

Factors associated with undernutrition among pregnant women in Chiro district, eastern Ethiopia

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Abstract

Background: Undernutrition denotes inadequate intake of energy and nutrients to meet one's optimal needs. Pregnant women are at an increased risk of undernutrition due to the added nutritional demand for fetal growth and development. Updated evidence is important for monitoring progress and informing healthcare decisions. However, there is a paucity of evidence about the nutritional status of pregnant women in the rural communities of eastern Ethiopia, particularly in Chiro district. Therefore, this study aimed to assess the prevalence of undernutrition and its associated factors among pregnant women in Chiro district, eastern Ethiopia.

Methods: A community-based cross-sectional study was employed in Chiro district, from November 1 to 30, 2022, among 423 randomly selected pregnant women. The data were collected using face-to-face interviews and anthropometric measurements by trained research assistants. Bi-variable and multivariable logistic regressions were fitted to identify predictors of undernutrition by using STATA-14 statistical software.

Results: The overall prevalence of undernutrition was 40.9% (95% confidence interval (CI): 36.2%, 45.8%). Antenatal care (ANC) follow-up (adjusted odds ratio (AOR): 5.61, 95% CI: 3.01, 10.45), history of illness in the past 2 weeks (AOR: 4.25, 95% CI: 2.23, 8.12), khat chewing (AOR: 4.01, 95% CI: 2.12, 7.56), household food security (AOR: 5.84, 95% CI: 3.36, 10.14), and dietary diversity practice (AOR: 2.74, 95% CI: 1.47, 5.09) were factors associated with undernutrition.

Conclusion: Four out of every 10 pregnant women in the study area were undernourished. ANC follow-up, illness in the past 2 weeks, khat chewing, household food security, and dietary diversity practice were significantly associated with undernutrition. Therefore, improving access to ANC services, strengthening nutritional counseling, and addressing food insecurity might reduce undernutrition among pregnant women.

Keywords

undernutrition, pregnant women, Ethiopia, associated factors

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Introduction

Nutrition is a vital component of life and has a substantial impact on health.¹ Undernutrition, which denotes inadequate intake of energy and nutrients to meet one's optimal needs, is an important public health problem that can affect any person at any stage of their life.² However, pregnant and lactating women, and children are among the most susceptible groups.^{3,4} Pregnancy increases women's nutritional demands due to the additional requirement for fetal growth and development.⁵ This raised nutritional demand,

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together with dietary inefficiencies as a result of culture, dietary habits, and feeding patterns put pregnant women at higher risk of undernutrition.^{6,7}

Maternal undernutrition is a widespread public health problem, particularly in low-and middle-income countries where maternal mortality, low birth weight, and childhood stunting are the major health problems due to the phenomenon.^{8,9} Pregnant women in sub-Saharan Africa are at particular nutritional risk as a result of poverty, recurrent infections, food insecurity, political and economic instabilities, and frequent pregnancies.¹⁰ About one-quarter of pregnant women in the region suffer from undernutrition.³ Previous studies in Ethiopia indicated that about half of pregnant women were undernourished.^{11,12}

Undernutrition during pregnancy is associated with devastating consequences both to the mother and her offspring.¹³ Undernourished mothers have higher morbidity and mortality due to their increased vulnerability to infection, anemia, and adverse pregnancy outcomes such as stillbirth, miscarriage, and preterm birth.^{12,14,15} On the other hand, children from undernourished mothers have a higher risk of low birth weight, intrauterine growth retardation, congenital malformation, retarded development, and reduced survival.^{13,16} Besides, poor nutrition's impact on maternal and child health has the potential to reduce the economic output of countries by 2%–3% annually.¹⁷

Previous studies have identified various predictors of undernutrition, including residence, income, family size, educational status, antenatal care (ANC) follow-up, dietary diversity practice, and food security.^{4,18,19} Yet, their importance varies across studies, mainly due to the socio-cultural differences among communities; hence, there is a need for locally tailored evidence for effective control of this important public health problem.²⁰

The world is on the path to ending hunger and malnutrition by 2030.²¹ In line with this, Ethiopia is implementing important programs like community-based management of acute malnutrition and sustainable undernutrition reduction; yet, the problem persists to be considerable.²² Updated evidence is important to monitor progress and inform healthcare decisions. However, despite the area being one of the areas where food insecurity is widely seen,²³ no study has been conducted to investigate the nutritional status of pregnant women. The district is also known for its high and rapidly shifting production and consumption of khat,^{24,25} which could affect nutrition by suppressing food crop availability and proper dietary intake.^{26,27} Besides, given the substantial sociocultural variation in Ethiopia, identifying determinants of malnutrition across different communities is helpful for controlling this disease through locally contextualized evidence based care. In light of the above, we aimed to assess the prevalence of undernutrition and its associated factors among pregnant women in Chiro district, eastern Ethiopia. In this study, we test the

competing hypothesis about the socioeconomic factors associated with undernutrition among pregnant women in Chiro district.

Materials and methods

Study design, area, and period

We conducted a community-based cross-sectional study in Chiro district from November 1 to 30, 2022. Chiro district is 1 of the 15 districts found under the west Hararghe zone of Oromia Regional State, Ethiopia. The district is located 326 km east of Addis Ababa. It is composed of 3 urban and 39 rural kebeles with an estimated total population of 314,056 people, of which 10,898 are pregnant women. There are 42 health posts, 8 health centers, and 1 General Hospital in the district that provides promotive, preventive, curative, and rehabilitative health services, including nutritional support.

Study participants

All pregnant women who reside in Chiro district constitute the source population. The study population was composed of all pregnant women who reside in the selected kebeles of Chiro district.

Inclusion and exclusion criteria

All pregnant women who were residents of Chiro district for at least 6 months were included in this study. However, pregnant women who were seriously ill and/or had difficulties to communicate, and women with physical deformities at their left upper extremity were excluded from this study.

Sample size determination and sampling procedures

The sample size for this study was determined using the sample size determination formula for a single population proportion, considering the following assumptions: a 95% confidence interval (CI), 5% margin of error, and 47.9% prevalence of undernutrition among pregnant women in Haramaya district.¹² Accordingly, the calculated sample size was 384. After adding a 10% non-response rate, the final sample size was determined to be 423 pregnant women.

From the 42 total kebeles in the district, 8 kebeles (one urban and 7 rural) were selected randomly. The sample size was allocated to each selected kebele proportionally (proportional to the number of pregnant women in each kebele). Study participants were then selected systematically by using the pregnancy screening registration book of health posts as a sampling frame.

Data collection tool, procedure, and quality control

The data were collected using an interview administered, structured questionnaire adapted from previous literature.^{4,19,28} The questionnaire was first prepared in English and then translated to Oromiffa and returned to English to ensure consistency by two different language experts who did not have information about the study.

Face-to-face interviews and anthropometric measurements were employed to collect the data. Eight clinical nurses who were fluent in the local language (Oromiffa) and had extensive experience in human nutrition were recruited as data collectors, and they were supervised by four BSc nurses. Mid-upper arm circumference (MUAC) was used to determine the nutritional status of pregnant women. With no clothing on the arm, the left arm's MUAC was measured in triplicate using a standard non-stretchable MUAC tape to the nearest 0.1 cm, and the mean of the triplicate measurements was taken.

Data quality was assured by providing 2 days training for data collectors and supervisors before data collection about how to collect data from pregnant women using the tool. Besides, the researchers monitored for data quality and completeness every day by reviewing the collected information with the data collection team. Furthermore, the questionnaire was pretested on 30 pregnant women in 1 of the kebeles not included in this study.

Operational definitions

Undernutrition. Pregnant woman whose MUAC was less than 23 cm were categorized as undernourished, while those whose MUAC was 23 cm or greater were considered to be normal.^{4,12,29} Hence, nutritional status of pregnant women was solely evaluated by using MUAC.

Food security. Food security was measured using the Household Food Insecurity Access Scale, which is composed of nine items specific to an experience of food insecurity occurring in the past 4 weeks; correspondingly, a household was considered food-secured if it did not experience any of the food insecurity (access) conditions or had just experienced worry, but rarely.³⁰

Dietary diversity. The updated dietary diversity measurement guide for women was employed to assess dietary diversity, and pregnant women who had consumed 5 or more out of the 10 food groups in the past 24 h were considered to practice high (optimal) dietary diversity.³¹

Khat chewing. A woman who chewed khat at least once in the last month.²⁴

ANC follow-up. A woman was considered as having ANC follow-up if she had at least one ANC visit for the current pregnancy.

Illness in the past 2 weeks. Experiencing an illness that made the woman visit her healthcare provider.

Meal frequency. The number of times food was consumed in the past 24 h.

Data management and analysis

After collection, the data were entered into EpiData-3.1 and subsequently exported to STATA-14 software for cleaning and further statistical analysis. Descriptive analyses such as percentage and frequency for categorical variables and mean or median for continuous variables were computed.

Binary logistic regression was employed to identify predictors of undernutrition. Variables with a *p*-value less than 0.25 during the bi-variable logistic regression were selected for subsequent multivariable logistic regression. Before fitting the multivariable model, candidate explanatory variables were examined for multi-collinearity using the variance inflation factor, and none of the candidate independent variables exhibited such an association. In the multivariable analysis, a significant statistical association was declared at a *p*-value < 0.05. In addition, the fitness of the final model was verified using the Hosmer–Lemeshow goodness-of-fit test and classification table.

Results

Sociodemographic characteristics

All the approached pregnant women (423) completed the survey, resulting in a response rate of 100%. The age of women ranged from 15 to 45 years, with a mean age of 26.8 (6.1) years old. The majority of the study participants were rural dwellers (83.9%), housewives (65.7%), and those who had attended primary education (49.6%). Nearly all (96.9%) of the respondents were married (Table 1).

Sciocultural characteristics of respondents

About 1 in 10 (9.0%) women lives in a polygamous relationship. Nearly, all (98.3%) of the pregnant women shared their decision on household purchasing, and about one-third (33.8%) of the pregnant women were supported by their partners in indoor activities (Table 2).

Housing and environmental characteristics of study participants

Most (56.3%) of the pregnant women were from households that did not practice home gardening. The majority

Table 1. Sociodemographic characteristics of pregnant women in Chiro district, eastern Ethiopia.

Variables	Category	Nutritional status		Total frequency, n (%)
		Not undernourished, n (%)	Undernourished, n (%)	
Age group	15–24	96 (38.4)	76 (43.9)	172 (40.7)
	25–34	116 (46.4)	76 (43.9)	192 (45.4)
	35–45	38 (15.2)	21 (12.2)	59 (13.9)
Residence	Urban	55 (22.0)	13 (7.5)	68 (16.1)
	Rural	195 (78.0)	160 (92.5)	355 (83.9)
Marital status	Married	242 (96.8)	168 (97.1)	410 (96.9)
	Divorced/widowed	8 (3.2)	5 (2.9)	13 (3.1)
Religion	Muslim	171 (68.4)	124 (71.7)	295 (69.7)
	Orthodox	70 (28.0)	43 (24.8)	113 (26.7)
	Others ^a	9 (3.6)	6 (3.5)	15 (3.6)
Ethnicity	Oromo	236 (94.4)	166 (95.9)	402 (95.0)
	Others ^b	14 (5.6)	7 (4.1)	21 (5.0)
Educational status	No formal education	96 (38.4)	80 (46.2)	176 (41.6)
	Primary	123 (49.2)	87 (50.3)	210 (49.6)
	Secondary and above	31 (12.4)	6 (3.5)	37 (8.8)
Occupation	Housewife	165 (66.0)	113 (65.3)	278 (65.7)
	Farmer	61 (24.4)	50 (28.9)	111 (26.2)
	Others ^c	24 (9.6)	10 (5.8)	34 (8.1)
Family size	<4	127 (50.8)	85 (49.1)	212 (50.1)
	>4	123 (49.2)	88 (50.9)	211 (49.9)
Income category	Highest	71 (28.4)	18 (10.4)	89 (21.0)
	Mild	69 (27.6)	23 (13.3)	92 (21.8)
	Moderate	48 (19.2)	41 (23.7)	89 (21.0)
	Lowest	62 (24.8)	91 (52.6)	153 (36.2)

^aProtestant, Catholic or Wake Feta.^bAmhara, Gurage or Sidama.^cGovernment employee, merchant or daily laborer.**Table 2.** Sociocultural characteristics of pregnant women in Chiro district, eastern Ethiopia.

Variables	Categories	Nutritional status		Total frequency, n (%)
		Not undernourished, n (%)	Undernourished, n (%)	
Polygamy	Yes	23 (9.2)	15 (8.7)	38 (9.0)
	No	227 (90.8)	158 (91.3)	385 (91.0)
Food taboo	Yes	18 (7.2)	14 (8.1)	32 (7.6)
	No	232 (92.8)	159 (91.9)	391 (92.4)
Sharing decisions on major household purchase	Yes	246 (98.4)	170 (98.3)	416 (98.3)
	No	4 (1.6)	3 (1.7)	7 (1.7)
Who does the market shopping	Herself	237 (94.8)	166 (95.9)	403 (95.3)
	Others ^a	13 (5.2)	7 (4.1)	20 (4.7)
Time to reach market	≤30 min	95	71 (41.0)	166 (39.2)
	30–60 min	101	71 (41.0)	172 (40.7)
	>60 min	54	31 (18.0)	85 (20.1)
Partner support on indoor activities	Yes	80 (32.0)	63 (36.4)	143 (33.8)
	No	170 (68.0)	110 (63.6)	280 (66.2)

^aHusband, children, or both husband and wife.

Table 3. Housing and environmental characteristics of pregnant women in Chiro district, eastern Ethiopia.

Variable	Categories	Nutritional status		Total frequency, n (%)
		Not undernourished, n (%)	Undernourished, n (%)	
Home gardening	Yes	111 (44.4)	74 (42.8)	185 (43.7)
	No	139 (55.6)	99 (57.2)	238 (56.3)
Production of crops	Yes	191 (76.4)	151 (87.3)	342 (80.8)
	No	59 (23.6)	22 (12.7)	81 (19.2)
Having large live-stocks	Yes	134 (53.6)	117 (67.6)	251 (59.3)
	No	116 (46.4)	56 (32.4)	172 (40.7)
Having small live-stock	Yes	169 (67.6)	120 (69.4)	289 (68.3)
	No	81 (32.4)	53 (30.6)	134 (31.7)
Does the household own latrine	Yes	209 (83.6)	138 (79.8)	347 (82.0)
	No	41 (16.4)	35 (20.2)	76 (18.0)
Source of drinking water	Pipe	108 (43.2)	40 (23.1)	148 (35.0)
	Spring	115 (46.0)	112 (64.7)	227 (53.7)
	River	27 (10.8)	21 (12.2)	48 (11.3)
Food source	Own production	139 (55.6)	88 (50.9)	227 (53.7)
	Purchased	48 (19.2)	35 (20.2)	83 (19.6)
	Both	63 (25.2)	50 (28.9)	113 (26.7)
Household food security	Food secured	206 (82.4)	54 (31.2)	260 (61.5)
	Not food secured	44 (17.6)	119 (68.8)	163 (38.5)

(53.7%) of pregnant women obtain their drinking water from springs, and most (61.5%) of the respondents were from food-secured households (Table 3).

Reproductive and behavioral characteristics of respondents

About three-fourths (73.3%) of pregnant women had ANC follow-up. The majority of pregnant women were in the second trimester (52.7%), chew khat (64.1%), and had low dietary diversity practices (61.0%) (Table 4).

Undernutrition and its associated factors

The MUAC of pregnant women varied between 19 and 29 cm, with a median (interquartile range) of 23 (22–23.6) centimeters. Overall, results of this study found that 40.9% (95% CI: 36.2%, 45.8%) of pregnant women were undernourished (Figure 1). Attending ANC, history of illness in the past 2 weeks, khat chewing, household food insecurity, and low dietary diversity were independently associated with undernutrition.

Accordingly, the odds of undernutrition were 5.61 (95% CI: 3.01, 10.45) times higher among pregnant women who had no ANC follow-up than among those women who attended ANC follow-ups. Pregnant women who had a history of illness in the past 2 weeks were 4.25 (95% CI: 2.23, 8.12) times more likely to be undernourished compared to their counterparts. The risk of undernutrition was 4.01 (95% CI: 2.12, 7.56) times higher among pregnant women

who chew khat as compared to women who do not chew khat. Pregnant women from food-insecured households were 5.84 (95% CI: 3.36, 10.14) times more likely to be malnourished than women from food-secured households. Similarly, the odds of undernutrition were 2.74 (95% CI: 1.47, 5.09) times higher among pregnant women who had lower dietary diversity practices than among their counterparts (Table 5).

Discussion

The purpose of this study was to assess the prevalence and factors associated with undernutrition among pregnant women in Chiro district, eastern Ethiopia. Consequently, 40.9% of pregnant women in the district were undernourished. Attending ANC, history of illness in the past 2 weeks, khat chewing, household food insecurity, and low dietary diversity practice were significantly associated with undernutrition.

The prevalence of undernutrition in this study was in line with the findings of previous studies from different parts of Ethiopia.^{4,19,32–34} This could possibly be due to the proximity of dietary patterns within the country. However, our prevalence estimate was slightly lower than that in a previous report from eastern Ethiopia (47.3%).³⁵ This might be due to the variation in study time, as the previous report was from a study conducted more than a decade ago.

On the contrary, our prevalence estimate was higher than that of previous findings from other areas of the country: 19.1% in Haramaya district, eastern Ethiopia,³⁶ 13.9%

Table 4. Reproductive and behavioral characteristics of pregnant women in Chiro district, eastern Ethiopia.

Variable	Categories	Nutritional status		Total frequency, n (%)
		Not undernourished, n (%)	Undernourished, n (%)	
Gravida	≤2	84 (33.6)	57 (32.9)	141 (33.3)
	3–4	89 (35.6)	56 (32.4)	145 (34.3)
	≥5	77 (30.8)	60 (34.7)	137 (32.4)
ANC follow-up	Yes	229 (91.6)	81 (46.8)	310 (73.3)
	No	21 (8.4)	92 (53.2)	113 (26.7)
Nutrition information	Yes	231 (92.4)	75 (43.4)	306 (72.3)
	No	19 (7.6)	98 (56.6)	117 (27.7)
Is this pregnancy planned	Yes	179 (71.6)	116 (67.1)	295 (69.7)
	No	71 (28.4)	57 (32.9)	128 (30.3)
Stage of pregnancy	First trimester	39 (15.6)	24 (13.9)	63 (14.9)
	Second trimester	134 (53.6)	89 (51.4)	223 (52.7)
	Third trimester	77 (30.8)	60 (34.7)	137 (32.4)
Illness within 2 weeks	Yes	33 (13.2)	69 (39.9)	102 (24.1)
	No	217 (86.8)	104 (60.1)	321 (75.9)
Meal frequency	<4	150 (60.0)	134 (77.5)	284 (67.1)
	>4	100 (40.0)	39 (22.5)	139 (32.9)
Dietary diversity practice	Diversified	131 (52.4)	34 (19.6)	165 (39.0)
	Not diversified	119 (47.6)	139 (80.4)	258 (61.0)
Fasting during pregnancy	Yes	160 (64.0)	110 (63.6)	270 (63.8)
	No	90 (36.0)	63 (36.4)	153 (36.2)
Khat chewing	Yes	128 (51.2)	143 (82.7)	271 (64.1)
	No	122 (48.8)	30 (17.3)	152 (35.9)

ANC: antenatal care.

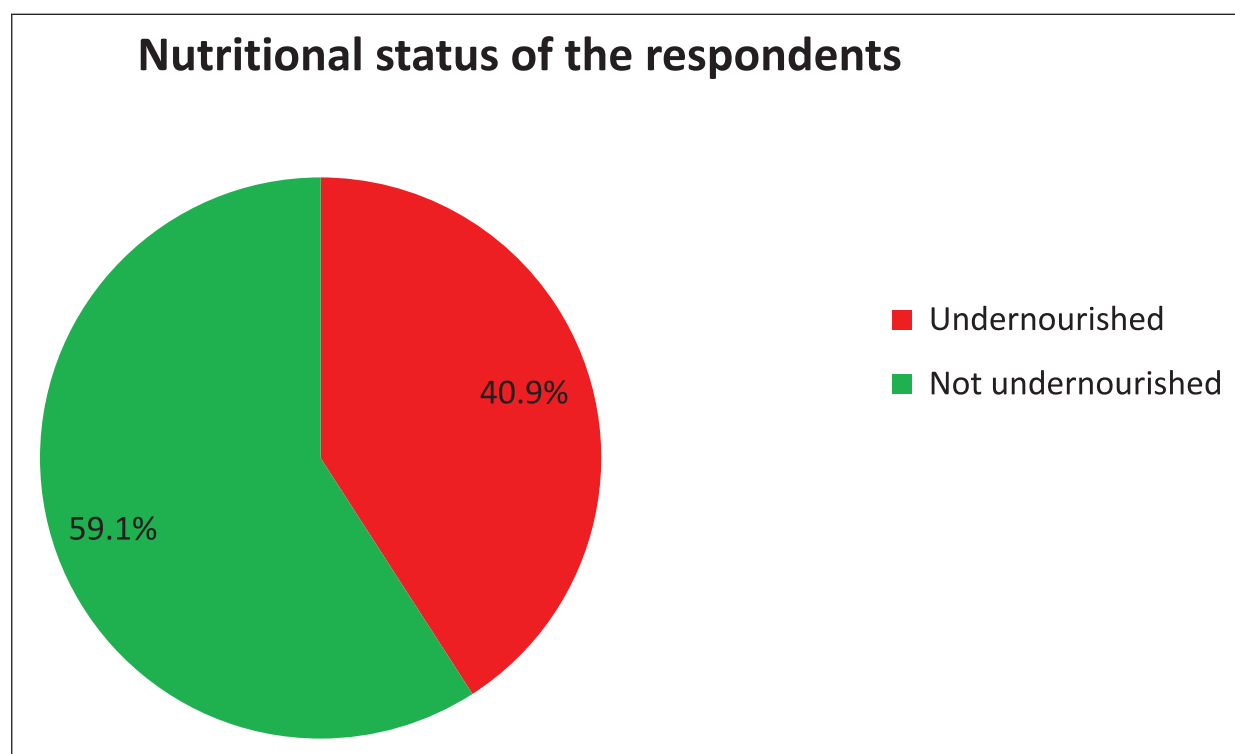
**Figure 1.** Nutritional status of pregnant women, Chiro district, Eastern Ethiopia.

Table 5. Multi-variable model for factors associated with nutritional status of pregnant women in Chiro district, eastern Ethiopia.

Variable	Categories	Nutritional status		COR	AOR (95% CI)	p-Value
		Not under-nourished	Under-nourished			
Residence	Urban	55 (80.9)	13 (19.1)	1	1	—
	Rural	195 (54.9)	160 (45.1)	3.47	1.14 (0.49, 2.64)	0.768
ANC follow-up	Yes	229 (73.9)	81 (26.1)	1	1	—
	No	21 (18.6)	92 (81.4)	12.39	5.61 (3.01, 10.45)*	<0.0001
Illness in the past 2 weeks	Yes	33 (32.3)	69 (67.7)	4.36	4.25 (2.23, 8.12)*	<0.0001
	No	217 (67.6)	104 (32.4)	1	1	—
Khat chewing	Yes	128 (47.2)	143 (52.8)	4.54	4.01 (2.12, 7.56)*	<0.0001
	No	122 (80.3)	30 (19.7)	1	1	—
Educational status	No formal education	96 (54.6)	80 (45.4)	4.31	1.30 (0.39, 4.38)	0.673
	Primary	123 (58.6)	87 (41.4)	3.65	1.59 (0.49, 5.21)	0.441
	Secondary and above	31 (83.8)	6 (16.2)	1	1	—
Meal frequency	4	150 (52.8)	134 (47.2)	2.29	0.76 (0.40, 1.44)	0.397
	≥4	100 (71.9)	39 (28.1)	1	1	—
Food security	Food secured	206 (79.2)	54 (20.8)	1	1	—
	Not food secured	44 (27.0)	119 (73.0)	10.32	5.84 (3.36, 10.14)*	<0.0001
Dietary diversity practice	High	131 (79.4)	34 (20.6)	1	1	—
	Low	119 (46.1)	139 (53.9)	4.50	2.74 (1.47, 5.09)*	0.001

ANC: antenatal care; AOR: adjusted odds ratio; COR: crud odds ratio; CI: confidence interval.

*Significant at $p < 0.05$.

in east Shoa zone, central Ethiopia³⁷; 21.8% in Silte zone, southern Ethiopia³⁸; 14.4% in Gondar town, northwest Ethiopia³⁹; and 28.6% in Gambella town, western Ethiopia.⁴⁰ This discrepancy in findings might be due to the variation in study settings (community-based versus institution-based), the difference in the MUAC cutoff point for undernutrition, and/or geographical variations.

Our finding was also higher than has been reported by previous studies from other countries: 12.5% in Sudan,⁴¹ 19.3% in Kenya,⁴² 9% in Madagascar,⁴³ 15% in Sri Lanka,⁴⁴ and 14.7% in China.⁴⁵ The possible explanation for this inconsistency might be partly due to the sociocultural variation between the countries.

Our analysis indicated that pregnant women who had no ANC follow-up for the current pregnancy were at a higher risk of undernutrition compared to women who attended ANC follow-ups. This finding is in line with previous reports,^{4,7} and might be due to the effect of dietary counseling and education provided during ANC. This explanation is supported by the findings of another study that revealed a positive association between nutritional counseling and the nutritional status of pregnant women.³⁶

Consistent with a previous report,⁷ this study showed that pregnant women who had a history of illness in the past 2 weeks were more likely to be undernourished as compared to their counterparts. This could be due to the multifaceted effect of infection on nutrition, resulting in increased demand contrasted with diminished appetite and intake.⁴⁶ Similarly, the odds of undernutrition were higher among pregnant women who chew khat than among women who do not chew khat. This result is supported by another study in the same study area but among lactating

mothers.²⁷ The possible explanation might be due to appetite loss and delayed absorption of nutrients secondary to gastrointestinal problems resulting from khat chewing.⁴⁷

As evidenced elsewhere,^{19,28,33} pregnant women from food-insecured households were more likely to be malnourished than women from food-secured households. This might be explained by the poor access to nutritious food among food insecure households, which leads to inadequate intake and undernutrition. In line with previous studies,^{12,18,33} the odds of undernutrition were higher among pregnant women who had low dietary diversity than among their counterparts. This could be due to the increased likelihood of higher dietary quality and a better chance of fulfilling daily nutritional and energy needs among women with high dietary diversity practices.

The results of this study should be interpreted considering the following limitations. First, variables like household food security and meal frequency might be affected by social desirability bias. Second, the effect of recall bias on some variables, such as dietary diversity practice, cannot be ruled out. Finally, the cross-sectional nature of the study makes it difficult to establish a causal association between undernutrition and its determinants.

Conclusion

Four out of every 10 pregnant women in the study area were undernourished. ANC follow-up, illness in the past 2 weeks, khat chewing, household food insecurity, and dietary diversity practice were significantly associated with undernutrition. Therefore, improving access to ANC service, strengthening nutritional counseling, and addressing

food insecurity might reduce undernutrition among pregnant women.

Declarations

Ethical approval and consent to participate

Ethical clearance and approval of the study proposal were granted by the Oda Bultum University ethical review committee (Reference No: RCSVPO/141/10/2014). The study was performed in accordance with the Declaration of Helsinki-Ethical principle for medical research involving human subjects. Informed consent was obtained from all pregnant women who participated in this study. Besides, confidentiality of the collected information was assured by not recording women's personal identifiers.

Consent for publication

No identifiable individual data were used in this study.

Author contributions

Eyasu Bamlaku Golla: Conceptualization; Funding acquisition; Writing – original draft; Writing – review & editing; Methodology; Formal analysis; Data curation; Supervision; Investigation; Visualization; Validation; Resources.

Habtamu Geremew: Investigation; Conceptualization; Funding acquisition; Writing – review & editing; Methodology; Data curation; Formal analysis; Supervision; Project administration; Writing – original draft; Software.

Abinet Tesfaye Diro: Investigation; Validation; Methodology; Formal analysis; Supervision; Data curation; Writing – review & editing.

Samuel Abdisa: Investigation; Validation; Methodology; Formal analysis; Supervision; Writing – review & editing.

Alegntaw Abate: Writing – review & editing.

Meron Admasu: Software; Methodology; Validation; Supervision; Data curation; Formal analysis; Writing – review & editing.

Mohammed Ahmed Ali: Validation; Methodology; Formal analysis; Software; Supervision; Data curation; Writing – review & editing.

Getachew Gashaw: Funding acquisition; Visualization; Validation; Methodology; Writing – review & editing; Supervision; Resources.

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Competing interests

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

Availability of data and materials

The datasets used in this study can be obtained from the corresponding author upon reasonable request.

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