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Level of dietary diversity score and its predictors among children aged 6–23 months: a linear mixed model analysis of the 2019 Ethiopian Mini Demographic Health Survey

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ABSTRACT

Background The dietary diversity score (DDS) of children is one of the indicators as part of infant and young child feeding practices. This study aimed to assess the level of DDS and its determinants among Ethiopian children aged 6–23 months.

Methods This study analysed retrospective cross-sectional data on a weighted sample of 1511 children aged 6–23 months after extracting it from the Ethiopian Mini Demographic and Health Survey 2019. A a linear mixed model was fitted and expressed as adjusted beta coefficients with a 95% CI. Finally, predictors with a p value <0.05 were considered statistically significant. Measures of variation were explained by intraclass correlation coefficients (ICC), and model fitness was determined using the Akaike information criterion.

Result The mean (±SD) DDS of children was 2.8 (±1.5). Only 56.3%, 13.4% and 11.6% of children met the minimum meal frequency (MMF), minimum dietary diversity score and minimum acceptable diet, respectively. The full model ICC was 0.266, which implied that 26.6% of the total variance of DDS among children was attributed to the differences between clusters. For a 1-month increase in the child's age, the DDS of children will increase by 0.016 units, holding all other variables constant. Also, for every 1-year increase in maternal education, a 0.057-unit increase in the DDS of children is predicted. Children from wealthy families, having mothers who have had media exposure, meeting MMF and taking fewer than 30 min to reach a nearby water supply have been proven to increase the DDS.

Conclusion In Ethiopia, the DDS of children is very low. To improve DDS enhancing maternal literacy, revenue production activities, media exposure and access to water sources should be prioritised. The significance of feeding children regularly throughout the day should be emphasised.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Micronutrient deficiency is the hidden hunger, especially in developing countries. Dietary diversity score (DDS) is one of the proxy indicators for micronutrient adequacy. Though there are a lot of initiatives in improving the nutritional status of children, still malnutrition is a growing burden in Ethiopia.

WHAT THIS STUDY ADDS

⇒ This study reveals a concerning trend of critically low DDS levels despite previous efforts aimed at enhancing the nutritional status of children using nationally representative data and a robust model. The findings underscore the complexity of improving children's dietary practices, highlighting the need for a comprehensive approach that addresses the multifaceted determinants of DDS. This necessitates coordinated action across diverse sectors such as agriculture, education, health and media, signifying the importance of integrated policy interventions to effectively tackle malnutrition among Ethiopian children.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ This study emphasises the critical need to address the alarmingly low DDS among Ethiopian children, which serves as a surrogate measure of micronutrient sufficiency. Inadequate intake of essential micronutrients poses long-term risks to children's brain development, health and future productivity, impacting the nation's economic growth. Urgent action is required to implement interventions promoting diverse and nutrient-rich diets, spanning sectors such as agriculture, education, healthcare and media. Along with nutrition-specific policies, other nutrition sensitive sectors should give emphasis to avert the long-term nutrition impact.

INTRODUCTION

Optimal infant and young child feeding (IYCF) practices are the most effective strategies for promoting full potential in growth, health and development.[1 2] The World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) advocate exclusive breastfeeding during the first six months of life, followed by the introduction of complementary foods at six months and sustained breastfeeding until the child is at least two years old.[3 4]

Appropriate complementary feeding includes the introduction of solid, semi-solid or soft foods at six months, followed by continuing breastfeeding for at least two years and beyond.[5] Minimum dietary diversity score (MDDS) is one of eight IYCF indicators developed by the WHO as one indicator aimed to quantify dietary quality and give proxy micronutrient sufficiency.[6]

Currently, far too few children are benefiting from minimum complementary feeding practices.[7] Worldwide, 30.5% of children did not introduce solid, semi-solid or soft foods at six months of age, and only 53.1%, 29.3% and 18.9% of children met the recommended minimum meal frequency (MMF), minimum dietary diversity (MDD) and minimum acceptable diet (MAD), respectively.[8]

One of the most direct causes of malnutrition is improper complementary feeding practices.[9] Many young children in developing countries are suffering from a number of nutritional deficiencies.[10] Globally, stunting still affects 149.0 million (21.9%) children under five years of age and wasting affects 49.5 million (7.3%) children.[8] Those nutritional deficiencies during the first two years of life have both short-term and long-term consequences.[11 12] They diminished immune competence and increased morbidity and mortality among children.[13] Malnutrition is responsible for more than half of deaths among children less than five years old.[14] They also lead to impaired cognitive development and, later in life, a risk of cardiovascular diseases and low economic productivity.[15]

Improving IYCF practices in children is therefore critical to improved nutrition, health and development.[16] In Ethiopia, efforts are made to improve IYCF practices and the nutritional status of children.[17–21] However, according to Ethiopian Demographic and Health Survey (EDHS) 2016, only 45%, 14% and 7% of children aged 6–23 months met the recommended MMF, MDD and MAD.[22] Also, studies indicated that complementary feeding practices are not optimal, and the predictors vary across different sociodemographic and healthcare characteristics.[23–29] The most common factors that contribute to low DDS are limited access to diversified food, poor socioeconomic status, limited knowledge of nutrition and cultural and dietary preferences.[23 30]

Therefore, this study aimed to assess the level of DDS and its associated factors among Ethiopian children aged 6–23 months using a mixed-effect analysis of nationally representative data.

METHODS

Study area, data source and design

The study was conducted in Ethiopia, a country located in the Horn of Africa.[31] Data from the 2019 Ethiopian Mini Demographic and Health Survey (EMDHS) were extracted. The data were retrieved from the demographic and health surveys (DHS) program's official database website (http://dhsprogram.com). This cross-sectional nationwide survey was collected from 21 March 2019 to 28 June 2019.[32]

Study variables

Dependent variable

The DDS of children is measured as a discrete variable. Dietary diversity was determined by counting the number of food groups from the WHO's seven food groups that children aged 6–23 months ate 24 hours before the survey.

Independent variables

Independent variables include sociodemographic variables (maternal age, maternal education level, marital status, family size, number of children under the age of five living in the home, age of household head, sex of household head, residence, religion, wealth index, region, child sex and child age), healthcare-related variables (parity, previous birth interval, antenatal care (ANC), meal frequency, maternal media exposure, birthplace, postnatal care (PNC)) and feeding practices (breastfeeding status, bottle feeding, prelacteal feeding).

Measurements and definition of terms

Minimum dietary diversity score

MDDS assesses the proportion of children 6–23 months of age who have consumed at least five out of eight predefined food groups the previous day or night. It is an indicator of a diet's micronutrient adequacy, an important dimension of its quality evaluated.[16 33 34]

Minimum meal frequency

MMF denotes the proportion of breastfed and non-breastfed children 6–23 months of age who received solid, semi-solid or soft foods (including milk feeds for non-breastfed children) for the minimum number of times or more. The minimum number of times is defined as two times for breastfed infants 6–8 months, three times for breastfed children 9–23 months and four times for non-breastfed children 6–23 months in the previous day.[16 33]

Minimum acceptable diet

MAD denotes the proportion of children 6–23 months of age who received a minimum acceptable diet (apart from breast milk). This composite indicator is calculated from the following two fractions: breastfed children 6–23 months of age who met the minimum dietary diversity and the MMF, and non-breastfed children 6–23 months of age who received at least two milk feedings and had at least the minimum dietary diversity, not including milk feeds, and the MMF during the previous day. Since the data on the minimum number of non-breast milk feeds are not available in the EDHS data, the calculation of the minimum acceptable diet for non-breastfed children is not possible. Thus, this indicator is for a non-breastfed child, which is defined the same as breastfed children.[16 33]

Prelacteal feeding

Prelacteal feeding denotes administration of any substances or fluid other than breast milk to newborn babies after birth before breastfeeding is established.[33]

Bottle feeding

Bottle feeding denotes proportion of children 6–23 months who were fed with a bottle with nipple/teat the previous day.

For the regression analysis, child age, maternal age, year of maternal education, family size, number of under-five children within the household, parity, ANC frequency, age of the household head in years and birth interval were measured as discrete variables, while residence (urban, rural), wealth index (poor, middle, reach), gender (male or female), birth order (first child, 2–4 birth orders, 5 or more birth orders), marital status (currently married, not married), religion (orthodox, Muslim, others), sex of the household head (male, female), birth place (home, health institution), maternal PNC received (yes, no), current use of contraceptives (yes, no), media exposure (yes, no), water source (improved, unimproved), time to get water (less than 15 min, 15–30 min, more than 30 min) and MMF (meet, not meet) were measured as categorical variables. The media exposure, a composite variable derived from the combination of listening to radio and viewing television, was dichotomised as either yes or no depending on whether the mother was exposed to one or both of the aforementioned media sources.

Sampling procedure and sample units

In the DHS, distinct multistage samples are chosen for each stratum based on a stratified two-stage cluster sampling approach. Implicit stratification is used inside each stratum to ensure that the selected major sampling units are representative of diverse geographical levels and areas. Stratified primary sampling units (clusters) were sampled in the first stage, and homes were sampled in the second.

For the 2019 EMDHS sample, stratification and selection were done in two steps. After stratifying each region into urban and rural clusters, 21 sampling strata were created. Within each stratum, samples of enumeration areas (EAs) were selected individually over the course of two stages. 305 EAs were individually selected in each sampling stratum in the first step, 93 of which were in urban areas and 212 of which were in rural areas, with a probability proportionate to the size of the EA. To ensure that survey precision was comparable across regions, 25 EAs were selected from 5 regions using an equitable allocation. In contrast, 35 EAs were chosen from each of the 3 bigger regions—Amhara, Oromia and the Southern Nations, Nationalities, and Peoples' Region. A systematic selection of 30 homes, on average, was made from each EA in the second stage. For the EDHS surveys, sample weights were applied to account for the complicated survey design, survey non-response and post stratification for sample representativeness. A weighted sample of 1511 children between the ages of 6 and 23 months was used in this study's analysis after the data had been cleaned and explored.

Patient and public involvement statement

This is a secondary data analysis from EDHS 2019 data set.

Data management and statistical analysis

Data analysis was performed using STATA V.17 after extracting and cleaning data from the EMDHS 2019 child data set. Tables and text were used to create and show descriptive and summary statistics. Prior to undertaking any statistical analysis, sampling weight was used to account for the sample's uneven distribution throughout the various areas. The results were reported using weighted frequency and percentage for categorical variables and mean (±SD) for continuous explanatory variables.

The assumption of observational independence was violated due to the hierarchical and clustering structure of EDHS data. This implies that advanced models must account for between-cluster variability. Using the 'standard' analysis technique to analyse variables from different levels at one common level in nested data (hierarchical data) leads in statistical power loss and conceptual problems. As a result, a mixed method analysis, namely the linear mixed model (LMM), was chosen to account for the form of dependency within clusters as well as the random and fixed effects of predictors on DDS.[35]

The relevance of measures of variation between clusters and the applicability of selecting mixed models were tested using intraclass correlation coefficients (ICC) or variance partition coefficients (VPC), median odds ratios (MOR), and proportionate change in variance (PCV).[36] The ICC (VPC) is a measure of variance components (clustering) that accounts for both between-cluster and within-cluster variation. In a regression model with no predictors and a random intercept, the level-1 residual variance for the logit model is $\pi^{2/3}$ = ($3.14^{2/3}$=3.29), and the ICC or VPC is equal to level-2 residual variance/(level-2 residual level variance+level 1 residual level variance). ICC is thus equal to level-2 residual variance/(level-2 residual variance plus 3.29).[37 38] The MOR is a measure of variability that is directly proportional to the area level variance (variation of the highest level errors): MOR=exp ((2×Vc) × 0.6745=exp (0.95(Vc)), where Vc denotes the variation between clusters. The PCV quantifies how much the variance of the following models has changed in comparison to the empty model. PCV = (VA − VB)/VA × 100, where VA represents the variance of the initial model (empty model) and VB represents the variance of the model with extra terms (consecutive models).[36]

Variables having a p value of up to 0.25 in the bivariable analysis were chosen to match the model in the multivariable LMM analysis. The following models with fixed and random effects were compared with the null model. As part of the model selection procedure, the Akaike information criterion (AIC) and Bayesian information criterion (BIC) of the models were examined, and a model with low AIC and BIC was chosen as the change in AIC or BIC was statistically significant at χ^2 with given degree of freedom.

The null model would also serve as a baseline against which later, more complicated models would be tested. The best-matched model was supposed to have the lowest AIC and BIC values. The adjusted odds ratio (AOR) with 95% CI was used to quantify the fixed effect of predictors on DDS. Finally, factors having p values less than 0.05 in the LMM multivariable model were considered statistically significant. The fixed effects of variables on DDS were evaluated using adjusted beta coefficients. To test for multicollinearity across the multiple independent variables, the variance inflation factor (VIF) was used. The mean value of 10 was used as the VIF cut-off point.[39]

RESULT

Sociodemographic characteristics of study participants

A total weighted sample of 1511 mother–child pairs were included for analysis. The mean (±SD) age of children and mothers was 14.4 (±5.1) months and 27.6 (±6.3) years, respectively. Nearly half (44.6%) of mothers had not attended formal education. The majority (86.1%) of children are from male-headed households and are from rural residents (71.7%) (table 1).

Healthcare-related characteristics of study participants

Only one-third (35.9%) of mothers had media exposure. Nearly one-fourth (23.6%) of mothers had no ANC follow-up, and 43.4% of them gave birth at home. The preceding birth interval was less than 24 months among 15.1% of children, with a mean (+SD) birth interval of 45.8 (+30.5) months (table 2).

Feeding practices of children

Using a 24-hour dietary recall, cereals, roots and tubers were consumed by the majority of children, accounting for 70.1%, followed by dairy products, consumed by 34.7% of children (figure 1).

From all the children who participated, 82.5% were breastfeeding at the time of the survey, while 2.9% never breastfed at all. Bottle feeding was practised by one-fourth (25.5%) of children. Only 56% (95% CI 52.4% to 60.1%), 13.4% (95% CI 10.7% to 16.2%) and 11.6% (95% CI 9.0% to 14.2%) of children met the MMF, MDDS and MAD, respectively (table 3).

Factors associated (fixed effects) with the dietary diversity score

Continuous predictors such as child age, year of maternal education, family size, number of under-5 children in the household, parity, ANC, birth interval and categorical predictors such as residence, wealth index, religion, birthplace, PNC, media exposure and MMF met the p <0.25

Table 1 Sociodemographic characteristics of study participants, 2019

Variable	Category	Frequency	Percentage
Child age (months)	Mean (±SD)	14.4 (±5.1)	
	6–8	257	17.0
	9–12	334	22.1
	13–17	451	29.8
	18–23	469	31.1
Child sex	Male	779	51.5
	Female	732	48.5
Maternal age (years)	Mean (±SD)	27.6 (±6.3)	
	15–19	111	7.4
	20–24	367	24.3
	25–29	497	32.8
	30–34	262	17.3
	35–39	188	12.5
	40–44	73	4.8
	45–49	13	0.9
Maternal education	Mean (+SD) year of education attained	5.5 (±2.8)	
	Not educated	673	44.6
	Primary	625	41.3
	Secondary and above	213	14.1
Marital status	Married/living together	1427	94.5
	Others*	84	5.5
Religion	Orthodox	555	36.7
	Muslim	499	33.0
	Protestant	421	27.8
	Others†	37	2.5
Family size	Mean (±SD)	5.6 (±2.2)	
	< 5	551	36.4
	≥ 5	960	63.6
Number of U-5 within the household	Mean (±SD)	1.7 (±0.7)	
	Only one	641	42.4
	Two children	711	47.1
	Three and above	159	10.5
Household head sex	Male	1302	86.1
	Female	209	13.9
Household head age (year)	Mean (±SD)	37.0 (±12.7)	
	15–24	120	8.1
	25–34	567	37.9
	35–44	530	35.4
	≥45	279	18.6
Wealth status (individual)	Poor	619	41.0
	Medium	289	19.1
	Rich	603	39.9
Residence	Urban	428	28.3
	Rural	1083	71.7

Continued

Table 1 Continued

Variable	Category	Frequency	Percentage
Water source (n=1500)	Open into premises	207	13.8
	Improved	797	53.1
	Unimproved	496	33.1
Time to fetch water	On premises	245	16.4
	<15 min	330	22.0
	15–30 min	531	35.4
	>30 min	392	26.2
Region	Oromia	566	37.4
	SNNP	311	20.6
	Amhara	328	21.7
	Tigray	107	7.1
	Somali	91	6.0
	Addis Ababa	49	3.2
	Benishangul	18	1.2
	Afar	21	1.4
	Dire Dawa	9	0.6
	Gambella	7	0.5
	Harari	4	0.3

*Single, divorced and widowed.
†Catholic, no religion.
SNNP, Southern Nations, Nationalities, and Peoples' Region.

criterion in the bivariable mixed effect linear regression and were candidates for the multivariable mixed effect logistic regression model.

Finally, child age, maternal education in years, wealth index, maternal media exposure and the MMF of children were statistically significant determinants at a p value of <0.05. For a 1-month increase in the child's age, the DDS of children will increase by 0.016 units (ß: 0.016, 95% CI 0.006 to 0.030), holding all other variables constant. Furthermore, with every 1-year increase in maternal education, a 0.057-unit (ß: 0.057, 95% CI 0.037 to 0.077) rise in DDS of children is expected. The DDS of children from the rich wealth quantile will increase by 0.218 units (ß: 0.218, 95% CI 0.003 to 0.433) when compared with children from the poor wealth quantile. Additionally, mothers who were exposed to media had a 0.215-unit (ß: 0.215, 95% CI 0.046 to 0.391) higher DDS in their children than their peers. Children who meet their MMF have a 1.12-unit (ß: 1.107, 95% CI 0.967 to 1.248) higher projected DDS than children who do not fulfil their MMF. Finally, the DDS of children from households that are more than 30 min away from a water source will drop by 0.32 units (ß: 0.320, 95% CI −0.506 to −0.134) when compared with children from households that are less than 15 min away from a water source (table 4).

Random effect and model fitness

The null model's ICC was found to be 0.242. This meant that differences between clusters accounted for 24.2% of the overall variance in DDS among children, indicating that mixed models were suitable. The estimate of the across-cluster variance for the null model was significant (community variance: 1.666; SE: 0.068; p <0.001). This also validated the multilevel mixed-effect model's applicability. The null model's MOR was 3.34, suggesting that the odds of DDS were 3.34 times higher in children with a higher propensity for the outcome of interest than in children with a lower inclination. The PCV of the whole model from the null model was 27.5%, indicating that the combined predictors explained approximately 27.5% of the variation in DDS in the final model (table 5).

Because the outcome variable is continuous, both classical linear regression and the LMM were used. The likelihood-ratio test between various models revealed that LMM is the best fit (p value 0.021). The modelling method began with the null model, followed by successive linear mixed effect models that took into account the type of covariance structure. The full model was selected because of having a lower AIC and BIC value (table 5).

DISCUSSION

In this study, the mean (±SD) DDS of children was 2.8 (±1.5). Only 13.4% (95% CI 10.7 to 16.2) of children meet the MDDS. The most prevalent forms of food ingested by children are cereals, roots and tubers (70.1%), followed by dairy products (34.7%). This level of DDS in children is comparable to the results of area-specific studies conducted in Gorche district, southern Ethiopia (10.6%),[26] Aleta Wondo district, southern Ethiopia (12.0%)[25] and Dangila, northwest Ethiopia (12.6).[29] Furthermore, research conducted in Dabat District, northwest Ethiopia (17%)[40] and Enebsie Sar Midir Woreda, East Gojjam, northwest Ethiopia (18.2%)[41] revealed that a roughly similar percentage of children met the MDDS. Further analysis of EDHS 2011 (10.8%),[28] and EDHS 2016 (12.09%)[42] revealed a similar finding, indicating that there has been no improvement in children's dietary feeding practices over the last 10 years. This study's mean DDS is very similar to the finding from Kitui County, Kenya, where the mean DDS for children aged 6–23 months was 2.8.[43]

But the proportion of children who meet the MDDS in this study is significantly lower than from studies done in Addis Ababa (59.9%),[44] Shashemene City West Arsi Zone, Oromia, Ethiopia (42.5%),[24] Bench Maji Zone, Southwest Ethiopia (38%),[23] Gedeo zone, Ethiopia (29.9%),[27] Bale zone, Southeast Ethiopia (28.5%),[45] Wolaita Sodo town (27.3%),[46] Dabat HDSS site (27%)[47] and Kemba Woreda, Southern Ethiopia (23.3%).[48] Additionally, compared with this finding, findings from sub-Saharan Africa (SSA) (23.5%),[49] Nepal (46.5%)[50] and Indonesia (53.95%)[51] revealed that appropriate MDD intake was greater. This variation in magnitude may be attributable to the differences in the study setting, sociodemographic characteristics, sample size, climate conditions and seasonal variation of data collection time.

Table 2 Maternal and child healthcare characteristics, 2019

Variable	Category	Frequency	Percentage
Maternal media exposure	Yes	542	35.9
	No	969	64.1
ANC follow-up (n=1461)	Mean (±SD)	2.97 (±2.1)	
	No	345	23.6
	1–3 times	451	30.9
	≥4 times	665	45.5
Place of delivery	Home	656	43.4
	Health institution	855	56.6
Postnatal care (n=1457)	Yes	1259	86.4
	No	198	13.6
Get health counselling (n=1116)	Yes	779	69.8
	No	337	30.2
Parity	Mean (±SD)	3.4 (±2.3)	
	Nulliparous	354	23.4
	Multiparous	1157	76.6
Birth order	First birth	369	24.4
	2–4	547	36.2
	4–5	311	20.6
	≥6	284	18.8
Preceding birth interval (month)	First birth child	375	24.8
	<24	228	15.1
	24–35	302	20.0
	≥36	606	40.1
	Mean (±SD)	45.8 (±30.5)	
Contraceptive use and intention	Yes	733	48.5
	No	778	51.5

ANC, antenatal care.

In this study, as children's ages increased, their DDS increased. This is supported by studies conducted in Southern Ethiopia (Gorche district,[26] Gedeo zone,[27] Aleta Wondo district[25]), and Northwest Ethiopia (Dabat district,[40] Dangila[29]). Other studies done in SSA,[52] Eastern and Southern Africa,[53] Indonesia[51 54] and Asia[55] found that older children had a higher chance of getting MDDS than younger children. This could be because as children

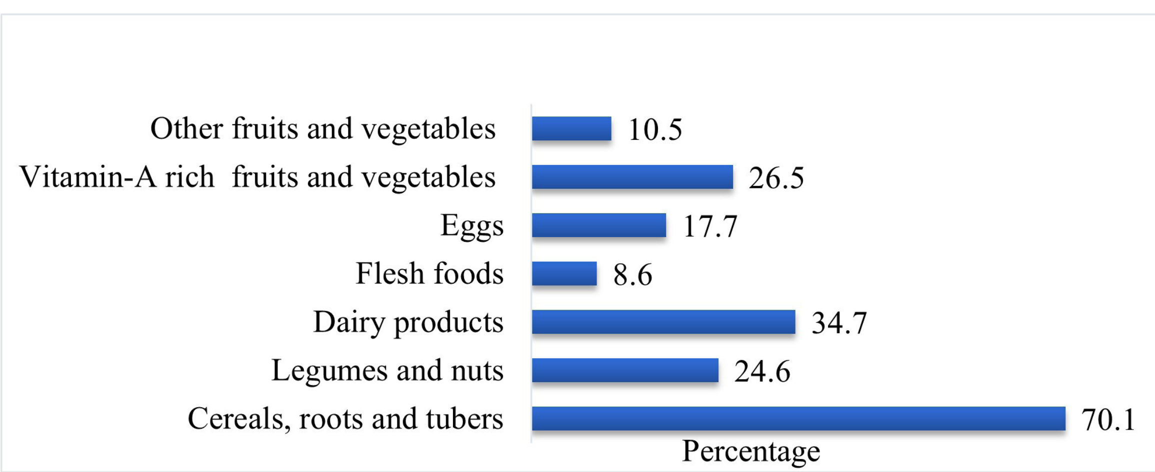

Figure 1 The 24-hour dietary food group consumption pattern of Ethiopian children aged 6–23 months, 2019 (n=1511).

Table 3 Feeding practice of Ethiopian children aged 6–23 months, 2019

Variables	Category	Frequency	Percentage
Breastfeeding status	Currently breastfeed	1246	82.5
	Ever breastfeed, but not now	220	14.6
	Never breastfeed	45	2.9
Breastfeeding initiation time (n=1418)	Immediately within 1 hour	1214	85.6
	After 1 hour	204	14.4
Prelacteal feeding (n=1418)	Yes	180	12.7
	No	1238	87.3
Bottle feeding practice	Yes	385	25.5
	No	1124	74.5
MMF	Mean (±SD)	2.7 (±1.8)	
	Meet	851	56.3
	Not meet	660	43.7
DDS	Mean (±SD)	2.8 (±1.5)	
	Meet	203	13.4
	Not meet	1308	86.6
MAD	Meet	176	11.6
	Not meet	1335	88.4

get older, their chances of getting a variety of meals rise, and mothers may have the notion that younger infants and children cannot digest items like meat and eggs. Furthermore, children of older ages are more likely to obtain the appropriate meal frequency than children of younger ages.[28 40] Therefore, those children who feed more frequently are likely to receive a diversified diet, as supported by this study. Furthermore, because infants of this age are predominantly breastfed, the requirement for frequent feedings of extra solid food is not viewed as necessary or a priority by moms and caregivers. In addition, older children have the option of eating a family diet, which increases feeding frequency and diversity of food. However, studies done at Wolaita Sodo town[46] and further analysis of EDHS 2011[48] were controversial with this finding, in which younger children had more DDS than older children.

Additionally, a rise in DDS among children is projected for every 1-year increase in maternal education. Similarly, research in several parts of Ethiopia, such as Gedeo Zone,[27] Addis Ababa,[44] Bench Maji Zone,[23] Dangila,[29] Bale Zone[45] and a national study done in Ethiopia[56] supports this finding. Also, studies done in Tanzania,[57] Nepal,[58] India,[59 60] Ghana,[61] Indonesia,[51 54] SSA,[49 52] Eastern and Southern Africa regions,[53] and Asian countries[55 62] support this finding. One possible explanation for this could be that individuals with formal education have a better chance of getting knowledge about their children's dietary needs and being aware of educational messages conveyed through various media outlets. Furthermore, as the educational level rises, so will maternal awareness of child care and IYCF practice, which will increase the variety of meals fed to their children.[26] Moreover, literacy is an important component of a household's ability to generate money (higher educated mothers have better jobs and empowerment) in order to get food with diverse nutritional components. Maternal empowerment has been linked to a higher likelihood of providing a minimum variety and an acceptable diet in studies.[56 63]

Also, this study found that children from the wealthy socioeconomic category had a higher risk of having DDS than those from the poor. This link is supported by single area-specific studies done in Ethiopia,[25 27 44 56] as well as further analysis of EDHS 2011 and EDHS 2016,[28 42] support this association. Similarly, studies from various African nations,[49 52 53 61] and Asian countries,[50 51 54 55 59 60 62 64 65] found that the DDS of children in the wealthy quantile was greater than that of children in the poor wealth quantile. This could imply that family income has a direct relationship with household food security. This means that middle-income and upper-income families are more likely to be food secure and able to acquire a variety of consumer goods for their families. It is also suggested that household food insecurity is one of the factors impeding DDS and child food consumption.[24 25]

In addition, this study found that maternal media exposure has a favourable effect on children's DDS. This finding was supported by studies conducted in various parts of Ethiopia, including Gorche district,[26] Dangila,[29] Aleta Wondo district[25] and Dabat district.[40] Furthermore, studies from SSA,[49 52] Eastern and Southern Africa,[53] India,[60] Indonesia[51 54 65] and South Asia[62] found that limited exposure and access to media (watching television, listening to radio, reading newspapers or magazines and accessing the Internet) are risk factors for not reaching MDDS in children. When women have access to the media, they will receive nutritional information, and their level of understanding of IYCF practices will grow, which will have a favourable impact on their children's DDS.[25] Because the media is generally regarded as a reliable source of health and nutrition information, such messages are more likely to be adopted.

Furthermore, this study found that children who met the MMF were more likely to meet the MDDS. Similarly, a study conducted in Amibara district, North East Ethiopia, found a link between meal frequency and DDS in children.[66] This could be explained by the fact that households that feed their children more regularly are more likely to be food secure and able to provide their children a diverse diet. It is also suggested that household food insecurity is one of the reasons impeding children's DDS.[24 25]

Finally, the DDS of children from households where the water source is more than 30 min away will be lower than the DDS of children from households where the water source is within their premises or less than 15 min away. Similarly, a study conducted in Tanzania,[57] Malawi[67]

Table 4 Linear mixed model regression analysis to identify predictors of DDS among children aged 6–23 months of age in Ethiopia, 2019 (n=1511)

Variable/category	Unadjusted analysis Coefficients (95% CI lower to upper)	Adjusted analysis Coefficients (95% CI lower to upper)	P value
Intercept	2.851 (2.742 to 2.961)	1.578 (1.080 to 2.075)	<0.001
Child age	0.026 (0.012 to 0.039)	**0.016 (0.006 to 0.030**)	**<0.015**
Maternal education	0.126 (0.092 to 0.160)	**0.057 (0.037 to 0.077**)	**<0.001**
Family size	−0.031 (−0.062 to −0.001)	−0.007 (−0.051 to 0.036)	0.752
Number of under-5 children	−0.213 (−0.309 to −0.118)	−0.005 (−0.126 to 0.117)	0.941
Parity	−0.079 (−0.111 to −0.048)	0.005 (−0.039 to 0.049)	0.814
ANC frequency	0.126 (0.091 to 0.160)	0.019 (−0.017 to 0.055)	0.301
Birth interval	0.002 (−0.001 to 0.005)	0.001 (−0.002 to 0.004)	0.626
Residence			
Rural	1	1	
Urban	−0.833 (−1.06 to 0.606)	0.012 (−0.205 to 0.230)	0.911
Wealth index			
Poor	1	1	
Middle	0.310(0.094 to 0.526)	0.025 (-0.182 to 0.232)	0.811
Rich	0.954 (0.775 to 1.133)	**0.218 (0.003 to 0.433**)	**0.047**
Religion			
Muslim	1	1	
Orthodox	0.224 (0.006 to 0.442)	−0.017 (−0.193 to 0.160)	0.852
Others*	−0.067 (-0.321 to 0.189)	−0.086 (−0.281 to 0.109)	0.386
Birth place			
Home	1	1	
Health institution	0.618 (0.454 to 0.782)	0.131 (−0.037 to 0.299)	0.126
PNC			
No	1	1	
Yes	0.353 (0.146 to 0.559)	0.182 (−0.022 to 0.387)	0.081
Media exposure			
No	1		
Yes	0.696 (0.535 to 0.856)	**0.215 (0.046 to 0.391**)	**0.013**
Minimum meal frequency			
Not meet		1	
Meet	1.373 (1.243 to 1.503)	**1.107 (0.967 to 1.248**)	**<0.001**
Water source			
Improved	1	**1**	
Unimproved	−0.284 (−0.457 to −0.112)	0.095(-0.056, 0.247)	0.218
Time taken to reach the water source			
Less than 15 min		**1**	
15–30 min	−0.359 (0.–537 to −0.181)	−0.067 (−0.242 to 0.107)	0.450
More than 30 min	−0.603 (−0.796 to −0.410)	**−0.320 (−0.506 to −0.134**)	**0.001**

Bold values are statistically significant.
*Protestant, Catholic, and those with no religion.

Table 5 Results from random intercept model (measure of variation) for dietary diversity score (DDS) of children at cluster level using linear mixed model analysis

Parameters	Null model	Full model
Random effect (measure of variation for DDS)		
Community-level variance (SE)	1.67 (0.07)	1.21 (0.06)
ICC or VPC (%)	24.2	3.8
PCV	Reference	27.5
MOR (95% CI)	3.34	2.84
Model fit statistics		
Log-likelihood	–2677.7	–1726.9
AIC	5361.5	3497.9
BIC	5377.5	3608.4

AIC, Akaike information criterion; BIC, Bayesian information criterion; MOR, median ORs; VPC, variance partition coefficients.

and the Eastern and Southern Africa region[53] showed that children's MDDS and household dietary diversity were determined by distance to a water source or optimal home water availability. Also, evidence from India[68] and Zimbabwe[69] indicated that water scarcity impedes children's dietary diversification. Another study conducted in Tanzania found that the distance from a water source is related to child malnutrition.[70] Longer hours spent fetching water for household usage affect the quality of care and feeding frequency due to a lack of time for care and meal preparation. Water availability and access also affect children's dietary diversity by affecting the food availability dimension through agricultural contributions, particularly home vegetable production.[71] Water is also mentioned as being important to food security and nutrition.[72]

Other studies also indicated sociodemographic and economic characteristics such as number of families,[27] number of children,[23 28 55] age of mothers,[40 53] residence,[23 29 42 49] father's literacy,[25 58] farmland ownership and home gardening,[25 29 41 47 56] maternal employment status and type,[42 49 52 53] women's empowerment (decision-making power),[42 56] an availability of cow's milk at household and number of animals[41] have a significant association with DDS of children. Additionally, studies also indicated that healthcare practices such as ANC follow-up,[23 47 59 60 62 64] institutional delivery,[47 49] postnatal checkups,[25 40 60 62] mothers visited a healthcare facility in the last 12 months,[52] child growth and monitoring follow,[40] receiving IYCF information or counselling during antenatal and postnatal checkups,[25 45] mother's participation in cooking demonstrations,[25] husband's involvement in the IYCF score and childcare support,[25 56] vitamin-A supplementation intake,[53 55] birth order,[29 53] child illness in the past 1 week,[45] current breastfeeding status of children,[47] lower maternal body mass index (<18.5 kg/m^2), were significantly associated with DDS of children. In this study, those mentioned predictors were not assessed or did not make a significant association.

Limitations and strengths

The current study adds to the body of knowledge by correlating socioeconomic and demographic characteristics with children's feeding practices in Ethiopia. However, some potential predictor variables that were missing in the EMDHS data set (such as maternal employment, paternal educational status and employment) or had more than 10% missing data (maternal nutritional counselling, and child vaccination status) were not included in the final regression analysis and thus may have had a residual effect on the parameter estimates. Furthermore, the dietary practice of children was assessed using a single 24-hour recall method, which may not indicate the usual dietary habits of the children.

CONCLUSION

Dietary diversity is inadequate in Ethiopia. DDS was affected by sociodemographic parameters such as child age, maternal education in years, wealth index, maternal media exposure, meal frequency and distance from a water source. Improving the literacy status of mothers, their economic status and their exposure to media are important in improving the intake of a diversified diet among Ethiopian children. It is critical to promote a diverse diet for children, particularly younger children, and to feed them more frequently throughout the day. Water accessibility and availability should be prioritised for communities.

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Patient consent for publication Not applicable.

Ethics approval The study topic and its major objective were registered in the DHS program in order to obtain the dataset. After examining the study objectives, an authorisation letter to download survey data from the Demographic and Health Surveys (DHS) Program was received. The data were entirely retrieved from www.dhsprogram.com in compliance with the data sharing policy. The data that were obtained were exclusively used for the registered study article. No attempt was made to identify any of the households or individuals polled, and the data were kept private. The records were not shared with other researchers without prior written consent from DHS.

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