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Anemia and its determinants among non-pregnant women of childbearing age at Tsirae Wonberta district, Tigray, Ethiopia, 2020: a community based cross sectional study

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Abstract

Background Anemia affects nearly one-third of women of reproductive age worldwide, with non-pregnant women being the third most impacted demographic. Despite the increased vulnerability of non-pregnant women of childbearing age, much of the research conducted in Ethiopia has primarily focused on anemia in pregnant women. Therefore, this study aimed to assess the prevalence and contributing factors of anemia among non-pregnant women of childbearing age in the Tsirae Wonbereta District of Tigray, Ethiopia, in 2020.

Method A community-based, cross-sectional study was conducted from September 24, 2020, to October 29, 2020, on a total of 251 non-pregnant women of childbearing age. Data were collected using a semi-structured, pretested questionnaire, and blood samples were collected to measure hemoglobin levels. The collected data was entered into the SPSS version 25 for analysis. Finally, an adjusted odds ratio, with a 95% confidence interval and a *p*-value of ≤ 0.05, was used to declare statistical significance for the factors associated with anemia.

Results The overall prevalence of anemia among non-pregnant women of childbearing age was 24.3% (95% CI: 19.1–30.1). In terms of severity, 68.9% of anemic cases are classified as mild, while 31.1% are categorized as moderate. Gender of household head (AOR: 2.307; 95% CI: 1.030–5.168), educational status of the women (AOR: 2.318; 95% CI: 1.027–5.229), ownership of poultry (AOR: 0.515; 95% CI: 0.272–0.977), the effect of the COVID-19 pandemic (AOR: 2.397; 95% CI: 1.108–5.184) and weekly consumption of pulse (AOR: 2.040; 95% CI: 1.024–4.065) were significantly associated with anemia in non-pregnant women.

Conclusion The overall prevalence of anemia among non-pregnant women of childbearing age in Tsirae Wonbereta District, Tigray, Ethiopia was 24.3%, indicating anemia as a moderate public health concern. The majority of the anemia cases were of the mild type. Making policies and programs gender-responsive to empower women in agriculture, education, income, and decision-making to improve nutrition is recommended.

Keywords Anemia, Hemoglobin, Non-pregnant reproductive-age women, Tigray, Ethiopia

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Background

Anemia is a condition in which the hemoglobin (Hb) concentration in the blood is lower than normal. This affects almost one-third of women of reproductive age worldwide [1]. World Health Organization (WHO) has defined anemia as Hb concentration < 120 g/l for non-pregnant women [2]. Numerous factors, including age, sex, altitude, smoking tendencies, and pregnancy status, significantly impact Hb concentration [3]. Anemia is a multi-faceted condition that is often classified according to its causes, which can be categorized as nutritional or non-nutritional. Nutritional anemia occurs when the intake of specific nutrients is inadequate to meet the body's requirements for synthesizing hemoglobin and producing erythrocytes [4]. Iron deficiency stands as the most prevalent cause of anemia, accounting for an estimated 50% of all anemia cases among both non-pregnant and pregnant women [5]. However, the proportion of anemia due to iron deficiency will vary, depending on the population group being studied and local conditions [6].

Anemia not only increases individuals' susceptibility to infections by negatively impacting immune function, but it also presents significant risks during pregnancy [7]. 50% of anemia cases diagnosed during pregnancy manifest at the time of conception [8] Consequently, low hemoglobin concentrations at the onset of pregnancy are linked to adverse birth outcomes, including preterm birth, low birth weight, diminished iron reserves in newborns, and, most critically, a rise in maternal and fetal mortality rates [9]. Furthermore, anemia poses a considerable socio-economic challenge due to its association with reduced physical and cognitive productivity [10].

The prevalence and distribution of anemia within a population is influenced by a complex interplay of political, ecological, social, and biological factors [7]. A 2011 report indicated that the global prevalence of anemia among non-pregnant women was 29%, with 1.1% classified as severely anemic [11]. Non-pregnant women were ranked as the third most affected group, following preschool-aged children and pregnant women [12]. Studies has identified several factors associated with an increased risk of developing anemia in women of reproductive age, including consumption of poor-quality drinking water, residing in rural areas, age, low educational attainment, poverty, lack of proper sanitation facilities, being underweight, having more than one child in the past five years, smoking, seasonality, and ethnicity [8, 13–18]. While studies specifically examining the relationship between dietary diversity and anemia risk in non-pregnant women is limited, numerous studies focusing on pregnant women have indicated that a lack of dietary diversity is a significant risk factor for developing anemia [19–22].

WHO classifies anemia as a public health problem when its prevalence exceeds 5% [16]. Additionally, the WHO emphasizes the importance of reducing anemia for the health of women and children. The second global nutrition target for 2025 aims for a 50% reduction in anemia among women of reproductive age; however, given current trends, this goal appears unlikely to be achieved [23]. As a developing country, Ethiopia faces a significant burden of anemia. According to the 2016 Ethiopian Demographic and Health Survey (EDHS), the prevalence of anemia among reproductive-age women in Ethiopia stands at 23% [24]. Since the 2016 EDHS, there has been a notable lack of representative data on anemia in women, both nationally and regionally [25]. While the majority of studies concentrate on anemia during pregnancy, a limited number of local studies have indicated that the prevalence of anemia in non-pregnant women ranges from 16.1 to 24.2% [26]. Therefore, this study aimed to assess the prevalence and associated factors of anemia among non-pregnant women of childbearing age in Tsirae Wonbereta District, Tigray, Ethiopia in 2020.

Methods

Study area, period, and population

The study is part of a broader research initiative titled "Developing an Innovation and Learning Platform for Enhanced Economic Opportunities and Resilience in the Gergera Watershed: An Action Research Programme." This project is implemented by the World Agroforestry Center in collaboration with University College Cork and local partners, with funding from Irish Aid. The Gergera watershed spans an area of 2,302 hectares and drains into the Birki/Agula River, covering a distance of 149 km. This study was conducted in Hayelom, one of Tsirae Wonbereta's District Kebelle of a district (an administrative division). According to Ethiopia's 2018 population estimates, Hayelom has a total population of 8,660, consisting of 5,375 females and 3,285 males. Within the watershed, 6,640 individuals reside in Hayelom, comprising 4,005 females and 2,635 males. Data collection took place in four kushets (smaller divisions within a Tabia): Gergera, Geter-Haikmeshal, Damayno, and Degeabur. All households surveyed are situated between 2,000 and 2,500 m above sea level. The study was conducted from September 24, 2020, to October 29, 2020, involving a total of 251 non-pregnant women.

Study design and study participant

A community-based cross-sectional study design was employed. The source population consisted of non-pregnant women of reproductive age who had resided in the Tsirae Wonbereta District for a minimum period of six months prior to the initiation of the study.

Sample size calculation

The sample size was determined using a single population proportion formula, considering a 19.9% prevalence of anemia among reproductive-age women in Ethiopia [27], A 5% margin of error and a 95% confidence interval were applied, resulting in a calculated sample size of 244. After accounting for a 10% non-response rate, the final sample size was adjusted to 268. A systematic random sampling technique was employed to select the study participants. Based on the number of reproductive-age women and the household identifiers, a K value of 5 was established. The first participant (household) was randomly selected from the first five using a lottery method, with subsequent participants chosen at intervals of five until the target sample size was achieved. In households with multiple reproductive-age women, one eligible woman was randomly selected for inclusion in the study. If no eligible woman was present in the selected household, the next available household was chosen.

Study variables

Anemia is the dependent variable: anemic women were labeled as 1 and non-anemic were labeled as 0.

Socio-economic and demographic factors, nutrition and agriculture-related factors, obstetrics, and medical history were the predictor variables.

Data collection tools, procedures, and quality control

Data were collected using an interviewer-administered semi-structured questionnaire. To assess anemia, hemoglobin concentration was measured with a portable hemoglobin meter (HemoCue 301+, Angelholm, Sweden), which is recommended by WHO for field surveys. Hemoglobin values were initially adjusted for altitude by subtracting 0.8, with Hb levels below 12 g/dl classified as indicative of anemia [3]. Furthermore, according to the WHO, the public health significance of anemia is categorized based on prevalence as follows: mild (5-19.9%), moderate (20-39.9%), and severe (≥ 40%) [3].

A woman's weight was measured to the nearest 0.1 kg using a battery-operated digital scale (Seca 770, Hanover, Germany). Heights were recorded to the nearest 0.1 cm with a wooden height-measuring board featuring a sliding head bar, adhering to standard anthropometric techniques. The body mass index (BMI) of the women was calculated by dividing the weight in kilograms by the square of the height in meters (kg/m^2).

To evaluate the food access aspect of food security, we employed household dietary diversity (HDDS) and the household food consumption score (HFCS) [28]. The HDDS tool inquires about consumption from 12 food groups over a recall period of 7 days [29]. Each food group consumed in this time frame received a score of one, resulting in a maximum possible HDDS of 12 points for each household. A household that consumed a particular food group at least once during the week was assigned a score of one, regardless of how often it was consumed. Although there are no established cut-offs to classify households as having adequate or inadequate dietary diversity [30], the HDDS scores are categorized into tertiles: low (three or fewer food groups), medium (four to six food groups), and high (seven or more food groups) [31].

The household food consumption score is determined by assessing dietary diversity, food frequency, and the nutritional significance of nine different food groups [32]. To calculate this score, households are asked to recall the number of days certain food items were consumed over the past week. The consumption frequency of each food group is then multiplied by a designated weight reflecting its nutrient content. The final household food consumption score is obtained by summing the weighted frequencies of each food group [32]. This score is subsequently classified into three categories: poor (0–21), borderline (21.5–35), and acceptable (greater than 35) [33].

To provide information on the consumption of specific nutrients in the household, the World Food Program (WFP) analytical method which is called food consumption score nutritional quality analysis (HFCS-N) was used [34]. Initially, the appropriate variables for HFCS-N were identified in accordance with WFP guidelines. Subsequently, individual food groups were consolidated into three categories of nutrient-rich foods: those rich in vitamin A, those high in protein, and those containing heme iron.

To collect data on Minimum Dietary Diversity for Women (MDD-W), an individual dietary diversity questionnaire utilizing a 24-hour recall method was implemented. Participants were asked to recall all food items they had consumed in the 24 h leading up to the survey date. If a special occasion had occurred in the days prior, respondents were prompted to report on foods they had consumed on those occasions as well. The reported food items were then categorized into ten distinct food groups. A woman was classified as having "poor dietary diversity" if she consumed fewer than five food groups, while those who consumed five or more food groups were categorized as having "good dietary diversity." [35].

To ensure consistency in the quality of data collected, data collectors underwent a comprehensive one-day training session. This training provided them with a unified approach to engaging with participants, obtaining informed consent, adhering to ethical procedures, explaining the study's objectives, administering questionnaires, following data collection protocols, utilizing interview techniques, and assisting with anthropometric measurements. Data collectors were chosen based on their proficiency in the local language (Tigrigna) and

their previous experience in data collection, which facilitated effective communication with study participants. A structured and standardized questionnaire that was originally prepared in English and translated to Tigrigna was used and the questionnaire was translated back to English to check for its consistency of concepts. Before the actual data collection, the questionnaire was pre-tested for validation with a few study participants in a similar study area and appropriate modification was made based on the results of the pretest before the actual data collection process. Hemoglobin concentration for each participant was measured using the portable HemoCue B-Hb photometer. A single drop of capillary blood was obtained through a finger prick for this purpose. A dietitian supervisor reviewed the quality and completeness of the questionnaires and provided necessary support throughout the data collection process.

Data analysis

Data exported from Excel was analyzed using Statistical Package for the Social Sciences (SPSS) version 25 which is developed by IBM in the United States. Initially, descriptive statistics for the study variables were computed, with results presented in tables and figures. The normality of continuous variables was assessed through histograms. For variables that followed a normal distribution, the mean and standard deviation (SD) were reported. Binary logistic regression analysis was carried out using bivariate analysis to select explanatory variables that fit the final model at a *p*-value of 0.25 and a confidence interval (CI) of 95%. Finally, all variables with a *P*value of less than 0.25 in the bivariate analysis were entered into multivariate analysis to control for the possible effect of confounders. Multivariate logistic regression analysis was employed to identify factors associated with anemia, an adjusted odd ratio (AOR) with a corresponding, 95% confidence interval was computed to show the strength of association, and a *P*-value of <0.05 was used to declare statistical significance. Multi-collinearity was checked using the variance inflation factor (VIF) and was between 1 and 10 for all of the independent variables. Hosmer and Lemeshow test (0.879) for the fitness of the model was also done.

Ethical considerations

The study was conducted following ethical approval from the Mekelle University College of Health Science Institutional Review Board (ERC1746/2020). A support letter to carry out the research was also obtained from the Tigray Regional Health Bureau (TRHB), the Tsire Womberta District Health Office, and the relevant health institutions in the study area. Oral informed consent was secured from all participants after clearly explaining the study's objectives and purpose before initiating data collection. All procedures adhered to the Declaration of Helsinki, and confidentiality and privacy were strictly maintained throughout the study. Participants were guaranteed their right to participate, decline, or withdraw at any stage of the data collection process. To ensure confidentiality, names and other identifying information were not recorded during data collection. Any test results pertinent to the participants were communicated promptly, along with recommendations to visit a health facility for further treatment and follow-up.

Results

Socio-demographic and economic characteristics

A total of 268 participants were initially sampled for the study; of these, 251 participants successfully completed the survey, resulting in a response rate of 93.6%. Participants' ages ranged from 18 to 49 years, with a mean age of 35.53 ± 7.99. A significant majority, 89%, identified as orthodox by religion, and 80.5% were married. Regarding educational attainment, 76% of participants were illiterate. Additionally, 55.8% of the women came from families with more than five members. Moreover majority of participants, making up 83.7%, were farmers (Table 1).

Nutrition-related characteristics of non-pregnant women

BMI was utilized to assess the nutritional status of non-pregnant women of childbearing age, revealing that approximately 57% of these women fell within the normal BMI range (18 kg/m^2). In terms of MDD-W, 81.7% were identified as having an inadequate nutrient intake. Furthermore, a staggering 90.4% of the non-pregnant women reported not consuming any animal-source foods in the past month. Alarmingly, 76% of the women had not received any information regarding nutrition, and 63.7% were unfamiliar with the term "anemia" (Table 2).

Household food access related characteristics

The mean HFCS was 48.48, with a SD of ± 14.11. The prevalence of unacceptable household food consumption, categorized as poor or borderline, was found to be 10% in this study. The average HDDS was 5.90, with a standard deviation of ± 1.62. The findings revealed that 61.4% of households fell under the medium household diversity category (Table 3). Furthermore, 90% of women did not consume a heme iron-rich diet during the same period, and 68% did not eat fruits and vegetables. However, 77% of women consumed pulses on an every-other-day basis in the previous month.

The frequency with which the three nutrient-rich food groups were consumed in the household in the previous one week

According to data derived from the HFCS-N, a significant majority of households (84.8%) did not engage in the

Table 1 Socio-demographic and economic characteristics of non-pregnant women of reproductive age at Tsirae Wonbereta district, Tigray, Ethiopia, 2020 ($n=251$)

Variable		Frequency	Percentage (%)
Age (years)	=<24	24	9.6
	25–34	58	23.1
	35– 49	169	67.3
Religion	Orthodox	224	89.2
	Muslim	27	10.8
Marital status	Single	13	5.2
	Currently married	202	80.5
	Formerly married	36	14.4
Educational status	Unable to read and write	190	76
	Primary education and above	511	24
Occupation of women	Farmer	210	83.7
	Unemployed	28	11.2
	Others/merchant/student/employee/	13	5.1
Household head	Male	186	74.1
	Female	65	25.9
Family size	<=5	111	44.2
	> 5	140	55.8

Table 2 Nutrition-related characteristics of non-pregnant women of reproductive age at Tsirae Wonbereta district, Tigray, Ethiopia, 2020 ($n=251$)

Variables	Category	Frequency	Percentage (%)
Animal source food	No	227	90.4
	Yes	24	9.6
MDD-W	Low	205	81.7
	Medium	44	17.5
	High	2	0.8
BMI	Normal	143	57
	Underweight	100	39.8
	Overweight	8	3.2
Information on nutrition	Yes	52	20.7
	No	199	79.3
Awareness about the term anemia	Yes	91	36.3
	No	160	63.7

consumption of a heme iron-rich diet at any point during the week. In contrast, 48.6% of households reported occasional consumption of a diet rich in vitamin A. Furthermore, an impressive 82% of households maintained a protein-rich diet for a minimum of seven days, (Fig. 1).

Environmental health related characteristics

A total of 62% of households have access to clean running water, whereas 67% are without a latrine. Furthermore, 78% of women report cooking over open charcoal in their residences, and 70.9% of women recognize the importance of hand washing (Table 4).

Reproductive health related characteristics

Among all study participants, 72.1% reported not experiencing any illness in the previous 30 days, while 78.5% of the women indicated a habit of seeking medical help when unwell. 93% of these women have given birth, and 53% of them have fewer than five children. Additionally, 77% of the women indicated that they lacked access to antenatal care (ANC) and post-natal care (PNC). Furthermore, 71% of households reported being severely impacted by the COVID-19 pandemic (Table 5).

Prevalence of anemia

After accounting for altitude, the mean hemoglobin concentration was measured at 12.69 g/dl (± 1.30), with values ranging from 8 g/dl to 15.9 g/dl. The overall prevalence of anemia among non-pregnant women of childbearing age was found to be 23.4% (95% CI: 19.1–30.1). Regarding the severity of anemia, 68.9% of the anemic cases showed a mild type of anemia, while 31.1% of them had a moderate type of anemia.

Table 3 Household food access related characteristics among non-pregnant women of childbearing age at Tsirae Wonbereta District, Tigray, Ethiopia, 2020 ($n=251$)

Variable	Category	Frequency	Percentage (%)
HFCS	Poor	9	3.6
	Borderline	16	6.4
	Acceptable	226	90
HDDS	Low	13	5.2
	Medium	154	61.4
	High	84	33.5
Women's consumption frequency of plant source protein in a month	Yes	204	81.3
	No	47	18.7
Women's consumption frequency of Vit-A rich food in a month	Yes	17	6.8
	No	234	93.2
Women's consumption frequency of any kind of fruits and vegetables in a month	Yes	80	31.9
	No	171	68.1
Women's consumption frequency of heme iron-rich foods in a month	No	227	90.4
	Yes	24	9.6
Women's consumption frequency of pulse in a month	Once a week	57	23
	Every other day	194	77

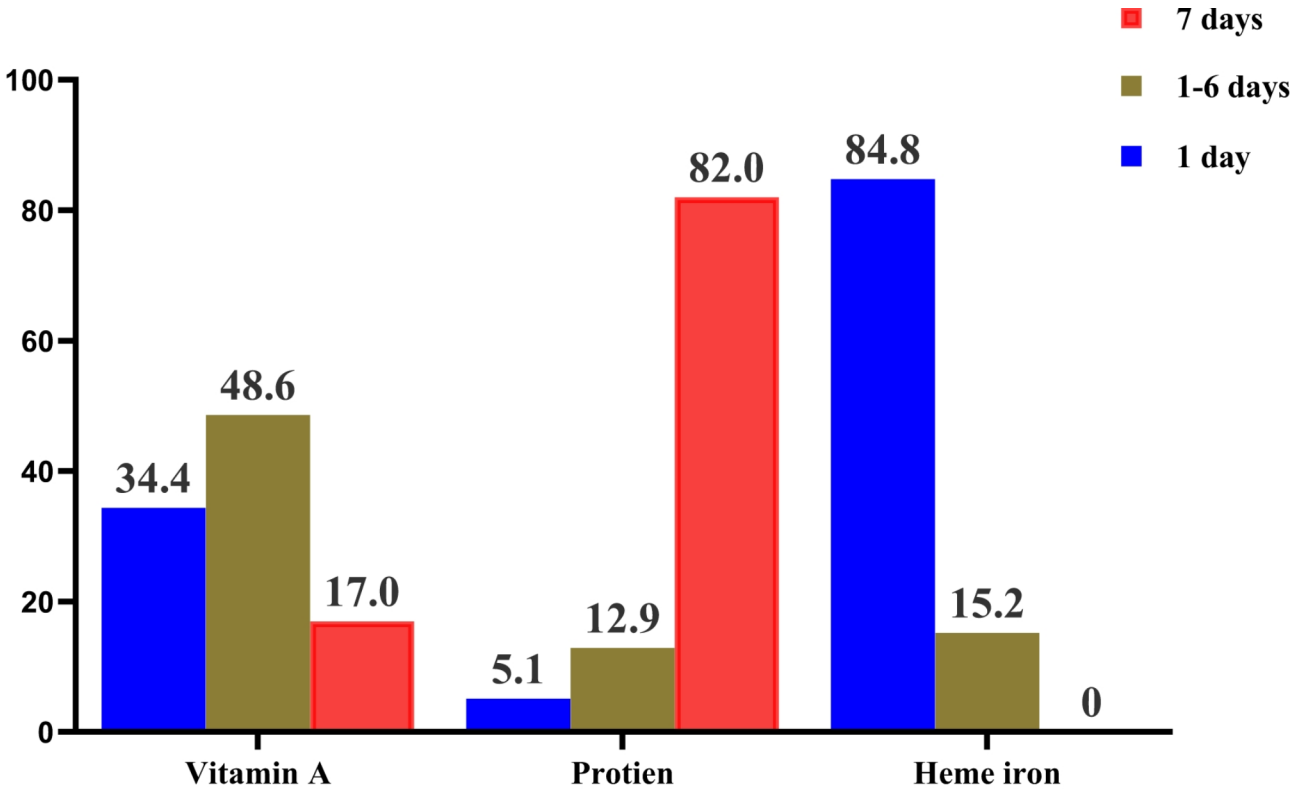

Fig. 1 Frequency of consumption of vitamin A, protien-rich foods, and heme-iron-rich foods in 251 households in the previous seven days

Factors associated with anemia

The results of the multivariable logistic regression analysis indicated that several factors, including the gender of the household head, the educational status of women, household ownership of poultry, the impact of the COVID-19 pandemic on the household, and the frequency with which women consume pulses, were significantly associated with anemia in non-pregnant women of childbearing age (Table 6). Controlling for other variables, non-pregnant women of childbearing age living in male-headed households had twice the odds of developing anemia compared to those from female-headed households (AOR: 2.307; 95% CI: 1.030–5.168). This study found that the prevalence of anemia was

Table 4 Environmental health related characteristics among non-pregnant women of childbearing age at Tsirae Wonbereta District, Tigray, Ethiopia, 2020 ($n=251$)

Variable	Category	Frequency	Percentage (%)
Availability of clean running water	Yes	155	61.8
	No	96	38.2
Aware of the importance of washing hands	Yes	178	70.9
	No	73	29.1
Availability of latrine	Yes	82	32.7
	No	169	67.3
Type of farming	Irrigated	138	55
	Rain-fed	113	45
Cooking on an open charcoal	No	55	22
	Yes	196	78

Table 5 Reproductive health related characteristics among non-pregnant women of childbearing age at Tsirae Wonbereta District, Tigray, Ethiopia, 2020 ($n=251$)

Variable	Category	Frequency	Percentage
Sickness in the last 1 month	Yes	70	27.9
	No	181	72.1
Seek help when ill	Never	54	21.5
	Yes	197	78.5
Given birth to a child	Yes	235	93.6
	No	16	6.4
Number of children	<=5	133	53
	>5	97	38.6
	No child	21	8.4
Access to ANC and PNC	No	192	76.5
	Yes	43	17.1
	Didn't get pregnant yet	16	6.4
The effect of COVID-19 on the household	Severe	179	71
	Mild	72	29

significantly higher among women without formal education compared to those with primary education (AOR: 2.318; 95% CI: 1.027–5.229). Additionally, non-pregnant women living in households with poultry were 48.5% less likely to experience anemia than those from households without poultry (AOR: 0.515; 95% CI: 0.272–0.977). Furthermore, women residing in households significantly impacted by the COVID-19 pandemic faced a 2.397-fold increased risk of developing anemia compared to those from families where the pandemic had minimal influence (AOR: 2.397; 95% CI: 1.108–5.184). The current study also indicated that women who consumed pulses once a week were twice as likely to experience anemia compared to those who consumed them every other day (AOR: 2.040; 95% CI: 1.024–4.065) (Table 6).

Discussion

In the current study, the prevalence of anemia among non-pregnant women of childbearing age was determined to be 23.4% (95% CI: 19.1–30.1). Among the anemic cases, over half were classified as mild (68.9%), while the remaining were categorized as moderate (31.1%). Significant associations were found between anemia and several factors, including the gender of the household head, poultry ownership, the educational status of women, the frequency of women's consumption of pulses, and the impact of the COVID-19 pandemic on the household.

The prevalence of anemia among non-pregnant women of childbearing age in this study area aligns with findings from studies conducted in Northeast Ethiopia (24.2%) [13], Southern Ethiopia (21.3%) [36], and the EDHS report of 2016 (23%) [24]. In contrast, the results of this study are lower than those reported in several studies from South Asia, including Coimbatore (64.4%), Uttar Pradesh (69%), Maharashtra districts, (55%), Bursa (32.8%), Mumbai (37.1%), and Nepal (37.6%) [26, 37–41]. A potential explanation for this disparity may lie in the differences in the age distribution of non-pregnant women between these studies and the current one. In prior studies, the mean age was lower than that in the current study, where the mean age was 35.53 with a standard deviation of ±7.99; notably, 67.3% of non-pregnant women fell within the age range of 35 to 48. Additionally, child marriage is prevalent among girls in South Asia and sub-Saharan Africa [42],, and those who marry and give

Table 6 Bivariate and multivariable logistic regression analysis of factors associated with anemia among non-pregnant women of reproductive age at Tsirae Wonbereta district, Tigray, Ethiopia, 2020 ($n = 251$)

Variable	Category	Anemia status(n)		COR(95% CI)	AOR(95% CI)
		No	Yes		
Age (years)	< 35 years	96	24	0.635 (0.353–1.143)	
	= >35 years	94	37	1	
Gender of HH head	Male	134	52	4.675 (1.388–15.754)*	2.307 (1.030–5.168)**
	Female	55	10	1	
Educational status	Unable to read and write	138	52	2.177 (1.002–4.731)*	2.318 (1.027–5.229)**
	Primary education	50	11	1	
HFCS	Unacceptable	17	8	0.976 (0.955–0.998)*	
	Acceptable	173	53		
Illness in the past 30 days	Yes	48	22	0.599 (0.323–1.110)	
	No	142	39	1	
Cooking on over open charcoal	All the time	30	15	2.687 (1.012–7.136)*	
	Sometimes	117	34	1.746 (0.755–4.039)	
	Never	43	12	1	
Animal source foods	Not Consumed	176	51	2.465 (1.033–5.880)*	
	Consumed	14	10	1	
Information on agriculture	Received	96	31	1.012 (0.568–1.802)	
	Not received	94	30	1	
Own poultry	Yes	96	20	0.478 (0.261–0.875)*	0.515 (0.272–0.977)**
	No	94	41	1	
Own cellphone	Yes	165	46	0.465 (0.226–0.953)*	
	No	25	15	1	
Awareness of the term Anemia	Yes	73	18	0.671 (0.360–0.999)*	
	No	117	43	1	
Consumption of plant source protein in a month	Consumed	161	43	0.430 (0.219–0.847)*	
	Not consumed	29	18	1	
Women's Consumption frequency of the pulse	Once a week	36	21	2.246 (1.183–4.263)*	2.040 (1.024–4.065)**
	Every other day	154	40	1	
The effect of COVID-19	Sever	128	51	2.470 (1.1176–5.191)*	2.397 (1.108–5.184)**
	Mild	62	10	1	
BMI	< 18.5	77	23	0.873 (0.482–1.580)	
	> 18.5	111	38	1	
Family size	=<5	83	28	0.914 (0.512–1.632)	
	> 5	107	33	1	
Clean running water	Yes	139	16	0.812 (0.412–1.599)	
	No	82	14	1	
Availability of latrine	Yes	64	18	0.824 (0.440–1.543)	
	No	126	43	1	
Awareness of hand washing	Yes	134	44	0.948(0.499–1.801)	
	No	56	17	1	
Information on nutrition	Yes	41	11	0.800(0.382–1.673)	
	No	149	50	1	

COR = Crude Odds Ratio, AOR = Adjusted Odds Ratio, C.I = Confidence Interval; *($p < 0.25$); ** ($p < 0.05$); 1 = reference group

birth at a young age are at a higher risk of various health issues, including anemia [43]. Anemia among pregnant teenagers has been attributed to the fact that they are still in a growth phase and require additional iron and folic acid to meet both their own nutritional needs and those of the developing fetus during pregnancy [44]. Consequently, older women tend to have a lower risk of developing anemia compared to their younger counterparts. In contrast to these findings, the prevalence of anemia observed in this study was higher than that reported in research conducted in Southwest Ethiopia (16%) [26], 2011's WHO report for Ethiopia (19%) [6], Center of Iran 14.5% [45], and Vietnam 19.7% [46]. The possible reason

for the variation might be due to the difference in diet composition and socioeconomic differences.

The present study reveals a current prevalence of inadequate HFCS (poor and borderline) in this study was found to be 10% which is lower than previous Ethiopian HFCS vulnerability assessment and mapping 26% [47], Tigray (15%), Somali (16%), Oromia (20%), Benshangulgumuz (17%), SNNPR (63%), Gambella (28%) and Addis Ababa (31%), but higher than a study conducted in Afar (6%) and Harari (9%). Besides our finding is relatively similar to a study conducted in Amhara (11%) and Dire Dawa (11%) [47]. Another local study in Northwest Ethiopia found a prevalence of inadequate HFCS of 18.5% [48]. In this study, 90% of households were classified as having adequate food consumption status. Moreover, the HDDS indicates that 91.2% of households consumed more than four food groups in the previous week. However, despite this, 96% of non-pregnant women displayed inadequate dietary diversity, with a MDD-W score of less than 5. While neither the HFCS nor the HDDS adequately captures intra-household disparities in food intake [33], the MDD-W findings suggest that such disparities may be present.

In contrast to a study conducted in a different region of Ethiopia [23, 49, 50], which indicated that having a male household head reduced the likelihood of women being anemic, our research found that households led by men had higher odds of anemia compared to those with female heads. This discrepancy may stem from women's limited capacity to make informed decisions regarding where to access resources and medical information. Gender power dynamics significantly influence who makes health-related decisions and how those decisions are made. These dynamics can affect health-seeking behaviors, such as dietary choices, as well as overall health outcomes within families and communities [51].

According to this study, households that raise poultry have a 50% lower risk of anemia among non-pregnant women compared to those without poultry. This finding may be attributed to the fact that women often manage finances and make decisions related to poultry, as they are typically responsible for caring for the animals. By selling eggs and chickens, women can enhance their income, as these products often command high prices [52]. This explanation appears more plausible than the direct consumption of poultry, particularly in rural areas where animal-source foods are generally reserved for special family or societal occasions, being viewed as luxury items rather than staples of the daily diet [56]. Although animal-source foods are rich in essential micronutrients that are more bioavailable than those found in plant-based foods [53–55], only 9.6% of non-pregnant women in this study reported consuming such foods in the past month (95% CI: 6.2–13.9). Consequently, most participants relied on plant-based diets. Promoting chicken production as a livelihood strategy could empower women and enhance their incomes [52].

In this study, the prevalence of anemia was found to be higher among women with no formal education compared to those with primary education. This finding aligns with other research conducted in Ethiopia [23, 56]. One possible explanation is that educated mothers tend to consume a wider variety of foods rich in vitamins and minerals, which may reduce the risk of nutritional deficiency anemia. Furthermore, education may empower women to adopt healthier lifestyle habits, including improved health-seeking behaviors and hygiene practices, thereby helping to prevent anemia.

Another finding of this study is that women residing in households severely impacted by the COVID-19 pandemic were more likely to experience anemia compared to those from households with mild effects. In countries like Ethiopia, the pandemic exacerbated food and nutrition insecurity, disproportionately affecting women and children [57]. Women and children under five particularly suffered from reduced access to food, especially nutritious options such as fruits and vegetables, alongside potential disruptions to health and nutrition-related programs and services, which hindered their access to healthcare [58]. This finding is supported by a study done in Addis Ababa which highlights a decline in dietary diversity indicators, a reduction in household food consumption scores, and increased food insecurity, particularly at the onset of the pandemic [59–61]. Furthermore, the compounded economic effects have been especially pronounced for women, who typically earn less, save less, work in insecure jobs, and often live close to the poverty line.

In the current study, the frequency of pulse and legume consumption was found to have a protective effect against anemia in non-pregnant women. This effect may be attributed to the regular inclusion of a local dish known as Shiro, made from chickpea flour that undergoes dehulling, milling, and slow-roasting processes to reduce its anti-nutritional factors. Chickpeas are recognized as a highly nutritious whole food, offering an excellent nutritional profile. Additionally, chickpeas are a notable source of essential minerals, particularly iron [62]. The average iron content of chickpea was reported as 3.0–14.3 mg per 100 g of the edible portion [63]. Furthermore, Shiro significantly contributed to increased HFCS in 90% of the households involved in this study, which were classified as having acceptable food consumption levels. While most households fell within this acceptable range, the MDD-W highlighted a notable disparity. A study done on intra-household nutrient inequity in rural Ethiopia (Oromiya and SNNPR) indicated that the inequities faced by perceived vulnerable groups, such

as adult women and children, were more pronounced for iron than for calories or protein.in [64].

Primary data were collected with a high response rate. The hemoglobin levels of each non-pregnant woman were adjusted for altitude. To address day-to-day variability in dietary intake, a one-week dietary recall method was employed to estimate the HDDS, rather than relying on a single 24-hour recall. A limitation of this study is that recall bias and social desirability bias may present challenges, as non-pregnant participants were asked to report their dietary intake from the previous days.

Conclusion

The overall prevalence of anemia among non-pregnant women of childbearing age in the Tsirae Wonbereta District of Tigray, Ethiopia, stands at 24.3%, indicating that anemia poses a moderate public health concern. The majority of these cases are classified as mild. It is essential to continue and enhance initiatives and programs that aim to educate and economically empower women in Ethiopia. Furthermore, nutrition-sensitive programs designed to improve maternal nutrition should be sustained and strengthened. There is also a need for improved inter-sectoral collaboration among agriculture, nutrition, and health sectors to effectively combat malnutrition.

Abbreviations

ANC	Antenatal care
AOR	Adjusted odds ratio
EDHS	Ethiopian demographic health survey
HDDS	Household dietary diversity score
HFCS	Household food consumption score
MDD-W	Minimum dietary diversity for women
PNC	postnatal score
WFP	World food program
WHO	World health organization

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Author contributions

ZT, GG, and SC significantly contributed to the conceptualization and design of the study. ZT, AH, TB, MH, and GK made significant contributions to the cleaning, analysis, and interpretation of data. GG, ZT, MH, AH, and TB drafted and finalized the manuscript. The final version of the manuscript was reviewed, feedback was provided, and confirmation was given by all authors.

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Data availability

Data supporting the findings in this paper are available upon reasonable request from the corresponding author and the summary data are available in the main document.

Declarations

Ethical approval and consent to participate

The study was conducted after getting ethical approval from the Mekelle University College of Health Science Institutional Review Board (IRB) (reference number ERC1746/2020). A support letter to undertake the study was also obtained from TRHB, Tsire Womberta District health office, and respective health institutions in the study area. Oral informed consent was obtained from study participants after explaining the objective and purpose of the study to each participant before conducting the actual data collection and confidentiality and privacy were maintained throughout the study. Besides, respondents' autonomy was maintained by informing them that they can refuse to participate or stop continuing to be part of the study at any time.

Consent of publication

Not applicable.

Competing interests

The authors declare no competing interests.

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