Heliyon 8 (2022) e11235

Contents lists available at ScienceDirect

Heliyon

journal homepage: www.cell.com/heliyon

Research article

Under-nutrition and its determinants among school-aged children in northwest Ethiopia

Desalegn Bayew Tebeje [a], Genanew Agitew [b], Netsanet Worku Mengistu [c], Setognal Birara Aychiluhm [d,*]

[a] AGP2 CDSF, Agriteam Canada, Central and West Gondar Zone, Amhara Regional State, Ethiopia
[b] Department of Rural Development & Agricultural Extension, College of Agriculture & Environmental Science, University of Gondar, Gondar, Ethiopia
[c] Department of Nutrition, Institute of Public Health, College of Medicine and Health Sciences, University of Gondar, Gondar, Ethiopia
[d] Department of Public Health, College of Medicine and Health Sciences, Samara University, Samara, Ethiopia

ARTICLE INFO

Keywords:
Stunting
Wasting
Underweight
School-age children
Under-nutrition
Northwest Ethiopia

ABSTRACT

Background: Malnutrition among children has lifelong implications, its outcomes not only cover the whole life but also transfer from one generation to another generation. Most studies conducted before focused on undernutrition in pregnant mothers and children less than 5 years of age, whereas school-age children are often omitted from health and nutrition surveys or surveillance. In Northwest Ethiopia, particularly in the study area, the community levels nutritional status of school-age is not well studied and documented. Therefore, this study aimed to assess the prevalence and determinants of the under-nutritional status of school-age children in Gondar Zuria District, Northwest Ethiopia.

Methods: A community-based cross-sectional study design was employed with 364 respondents from January to April 2020. Data entered using Epi Data software version 3.1. Standard deviation scores were obtained by the world health organization Anthro Plus software to determine the nutritional status of children, and further analysis was done by using STATA version 14 software. Adjusted odds ratio with its corresponding 95 % confidence interval was used to declare statistically significant variables.

Results: The prevalence of overall under-nutrition was 71.98% (95%, CI: 67%–76%) from which, 43.13% (95%, CI: 38%–48%) were stunted, 40.93% (95%, CI: 35%–46%) were under-weight, and 35.44% (95%, CI: 30%–40%) were wasted. Child age [AOR = 0.30, 95% CI (0.13–0.68)], food insecurity [AOR = 2.24, 95% CI (1.03–4.83)], good knowledge of mother/care giver [AOR = 0.40, 95% CI (0.17–0.92)], having larger family size (Tzioumis and Adair, 2014; Wolde et al., 2015; Mohammed et al., 2019) [6-8] [AOR = 2.92, 95% CI (1.29–6.58)], and unprotected drinking water sources [AOR = 2.84, 95% CI (1.00–8.06)] were the predictors of under-nutrition.

Conclusion: According to the world health organization cut-offs, the prevalence of overall under-nutrition in the study area was very high. Child age, food insecurity, knowledge of mother/caregiver, having a larger family size, and unprotected drinking water sources were the predictors of under-nutrition. The district offices should give attention to the improvement of the food security status of the community, and give priority to the availability and accessibility of drinking water sources, particularly pipe water sources. Special attention to older age groups of children is important to control the prevalence of under-nutrition.

1. Introduction

Undernutrition is defined as a person's inability to consume enough energy and nutrients to meet their demands for maintaining good health [1]. Z-scores less than 2 standard deviations of weight for height, height for age, and weight for age, respectively, are considered underweight, stunting, and wasting [2]. Acute and chronic nutritional deficiencies are referred to as wasting and stunting, respectively. However, being underweight is a result of both acute and long-term nutritional deficiencies [3].

Although many people assume that schoolchildren are naturally healthy, many of them are anemic, underweight, stunted in height, and low in iodine or vitamin A [4]. Globally, between 1990 and 2016, the average annual death rate for children and adolescents aged 5 to 14 fell

* Corresponding author.
E-mail address: geez4214@gmail.com (S.B. Aychiluhm).

https://doi.org/10.1016/j.heliyon.2022.e11235
Received 4 August 2021; Received in revised form 28 December 2021; Accepted 19 October 2022

from 1.7 million to 1 million [5]. There is evidence that children in low- and middle-income nations are more vulnerable [6].

In comparison to other locations, sub-Saharan Africa has a disproportionately higher mortality rate for older children and young adolescents. In sub-Saharan Africa, 55 percent of mortality of children this age are on average. Additionally, undernutrition has a significant negative economic impact on development [7].

Children who are malnourished suffer lifetime consequences that not only affect them personally but also affect future generations. Even if the general course of growth is genetically set, undernutrition, especially in young children, can seriously impair both physical and mental growth [8]. It is responsible for more ill-health than any other cause [9]. It is the primary cause of the disease burden, which results in around 300,000 deaths year and is directly or indirectly to blame for more than half of all child fatalities [10].

Children of school age in our nation face health and nutrition-related issues that limit their capacity to flourish and gain from schooling. Parasitic infections, malaria, anemia, trachoma, skin conditions, impairments, accidents, sexual and reproductive illnesses, psychosocial disorders, and substance misuse are among the common health issues [4]. Consequently, inadequate food consumption, severe malnutrition, iodine insufficiency, and vitamin A deficiency are some of the frequent nutrition-related issues. Having a food insecure household, having a low maternal education level, and having *Trichuris trichiura* infection are some of the common causes of undernutrition [7].

The 2004 National Strategy for Infant and Young Child Feeding Practices, the 2005/2006 National Nutrition Strategy, and the 2008 National Nutrition Program are just a few of the methods that the Ethiopian government has been putting into reality. Additionally, the government intends to eradicate undernutrition by 2030 [11]. There is a glaring lack of information on the real nutritional condition of children of school age in impoverished countries like Ethiopia, despite advocacy for health and nutrition programs in primary schools [12] and in the nation, child malnutrition continues to be a serious public health issue.

Most studies [11, 12, 13] undertaken by various researchers concentrate on malnutrition in young children under the age of five and pregnant women, whereas school-age children are frequently left out of health and nutrition surveys or monitoring [14]. Even if some studies were available in different parts of Ethiopia, most of them were institution-based [15, 16, 17, 18].

In addition, there is a dearth of data on the prevalence and causes of undernutrition among school-age children, particularly in the study area. Therefore, this study aimed to determine the prevalence and associated factors of undernutrition (wasting, stunting, and underweight) among school-age children in Gondar Zuria District, Amhara Regional State, Northwest Ethiopia.

2. Methods

2.1. Study design, period, and setting

A community-based cross-sectional study design was employed in Gondar Zuria district, Northwest Ethiopia from January to April 2020.

The district is located in Central Gondar Zone, Amhara Regional State and it is about 708 km from Addis Ababa, 140 km from Bahir Dar, and 40 km from Gondar town. It covers an area of 10828Km^2. It shares boundaries with Lake Tana, Gondar town, Dembiya, West Belesa, and Libo Kemikem districts.

According to the 2013 district agricultural office report, Gondar Zuria district is located at 12°7'23"N-12°39'24"N and 37°24'24"E-37°45'43"E and its total area is 1286.76 km^2. The altitude of the district ranges from 2100 to 2850m above mean sea level. The two agro-ecologies are *Woyinadega* and *Dega* in the district, temperature ranges between 14-20 °C with a mean annual temperature of 17.9 °C.

The district has 44 kebeles (4 kebeles urban and 40 kebeles rural). According to the 2019 district health office report, the district has an estimated total population of 264,920 and a total of 80,373 (30.3%) school-age children. Seven health centers and forty-two health posts are found in the district.

2.2. Sampling techniques and sample size determination

A simple random sampling technique was applied to select 4 kebeles out of a total of 44 Kebeles in the district. A systematic random sampling procedure was applied to select respondents. The total sample size of 374 respondents was distributed proportionally to each kebele based on the number of households and the total population of the kebeles. The numbers of households in each kebele were obtained from the respective kebeles offices and assigned by using systematic random sampling. Systematic random sampling interval (K) was calculated for each household, and the first household in each kebele was identified using a random method from the kth unit number of households. If we get the households that have no eligible child (school-aged child) we go to the next households until we get the households that have an eligible child. Then, if households were found to have more than one eligible child, a simple random sampling technique or lottery method was applied to select one for the study, and if households have no child then the next household was selected.

For the first specific objective, the sample size was estimated using the single population proportion calculation, taking into account a 95% confidence level, a 5% margin of error, and a prevalence of undernutrition of 31% [19].

$$n=\frac{(Z\alpha/_2)^2P(1-P)}{d^2}\quad n=\frac{(1.96)^20.31(1-0.31)}{(0.05)^2}\quad\leftrightarrow\quad n=329$$

Where.

n: sample size, $Z\alpha/_2$: 1.96, p: prevalence, and d: degree of precision/margin of error

For the second specific objective, the sample size was calculated using Epi-info version 7.2.1.0 statistical software by taking statistically significant and pertinent factors for under-nutrition status with the consideration of 1:1 under-nutrition status to non-under-nutrition status ratio, 95% confidence level, and 80% power. By comparing the sample size from the first and second specific objectives the minimum adequate largest sample size was selected, which, in our case, equals 340. Then, a 10% non-response rate was considered and, finally, 374 participants were included in the study.

2.3. Study variables

The nutritional status of children was assessed using anthropometric indicators, Body Mass Index for age (BAZ), Height-for-Age (HAZ), and weight for age (WAZ) Consequently, children having BAZ < - 2 SD, HAZ < - 2SD, and WAZ < - 2 SD were considered as thin, stunted, and wasted respectively.

A 24-hour recall method was used to estimate the feeding practice of children and the collected dietary information was transferred to a dietary diversity score tool that consisted of nine food groups. Adequate dietary diversity was defined as children who received food made from four or more food groups in the previous 24 h [20].

Mother/caregiver nutritional knowledge was assessed using certain questions related to breastfeeding and complementary feedings. It is categorized as good and poor for analysis purposes based on literature. Good knowledge: Those mothers who answer correctly the breastfeeding and complementary feeding questions and if they score median value and

above. Poor knowledge: Those mothers who answer correctly the breastfeeding and complementary feeding questions and if they score below median the value.

2.4. Data collection methods and quality control

Degree and diploma holders with prior expertise in similar data collection conducted the data collection. A structured questionnaire was used to interview the mothers and other caregivers as part of a household survey to learn more about the risk factors for undernutrition. The survey was created using data from a nationwide survey and improved using research from many sources [21]. Information about household food security access was gathered using the instrument created by the Food and Nutrition Technical Assistant Project (FANTA) [22].

The questionnaire was originally written in English before being translated into Amharic, the language used locally in the study location. Amharic was also used throughout the interviews to collect data, which was then translated back into English to maintain consistency during data analysis. For one day, data collectors received training on the study. Pre-testing the questionnaire in an area where the study was not conducted allowed for the correction of any inaccuracies.

Each child's weight was determined using a calibrated digital balance. Every day, the data was examined, and any errors were reported back to the data collectors for correction.

The principal investigator was able to maintain the data's validity and dependability by continuously monitoring the data collection. Five percent of the sample size in a nearby district was used for pre-testing the produced sets of data gathering tools.

Pre-testing was done to keep the questionnaire's correctness and clarity, to make sure that respondents were consistently interpreting the questions, to spot any problematic items, and to calibrate the anthropometric equipment. Following the pre-test, all the unclear, deceptive, and incorrectly understood questions were removed, and the questionnaire was amended in light of the results.

2.5. Anthropometric measurement and nutritional status assessment

Each child was coached to stand in the center of a digital balance. The digital balance had a vertical wooden bar with a plastic tap attached to it. The weight and height of each child were measured after calibrating to the nearest 0.1 kg and 0.1 cm, respectively. Height was measured against a scale where a flat headpiece (attached to the plastic tap at a right angle) touched the crown of the head and formed a right angle. Each child was measured while wearing light clothes after removing shoes, belts, caps, or any other material that could interfere with their actual height and weight. Z-score was determined using the world health Anthro-Plus software [23].

2.6. Data management and statistical analysis

Data was firstly cleaned, coded, and entered into Epi data version 3.1 and for anthropometric data analysis, standard deviation (Z-scores) scores were obtained by the world health organization (WHO) Anthro Plus software. Further analysis was done by using the STATA version 14.0 software. Adjusted odds ratio (AOR) with 95% CI was used in the multivariable logistic regression model and a p-value less than 0.05 was considered to declare statistically significant independent variables of each outcome variable.

2.7. Ethical consideration

Ethical clearance was obtained from the Review Committee of the Department of Rural Development and Agricultural Extension, College of Agriculture and Environmental Science, and the institutional review board of the University of Gondar.

Finally, verbal informed consent was taken from each participant after delivering information regarding the purposes, the importance of the study, and the variety of information needed, and assuring that confidentiality of data was kept by using identification numbers rather than names of participants. Participants' involvement in the study was voluntary. The chance to ask anything about the study as well as the freedom to refuse or stop the interview at any moment was given.

3. Results

3.1. Demographic and socio-economic characteristics of study participants

In this study, a total of 364 children aged 5–14 years and their mothers/caregivers have participated. The overall response rate was 97.3%. Among the total participant children, 202 (55.49 %) study participants were females, and the majority of them (78.02%) were school enrolled. Of the total participants, 346 (95.05%) of interviewed caregivers were females and the majority (85.16 %) of mothers/caregivers did not attend formal education, and the majority of them (55.22%) were within the age range of 20–35 years. From participated households, 216 (59.34 %) were food in secured (Table 1).

3.2. Child health, dieting habits, and environmental characteristics of study participants

80 (21.98%) of children experienced an illness two weeks preceding the data collection period. The majority of children 285 (78.30%) consumed three or less than three times per day. More than 86% of the

Table 1. Demographic and socio-economic characteristics of study participants, Gondar Zuria District, Northwest Ethiopia.

Variables	Category	Frequency	Percentage
Age of child (in years)	5–9	170	46.70
	10–14	194	53.30
Child sex	Male	162	44.51
	Female	202	55.49
School Enrolment	Enrolled	284	78.02
	Non enrolled	80	21.98
Grade	1–4	241	66.21
	5–8	123	33.79
Child birth order	≤2	138	37.91
	>2	226	62.09
Age of mother/caregiver	20–35	201	55.22
	36–45	117	32.14
	>45	46	12.64
Sex of mother/caregiver	Male	18	4.95
	Female	346	95.05
Educational status of mothers/caregiver	No formal education	310	85.16
	Primary	43	11.81
	Secondary	11	3.02
Educational status of the father	No formal education	310	85.16
	Primary	46	12.64
	Secondary and above	8	2.20
Occupation of mother/caregiver	House wife	340	93.41
	Private*	6	1.65
	Unemployed	18	4.95
Occupation of father	Farmer	326	93.68
	Others**	22	6.32
Family size	2–5	149	40.93
	6–8	184	50.55
	>8	31	8.52
Household food security status	Food secured	148	40.66
	Food insecured	216	59.34

Private* = Self-employed and employed others** = un-employed, government and private employed.

study participants had a Dietary Diversity Score (DDS) of <4 groups. Of the total study participants, 46.98 % of the households had no latrine and only 55.49% used pipe water as their source of drinking water (Table 2).

3.3. The prevalence of undernutrition among school-age children (5–14 years) (HAZ, BAZ, and WAZ) in the study area

The mean Z-Score (+/-SD) HAZ, WAZ and BAZ of school-age children were -1.71 (+/-2.30), -2.06 (+/-1.47), and -1.91 (+/-2.14) respectively. According to the WHO growth reference for school-age children, the prevalence of undernutrition was found to be71.98% (95%, CI: 67%–76%). Specifically, the prevalence of stunting, wasting and under-weight was observed to be 43.13% (95%, CI: 38%–48%), 35.44% (95%, CI: 30%–40%) and 40.93% (95%, CI: 35%–46%), respectively. The prevalence of a severe form of stunting (HAZ < -3SD), thinness (WAZ < -3SD), and under-weight (BAZ < -3SD) among these study subjects was 21.70 %, 16.48 %, and 25.27%, respectively (Table 3).

Overall, out of the 364 children, 262 (71.98%) were undernourished. Having a large family size [6, 7, 8] and drinking from unprotected water sources had nearly three times more likelihood (AOR = 2.92; 95% CI (1.29–6.58) and (AOR = 2.84; 95% CI (1.00–8.06) of becoming undernourished, respectively. Those children from food in secured households were twice more likely to be malnourished than those from food-secured households (AOR = 2.24; 95%CI (1.03–4.83). Besides, children aged 5–9 years (AOR = 0.30; 95% CI (0.13–0.68) and mothers/caregivers with good nutritional knowledge (AOR = 0.40; 95% CI (0.17–0.92) were less likely to be under-nourished (Table 4).

3.4. Factors associated with stunting

Based on the multivariable regression results, the odds of stunting was significantly high (p = 0.04) in children living in food in secured households (AOR = 1.67; 95% CI (1.00–2.78) and nearly five times more likely to be stunted (AOR = 4.95; 95% CI (2.71–9.02) when during wasting. Children whose ages were from 5-9 years (AOR = 0.16; 95%CI (0.08–0.28) were less likely stunted than those within the age range of 10–14 years. Also, children with the absence of handwashing facilities were twice more likely (AOR = 2.05; 95% CI (1.13–3.70) to be stunted than the children with handwashing facilities (Table 5).

Table 2. Child health, dietary habit, and environmental characteristics of study participants in Gondar Zuria District, Northwest Ethiopia.

Variables	Category	Frequency	Percentage
Illness	Yes	80	21.98
	No	284	78.02
Hand washing before meal	Yes	280	76.92
	No	84	23.08
Child DDS	<4	316	86.81
	≥4	48	13.19
Latrine availability	Yes	193	53.02
	No	171	46.98
Waste disposal system	Composting	78	21.43
	Burning	64	17.58
	Add farming	185	50.82
	Open field	37	10.16
Source of drinking water	Pipe	202	55.49
	Protected	61	16.76
	Unprotected	96	26.37
	River	5	1.37
Mother/caregiver nutritional knowledge	Good	217	59.62
	Poor	147	40.38
Housing floor materials	Mud or soil	362	99.45
	Cement	2	0.55
Meal frequency	≤3	285	78.30
	>3	79	21.70

Table 3. Nutritional status of study participants in Gondar Zuria District, Northwest Ethiopia.

Variable	No	%	Mean (SD)
Under-nutrition	262	71.98	
HAZ			-1.71 (2.30)
Below -2SD stunted	157	43.13	
Below -3SD (Severe stunted)	79	21.70	
WAZ			-1.91 (2.14)
Below -2SD wasted	129	35.44	
Below -3SD (Severe wasted)	60	16.48	
BAZ			-2.06 (1.47)
Below -2SD under-weight	149	40.93	
Below-3SD (Severe under-weight)	92	25.27	

Factors associated with undernutrition status.

3.5. Factors associated with wasting

According to the multivariable logistic regression result, the odds of wasting were significantly high (AOR = 2.31; 95% CI (1.00–5.33) in children living in a household of food in secured than among children living in food-secured households. Children whose age was within 5–9 years were 3.5 times more likely (AOR = 3.57; 95% CI (1.50–8.51) to be wasted than children of 10–14 years old. Besides children whose, drinking water source was from an unprotected source were nearly three times more likely (AOR = 2.67; 95% CI (1.0–6.90) to be wasted than those who drink from a piped water source (Table 6).

3.6. Factors associated with children underweight

The likelihood of being underweight was significantly less among children 5–9 years old (AOR = 0.64; 95% CI (0.41–0.99) than among those children within the 10–14 years age category, and children having an open waste disposal system were nearly three times more likely (AOR = 2.92; 95% CI (1.23–6.91) to be underweight compared to those with burning waste disposal system (Table 7).

4. Discussion

Based on the findings of this study, 71.98% of the school-age children living in Gondar *Zuria woreda*, North West Ethiopia were undernourished. This figure was higher than the studies conducted in Addis Ababa (31%) [24] and Northeastern Ethiopia (31.8%) [25]. The prior research was carried out in an urban setting, where people would have better access to a variety of foods, higher nutritional awareness, and better infrastructure, which could explain the gap. Additionally, the agroecology and study periods between these investigations varied.

The prevalence of stunting was 43.13% (21.70% of whom were severely stunted). It is comparable with the results of the study conducted in Haik Town, Northeastern Ethiopia [26], Fogera and Libo Kemkem Districts, Northwestern Ethiopia [27], and Arba Minch, Southern Ethiopia [28]. However, it was higher than the study results conducted in Lalibela Town, Northern Ethiopia where 29.5% of subjects were stunted [29], Northwestern Ethiopia where 37.9% were stunted [30], in Dale Woreda, Southern Ethiopia where 25.6% were stunted [7], and Addis Ababa Ethiopia where only 19.6% were stunted [24]. Similarly, it was higher than the study conducted in Urban slums in India [31], South India [32], and Nairobi Peri-Urban Slum of Kenya [33] where 18.5%, 19.3%, and 30.2% of children were stunted, respectively.

But the prevalence was less than in the study conducted in Humbo district, Southern Ethiopia [[12]], Gondar town, Northwest, Ethiopia [

Table 4. Factors associated with under-nutrition among school-age children (5–14years) in Gondar Zuria District, Northwest Ethiopia.

Variables	Categories	Under-nutrition		P-value	AOR (95% CI)
		Yes	No		
Age of child (in years)	5–9	137 (80.59)	33 (19.41)	0.004**	0.30 (0.13–0.68)
	10–14	125 (64.43)	69 (35.57)		
Child sex	Male	119 (73.46)	43 (26.54)		
	Female	143 (70.79)	59 (29.21)	0.918	1.04 (0.49–2.19)
School Enrolment	Enrolled	204 (71.83)	80 (28.17)		
	Non enrolled	58 (72.50)	22 (27.50)	0.898	0.93 (0.36–2.43)
Age of mother/caregiver	20–35	142 (70.65)	59 (29.35)		
	36–45	85 (72.65)	32 (27.35)	0.294	0.65 (0.29–1.44)
	>45	35 (76.09)	11 (23.91)	0.227	2.22 (0.60–8.16)
Household food security status	Food secured	100 (67.57)	48 (32.43)		
	Food insecured	162 (75.00)	54 (25.00)	0.040**	2.24 (1.03–4.83)
Mother/caregiver nutritional knowledge	Good	110 (74.83)	37 (25.17)	0.032**	0.40 (0.17–0.92)
	Poor	152 (70.05)	65 (29.95)		
Waste disposal system	Composting	60 (76.92)	18 (23.08)		
	Burning	45 (70.31)	19 (29.69)	0.496	0.67 (0.22–2.06)
	Add farming	124 (67.03)	61 (32.97)	0.715	0.82 (0.29–2.29)
	Open field	33 (89.19)	4 (10.81)	0.996	1.00 (0.14–7.05)
Source of drinking water	Pipe	137 (67.82)	65 (32.18)		
	Protected	41 (67.21)	20 (32.79)	0.668	1.24 (0.45–3.40)
	Unprotected	84 (83.17)	17 (16.83)	0.049**	2.84 (1.00–8.06)
Get credit	Yes	125 (75.30)	41 (24.70)		
	No	137 (69.19)	61 (30.81)	0.267	0.65 (0.31–1.37)
Place of health service	hospital	12 (66.67)	6 (33.33)		
	health post	202 (72.73)	18 (27.27)	0.054	11.51 (0.96–37.89)
	Health center	48 (72.14)	78 (27.86)	0.179	4.70 (0.49–44.94)
Hand wash	Yes	197 (70.36)	83 (29.64)		
	No	65 (77.38)	19 (22.62)	0.566	0.71 (0.23–2.22)
Toilet owner	Communal	21 (75.00)	7 (25.00)		
	Private	111 (67.27)	54 (32.73)	0.401	0.62 (0.21–1.85)
Number of house room	One	46 (67.65)	22 (32.35)		
	Two	130 (73.03)	48 (26.97)	0.286	1.84 (0.60–5.64)
	>two	86 (72.88)	32 (27.12)	0.141	2.56 (0.73–9.03)
Family size	2–5	105 (70.47)	44 (29.53)		
	6–8	133 (72.28)	51 (27.72)	0.010**	2.92 (1.29–6.58)
	>8	24 (77.42)	7 (22.58)	0.114	2.88 (0.77–10.70)
Father employment	Farmer	15 (68.18)	7 (31.82)	0.097	0.14 (0.01–1.41)
	Others	235 (72.09)	91 (27.91)		

** = Statistically significant variables at 95% confidence interval.

[21]], and East Gojjam Zone, Amhara Regional State Ethiopia [[20]] where 57%, 46.1%, and 48.1% of the study subjects were stunted, respectively. It is also lower than other studies conducted in other countries including Tea Garden Workers of Assam 47.4% [34] and Dhaka City, Bangladesh where 60% [35] were stunted. The disparity might be explained by the geographic separation and the disparity in agricultural productivity.

The prevalence of wasting was 35.44% (16.48% severely wasted). It was the highest magnitude than in other studies conducted in Gondar town, North West Ethiopia 9% [16], Arba Minch, southern Ethiopia 8% [28], Fogera and Libo Kemkem Districts, 21.6% [27], in Dale Woreda, Southern Ethiopia (14%) [7] and Lalibela Town, Northern Ethiopia (29.5%) [29]. The differences in the studies' study period, study design, study area, and dietary intervention activities could be to blame for the inconsistencies. But it was less than the study conducted in Cachar District, Assam 51.3% [36]. This variation might due to differences in the study area and time.

The prevalence of underweight was 40.93% (25.27% were severely underweight). It was higher than the study conducted in Addis Ababa, Ethiopia 15.9% [24], and in Dale Woreda, Southern Ethiopia (19%) [7]. Besides, it was higher than the study conducted in the Peri-Urban Slum area of Nairobi (14.9%) [33], in Kavre District (30.85%) [37], and Bengaluru, South India (35.9%) [32]. These inconsistencies may result from variations in study design, study area, study period, and age group. However, it was less than the study conducted in the Tea Garden Workers of Assam (51.7%) [34] and in Dhaka City of Bangladesh (84%) which was the highest one of all other studies [35]. This might be due to the lack of or a difference in nutritional intervention activities.

Having a large family size [6, 7, 8], good nutritional knowledge of a mother/caregiver, household food insecurity, unprotected spring water source, and child age (5–9years) were determinant factors for overall under-nutrition.

In this study, younger age groups (5–9 years) were less likely than older children (10–14 years) to experience undernutrition. Several studies carried out in Ethiopia [24, 25, 27, 28], also indicated that there was a highly significant association between age and the under-nutrition status of children. Additionally, the research in northeastern Ethiopia found that older children had a higher risk of malnutrition than younger

Table 5. Factors associated with stunting among school-age children (5–14years) in Gondar Zuria District, Northwest Ethiopia, 2020.

Variable	Categories	Stunting		P-value	AOR (95% CI)
		Yes	No		
Age of child (in years)	5–9	60 (30.93)	134 (69.07)	0.000**	0.16 (0.08–0.28)
	10–14	97 (57.06)	73 (42.94)		
Child sex	Male	74 (45.68)	88 (54.32)		
	Female	83 (41.09)	119 (58.91)	0.306	0.77 (0.47–1.26)
Age of mother/caregiver	20–35	85 (42.29)	116 (57.71)		
	36–45	48 (42.29)	69 (58.97)	0.547	0.84 (0.48–1.46)
	>45	24 (52.17)	22 (47.83)	0.132	1.82 (0.83–3.97)
Household food security status	Food secured	57 (38.51)	91 (61.49)		
	Food insecured	100 (46.30)	116 (53.70)	0.046**	1.67 (1.00–2.78)
Waste disposal system	Composting	38 (48.72)	40 (51.28)		
	Burning	34 (53.13)	30 (46.88)	0.278	1.55 (0.70–3.42)
	Add farming	67 (36.22)	118 (63.78)	0.313	0.71 (0.38–1.36)
	Open field	18 (48.65)	19 (51.35)	0.809	1.12 (0.43–2.93)
Source of drinking water	Pipe	84 (41.58)	118 (58.42)		
	Protected	21 (34.43)	40 (65.42)	0.422	0.75 (0.38–1.49)
	Unprotected	52 (51.49)	49 (48.51)	0.695	1.13 (0.60–2.14)
Hand wash	Yes	109 (38.93)	171 (61.07)		
	No	48 (57.14)	36 (42.86)	0.017**	2.05 (1.13–3.70)
Wasting	Yes	86 (36.60)	149 (63.40)	0.001**	4.95 (2.71–9.02)
	No	71 (55.04)	58 (44.96)		

** = Statistically significant variables at 95% confidence interval.

Table 6. Factors associated with wasting among school-age children in Gondar Zuria District, Northwest Ethiopia.

Variable	Categories	Wasting		P-value	AOR (95% CI)
		Yes	No		
Age of child (in years)	5–9	95 (48.97)	99 (51.03)	0.004**	3.57 (1.50–8.51)
	10–14	34 (20.00)	136 (80.00)		
Child sex	Male	51 (31.48)	111 (68.52)		
	Female	78 (38.61)	124 (61.39)	0.336	1.45 (0.67–3.14)
Educational status of mothers/caregiver	Illiterate	103 (33.23)	207 (66.77)		
	Primary	23 (53.49)	20 (46.51)	0.167	2.23 (0.71–6.95)
	Secondary	3 (27.27)	8 (72.73)	0.831	0.74 (0.05–10.53)
Age of mother/caregiver	20–35	82 (40.80)	119 (59.20)		
	36–45	36 (30.77)	81 (69.23)	0.287	0.60 (0.24–1.51)
	>45	11 (23.91)	35 (76.09)	0.572	0.69 (0.19–2.48)
Marital status of the mother	Married	115 (35.49)	209 (64.51)		
	Divorced	5 (26.32)	14 (73.68)	0.655	0.62 (0.08–4.87)
	Other	9 (42.86)	12 (57.14)	0.880	0.84 (0.100–7.19)
Father employment	Farmer	8 (36.36)	14 (63.64)	0.398	0.49 (0.09–2.55)
	Others	112 (34.36)	214 (65.64)		
Family size	2–5	58 (31.52)	91 (61.07)		
	6–8	58 (31.52)	126 (68.48)	0.186	1.79 (0.75–4.24)
	>8	13 (41.94)	18 (58.06)	0.670	1.35 (0.33–5.38)
Household food security status	Food secured	47 (31.76)	101 (68.24)		
	Food insecured	82 (37.96)	134 (62.04)	0.048**	2.31 (1.00–5.33)
Source of drinking water	Protected	24 (39.34)	37 (60.66)		
	Pipe	64 (31.68)	138 (68.32)	0.052	0.34 (0.11–1.00)
	Unprotected	41 (40.59)	60 (59.41)	0.883	0.91 (0.26–3.16)
Mother/caregiver nutritional knowledge	Good	52 (64.63)	95 (64.63)	0.735	0.87 (0.39–1.92)
	Poor	77 (35.48)	235 (64.56)		
Place of health service	hospital	5 (27.78)	13 (72.22)		
	health post	22 (33.33)	44 (66.67)	0.943	1.09 (0.08–14.67)
	Health center	102 (36.43)	178 (63.57)	0.833	1.30 (0.11–15.43)
Healthcare services affordable	Yes	109 (36.70)	188 (63.30)		
	No	20 (29.85)	47 (70.15)	0.337	1.60 (0.61–4.19)

(*continued on next page*)

Table 6 (*continued*)

Variable	Categories	Wasting		P-value	AOR (95% CI)
		Yes	No		
Toilet owner	Communal	12 (42.86)	16 (57.14)		
	Private	51 (30.91)	114 (69.09)	0.413	0.63 (0.20–1.90)
Waste disposal system	Composting	36 (46.15)	42 (53.85)		
	Burning	25 (39.06)	39 (60.94)	0.950	0.96 (0.32–2.84)
	Add farming	55 (29.73)	130 (70.27)	0.324	0.59 (0.21–1.66)
	Open field	13 (35.14)	24 (64.86)	0.299	0.39 (0.06–2.28)
No of house room	One	28 (41.18)	40 (58.82)		
	Two	53. (29.78)	125 (70.25)	0.548	0.69 (0.21–2.26)
	>two	48 (40.68)	70 (59.32)	0.871	1.11 (0.29–4.29)
School Enrolment	Enrolled	85 (29.93)	199 (70.07)		
	Non enrolled	44 (55.00)	36 (45.00)	0.173	3.24 (0.59–17.67)
Get credit	Yes	59 (35.54)	107 (64.46)		
	No	70 (35.35)	128 (64.65)	0.934	1.03 (0.46–2.28)

** = Statistically significant variables at 95% confidence interval.

children [25]. In a similar vein, the Burkina Faso study's findings showed an association between undernutrition and advanced age (that is 12–14 years compared to <12 years [38].

This might be because young children are transitioning from childhood to adolescence; as a result, they are more likely to be exposed to demanding environments outside of their immediate environment and to work-related activities, which increases the body's need for nutrients. In addition, when kids get older, their families can stop giving them enough food and give them less attention. It may be because many parents in rural regions fail to provide their children with the best nutrition possible given their age and other factors [39].

This study also revealed that the odds of being undernourished were more common among children who were from food-insured households than those coming from food-secured households. The study conducted in Dale woreda, Southern Ethiopia similarly indicated that household food insecurity significantly affects under-nutritional status [10]. Another study conducted in South Africa also revealed that household-level food insecurity was highly determinant of the occurrence of malnutrition [40].

A larger family size (6–8 household members) was significantly associated with an increased risk of undernutrition among school-age children. This is in agreement with the studies done in different African countries, including Ethiopia [7, 15, 19, 28, 30, 33, 41].

Mother/caregiver knowledge was also one of the significantly associated factors of undernutrition. Children whose mother/caregiver had good nutritional knowledge were less likely to encounter under-nutrition when compared to those whose mothers had poor nutritional knowledge. This finding supports the study conducted in Kenya [42] and Nigeria [43].

In the present study, subjects who were drinking from unprotected drinking water sources were more than two times more likely to be undernourished than those who were drinking from pipe drinking water sources. This result agreed with studies conducted in Mieso Woreda, Somali Region, Ethiopia [44], Gondar town, northwest, Ethiopia [16], and Dhaka City in Bangladesh [35].

In this study, the younger age group (5–9 years) was less likely stunted than the older age group (10–14 years). This was in line with studies documented in Gondar town, Northwest Ethiopia [16], Durbete Town, northwest Ethiopia [18], Dale Woreda, Southern Ethiopia [7], and Arba Minch, Southern Ethiopia [28]. Similarly, the study was conducted on 5–14 years old children in rural Madagascar [45], and India [31]. This suggested that the likelihood of stunting was much higher in older schoolchildren. This is because children between the ages of 9 and 14 are more active and expend more energy. They may become stunted as a result of their excessive energy loss and a lack of nutrient-rich food.

Table 7. Factors associated with under-weight among school-age children in Gondar Zuria District, Northwest Ethiopia.

Variable	Categories	Under-weight		P-value	AOR (95% CI)
		Yes	No		
Age of child (in years)	5–9	80 (47.06)	125 (64.43)	0.049**	0.64 (0.41–0.99)
	10–14	69 (35.57)	90 (52.94)		
Household food security status	Food secured	68 (45.95)	80 (54.05)		
	Food insecured	81 (37.50)	135 (62.50)	0.337	0.80 (0.51–1.25)
Waste disposal system	Composting	33 (42.31)	45 (57.69)		
	Burning	21 (32.81)	43 (67.19)	0.321	0.69 (0.33–1.43)
	Add farming	69 (37.30)	116 (62.70)	0.546	0.83 (0.47–1.48)
	Open field	26 (70.27)	11 (29.73)	0.015**	2.92 (1.23–6.91)
Family size	2–5	55 (36.91)	94 (63.09)		
	6–8	81 (44.02)	103 (55.98)	0.345	1.26 (0.78–2.02)
	>8	13 (41.94)	18 (58.06)	0.541	1.29 (0.57–2.96)
Get credit	Yes	71 (42.77)	95 (57.23)		
	No	78 (39.39)	120 (60.61)	0.744	0.93 (0.59–1.46)
Father employment	Farmer	137 (42.02)	189 (57.98)	0.520	1.39 (0.51–3.78)
	Others	6 (27.27)	16 (72.73)		

** = Statistically significant variables at 95% confidence interval.

Stunting was more prevalent in children living in households where there was food insecurity than it was in children living in households where there was food security, which is consistent with the South African study [40]. The study conducted in Dale Woreda, Southern Ethiopia revealed that Children living in food-insecure households are more likely to be stunted than children who live in food-secure households [7]. Moreover, the study conducted in Southern Ethiopia also indicated that food security status was associated with the prevalence of stunting [46].

In this study, children without hand-washing facilities were twice more likely to be stunted than those with hand-washing facilities. This finding is consistent with a study done in Dangila Town [15], and Lay Armachiho District [20], Northwestern Ethiopia.

The present study revealed that stunting was highly associated with wasting. A child who wasted was five times more likely to be stunted than those who were not wasted. This finding is similar to a study done on Ghanaian Preschool Children [47].

Our current finding also revealed that children living in food in secured households' were more likely to be wasted than children living in food-secured households. This was supported by the study conducted in, Gondar town, northwest, Ethiopia [16], Dale Woreda in Southern Ethiopia [7], and the Southern region of Ethiopia [46].

In the present study children within the age category of 5–9 years were less likely to be wasted than those within 10–14 years. This is in line with the recent study conducted in Gondar town, northwest, Ethiopia [16]. Similarly, the finding in rural Madagascar, who were 5–14 years of age, indicated that older school children had a significantly greater likelihood of being thin [45].

In our study, younger children ages (5–9 years) were less likely to be under-weight than older aged children of 10–14 years old. This result was also supported by the study conducted by Dawit Degarege and his colleagues in Addis Ababa, Ethiopia [24]. Similarly, the study conducted in India indicated that the prevalence of underweight was highest in the age group within 11–13 years [31]. The other study conducted in Nairobi Peri-Urban Slum also revealed that children who were over nine years of age were more likely to be underweight [33].

In this study, children who lived in households with an open-field waste disposal system had a greater than a two-fold increased risk of being underweight compared to children who lived in households with a burning waste disposal system. This was consistent with research conducted in Dhaka City, Bangladesh [35].

5. Conclusion

The overall findings of the research indicated that undernutrition was very high in the study area. Stunting, wasting, and underweight among school-age children were also high relative to other studies conducted in Ethiopia. In the multivariable logistic regression model, child age, food insecurity, knowledge of mother/caregiver on nutrition, having a larger family size and utilization of unprotected drinking water sources were the determinant factors of under-nutrition.

Child age, food insecurity, hand washing, and being wasted were independent predictors of stunting among school-age children in the study area. Open waste disposal system and older child age were determinants of underweight, and child age and food insecurity were the significant determinant factors for wasting among school-age children in the study area.

Therefore, the district's agriculture and animal agency, health office, and education offices should place a priority on enhancing household food security and raising mothers' and caregivers' awareness of nutritional activities taking place at the household level. When putting undernutrition prevention, management, and intervention strategies into practice, they should also pay special attention to older kids. To further reduce issues with undernourishment in the community, they should support and expand the use of various waste disposal systems rather than open field disposal systems.

It is important to consider the community's accessibility to and supply of piped drinking water. Due to the cross-sectional nature of the study design, a drawback of the study was that it was unable to demonstrate the causal association between variables. Furthermore, genetic factors were not taken into account in this investigation, which may have affected our results.

Declarations

Author contribution statement

Desalegn Bayew Tebeje: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Genanew Agitew: Conceived and designed the experiments; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Netsanet Worku Mengistu: Conceived and designed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Setognal Birara Aychiluhm: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

Funding statement

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Data availability statement

Data will be made available on request.

Declaration of interests statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

Acknowledgements

Our heartfelt gratitude goes to Mr. Afardew Getahun and Mr. Maru Dessie for their coordination of data collectors and facilitation of the data collection process. We greatly thank the study participants as well as the data collectors, without whom the success of this study would be unthinkable. Last but not least; we would like to thank the University of Gondar for the provision of all necessary services like library and internet access.

References

[1] P. Kelly, Undernutrition, Nutr. Metabol. (2010) 378–386.
[2] W.H. Organization, WHO Child Growth Standards and the Identification of Severe Acute Malnutrition in Infants and Children: Joint Statement by the World Health Organization and the United Nations Children's Fund, 2009.
[3] A. Gebre, P.S. Reddy, A. Mulugeta, Y. Sedik, M. Kahssay, Prevalence of malnutrition and associated factors among under-five children in pastoral communities of Afar Regional State, Northeast Ethiopia: a community-based cross-sectional study, J. Nutri. Metab. 2019 (2019).
[4] Ethiopia Tfdro, National School Health and Nutrition Strategy, 2012.
[5] B. Masquelier, L. Hug, D. Sharrow, D. You, D. Hogan, K. Hill, et al., Global, regional, and national mortality trends in older children and young adolescents (5–14 years) from 1990 to 2016: an analysis of empirical data, Lancet Global Health 6 (10) (2018) e1087–e1099.
[6] E. Tzioumis, L.S. Adair, Childhood dual burden of under-and overnutrition in low- and middle-income countries: a critical review, Food Nutr. Bull. 35 (2) (2014) 230–243.
[7] M. Wolde, Y. Berhan, A. Chala, Determinants of underweight, stunting and wasting among schoolchildren, BMC Publ. Health 15 (1) (2015) 1–9.

[8] S.H. Mohammed, T.D. Habtewold, B.S. Tegegne, M.M. Birhanu, T.A. Sissay, B. Larijani, et al., Dietary and non-dietary determinants of linear growth status of infants and young children in Ethiopia: hierarchical regression analysis, PLoS One 14 (1) (2019) e0209220.

[9] J. Fanzo, C. Hawkes, E. Udomkesmalee, A. Afshin, L. Allemandi, O. Assery, et al., Global Nutrition Report: Shining a Light to spur Action on Nutrition, 2018.

[10] M. Alemu, J. Nicola, T. Belele, Tackling child malnutrition in Ethiopia, Young Lives Project Working Paper (19) (2005).

[11] Ethiopia. FDRo. Implementation Plan (2016 – 2030), 2016.

[12] A. Abdulahi, S. Shab-Bidar, S. Rezaei, K. Djafarian, Nutritional status of under five children in Ethiopia: a systematic review and meta-analysis, Ethiopian J. Health Sci. 27 (2) (2017) 175–188.

[13] N. Endris, H. Asefa, L. Dube, Prevalence of malnutrition and associated factors among children in rural Ethiopia, BioMed Res. Int. 2017 (2017).

[14] C. Best, N. Neufingerl, L. Van Geel, T. van den Briel, S. Osendarp, The nutritional status of school-aged children: why should we care? Food Nutr. Bull. 31 (3) (2010) 400–417.

[15] Y.M. Demilew, A.A. Emiru, Under nutrition and associated factors among school adolescents in Dangila Town, Northwest Ethiopia: a cross sectional study, Afr. Health Sci. 18 (3) (2018) 756–766.

[16] Z. Getaneh, M. Melku, M. Geta, T. Melak, M.T. Hunegnaw, Prevalence and determinants of stunting and wasting among public primary school children in Gondar town, northwest, Ethiopia, BMC Pediatr. 19 (1) (2019) 1–11.

[17] D. Zelellw, B. Gebreigziabher, K. Alene, B. Negatie, T. Kasahune, Prevalence and associated factors of stunting among schoolchildren, in debre markos town and gozamen woreda, East Gojjam Zone, Amhara regional state, Ethiopia, J. Nutr. Food Sci. 4 (2014) (2013) (Special Issue).

[18] T. Alelign, A. Degarege, B. Erko, Prevalence and factors associated with undernutrition and anaemia among school children in Durbete Town, northwest Ethiopia, Arch. Publ. Health 73 (1) (2015) 1–7.

[19] A.D. Dawit Degarege, Abebe Animut, Undernutrition and Associated Risk Factors Among School Age Children in Addis Ababa, Ethiopia, 2015.

[20] E. Belay, S. Handebo, T. Derso, A. Tariku, M. Sisay, Prevalence and determinants of pre-adolescent (5–14 years) acute and chronic undernutrition in Lay Armachiho District, Ethiopia, Int. J. Equity Health 18 (1) (2019) 1–7.

[21] A. Hall, T. Kassa, T. Demissie, T. Degefie, S. Lee, National survey of the health and nutrition of schoolchildren in Ethiopia, Trop. Med. Int. Health 13 (12) (2008) 1518–1526.

[22] J. Coates, A. Swindale, P. Bilinsky, Household food insecurity access scale (HFIAS) for measurement of household food access: indicator guide (v. 3), in: Food and Nutrition Technical Assistance Project, academy for educational Development, Washington, DC, 2007, pp. 1–36.

[23] WHO, WHO AnthroPlus for Personal Computers Manual: Software for Assessing Growth of the World's Children and Adolescents. Geneva, 2009.

[24] Degarege D, Degarege A, Animut A. Undernutrition and associated risk factors among school age children in Addis Ababa, Ethiopia Global health. BMC Publ. Health.15(1).

[25] A. Degarege, E. Hailemeskel, B. Erko, Age-related factors influencing the occurrence of undernutrition in northeastern Ethiopia, BMC Publ. Health 15 (1) (2015) 1–7.

[26] Y. Menber, D. Tsegaye, A. Woday, H. Cherie, S. Kebede, Prevalence of stunting and associated factors among school age children in primary schools of Haik Town, South Wollo Zone, North-Eastern Ethiopia, 2017, J. Clin. Cell. Immunol. 9 (1) (2018) 539.

[27] Z. Herrador, L. Sordo, E. Gadisa, J. Moreno, J. Nieto, A. Benito, et al., Cross-sectional study of malnutrition and associated factors among school aged children in rural and urban settings of Fogera and Libo Kemkem districts, Ethiopia, PLoS One 9 (9) (2014) e105880.

[28] E.Z. Tariku, G.A. Abebe, Z.A. Melketsedik, B.T. Gutema, Prevalence and factors associated with stunting and thinness among school-age children in Arba minch health and demographic surveillance site, southern Ethiopia, PLoS One 13 (11) (2018) e0206659.

[29] M. Ayalew, A. Bayray, A. Bekele, S. Handebo, Nutritional status and educational performance of school-aged children in Lalibela Town primary schools, Northern Ethiopia, Int. J. Pediatr. (2020) 2020.

[30] A. Lisanu Mazengia, G. Andargie Biks, Predictors of stunting among school-age children in Northwestern Ethiopia, J. Nutri. Metab. 2018 (2018).

[31] B. Kumar, V.P. Shrotriya, P.M. Srivastava, S.E. Mahmood, A. Srivastava, Nutritional Status of School-Age Children-A Scenario of Urban Slums in India, 2012.

[32] Madhusudan M, Nagar N, Post M. Nutritional Status of School Age Children (6-15 Years) Using the New WHO Growth Reference in a Rural Area of Bengaluru, South India.

[33] E. Chesire, A. Orago, L. Oteba, E. Echoka, Determinants of under nutrition among school age children in a Nairobi peri-urban slum, East Afr. Med. J. 85 (10) (2008) 471–479.

[34] G. Medhi, Aa Barua, J. Mahanta, Growth and nutritional status of school age children (6-14 years) of tea garden worker of Assam, J. Hum. Ecol. 19 (2) (2006) 83–85.

[35] S. Yeasmin, K. Islam, Prevalence and determinants of undernutrition among school age slum children in Dhaka City, Bangladesh J. Nutr. Health Sci. 3 (2) (2016) 201.

[36] A.K. Dey, A.B. Nath, Nutritional status of school going children (6-15 years) in a semi-urban area of Cachar District, Assam, J. Evolution Med. Dent. Sci. 6 (54) (2017) 4057–4062.

[37] D. Mansur, M. Haque, K. Sharma, D. Mehta, R. Shakya, A study on nutritional status of rural school going children in Kavre District, Kathmandu Univ. Med. J. 13 (2) (2015) 146–151.

[38] S. Erismann, A.M. Knoblauch, S. Diagbouga, P. Odermatt, J. Gerold, A. Shrestha, et al., Prevalence and risk factors of undernutrition among schoolchildren in the Plateau Central and Centre-Ouest regions of Burkina Faso, Infect. Dis. Pov. 6 (1) (2017) 1–14.

[39] R.E.A. Khan, M.A. Raza, Determinants of malnutrition in Indian children: new evidence from IDHS through CIAF, Qual. Quantity 50 (1) (2016) 299–316.

[40] E.W. Kimani-Murage, Exploring the paradox: double burden of malnutrition in rural South Africa, Glob. Health Action 6 (1) (2013) 19249.

[41] T.Y. Bogale, E.T. Bala, M. Tadesse, B.O. Asamoah, Prevalence and associated factors for stunting among 6–12 years old school age children from rural community of Humbo district, Southern Ethiopia, BMC Publ. Health 18 (1) (2018) 1–8.

[42] M. Abdirahman, P. Chege, J. Kobia, Nutrition knowledge and dietary practices among pregnant adolescents in mandera county, Kenya, Food Sci. Nutr. Res. 2 (2) (2019) 1–8.

[43] R.U. Onyeneke, C.A. Nwajiuba, C.O. Igberi, M. Umunna Amadi, F.C. Anosike, A. Oko-Isu, et al., Impacts of caregivers' nutrition knowledge and food market accessibility on preschool children's dietary diversity in remote communities in Southeast Nigeria, Sustainability 11 (6) (2019) 1688.

[44] A.A. Awel, T.B. Lema, H.J. Hebo, Nutritional status and associated factors among primary school adolescents of pastoral and agro-pastoral communities, Mieso Woreda, Somali Region, Ethiopia: a comparative cross-sectional study, J. Publ. Health Epidemiol. 8 (11) (2016) 297–310.

[45] H. Aiga, K. Abe, V.N. Andrianome, E. Randriamampionona, A.R. Razafinombana, T. Murai, et al., Risk factors for malnutrition among school-aged children: a cross-sectional study in rural Madagascar, BMC Publ. Health 19 (1) (2019) 1–13.

[46] M. Zenebe, S. Gebremedhin, C.J. Henry, N. Regassa, School feeding program has resulted in improved dietary diversity, nutritional status and class attendance of school children, Ital. J. Pediatr. 44 (1) (2018) 1–7.

[47] M. Saaka, S.Z. Galaa, Relationships between wasting and stunting and their concurrent occurrence in Ghanaian preschool children, J. Nutri. Metab. 2016 (2016).