reliable estimations were produced using the sampling weight. This study also uses a multilevel logistic regression, which is appropriate for cluster data analysis. Our study has the following limitations: First, the recall bias might have occurred because the birth size and history of infection were reported only by mothers from memory. Second, because this study employed secondary data, it did not account for factors that could affect the occurrence of CSO, such as food security, health problems, and nutrition status during pregnancy. Third, because this study was a cross-sectional design, a cause-and-effect relationship could not be inferred. Fourth, because of the relatively low proportion of CSO in some of the exposure variables, the expected number of observations may be insufficient. As a result, interpretation of some of the findings requires caution.

Policy implications

In a country where chronic malnutrition has been persistent for centuries, strong policies are needed to address malnutrition and its concurrent forms, such as concurrent stunting and overweight or obesity (CSO). Additionally, addressing the double burden of childhood malnutrition is one of the key factors to achieving the Sustainable Development Goals (in particular Goal 2 and Target 3.4). Our study findings reveal that the burden of CSOs in Ethiopia is increasing. Current national nutrition policies, strategies, and programs need to be tailored for early case identification and management of this concurrent phenomenon. Moreover, given Ethiopia's high prevalence of stunting, strong policies and a commitment to overcoming malnutrition in all forms are required to have a promising impact.

Conclusion

We found that more than two-fifths of Ethiopian children less than 5 years old were stunted, two in every ten children were overweight or obese, and less than 2% of children had CSO. We found a higher prevalence of CSO among boys rather than among girls, and rural than urban dwellers. Overall, the prevalence of CSO was lower than what has been previously reported in different low-income settings, but the prevalence of CSO was a rising trend between 2011 and 2016. Our results also indicated both individual (i.e. breastfeeding status, maternal BMI, and household size) and community-level factors were associated with CSO. These findings highlight the need for targeted interventions to simultaneously address childhood stunting and overweight or obesity in Ethiopia. Furthermore, to combat CSO, children born to overweight or obese mothers and living in households with multiple household members should be prioritized for earlier interventions. In conclusion, further research is still warranted to address Ethiopia's nutrition transition to tailor public health interventions to address the double burden of childhood malnutrition (undernutrition (stunting) and overweight/obesity in early childhood).

Abbreviations

| AOR | Adjusted odds ratio |
|------|---|
| ANC | Antenatal care visits |
| BMI | Body mass index |
| CI | Confidence interval |
| CSO | Concurrent stunting and overweight or obesity |
| EDHS | Ethiopian Demographic and Health Surveys |
| SNNP | Southern Nations and Nationalities and People |
| WHO | World Health Organization |

Supplementary Information

The online version contains supplementary material available at https://doi. org/10.1186/s12887-023-04037-7.

Additional file 1: Supplementary File 1. Lists of independent variables included in this study

Additional file 2: Supplementary File 2. Prevalence of stunting, overweight/obesity and CSO among in children 0–59 months, EDHS 2005-2016.

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Authors' contributions

BS: Conceptualization, Formal analysis, Investigation, Methodology, Writing – original draft. LM: Visualization, Validation, Writing – review & editing. AK: Supervision, Visualization, Validation, Writing – review & editing. GB, DA, YT, DZ, FD, CK, KS, DG, and DW: Writing – review & editing. KEA: Supervision, Visualization, Validation, Writing – review & editing. All authors have read and approved the final manuscript.

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Availability of data and materials

The datasets analysed during the current study are publicly available in the Measure DHS website https://dhsprogram.com after formal online registration and submission of the project title and detail project description.

Declarations

Ethics approval and consent to participate

Data is publicly available in open access repository and available here: http://dhsprogram.com/data/available-datasets.cfm. The data were obtained via online registration to measure the DHS program and downloaded after the purpose of the analysis was communicated and approved. An approval letter for the use of the EDHS data set was gained from MEASURE DHS. All methods were carried out in accordance with relevant guidelines and regulations.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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