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Gender differences in nutritional status and determinants among infants (6–11 m): a cross-sectional study in two regions in Ethiopia

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Abstract

Background: A limited number of studies suggest that boys may have a higher risk of stunting than girls in low-income countries. Little is known about the causes of these gender differences. The objective of the study was to assess gender differences in nutritional status and its determinants among infants in Ethiopia.

Methods: We analyzed data for 2036 children (6–11 months old) collected as the baseline for a multiple micronutrient powders effectiveness study in two regions of Ethiopia in March–April 2015. Child, mother, and household characteristics were investigated as determinants of stunting and wasting. Multiple logistic regression models were used separately for boys and girls to check for gender differences while adjusting for confounders. The study is registered at <http://www.clinicaltrials.gov/> with the clinical trials identifier of NCT02479815.

Results: Stunting and wasting prevalence is significantly higher among boys compared to girls, 18.7 vs 10.7% and 7.9 vs 5.4%, respectively. Untimely initiation of breastfeeding, not-exclusive breastfeeding at the age of 6 months, region of residence, and low maternal education are significant predictors of stunting in boys. Untimely introduction to complementary food and low consumption of legumes/nuts are significant predictors of stunting in both boys and girls, and low egg consumption only in girls. Region of residence and age of the mother are significant determinants of wasting in both sexes. Analysis of interaction terms for stunting, however, shows no differences in predictors between boys and girls; only for untimely initiation of breastfeeding do the results for boys (OR 1.46; 95%CI 1.02,2.08) and girls (OR 0.88; 95%CI 0.55,1.41) tend to be different ($p=0.12$).

Conclusion: In Ethiopia, boys are more malnourished than girls. Exclusive breastfeeding and adequate dietary diversity of complementary feeding are important determinants of stunting in boys and girls. There are no clear gender interactions for the main determinants of stunting and wasting. These findings suggest that appropriate gender-sensitive guidance on optimum infant and young child feeding practices is needed.

Keywords: Gender, Determinants, Nutritional status, Stunting, Infants, Young children, Growth, Ethiopia

Background

Globally, stunting – an indicator of chronic undernutrition – affects at least 149.2 million children under the age of 5 years [1]. The Ethiopia Demographic and Health Survey (DHS) 2016 reports that, despite some improvements

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in the last 16 years, Ethiopia still displays high rates of childhood malnutrition, with 38% of Ethiopian children under 5 years of age being stunted and 10% being wasted [2]. Child linear growth is the measure of chronic malnutrition.

Epidemiological studies demonstrate that stunting is frequently associated with repeated exposure to poor sanitation and hygiene; and individual factors such as a child's gender, poor economic conditions [3, 4], child morbidity [4, 5], and inadequate infant and young child feeding (IYCF) practices [6] have been identified as immediate causes of child stunting. The studies also show that wasting or thinness is generally associated with recent illness and/or food deprivation [3], presence of infectious disease [4], and inappropriate complementary feeding [7]. For example, a too-early introduction of solid foods before 6 months of age has a significant association with long-term deterioration of physical growth [7, 8].

Recent studies from several countries worldwide show a higher prevalence of stunting in boys compared to girls [9–11]. In Senegal and Guatemala, the observed gender difference in stunting prevalence is attributed to differential feeding practices, with boys starting complementary feeding at an earlier age, i.e. 2–3 months of age, thereby reducing the period of exclusive breastfeeding [9, 11]. A study from South West Uganda reports that stunted children are significantly less likely to be introduced to complementary food (CF) at an appropriate age [10].

Little is known about the existence of gender differences in nutritional status and underlying IYCF practices in Ethiopian infants. The current health promotion activities do not take gender issues into account. Thus, our study aims to compare the prevalence and potential determinants of stunting and wasting between boys and girls. IYCF practices, dietary intake, and maternal and household characteristics are the main determinants investigated. The determinants of wasting as an important indicator of acute undernutrition in young children are also compared between boys and girls.

Methods

This cross-sectional study was performed using the baseline data for a large effectiveness study on the use of multiple micronutrient powders (MNPs) within a local CF program on iron status, morbidity, and children's growth. Methods and findings of the MNP effectiveness study are described in detail elsewhere [12].

Study area and population

The baseline data collection took place in the predetermined nine districts from Oromiya and Southern Nations, Nationalities, and Peoples (SNNP) regions of Ethiopia between March and April 2015. Both regions

were selected because of their similar characteristics in food security, child health, and nutritional status; explicitly stunting (37% and 39%) and wasting (10.6% and 6.0%) in Oromiya and SNNP regions respectively [2], and infant feeding practices [13].

The study population consisted of young children 6–11 months of age [12]. The study intended to assess whether there will be a difference in IYCF practices between boys and girls, particularly in the introduction of solid, semi-solid, or soft foods which usually need to be initiated at 6–8 months [12]. This difference will lead to a difference in nutritional status. In addition, the objective of the intervention study was to assess the effectiveness as well as risks and benefits of a low-dose (6 mg iron per serving every other day) iron Micronutrient Powders (MNP) on iron status, morbidity, and growth of Ethiopian infants and young children [12]. We chose this age group to ensure that all children continued to be eligible to receive the program intervention for the entire duration of the follow-up. Details on the study site and sample selection are described elsewhere [12].

Operational definition

Stunting is defined as low height-for-age and it results from chronic undernutrition.

Wasting is defined as low weight-for-height. It often indicates recent and severe weight loss, although it can also persist for a long time.

Sample selection

We used a three-stage sampling for sample selection. At the first stage, intervention and non-intervention districts were purposively selected which were 3 intervention districts and 3 non-intervention districts which make 6 districts per region in total 12. Out of these 12 districts, three districts were excluded based on the status of the grain-bank program leaving nine districts for the study. Once the districts were chosen, the sub-district (second stage) within the district were selected using inclusion criteria [12]. A total of 35 sub-districts were identified. At the third stage, the selection of households within the sampled sub-districts was performed using criteria including a child 6–11 months, a child not having any serious illness that changes his/her food intake, and a mother willing to stay in the sub-district during the study period. Before screening for admission, all children below 1-year age in the selected sub-districts were listed by Health Extension Workers. Using the criteria, 65 eligible children (6–11 months) per sub-district; a total of 2356 children were included.

A total of 2356 children from 35 sub-districts/clusters (the smallest administrative unit in Ethiopia) of 9 districts were screened and admitted to the study [12].

A child could participate in the study if he/she was ≥ 6 and < 12 months old on the recruitment day and living in one of the selected sub-districts. Participating children also had to be free from chronic conditions such as metabolic or neurological disorders that might impact their health (e.g. mental retardation). Exclusion criteria included the presence of serious disabilities that would affect normal growth and development. In addition, children with a severe or protracted illness for which continuous medication is required and children with severe undernutrition (weight-length-z score (WLZ) < -3 SD) were excluded from the study and referred to the nearest health facility. In total, 320 children were excluded, and the analyses were performed on data for 2036 children.

Data collection and measurements

Procedures

Three data collectors were assigned to work on a study area of three sub-districts as a field team. Thirty-six data collectors and six field supervisors were trained in the administration of questionnaires (IYCF, 24 h. recall, and morbidity) and anthropometric measurements, including standardization of data collectors (see [supplemental file](#)). After nine days of training on methodological procedures and quality assurance, the questionnaires were tested in a pilot group and adapted based on the received feedback from the survey team. The questionnaires were translated into local languages (Oromifa and Amharic) and back-translated to English to ensure the quality of the translation. The data collectors' measurements were standardized to ensure that the inter-observer variability was within tolerable limits. Supervisors received additional training on teamwork and monitoring and supervising the data collection process. The field teams were provided with training and data collection manuals, a chart for calculating age in months, an event calendar, and a World Health Organization (WHO) classification table for Weight for Height (WHZ) to identify severely malnourished children. Data were collected at the sub-districts' health posts by interviewing the child's mother/primary caregiver and taking anthropometric measurements. The supervisors monitored the measurements to ensure the quality of the data.

Anthropometric measurements (length and weight) were taken following standard procedure [14]. Weight was measured using the UNICEF Seca 874 U electronic scales (UNICEF Supply Division, Copenhagen, Denmark) with 100 g precision calibrated daily with a known weight, and height was measured on UNICEF's standard measuring board (precision of 0.1 cm). All children were measured lying down. Measurements were taken in duplicate and repeated a third time if the difference between the first two was more than 0.5 cm or 0.5 kg.

IYCF practices and morbidity status were assessed using a questionnaire based on WHO recommendations to collect data for the IYCF indicators [15]. A 1-day non-quantified 24 h dietary recall was collected, including information on the source of food, method of preparation, and meal description to assign all ingredients to the respective food groups consumed by the child in the previous 24 h period.

Data processing and analysis

Data processing

All the questionnaires were manually checked for completeness before data entry. Data were coded in duplicate and analyzed using SPSS (Version 22.0 for Windows, IBM, New York, USA). The data were cleaned for inconsistencies and missing values. If inconsistencies and missing values could not be resolved by checking the original questionnaires, those data were excluded from further analysis. Children's age was entered as the date of birth provided by the caregivers. Length-for-age z scores (LAZ) and WLZ z scores were determined using the WHO Anthro software version 3.2.2 [16] based on the WHO reference population (2006). Stunting was defined as LAZ < -2 of the standard deviation (SD) and wasting was WLZ z scores < -2 SD. IYCF indicators were calculated following the UNICEF guidelines [17]. For this study, we defined as 'timely introduced to CF' a) children aged 6–8 months who were fed breast milk and had had at least one solid or semi-solid food the previous day or b) children aged 9–11 months who had a recall age of the first introduction of CF between 6 and 8 months of age. The seven food groups described by the WHO [17] were used to classify foods consumed, namely: 1) grains, roots, and tubers; 2) legumes and nuts; 3) dairy products; 4) flesh foods; 5) eggs; 6) vitamin A-rich fruits and vegetables; 7) other fruits and vegetables. Minimum dietary diversity was defined as the consumption of four or more food groups from the seven food groups [17]. Minimum meal frequency was defined as the consumption of 2 or more (at age 6–8 months), 3 or more (at age 9–23 months) solid or semi-solid feeds for breastfeeding children, or 4 or more solid or semi-solid or milk feeds for non-breastfeeding children at age 6–23 months [17]. A minimum acceptable diet was defined as a combination of minimum dietary diversity and meal frequency [17]. Basic drinking water and adequate sanitation facilities were defined according to UNICEF and WHO's joint monitoring programme water, sanitation, and hygiene (WASH) targets and indicators post-2015 [18]. Full anthropometric data (age or length or weight) were missing for about 8% of children and the WLZ z score of some of the children was below entry point (≤ -3.0). Thus, children with incomplete data on nutritional status

and the flagged cases were therefore excluded from our analyses.

Statistical analysis

All continuous data were checked for normality by investigating the skewness and kurtosis of the distribution. For the linear regression, we used a graph of standardized residuals against each of the predictor variables in the regression models. We also used graphs to test the homogeneity of variance of the residuals by plotting the residuals versus predicted values.

Child characteristics, i.e. age, height, weight, LAZ z score, WLZ z score, stunting, wasting, and IYCF indicators, mother/caregiver characteristics including mother's age, marital status, maternal education and occupation, and household characteristics, i.e. WASH indicators and region of residence, were compared between boys and girls using Chi-square tests for categorical variables and Student t-tests for continuous variables.

Binary logistic regression was used to investigate the association between potential determinants vs stunting and wasting. Variables associated with the outcome at $p < 0.2$ were selected for multiple logistic regression, stratified by gender, and adjusted for age, sub-district/cluster, and mother's characteristics. The interactions between each variable and gender were tested with cross-product terms. For continuous variables (LAZ z score and WLZ z score), multiple linear regression was performed including independent variables associated with the outcome in unadjusted analyses at $p < 0.2$. A p -value of < 0.05 was considered significant. For the tests of interaction terms, a p -value of < 0.2 was considered relevant [19].

Results

The study participants' ($n = 2036$) characteristics are summarized in Table 1. The average (\pm SD) age of children was 8.2 ± 1.7 months. An almost equal proportion of male (51.5%) and female (48.5%) children was included. Socio-demographic characteristics were not different between boys and girls. The average age of mothers was 25.4 ± 5.7 years. Almost half of the mothers were illiterate; among literate mothers, a majority (43.8%) had attended primary school (grades 1–8) only. Most households had adequate sanitation facilities and basic drinking water sources.

Stunting and wasting prevalence was significantly higher among boys than girls (18.7% vs 10.7%, $p < 0.001$, and 7.9% vs 5.4%, $p < 0.026$, respectively, Table 1), and girls had a significantly higher means of LAZ and WLZ z scores than boys. Stunting and wasting increased as the children's age increased (Fig. 1, A and B).

In total, 28.3% of young children were reported as having diarrhea the week before the survey, and 25.5% were

reported as having had a common cold or flu, with similar results for boys and girls (Table 1).

More than 75% of mothers started breastfeeding their new-born within one hour of birth (Table 2). Most children, 77% of boys and 78.2% of girls were exclusively breastfed during the first 6 months of life. Only 5.9% of boys and 7.8% of girls consumed a minimum acceptable diet (MAD), and 6.2% of the boys and 7.8% of the girls met the minimum dietary diversity (MDD) cut-off.

We examined gender differences in the consumption of seven selected food groups (Table 3). Most children (>76%) had consumed cereals and roots/tubers during the previous 24 h. The consumption of legumes/nuts and eggs was low but increased slightly with age, with the highest consumption of legumes/nuts in boys aged 9–11 months (45.4%); this was significantly higher than the consumption of legumes/nuts in girls of that same age. The use of fruits and vegetables tended to be lower in the older boys compared to the girls (19.7% vs 25.0%, $p = 0.057$), whereas the consumption of eggs tended to be higher in older girls compared to boys (25.2% vs 20.5%, $p = 0.099$). The consumption of flesh foods was negligible. There were no significant differences in the consumption of any of the other food groups between boys and girls.

Table 4 describes the factors associated with stunting and wasting. Gender was a significant determinant of nutritional status (odds ratio (OR) for boys vs girls: 1.91 (95%CI 1.48, 2.46) for stunting and OR 1.51 (95%CI 1.06, 2.16) for wasting), showing boys more affected than girls. In addition to gender, of the 18 characteristics investigated, the following were significantly associated with stunting: region of residence, non-exclusive breastfeeding, untimely introduction to CF, diarrhea during last 7 days, absence of consumption of legumes/nuts, lack of consumption of eggs, and maternal education. Determinants of wasting included region of residence, absence of consumption of legumes and nuts, absence of consumption of other fruits and vegetables, age of the mother, and education of the mother.

We further explored factors associated with stunting and wasting (Table 5) separately for boys and girls, taking age, sub-district/cluster, and characteristics of the mother and/or household into account. In boys, independently increased odds of stunting were observed for residing in SNNP, late initiation of breastfeeding, non-exclusive breastfeeding until age 6 months, untimely introduction to CF, absence of consumption of legumes/nuts, and an illiterate mother. Among girls, only untimely CF introduction, the absence of legumes/nut use, and non-use of eggs were significantly associated with the presence of stunting.

Regarding wasting, for both boys and girls, the region of residence and age of the mother were the only

Table 1 Selected characteristics of young children in Oromiya and SNNP^a regions of Ethiopia, 2015

Characteristics	Total population	Boys		Girls	p-value ^{††}
	n = 2036	n = 1049			
Region, Oromiya %	47.6	53.7		46.3	0.069
Child characteristics					
Child's age in months, mean ± SD	8.2 ± 1.7	8.2 ± 1.7	8.2 ± 1.7		0.459
6–8 n (%)	113 (54.7)	562 (53.6)	551 (55.8)		0.327
9–1.9 n (%)	923 (45.3)	487 (46.4)	436 (44.2)		
Male child, n (%)	1049 (51.5)				
Height, mean ± SD, cm	68.4 ± 3.8	68.9 ± 3.8	67.9 ± 3.8		< 0.001
Weight, mean ± SD, kg	7.72 ± 1.1	7.9 ± 1.1	7.5 ± 1.0		< 0.001
Length-for-age z score (LAZ), mean ± SD	-0.65 ± 1.4	-0.86 ± 1.4	-0.43 ± 1.3		< 0.001
Stunted (< -2SD) %	14.8	18.7	10.7		< 0.001
Severely stunted (< -3SD) %	3.9	6.0	1.7		< 0.001
Weight-for-length z score (WLZ), mean ± SD	-0.37 ± 1.1	-0.43 ± 1.1	-0.30 ± 1.1		0.011
Wasted (< -2SD) %	6.7	7.9	5.4		0.026
Diarrhea (prior 1 wk) %	28.3	28.2	28.4		0.961
Common cold or flu (prior 1 wk) %	25.5	26.0	25.0		0.612
Mother's characteristics					
Mother's age in years, mean (SD)	25.4 ± 5.7	25.5 ± 5.9		25.4 ± 5.4	0.903
Mother's educational status %					
Illiterate/none–formal education	48.4	48.8		48.0	0.374
Grades 1–8	43.8	42.8		44.8	
Grade 9 and above	7.8	8.4		7.2	
Marital status %					
Married	96.4	96.3		96.6	0.812
Single/separated/divorced/widowed	3.6	3.7		3.4	
Mother's occupation %					
Housewife/live with family	80.9	80.4		81.6	0.499
Working mother ^b	19.1	19.6		18.4	
Household characteristics^c					
WASH indicators					
Adequate sanitation %					
Adequate ^d	93.9	94.3		93.5	0.517
Drinking water ^f					
Basic drinking achieved	92.7	93.2		92.1	0.349
Farmland ownership %	91.2	90.1		92.3	0.149

^{††} Chi-square tests were used for categorical variables and Student t-tests (sig 2-tailed) were used for continuous variables to compare the characteristics between boys and girls

^a Southern Nations, Nationalities, and Peoples

^b Working mother includes farmer, trader, merchant, civil servant, and teacher

^c n = 2023 (undefined n = 13)

^d Adequate sanitation includes a pit latrine with a superstructure, and a platform or squatting slab constructed of durable material; inadequate sanitation includes open pit, shared facilities of any type, no facilities, bush, or field [18]

^f Basic drinking water includes piped water with the subcategories public tap and private tap, protected spring, protected well, water from a borehole, water from a tanker truck, and rainwater; inadequate basic drinking water: surface water, river, unprotected spring [18]

significant independent risk factors, with lower odds of wasting when residing in SNNP (compared to Oromiya) and when having a mother < 25 years of age (Table 5). Consumption of legumes and mother's marital status are not significant ($p < 0.05$) but they tended to be significant

determinants for wasting in boys ($p < 0.10$) but not in girls, whereas the absence of adequate sanitation tended to be significant in girls but not in boys.

The interaction terms between gender and all main determinants were tested in additional logistic regression

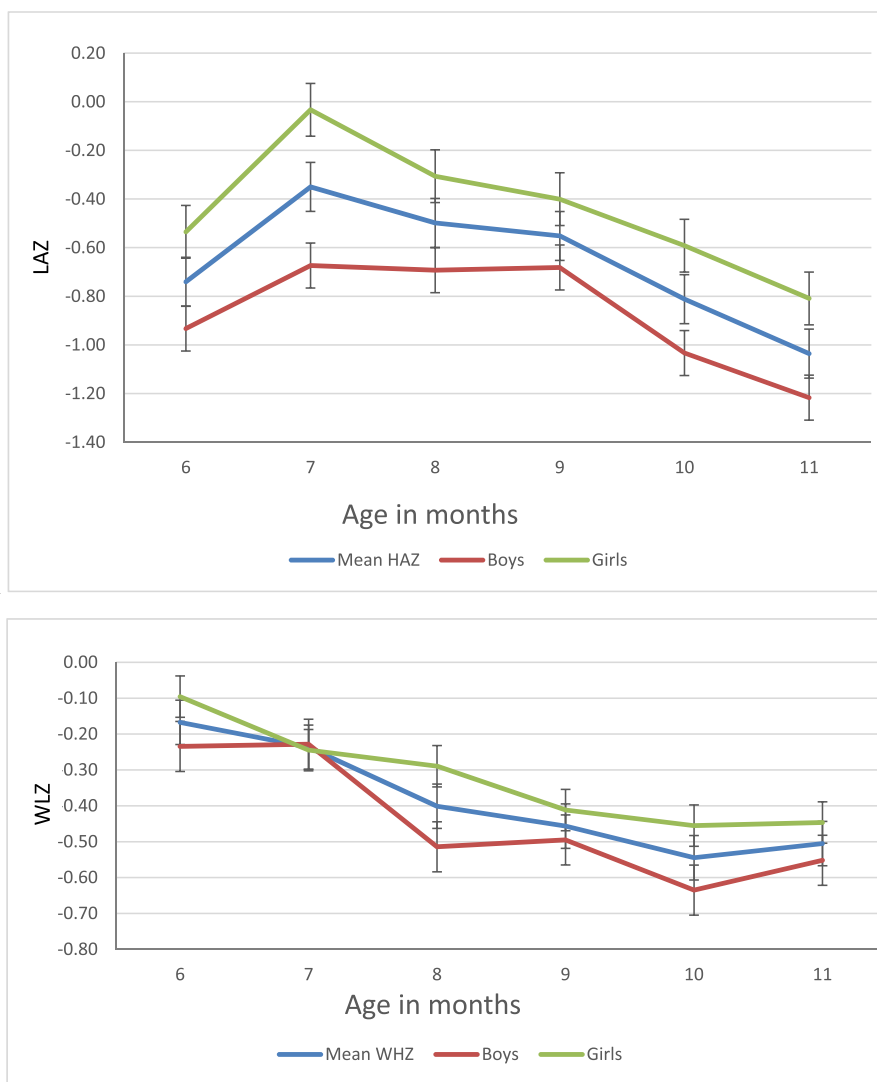


Fig. 1 Stunting (A) and wasting (B) in Oromiya and SNNP†† regions of Ethiopia, 2015 (n = 2036). †Error bars are defined using standard errors. †† Southern Nations, Nationalities, and Peoples

analyses. There was an indication of an interaction between early initiation of breastfeeding and gender ($p=0.128$), suggesting that the association between initiation of breastfeeding and stunting was different between boys and girls. No clear interactions with sex were observed for the other variables, neither for stunting nor for wasting (see Additional file 1).

Determinants were also investigated in relation to the LAZ z score and WLZ z score as continuous outcome variables (see Additional file 2). Boys had a lower mean of LAZ z score than girls, and LAZ z score decreased with age, was lower in those with the untimely introduction of CF, not consuming legumes and nuts and not consuming eggs, and having a mother or caregiver < 25 years of age.

WLZ z score was lower in Oromiya in boys; decreased with age; and was lower in those with no MDD, in the presence of diarrhea, in older mothers or caregivers, in non-working mothers, and from a household with inadequate sanitation.

Discussion

Our analyses show that gender differences in stunting and wasting exist in Ethiopian infants aged 6–11 months, with boys being 1.9 times more likely to be stunted and 1.5 times more likely to be wasted than girls. Risk factors for stunting and wasting are not significantly different between boys and girls, although small differences exist. Region of residence, untimely

Table 2 Infant and young child feeding practices in Oromiya and SNNP^a regions of Ethiopia, 2015

	Total population <i>n</i> = 2036	Boys <i>n</i> = 1049	Girls <i>n</i> = 987	<i>p</i> -value
IYCF indicators				
Initiation of BF < 1 h %	75.7	76.9	74.5	0.196
Currently breastfeeding (CBF) %	99.7	99.8	99.5	0.275
Exclusive BF (EBF) at least 6 m %	77.6	77.0	78.2	0.524
EBF in months, mean (SD)	5.9 ± 1.2	5.9 ± 1.4	5.8 ± 0.8	0.344
Introduction to soft and semi-solid foods				
Age (months) CF introduced ^b , mean (SD)	5.9 ± 1.2	5.9 ± 1.3	6.0 ± 1.2	0.206
Introduction CF (6–8 months) ^c %	87.2	87.3	87.0	0.894
Minimum dietary diversity (MDD) ^d %	7.0	6.2	7.8	0.164
Minimum meal frequency (MMF) ^e %	75.3	74.8	75.9	0.607
Minimum acceptable diet (MAD) ^f %	6.8	5.9	7.8	0.095

^a Southern Nations, Nationalities, and Peoples; CBF: currently breastfeeding (at the time of the survey); EBF: exclusive breastfeeding; IBF: initiation of breastfeeding; MDD: minimum dietary diversity; MMF: minimum meal frequency; MAD: minimum acceptable diet

^b *n* = 1998: Boys *n* = 1031, Girls *n* = 967

^c Received CF: children from 6 to 8 months who received solid, semi-solid, or soft foods in addition to breastfeeding

^d Minimum dietary diversity: consumption of 4 or more food groups from the 7 food groups, namely: grains, roots, and tubers; legumes and nuts; dairy products (milk, yogurt, cheese); flesh foods (meat, fish, poultry, liver/organ meats); eggs; vitamin A-rich fruits and vegetables; and other fruits and vegetables

^e Minimum meal frequency: consumption of 2 or more (at age 6–8 months), 3 or more (at age 9–23 months) solid or semi-solid feeds for breastfeeding children, or 4 or more solid or semi-solid or milk feeds for non-breastfeeding children at age 6–23 months

^f Minimum acceptable diet: a combination of minimum dietary diversity and meal frequency

Table 3 Food group use (%) in young children in Oromiya and SNNP^a regions of Ethiopia, 2015

Food groups ^{††}	6–8 months (<i>n</i> = 1139)			9–11 months (<i>n</i> = 923)		
	Boys	Girls	<i>p</i> -value [‡]	Boys	Girls	<i>p</i> -value [‡]
	<i>n</i> = 562	<i>n</i> = 551		<i>n</i> = 487	<i>n</i> = 436	
Cereals and roots/tubers	76.9	78.8	0.471	90.1	89.9	0.913
Legumes and nuts	26.5	28.7	0.422	45.4	38.5	0.039
Dairy	32.9	34.7	0.568	31.6	33.7	0.527
Flesh foods	0	0	-	0.2	0	1.000
Eggs	18.9	20.5	0.498	20.5	25.2	0.099
Vitamin A-rich fruits and vegetables	4.6	4.9	0.888	4.3	5.0	0.641
Other fruits and vegetables	19.0	20.5	0.548	19.7	25.0	0.057

^a Southern Nations, Nationalities, and Peoples

^{††} † Calculated based on consumption of the food group in the previous 24 h

[‡] Chi-square tests were used to compare between boys and girls

initiation of breastfeeding, not-exclusive breastfeeding at age 6 months, and low maternal education are significant risk factors for stunting in boys. Untimely introduction to complementary food and low consumption of legumes/nuts are significant risk factors for stunting in both boys and girls, and only in girls is low egg consumption associated with stunting. Region of residence and mother's age are the significant independent predictors of wasting in both sexes.

The gender differences that we observed in nutritional status are consistent with findings from the northern part of Ethiopia [20] as well as from some other Sub-Saharan African countries [10, 21–25]. A meta-analysis of 16 demographic and health surveys from 10 Sub-Saharan African countries in 2007 also shows that male children were 1.16 times more likely to be stunted than females [26]. A recent meta-analysis of data on children (6–59 months) from 84 countries in 2018 also reports a

Table 4 Factors associated with stunting and wasting in Oromiya and SNNP^a regions of Ethiopia, 2015 (*n* = 2036)

Variables	Stunting ^b		Wasting ^c	
	OR (95%CI) ^d	<i>p</i> -value	OR (95%CI) ^d	<i>p</i> -value
Region SNNP	1.39 (1.08,1.78)	0.010	0.35 (0.24,0.52)	< 0.001
Oromiya	1		1	
Child characteristics				
Sex Male	1.91 (1.48,2.46)	< 0.001	1.51 (1.06,2.16)	0.022
Female	1		1	
Age (month)	1.06 (0.98,1.14)	0.133	0.77 (0.54,1.09)	0.138
IBF (Late)	1.22 (0.93,1.61)	0.158	1.00 (0.67,1.50)	1.000
Before 1 h	1		1	
EBF (No)	1.56 (1.19,2.05)	0.001	1.03 (0.68,1.55)	0.908
Yes	1		1	
Timely introduced to CF (No)	1.89 (1.38,2.60)	< 0.001	1.19 (0.73,1.94)	0.500
Yes	1		1	
MDD (No)	1.30 (0.77, 2.20)	0.321	1.41 (0.65,3.08)	0.389
Yes	1		1	
MMF (No)	1.17 (0.89,1.54)	0.276	0.90 (0.59,1.36)	0.602
Yes	1		1	
MAD (No)	1.27(0.75, 2.14)	0.372	1.38 (0.63,3.00)	0.423
Yes	1		1	
Diarrhea last 7 days (Yes)	1.31 (1.01,1.70)	0.044	1.10 (0.75,1.61)	0.619
No	1		1	
Consumed legumes and nuts (No)	1.42 (1.08, 1.86)	0.012	0.64 (0.45,0.91)	0.012
Yes	1		1	
Consumed eggs (No)	1.41 (1.02,1.95)	0.038	0.82 (0.55,1.24)	0.345
Yes	1		1	
Consumed other fruits and vegetables (No)	0.87 (0.65,1.17)	0.361	1.67 (1.02,2.75)	0.042
Yes	1		1	
Mother's characteristics				
Age of mother (< 25 years)	1.01 (0.79,1.30)	0.929	0.60 (0.42,0.85)	0.004
> 25 years	1		1	
Education (illiterate)	1.32 (1.03,1.69)	0.027	1.42 (1.00,2.02)	0.049
Literate	1		1	
Marital status (married)	0.61 (0.34,1.07)	0.086	0.49 (0.24,1.01)	0.054
^e	1		1	
Occupation (working mother)	0.75 (0.54,1.05)	0.095	1.46 (0.97,2.18)	0.069
Housewife	1		1	
HH characteristics				
Basic drinking water (No)	0.83 (0.50,1.36)	0.458	0.47 (0.19,1.16)	0.099
Yes	1		1	
Adequate sanitation (No)	0.78 (0.45,1.36)	0.378	1.55 (0.83,2.88)	0.171
Yes	1		1	

^a Southern Nations, Nationalities, and Peoples; OR: odds ratio; CI: confidence interval; IBF: initiation of breastfeeding; MDD: minimum dietary diversity; MMF: minimum meal frequency; MAD: minimum acceptable diet; EBF: exclusive breastfeeding; Timely introduced to CF: introduced to complementary food at 6–8 m; HH: household

^b Stunted *n* = 302, Not stunted *n* = 1734

^c Wasted *n* = 136, Not wasted *n* = 1900

^d Univariate analyses were run using logistic regression with stunting or wasting as the dependent variable and each variable as an independent variable

^e Single/separated/widowed/divorced

Table 5 Determinants of stunting and wasting in Oromiya and SNNP^a regions of Ethiopia, 2015

Variables	Boys, n = 1049				Girls, n = 987				
	Stunting	Wasting		Stunting	Wasting		Stunting	Wasting	
		AOR (95%CI)	p-value		AOR (95%CI)	p-value		AOR (95%CI)	p-value
Region (SNNP)	2.00(1.41, 2.83)	< 0.001	0.45 (0.26, 0.78)	0.004	1.52 (0.98,2.36)	0.060	0.38 (0.19, 0.75)	0.006	
Child characteristics									
Oromiya	1		1		1		1		
Age (month ^b)	1.07 (0.98,1.18)	0.140	1.11 (0.98, 1.27)	0.110	1.02 (0.90,1.15)	0.752	1.03(0.87,1.21)	0.755	
IBF (Late)	1.46 (1.02,2.08)	0.037	-	-	0.88 (0.55, 1.41)	0.589	-	-	
Before 1 h	1				1				
EBF(No)	1.66 (1.17,2.35)	0.004	-	-	1.28 (0.81,2.04)	0.294	-	-	
Yes	1				1				
Timely introduced to CF									
(No)	2.14 (1.40,3.27)	< 0.001	-	-	1.85 (1.09,3.15)	0.024	-	-	
Yes	1				1				
Diarrhoea last 7 days (Yes)	1.27 (0.90,1.78)	0.172	-	-	1.44 (0.94, 2.21)	0.096	-	-	
No	1				1				
Consumed legumes and nuts (No)	1.45 (1.02, 2.06)	0.037	0.66 (0.41, 1.06)	0.088	1.86 (1.15, 3.00)	0.011	0.86(0.48,1.54)	0.605	
Yes	1		1		1		1		
Consumed eggs (No)	1.21 (0.80,1.83)	0.363	-	-	1.76 (1.00, 3.08)	0.049	-	-	
Yes	1				1				
Consumed other fruits and vegetables (No)	0.78 (0.53, 1.15)	0.209	1.40(0.74,2.66)	0.305	-	-	1.83 (0.81, 4.15)	0.150	
Yes	1		1				1		
Mother's characteristics									
Age of mother (<25 years)	-	-	0.60 (0.37,0.97)	0.035	-	-	0.56 (0.31,1.00)	0.051	
> 25 years			1				1		
Education (illiterate)	1.44 (1.05,1.97)	0.023	1.09(0.67,1.76)	0.741	1.22 (0.82,1.84)	0.329	1.55 (0.85, 2.80)	0.150	
Literate	1		1		1		1		
Marital status (Married)	0.62 (0.29,1.31)	0.209	0.43 (0.17, 1.07)	0.070	0.44 (0.17, 1.11)	0.081	0.54(0.15,1.90)	0.335	
^c	1		1		1		1		
Occupation (^d)	0.65 (0.43, 1.00)	0.051	1.15(0.67,1.98)	0.623	0.73 (0.42,1.28)	0.278	1.59 (0.84, 3.01)	0.155	
House wife	1		1		1		1		
HH characteristics									
Basic drinking water (No)	-	-	0.30 (0.07, 1.26)	0.101	-	-	0.69(0.21,2.27)	0.537	
Yes			1				1		
Adequate sanitation (No)	-	-	0.97(0.37, 2.53)	0.955	-	-	2.02 (0.86, 4.74)	0.106	
Yes			1				1		

^a Southern Nations, Nationalities, and Peoples; AOR: adjusted odds ratio; CI: confidence interval; IBF: initiation of breastfeeding; EBF: exclusive breastfeeding; Timely introduced to CF: introduced to complementary food at 6–8 m; HH: household

The adjustment was made for age, cluster (a study sub-district), and mother's characteristics

^b Adjusted for cluster only and mother's characteristics

^c Single/separated/widowed/divorced

^d Working mother

similar trend of a significantly higher prevalence of stunting (34.3% vs 31.7%) and wasting (9.5% vs 8.1%) among boys compared to girls [27].

Although poor IYCF practices were observed in both boys and girls, our multivariate analysis shows that risk factors for stunting are not completely

similar for each gender. Variation in the initiation of breastfeeding and exclusive breastfeeding are significant independent determinants of stunting in boys, but not in girls, suggesting a higher vulnerability to poor feeding practices among boys compared to girls in the first months of life. In contrast,

timely introduction to CF is a common determinant of stunting for both boys and girls.

Several possible explanations are reported concerning gender differences in nutritional status. First of all, these differences might result from biological differences that could be independent of infant feeding patterns [9]. For instance, boys are more susceptible to infectious diseases [26] and show higher biological fragility in the first year of life [28]. However, the underlying mechanisms for the biological difference are poorly understood [26]. Secondly, a study in Madagascar [29] found that gender differences in stunting tend to vary with age, with males more likely to become stunted in the first year, whereas females are more likely to become stunted in the second year of life [30]. Our study included only children in the first year of life, and this could partly explain the higher stunting rates in boys.

The high morbidity observed in our study may be associated with a high number of illiterate mothers in the study regions. The finding of the association between increased risk of morbidity and mother's illiteracy is consistent with findings of studies conducted in rural Ethiopia [31] and Tanzania [32]. Our results show that the mother's literacy status and maternal occupation are two of the independent determinants of stunting in boys but not in girls. Studies in Southern Ethiopia [33], Mozambique [25], and Bangladesh [34] also found the mother's literacy status to be associated with stunting. Literacy status may be indicative of a mother's better knowledge and awareness of child nutrition and may therefore result in relatively better feeding practices [34].

One of the main findings of this study is that the region of residence is a determinant of stunting and wasting independent of the other determinants. We observed regional differences in stunting and wasting, where stunting is higher (OR 1.39) but wasting lower (OR 0.35) in SNNP compared to Oromiya. In the Ethiopia 2016 DHS, a similar trend was observed for stunting (38.6% vs 36.5%) and for wasting (6.0% vs 10.6%) in SNNP versus Oromiya, respectively, for children under 5 years of age [2]. According to Teklie et al. (2019), the odds of being wasted in SNNP and Oromiya were 0.365 and 0.727 times lower compared to the Tigray region respectively, indicating the lower odds of SNNP compared to Oromiya [35]. A recent meta-analysis conducted in Sub-Saharan Africa also shows regional differences in stunting patterns and suggests the importance of contextualizing appropriate nutrition interventions [36, 37].

A limitation of this study is that it uses the baseline data of an intervention study, with one of the inclusion

criteria being WLZ z scores > -3 SD. This means that first, we cannot exclude the possibility that the results, of for example differences between regions, might have been different if severely stunted children had been included. Second, we are unable to account for unknown confounding variables. Third, birth weight data were not collected in this study, mainly because it was beyond the scope of the study. Hence, the effect of low birth weight on nutritional status cannot be measured. Fourth, due to the cross-sectional nature of the study, we could only discuss the association rather than causation. Fifth, our study did not address infection-driven malnutrition. However, at the time of data collection, there was no significant difference in the presence of morbidity between female and male children. Lastly, another important limitation of our study is that the generalizability of our finding is limited to young children (6–11 months), which might result in different risk factors in other age groups.

The main strength of the study is that it involves a large sample size that represents the target population in the two large regions among the three largest regions of the country namely Amhara, Oromiya and SNNP and an area where nutritional improvements are needed. Secondly, the study team underwent 9 days of intensive training, including standardization of data collectors and pilot testing of the questionnaires, which helped to refine the questionnaires and avoid questions that might lead to biased answers [38]. This reduced the measurement error that can occur during data collection if measurements are collected differently in exposure and outcome. To our knowledge, this is the first study to assess gender differences in determinants of nutritional status in these regions in Ethiopia with such a large sample size ($n = 2036$).

Even though the selected districts are UNICEF's Community-Based Nutrition (CBN) districts, which presumably have better Infant and Young Child Nutrition (IYCN) programs, the observed IYCF practices are suboptimal; this partly suggests that these districts have been correctly targeted, as the worst-off districts are more eligible for CBN interventions. However, it also suggests the need for more efforts to strengthen the on-going IYCN programs within the CBN districts. An ethnographic study on gender-related maternal beliefs and attitudes regarding IYCF practices would help to better clarify the underlying causes of the observed gender differences and the differences in vulnerability of the two sexes during infancy. In addition, there is emerging evidence that early life nutrition may affect the development of chronic diseases differently in boys than in girls [39].

For instance, birth weight has been found to predict the risk of insulin resistance later in life in men, but not in women [39]. Therefore, the observed gender differences in early life nutrition may have long-term health implications and need to be addressed [39]. Despite the inclusion of relatively healthy children in the study, we do not expect any problems regarding the generalizability of the recommended IYCF practices to other areas of the country, especially to a similar age group population. As stated in the report of the national survey; these age group children's characteristics are similar to those in other sub-districts in Ethiopia [13]. However, the fact that there exists a difference in sample size in both sex; might result in variability of some of the estimates thus further study is needed with a larger sample size.

Conclusion

In conclusion, the results of this study show that gender differences in nutritional status exist in Ethiopia: girls have a better nutritional status compared to boys during the first year of life. Determinants of stunting and wasting are largely similar between the sexes, although poor breastfeeding practices in the first 6 months of life seemed to affect stunting more in boys than in girls. The observed gender and regional differences suggest the need for region-specific intervention plans emphasizing gender-sensitive guidance on optimum IYCF practices. Our results suggest the need for addressing child undernutrition in early infancy by promoting appropriate breastfeeding practices, for instance, early initiation of breastfeeding with emphasis on exclusive breastfeeding (EBF) until the child reaches 6 months. EBF and adequate dietary diversity of complementary feeding are important determinants of stunting in boys and girls. The findings of this study will contribute to the development of gender-sensitive behavior change intervention materials that would contribute to the effort to convince and guide mothers to introduce complementary foods in a timely fashion, regardless of the child's gender.

Abbreviations

BF: Breastfeeding; CBF: Current breastfeeding; CF: Complementary food; CI: Confidence interval; cm: Centimeter; EBF: Exclusive breastfeeding; EPHI: Ethiopian Public Health Institute; LAZ: Length-for-age Z score; IBF: Initiation of breastfeeding; IYCF: Infant and young child feeding; IYCN: Infant and young child nutrition; MAD: Minimum acceptable diet; MDD: Minimum dietary diversity; MMF: Minimum meal frequency; NI: Nutrition International; SD: Standard deviation; SNNPR: South Nations, Nationalities, and Peoples Region; SPSS: Statistical Package for the Social Sciences; UNICEF: United Nation Children's Fund; WASH: Water, Sanitation, and Hygiene; WLZ: Weight-for-length z score; WHO: World Health Organization.

Supplementary Information

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Additional file 1.

Additional file 2.

Additional file 3.

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Authors' contributions

AS was responsible for the design of the study, data collection, data preparation, data analysis and interpretation, manuscript preparation, and has full responsibility for the final manuscript. SO and IB were responsible for the conception, design, overview of the study, overview of data analysis and interpretation, and contributed to the final manuscript. EF contributed to data analysis and interpretation, and the final manuscript. AL, AA, and AK facilitated study implementation and contributed to the final paper. All authors have contributed to and approved the final manuscript.

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Availability of data and materials

The data collected and analyzed for this study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The Ethical approval was obtained from the Ethiopian National Research Ethics Review Committee, Ministry of Science and Technology, reference number 3.10/865/07. Written permission was also obtained from the Regional Health Bureau of Oromiya and SNNP regions, the zonal, district, and sub-district offices, before starting the data collection. In addition, permission was received from local leaders in the study area. Detailed information on the purpose of the survey was provided to the mothers/caretakers, both orally and in writing (including a brochure in a local language about the study). Signed informed consent was obtained from mothers/caregivers of the study children before participation in the study. The study is registered at <http://www.clinicaltrials.gov/> with the clinical trials identifier of NCT02479815. All methods were performed in accordance with the relevant guidelines and regulations.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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