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Postwar nutritional status of lactating mothers: evidence from war-torn Tigray, Ethiopia

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Abstract

Background Poor maternal nutrition is a significant public health problem, especially in conflict-affected areas. Lactating mothers are particularly vulnerable due to increased nutritional demands. The recent conflict in the Tigray region has resulted in serious crises and disruptions, worsening maternal undernutrition.

Objective This study aimed to determine the post-war nutritional status of lactating mothers, in Tigray, Ethiopia, 2024.

Methods A household-based cross-sectional study was conducted from January 16 to February 14, 2024, across six zones of Tigray, excluding the Western zone, which included 1245 lactating mothers with children under six months of age. Data were collected through a structured interview-based questionnaire designed in KoboToolBox. The collected data were managed and analyzed via Stata version 17 software. Descriptive statistics and bivariate and multivariable robust (modified) Poisson regression models were fitted to identify the factors associated with maternal undernutrition, after checking the necessary model assumptions. Adjusted prevalence rates with 95% confidence intervals were used as measures of effects and statistical significance.

Results The prevalence of undernutrition among lactating mothers was 55.2% (95% CI: 52.3–58.1). The proportion of undernourished lactating mothers was greater in rural areas (60.7%: 57.3–64.0) than in urban (41.8%: 36.5–47.2). The factors independently associated with maternal undernutrition included elementary education [aPR (95% C.I): 1.1(1.01–1.3)], rural residence [aPR (95% C.I): 1.3(1.1–1.5)], iodized salt use [aPR (95% C.I): 0.9(0.8–0.99)], and low meal frequency [aPR (95% C.I): 1.3(1.2–1.5)].

Conclusions This study revealed a high maternal undernutrition prevalence among lactating mothers in Tigray in the post-conflict era. Therefore, interventions targeting educational opportunities, iodized salt use, and adequate

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meal frequency may help improve the nutritional status of lactating mothers in the conflict-affected areas in Tigray, Ethiopia.

Introduction

Women have distinct nutritional requirements throughout their lives, especially before and during pregnancy and while breastfeeding when nutritional vulnerability is greatest [1]. Compared with that of nonpregnant women, the daily energy needed during lactation increases on average from 450 to 500 kcal/day [2, 3], and even the energy requirements increase by 640 kcal/day during the first six months postpartum among women who practice exclusive breastfeeding [1].

Malnutrition among mothers remains a major concern in the area of global health, particularly in sub-Saharan Africa, which bears a large proportion of the disease-related burden and impairs the health of both mothers and babies [4]. Undernutrition during pregnancy and lactation, defined as insufficient nutrient intake in pregnant and lactating women, is an optimal and critical determinant of adverse pregnancy outcomes such as pre-term birth, low birth weight, and poor growth and development in newborns [5, 6]. The nutritional status of pregnant and lactating mothers is still inadequate in many regions of the world [1].

Breastfeeding women are at greater risk of malnutrition due to the extra nutritional demands during this period [7]. Achieving a balanced diet for lactating mothers becomes critical to benefit their selves and their infants [1, 4].

In Ethiopia, maternal undernutrition remains a major issue of concern, where according to the latest data, at least 18% of reproductive-aged women are undernourished at the national level [8]. According to various studies conducted in Ethiopia, the prevalence of undernutrition among lactating mothers ranges from 10.3 to 51%, with the highest prevalence reported in Tigray [9–19].

The Tigray region of Ethiopia has endured a state of suffering since early November 2020 due to conflict and its negative consequences for natural resources and humans [20–22]. The conflict has led to 3.2 million people being displaced; health and sanitation facilities and systems have been severely damaged; and economic disruptions have led to an increased prevalence of acute malnutrition among vulnerable groups, including breastfeeding mothers [20, 22, 23]. However, the nutritional status of lactating mothers following the war in Tigray is not known or documented. Thus, the knowledge derived from this study will help fill the existing knowledge gap on malnutrition among lactating women in Tigray to implement effective maternal nutrition strategies in post-conflict settings. Besides, it will help in designing interventions and policies targeting maternal nutritional status and breastfeeding in general. Therefore, this study aimed to estimate the postwar nutritional status of lactating mothers in the war-torn Tigray, Ethiopia.

Methods and materials

Study settings

The study was conducted in all zones of the Tigray region except the Western zone due to insecurity (Fig. 1). According to the projection of the 2007 population census, the population of Tigray is approximately 7 million, and approximately 80% of the population comprises rural dwellers. Tigray had a well-established healthcare system before the start of the war in November 2020, with 1,011 public health institutions. Public healthcare services in Tigray are provided through two referral hospitals, 14 general hospitals, 24 primary hospitals, 231 health centers, and 743 health posts. However, more than 80% of health facilities were completely or partially damaged or looted during the war [20, 23]. This study was conducted from January 16–February 14, 2024.

Study design

A household-based cross-sectional study design was used.

Population

All lactating mothers in the six zones of the Tigray region composed the source population for this study. The selected lactating mothers who were lactating for less than six months in the selected districts of the six zones of the Tigray region composed the study population. Households were the study units where a lactating mother was interviewed.

Sample size calculation and sampling procedures

The sample size was determined using a double proportion formula using Epi-Info 7.2.5 software, with different assumptions to achieve sufficient power to identify the differences that may exist and address non-response rates. A significance level of 95%, 90% power, 37% proportion of undernutrition on exposure, 1.49 odds ratio between exposed and non-exposed individuals, and a non-response rate of 10% were used [18]. Consequently, a final sample size of 1245 was calculated and employed.

A multistage stratified sampling procedure was employed. First, the 78 accessible districts in the six zones of Tigray were stratified by rural-urban residence
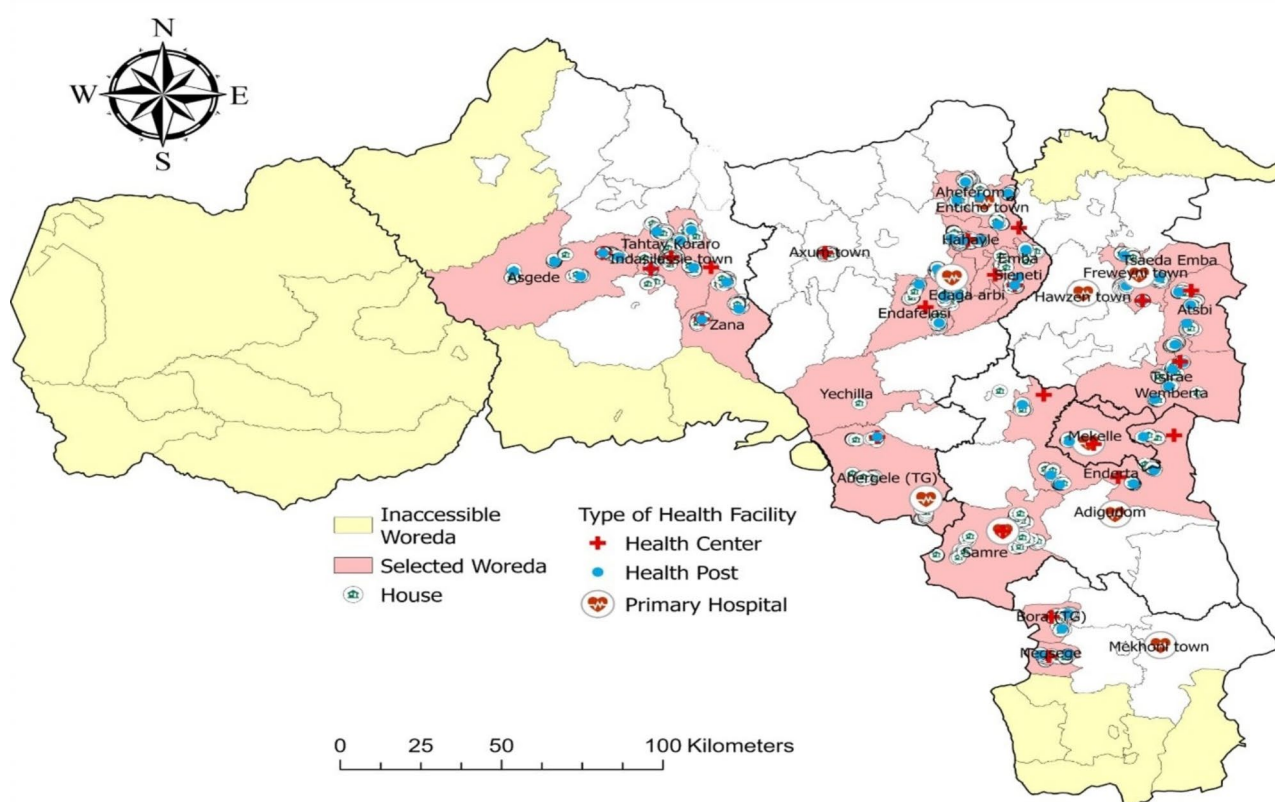
Fig. 1 Illustrative map of the study area (Tigray), 2024

into 51 rural and 27 urban districts. Then, 24 (16 rural districts and 8 urban districts) districts were randomly and proportionally selected. From each selected district, kebelles (the smallest administrative units) were selected proportionally. The proportional inclusion aimed for a 30% inclusion rate of the kebelles within each district. The number of kebelles selected from each district was proportional to the district's population size. Hence, 78 total kebelles were randomly chosen from each district, and random sampling was also performed for each kebelle. In this study, fifteen to twenty households were selected randomly from each of the kebelles using a list of the eligible households in the kebelles as a sampling frame. The sampling frame consisted of lactating mothers who had under six months old children.

Data collection tools and procedures

We collected quantitative data using a standard inter-viewer-administered questionnaire, which included questions related to the sociodemographic characteristics of the household/mother, obstetric-related characteristics, nutritional characteristics of the mother, and water, hygiene, and sanitation (WASH) status. The study employed 8 experienced master's degree holder supervisors and 24 BSc holder data collectors with extensive experience in data collection.

Nutritional assessments

Mid-upper Arm Circumference measurements (MUAC) were used for quick screening of the nutritional status of lactating mothers among mothers who have children aged less than 6 months from the selected study communities. The MUAC measurement is recommended for pregnant and lactating mothers with a cut-off point from 21 to 23 cm, especially in emergency or humanitarian contexts when measuring weight and height may be difficult [24–26]. This study used a cut-off point of 23 cm. The measurement was taken by placing a non-stretchable MUAC tape on the non-dominant arm, usually the left arm, without clothing. The tape was placed at the midpoint between the tips of the shoulder and elbow. The measurement was taken three times for each mother to ensure accuracy, and the average values were taken. The MUAC measurements were recorded to the nearest 0.1 cm.

A questionnaire designed to measure food security status was adopted from the Food and Nutrition Technical Assistance Household Food Insecurity Access Scale guidelines [27]. The questionnaire consists of 27 questions in total. The first nine questions are answered with a yes or no response after the respondent is asked to recall whether the condition in each occurrence question occurred at any point in the past four weeks. If the

respondent answered "yes" to a question about the occurrence of a certain condition, they were then asked how often it occurred in the past four weeks. The frequency options were "rarely" (one or two times), "sometimes" (three to ten times), and "often" (more than ten times). Based on these scores, the respondent's level of food security was classified into one of four categories: food secured, mildly food insecure, moderately food insecure, and severely food insecure, which were ultimately dichotomized into food-secured and food insecure households. This tool is widely validated and has good reliability internationally including in Ethiopia.

Finally, the data were collected using the Kobo toolbox, which is designed to collect real-time data.

Variables of the study
Dependent variable
Undernutrition (Yes if the MUAC < 23 = Yes, and if the MUAC ≥ 23 = No).

Independent variables
Sociodemographic Maternal age, educational status, occupational status, marital status, and family size.

Obstetrics related Parity, gravidity, antenatal care visit, current use of family planning, ever use of family planning, and place of delivery,

Nutrition-related Nutritional counseling, Iron folic acid (IFA) intake, household salt, number of meals, and household food security (HHFS).

Water, sanitation, and hygiene-related Basic sanitation, water source, handwashing, and water treatment practices.

Data quality assurance
A standard questionnaire was prepared in the English language, and translation to the local language (Tigrigna) and back-translation to English was done. Extensive training was provided to the supervisors and data collectors on the data collection procedures, sampling procedures, appropriate MUAC measurements, and the ODK/KoboToolBox applications. We pre-tested the questionnaire using Kobo collect in the field, and necessary modifications were made accordingly.

The Kobo toolbox helped us collect real-time data to monitor the progress and any errors on time on the central server. In addition, the automated check-in features such as skip logic, constraints, and other data validation rules enabled us to collect accurate data. Moreover, there was strict field supervision to check the completeness and consistency of the completed questionnaires. After data collection, rigorous data cleaning is conducted to increase the quality of the data.

Data management and analysis
We exported the data collected through Kobo to Stata version 17 software for data cleaning, management, and analysis. Descriptive statistical analyses such as frequency, proportion, mean, and standard deviation, were initially performed. Cross-tabulation of the dependent variable with each independent variable was performed.

Robust (modified) Poisson regression was used to identify the factors associated with maternal nutritional status. We preferred the robust Poisson regression model over the convenient logistic regression model because it directly provides the prevalence rate as a measure of effect. This measure of effect is more straightforward to interpret and communicate in survey (prevalence) studies [28, 29].

Binary robust(modified) Poisson regression was fitted for each independent variable to select candidate variables for the final model. A *P*-value < 25% was used as a cut-off point to select candidate variables for the final regression model. Finally, a multivariable robust(modified) Poisson regression model was used to identify the independent factors associated with maternal nutritional status using an adjusted Prevalence rate (aPR) and 95% Confidence Interval (CI). The model fitness was checked using different techniques, which revealed that there was no overdispersion suggesting the model fit the data well (deviance goodness-of-fit = 739.5, *P*-value = 1; Pearson goodness-of-fit = 536.5, *p*-value = 1).

We checked for multicollinearity among the independent variables using variance inflation factor (VIF) statistics, and there was no problem (1.03–6.57).

Results
Among the 1245 targeted lactating mothers, 1199 lactating mothers were interviewed, resulting in a 96.3% response rate. Although the nonresponse rate is low, the reasons for the nonresponse rate were due to the absence of repeated visits and the refusal to participate.

Socio-demographic characteristics of the lactating mothers
The mean age of the lactating mothers was 28.5 (SD = 6.14), and more than half (59.6%) of the lactating mothers were aged 15–24 years, both in urban (36.9%) and rural (59.7%) areas. Concerning educational status, (41.4%) of the lactating mothers from rural areas had only an elementary education, whereas more than half (57.9%) of the lactating mothers from urban areas had a secondary education or higher. Additionally, approximately 58.8% of the lactating mothers from rural areas had five or more families, whereas approximately 54% of

Table 1 Socio-demographic characteristics of lactating mothers by residence in the Tigray region, Northern Ethiopia 2024 (*n* = 1199)

Socio-demographic characteristics		Rural	Urban	Total
		n(%)	*n*(%)	*n*(%)
Age	15–24	508(59.7)	206(59.4)	714(59.6)
	25–34	305(35.8)	128(36.9)	433(36.1)
	35–49	38(4.5)	13(3.8)	51(4.3)
Education	No education	264(31.0)	27(7.8)	291(24.3)
	Elementary	353(41.4)	119(34.3)	472(39.4)
	Secondary and above	235(27.6)	201(57.9)	436(36.4)
Occupation	Housewife	550(64.6)	247(71.2)	797(66.5)
	Employed	34(4.0)	80(23.1)	114(9.5)
	Farmer/Daily labor	268(31.5)	20(5.8)	288(24.0)
Marital status	Not married	89(10.4)	51(14.7)	140(11.7)
	Married	763(89.6)	296(85.3)	1059(88.3)
Family size	Five and below	351(41.2)	186(53.6)	537(44.8)
	Above five	501(58.8)	161(46.4)	662(55.2)

Table 2 Obstetric-related characteristics of lactating mothers by residence in the Tigray region, Northern Ethiopia 2024 (*n* = 1199)

Obstetric characteristics		Rural	Urban	Total
		n(%)	n(%)	n(%)
Gravidity	Primigravida	158(18.5)	75(21.6)	233(19.4)
	Multigravida	538(63.1)	252(72.6)	790(65.9)
	Grand multigravida	156(18.3)	20(5.8)	176(14.7)
Parity	Primipara	175(20.5)	86(24.8)	261(21.8)
	Multipara	543(63.7)	245(70.6)	788(65.7)
	Grand multipara	134(15.7)	16(4.6)	150(12.5)
Antenatal care (ANC) visit	Yes	738(86.6)	325(93.7)	1063(88.7)
	No	114(13.4)	22(6.3)	136(11.3)
Family Planning (FP) ever use	Yes	543(63.7)	261(75.2)	804(67.1)
	No	309(36.3)	86(24.8)	395(32.9)
FP current use	Yes	131(15.4)	112(32.3)	243(20.3)
	No	721(84.6)	235(67.7)	956(79.7)
Place of delivery	Home	376(44.1)	24(6.9)	400(33.4)
	Institution	476(55.9)	323(93.1)	799(66.6)

the mothers from urban areas had fewer than five families (Table 1).

Obstetric-related characteristics of the lactating mothers

The majority of the mothers (65.9%) were multigravida, with 538 (63.1%) in rural areas and 252 (72.6%) in urban areas. Similarly, nearly two-thirds (65.7%) of the mothers, with 543 (63.7%) in rural areas and 245 (70.6%) in urban areas, were multipara. Most mothers, both in urban and rural areas, had antenatal care visits during their recent pregnancies. On the other hand, nearly 80% of the mothers, including 721 (84.6%) in rural areas and 235 (67.7%) in urban areas, were not using family planning during the

Table 3 Nutritional characteristics of lactating mothers by residence in the Tigray region, Northern Ethiopia 2024 (*n* = 1199)

Nutritional characteristics		Rural	Urban	Total
		n(%)	*n*(%)	*n*(%)
Received IFA in a recent pregnancy	Yes	736(86.4)	294(84.3)	1030(85.9)
	No	116(13.6)	53(15.3)	169(14.1)
Received nutrition counseling in the past 6 months	Yes	243(28.5)	100(28.8)	343(28.6)
	No	609(71.5)	247(71.2)	856(71.4)
Household iodized salt use	Yes	448(52.6)	308(88.8)	756(63.1)
	No	404(47.4)	39(11.2)	443(37)
Number of meals	< 3 meals	190(22.3)	48(13.8)	238(19.8)
	≥ 3 meals	662(77.7)	299(86.2)	961(80.2)
Household Food Security (HHFS)	Yes	196(23.0)	95(27.4)	291(24.3)
	No	656(77.0)	252(72.6)	908(75.7)

study period. More than half (55.9%) of the mothers from rural areas and the majority (93.1%) of mothers from urban areas delivered at health institutions. In general, urban mothers had better access to antenatal care and institutional delivery services and showed greater utilization of family planning services than their rural counterparts (Table 2).

Nutrition-related characteristics of the lactating mothers

Among the 1199 lactating mothers interviewed, the majority (85.9%) self-reported taking iron/folic acid (IFA) tablets during their recent pregnancy. IFA intake was slightly greater in rural areas (86.4%) than in urban areas (84.3%). More than 71% of the mothers reported that they had not received nutrition-related counseling from health extension workers in the previous six months. Approximately 63% of households used iodized salt, with higher consumption in urban areas (88.8%) than in rural areas (52.6%). Concerning the food security assessment, only 291 (24.3%) households were food secure, 27.4% in urban areas and 23% in rural areas (Table 3).

Water, hygiene, and sanitation characteristics of the households

Water, sanitation, and hygiene (WASH) characteristics significantly differed between rural and urban areas. A majority (71.4%) of the households used improved water sources, which was more common in urban areas (91.1%) than in rural areas (63.4%). Conversely, only 13.5% of the households visited had access to basic sanitation facilities (Table 4).

Nutritional status of lactating mothers

The nutritional status of the lactating mothers was assessed using mid-upper arm circumference (MUAC). The mean MUAC measurement was 22.8 cm with a standard deviation of ±2.18 cm. More than half of the lactating mothers, 662 (55.2%; 95% CI: 52.3–58.1), were

Table 4 WASH-related characteristics of lactating mothers by residence in the Tigray region, Northern Ethiopia 2024 (*n* = 1199)

WASH-related characteristics		Rural	Urban	Total
		n(%)	n(%)	n(%)
Water source	Improved	540(63.4)	316(91.1)	856(71.4)
	Unimproved	312(36.6)	31(8.9)	343(28.6)
Basic Sanitation Access	Yes	50(5.9)	112(32.3)	162(13.5)
	No	802(94.1)	235(67.7)	1037(86.5)
Water treatment	Yes	187(21.9)	117(33.7)	304(25.4)
	No	665(78.1)	230(66.3)	895(74.6)
Hand washing	Yes	5(0.6)	55(15.9)	60(5.0)
	No	847(99.4)	292(84.1)	1139(95.0)

undernourished, whereas 44.8% of them were adequately nourished. The proportion of undernourished lactating mothers was higher in rural areas (60.7%: 57.3–64.0) than in urban areas (41.8%: 36.5–47.2) (Fig. 2).

Factors associated with maternal undernutrition

To identify the factors associated with maternal undernutrition, we performed the bivariate robust (modified) Poisson regression for each independent variable with the maternal nutritional status. Accordingly, we selected maternal age, educational status, occupation, residence, family size, gravidity, parity, antenatal care (ANC) visit, family planning ever use, place of delivery, IFA supplementation, nutritional counseling, household iodized salt use, number of meals, household food security, water source, basic sanitation access, water treatment, and handwashing practice as candidate variables from

the bivariate analysis to the final multivariable modified (robust) Poisson model.

According to the final fitted model, educational status, residence, household iodized salt use, and number of meals were the only independent factors that were significantly associated with maternal nutritional status. Mothers with only an elementary education had a 10% higher prevalence of undernutrition compared to those with secondary education or above [adjusted prevalence rate (aPR) (95% C. I): 1.1(1.01–1.3)]. Moreover, mothers living in rural areas have a 30% greater prevalence of undernutrition than those living in urban areas [aPR (95% C. I): 1.3(1.1–1.5)]. Households using iodized salt have a 10% lower prevalence of maternal undernutrition than those using non-iodized salt [aPR (95% C. I): 0.9(0.8–0.99)]. Finally, mothers who consume fewer than 3 meals a day have a 30% higher prevalence of undernutrition than do those who consume 3 or more meals a day after adjusting for other factors [aPR (95% C. I): 1.3(1.2–1.5)] (Table 5).

Discussion

This study aimed to determine the prevalence of undernutrition and associated factors among lactating mothers in the Tigray region of Ethiopia. The prevalence of undernutrition among lactating mothers was 55.2% (95% CI: 52.3–58.1). The independently associated factors with maternal undernutrition were maternal educational status, residence, household iodized salt use, and number of meals.

The 55.2% prevalence of undernutrition among lactating mothers in this study is higher than that reported in
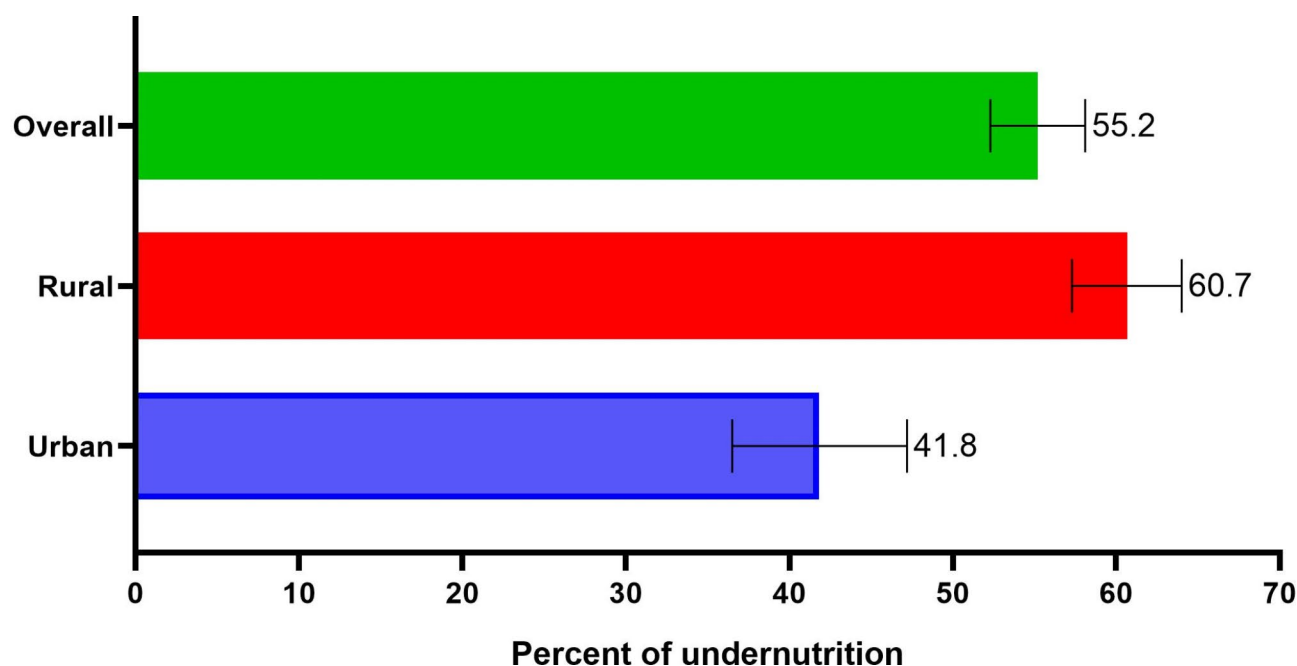
Fig. 2 Nutritional status of lactating mothers by residence based on MUAC in the Tigray region, Northern Ethiopia, 2024 (*n* = 1199)

Table 5 Factors independently associated with the nutritional status of lactating mothers in the Tigray Region, 2024

Factors		Undernutrition		cPR (95% C.I)	aPR (95% C.I)
		Yes *n*(%)	No *n*(%)		
Age	15–24	207(61.2)	131(38.8)	1.3(1.1–1.5)	1.2(1.0-1.5)
	25–34	334(54.9)	274(45.1)	1.1(1.0-1.3)	1.1(0.9–1.3)
	35–49	121(47.8)	132(52.2)	1	1
Education	No education	161(55.3)	130(44.7)	1.1(1.0–1.3)	1.1(0.9–1.3)
	Elementary	283(60.0)	189(40.0)	1.2(1.1–1.4)	1.1(1.01–1.3)**
	Secondary and above	218(50.0)	218(50.0)	1	1
Occupation	Housewife	419(52.6)	378(47.4)	0.8(0.7–0.9)	0.9(0.8-1.0)
	Employed	56(49.1)	58(50.9)	0.8(0.6–0.9)	1.0(0.8–1.2)
	Farmer/Daily labor	187(64.9)	101(35.1)	1	1
Residence	Rural	517(60.7)	335(39.3)	1.5(1.3–1.7)	1.3(1.1–1.5)**
	Urban	145(41.8)	202(58.2)	1	1
Family size	Five and below	308(57.4)	229(42.6)	1.1(1.0-1.2)	1.0(0.9–1.1)
	Above five	354(53.5)	308(46.5)	1	1
Gravidity	Primigravida	142(60.9)	91(39.1)	1.3(1.1–1.6)	1.7(0.9–3.2)
	Multigravida	438(55.4)	352(44.6)	1.2(1.0-1.4)	1.4(0.9–2.3)
	Grand-multigravida	82(46.6)	94(53.4)	1	1
Parity	Primipara	155(59.4)	106(40.6)	1.2(1.0–1.5)	0.7(0.4–1.3)
	Multipara	434(55.1)	354(44.9)	1.1(0.9–1.3)	0.8(0.5–1.3)
	Grand-multipara	73(48.7)	77(51.3)	1	1
ANC visit	Yes	576(54.2)	487(45.8)	0.9(0.7-1.0)	0.9(0.8–1.1)
	No	86(63.2)	50(36.8)	1	1
Family planning ever use	Yes	429(53.4)	375(46.6)	0.9(0.8-1.0)	1.0(0.9–1.1)
	No	233(59.0)	162(41.0)	1	1
Place of delivery	Home	242(60.5)	158(39.5)	1.2(1.0-1.3)	1.0(0.9–1.1)
	Institution	420(52.6)	379(47.4)	1	1
IFA in recent pregnancy	Yes	579(56.2)	451(43.8)	1.1(1.0-1.3)	1.1(1.0-1.3)
	No	83(49.1)	86(50.9)	1	1
Household salt use	Yes	374(49.5)	382(50.5)	0.8(0.7–0.8)	0.9(0.8–0.99)**
	No	288(65.0)	155(35.0)	1	1
Number of meals	<3 meals	168(70.6)	70(29.4)	1.4(1.2–1.5)	1.3(1.2–1.5)***
	≥3 meals	494(51.4)	467(48.6)	1	1
HHFS	Yes	152(52.2)	139(47.8)	0.9(0.8–1.1)	1.0(0.9–1.2)
	No	510(56.2)	398(43.8)	1	1
Water source	Improved	202(58.9)	141(41.1)	0.9(0.8-1.0)	1.0(0.9–1.1)
	Unimproved	460(53.7)	396(46.3)	1	1
Basic Sanitation Access	Yes	79(48.8)	83(51.2)	0.9(0.7-1.0)	1.0(0.9–1.2)
	No	583(56.2)	454(43.8)	1	1
Hand washing	Yes	18(30.0)	42(70.0)	0.5(0.4–0.8)	0.7(0.5–1.1)
	No	644(56.5)	495(43.5)	1	1

* Significant association at *P*-value<0.05

** Significant association at *P*-value<0.01

*** Significant association at *P*-value<0.001

similar previously conducted studies in Ethiopia [9–15, 17, 18, 30–32], and other parts of the world such as Indonesia [33], Bangladesh [34], India [35], and Pakistan [36]. The variations might be explained by disruptions to the food system and health facilities due to the war, and differences in assessment tools and cut-off points from study to study. However, the current finding is in agreement with the results from the Ethiopian mini-review [37] and study done on Babile, Enderta, and Hintalo Wejerat districts of Ethiopia [38], which also reported high prevalence rates of 50.6% and 55.2%, respectively. On the other hand, the current finding is lower than those of emergency food security assessment [39] and smart surveys [40] conducted in the Tigray region, which reported a 61% prevalence of undernutrition among pregnant and lactating mothers.

The prevalence of undernutrition among lactating mothers was disproportionately higher in rural areas

(60.7%) than in urban areas (41.8%) in this study. Furthermore, living in rural areas was associated with a 30% higher prevalence of undernutrition than in urban areas. This finding is inconsistent with a study from Shashemene [16]. This may be explained by the lower socio-economic status, limited healthcare and market access, limited access to a diverse and nutritious food supply, and higher physical workloads related to agricultural activities and household responsibilities of mothers from rural areas compared to mothers from urban areas [41, 42]. This finding can also be justified by the higher impact of conflicts on rural infrastructures. In addition, conflict severely impacts the farming system, leading to no alternative means of food sources in rural areas [43].

Mothers with only an elementary school education had a 10% higher prevalence of undernutrition compared to those with a secondary education or above. Our findings align with existing literature that links lower educational attainment to poorer nutritional outcomes [10, 44], which may be explained by limited knowledge of nutrition-related information.

Households using iodized salt had a 10% lower prevalence of maternal undernutrition compared to those using non-iodized salt. This is in line with previous studies conducted in low- and middle-income countries [45, 46]. Similarly, mothers with a meal frequency of less than three had a 1.3-fold greater prevalence of undernutrition than those with three or more meals. This finding is also supported by previous similar research conducted in Ethiopia [45, 47]. This might be due to a low meal frequency resulting in the inadequacy of nutrients, and thus maternal undernutrition.

Finally, this study has several limitations that are worthy of being acknowledged. This study missed variables including dietary diversity, micronutrient intake, breastfeeding practices, maternal health conditions, seasonal variation, and physical activity levels that may influence maternal nutrition. However, the self-reported information could introduce recall bias, particularly when assessing dietary intake, meal frequency, or food insecurity, potentially leading to under or overestimation of the findings. The exclusion of some parts of the region due to insecurity might introduce selection bias, hence affecting the generalizability of the findings to the region. Despite these limitations, our finding provides critical insights into the nutritional status of lactating mothers in a post-war context.

Conclusions

This study revealed a high prevalence of undernutrition among lactating mothers in Tigray, Ethiopia. The study also identified elementary maternal educational status, rural residence, household iodized salt use, and fewer number of meals as factors associated with undernutrition. Therefore, interventions targeting the literacy of mothers, rural healthcare services, iodized salt use, and meal frequency may help improve the nutritional status of lactating mothers in conflict-affected areas.

Abbreviations

ANC	Antenatal care
FP	Family Planning
HHFS	Household Food Security
IFA	Iron Folic Acid
MUAC	Mid-Upper Arm Circumference
WASH	Water, Sanitation, and Hygiene

Data availability
The data are available from the corresponding authors upon reasonable request.

Declarations

Ethics approval and consent to participate
Ethical approval for this study was obtained from the Tigray Health Research Institute (reference number: THRI/4031/0503/16). We obtained a support letter from the Tigray Health Bureau and received permission from the targeted districts and tabias. Written informed consent was secured from the participating mothers after they were informed about the study objectives, confidentiality, participants' rights, potential risks, and the option to withdraw at any time. As the study was conducted post-war, the mothers had terrible traumatic experiences associated with war. Therefore, the researchers have tried to ensure the psychological well-being of the participants by being patient and respectful. Finally, all the collected data were anonymized, and stored and analyzed confidentially to ensure the participants' privacy.

Consent for publication
The author declares that any person named the co-author of the contribution is aware of the fact and has agreed to be so named. The authors guarantee that the work has not been previously published elsewhere. All the authors have read and approved the final manuscript and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Competing interests
The authors declare no competing interests.

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