MEKELLE UNIVERSITY

COLLEGE OF HEALTH SCIENCE

INSTITUTE OF BIOMEDICAL SCIENCES

DEPARTMENT OF MEDICAL BIOCHEMISTRY AND MOLECULAR BIOLOGY

Magnitude and Associated Factors of Anemia Among First Trimester Pregnant Women Attending Antenatal Care at Public Hospitals in Mekelle city, Tigray, Ethiopia, 2025: A Cross-sectional Study

By: Abrahaley Hadush (BSc in PH, MSc Candidate)

A Thesis Submitted to Department of Medical Biochemistry and Molecular Biology, College of Health Science, Mekelle University in Partial Fulfilment of the Requirements for Master of Science in Clinical Biochemistry

May 2025

Mekelle, Tigray, Ethiopia

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Full title of the research thesis	Magnitude and Associated Factors of Anemia Among First Trimester Pregnant Women Attending Antenatal Care at Public Hospitals in Mekelle city, Tigray, Ethiopia, 2025: A Cross-Sectional Study.
Total duration of the study	7 months (From November 2024 to May 2025)
Study area	Public hospitals in Mekelle city (ACSH, Mekelle general hospital, Quiha general hospital and Lekatit 11 primary hospital)
Total budget of the study	24,843.00 Ethiopian birr (ETB)
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Advisor's Approval Sheet

This is to certify that the thesis research entitled "Magnitude and Associated Factors of Anemia Among First Trimester Pregnant Women Attending Antenatal Care at Public Hospitals in Mekelle city, Tigray, Ethiopia, 2025, Cross-Sectional Study" is submitted in partial fulfillment of the requirements for the Master of Science (MSc.) degree in "clinical biochemistry" to the Graduate Program of the College of Health Sciences of Mekelle University and has been carried out by: **Abrahaley Hadush Gebremeskel** ID No: **CHS/MCB/001/13** under our supervision. Therefore, we recommend that the student has fulfilled the requirements and hence, hereby can submit his Thesis Research to the department.

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Declaration

I hereby declare that this MSc thesis is my original work and has not been presented for a degree or postgraduate program in any other university and all sources of material used for this thesis proposal have been duly acknowledged.

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This MSc research thesis had been submitted for examination with my approval as thesis advisor.

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Examiners' Approval Sheet

We, the undersigned, members of the Board of Examiners of the final open thesis defense by "**Abrahaley Hadush Gebremeskel**," had read and evaluated his thesis "Magnitude and Associated Factors of Anemia Among First Trimester Pregnant Women Attending Antenatal Care at Public Hospitals in Mekelle city, Tigray, Ethiopia, 2025**, Cross-Sectional Study**." and evaluated the candidate. This is therefore to certify that the thesis has been accepted in partial fulfillment of the requirements for the MSc. degree in clinical biochemistry.

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Name of Major Advisor Signature Date

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Final approval and acceptance of the thesis is contingent upon the submission of the final copy of the thesis to the candidate's department through the office of the Department Graduate Program Coordinator.

Thesis approved by _____ _____ _____

Graduate Program Coordinator Signature Date

Certification of the final thesis

I hereby certify that all the corrections and recommendations suggested by the Board of Examiners are incorporated into the final thesis entitled "Magnitude and Associated Factors of Anemia Among First Trimester Pregnant Women Attending Antenatal Care at Public Hospitals in Mekelle city, Tigray, Ethiopia, 2025, Cross-Sectional Study", By Abrahaley Hadush Gebremeskel

_____ _____ _____

Department Head Signature Date

Stamp of the Department of Public Health

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LIST OF ABBREIVATIONS

ACSH……. Ayder Comprehensive Specialized Hospital

ANC……. Antenatal care

AOR……. Adjusted Odds Ratio

CDC……. Center for Diseases Control

CI……. Confidence Interval

COR……. Crude odds ratio

EDTA……... Ethylene Diamine Tetra acetic Acid

ETB……. Ethiopian Birr

FAO……. Food and Agricultural Organization

Hb……. …Hemoglobin

IDA ……. Iron Deficiency Anemia

IFA……...Iron and Folic Acid

MCH…… Mean Corpuscular Hemoglobin

MCHC……. Mean Corpuscular Hemoglobin Concentration

MCV……. Mean Corpuscular Volume

MDD……Minimum Dietary Diversity

MUAC……. Mid-Upper-Arm Circumference

PCC……. Preconception care

RBC……Red Blood Cell

SD …… Standard Deviation

SOP……...Standard Operating Procedures

SPSS……Statistical Packages for Social Sciences

VIF……. Variance Inflation Factor

WHO……World Health Organization

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ACKNOWLEDGMENT

First, I would like to acknowledge Mekelle University, college of health science, institute of biomedical science, department of medical biochemistry and molecular biology for their incredible guidance and support. Then, I wish to extend my deepest gratitude to Adigrat University for sponsoring me with this MSc. program. Next, I would like to thank ACSH, Mekelle general hospital, Quiha general hospital and Lekatit 11 primary hospital antenatal care unit health providers and laboratory staffs for their generous cooperation during the data collection period. In addition, I am also grateful to the data collectors and study participants.

Finally, I will give my heartfelt thanks to my major advisor Dr. Hagos Amare and my co-advisors Mr. Mulugeta Hiruy (Assistant professor), Mr. Kahsu Girmay (MSc. In clinical biochemistry) and Dr. Birhane Amare (Gynecologist and obstetrician) for their invaluable and unfailing support for the accomplishment of this thesis.

ABSTRACT

Background: Detecting anemia and identifying its risk factors in the first trimester pregnant women is very crucial to prevent and treat it early. Despite this, data regarding anemia among women in such early pregnancy is quite limited in Ethiopia and particularly in Tigray. Therefore, this study aimed to determine the magnitude and factors associated with anemia among first trimester pregnant women attending antenatal care follow up at public hospitals in Mekelle city, Tigray, Ethiopia.

Methods: A hospital-based cross-sectional study was conducted from January to February 2025 at public hospitals in Mekelle city. The sample size was 396 and consecutive sampling was used to recruit them. Interviews using structured questionnaires were employed to collect sociodemographic, nutritional and maternity related data. Laboratory measurements were performed to determine the level of hematological parameters. The data were exported, cleaned, coded and analyzed using SPSS Version 27.0. Descriptive statistics were utilized to summarize the data collected. Logistic regression analysis was used to identify factors associated with anemia in the first trimester of pregnancy. P-value < 0.05 was used to declare statistical significance.

Result: A total of 396 respondents were included in this study and their mean age was 28.5 ± 5.80 years. The magnitude of anemia among the first trimester pregnant women was 13.4% (95% CI; 10.2-17.1). Out of them, 38 (71.7%) were mildly anemic while 13 (24.5%) and 2(3.8%) were moderately and severely anemic respectively. The mean hemoglobin level was 12.33(± 1.48) g/dl. Low dietary diversity (AOR=4.36, 95% CI: 1.74, 1..87); feeding frequency (AOR=2.43, 95% CI: 1.03, 5.72); coffee/tea consumption (AOR = 2.81, 95% C:1.22, 6.48); low mid-upper arm circumference (AOR=3.34, 95% CI:1.23,9.00), and monthly household income (AOR= 2.46, 95% CI: 1.05,5.72) were factors found to have a statistically significant association with the anemic status in the first trimester pregnant women.

Conclusion: Considerable number of the study participants in this study had varying degrees of anemia. Therefore, we recommend healthcare providers strengthen their nutritional counseling services so as to get the dietary habits and nutritional status of the mothers corrected. Moreover, multi-sectorial (Agricultural, financial institutions, small scale industries and trade organizations) involvement is warranted to improve their economic status.

Key words: *magnitude, anemia, risk factors, first trimester, pregnant women*

1. INTRODUCTION

1.1 Background

Anemia is a condition in which the number of red blood cells or the hemoglobin level is below the normal range for that age, gender and physiological status(1). Currently, anemia in first trimester pregnancy is defined as when the Hb level is lower than 11.0 g/ dL. World health organization (WHO) classifies anemia based on its severity as mild anemia when Hb level is between 10 -10.9 g/dl, moderate anemia when Hb level is between 7.0 -9.9 g/dl and severe anemia when Hb level is <7.0 g/dl(2). Anemia is further classified as microcytic, normocytic, and macrocytic anemia based on size of RBCs(3). Anemia occurs at all life cycles, but pregnant women are at greatest risk of anemia(4).

The etiologies of anemia are diverse and multifactorial, ranging from nutritional deficiencies to genetic disorders and chronic diseases. They can be acquired or inherited. The most common acquired causes are nutritional deficiencies, blood loss and chronic diseases(5). Anemia in pregnancy can be pathological or physiological. Pathological causes of anemia in pregnancy include iron deficiency, folic acid deficiency, vitamin B12 deficiency, parasitic infections, preexisting chronic diseases and genetic hemoglobinopathies(6). The relative contribution of each of these factors to anemia during pregnancy varies greatly by geographical location, season, and dietary practice. Among them, iron deficiency being the most common type, often resulting from inadequate dietary intake of iron or increased physiological demands(7).

Early pregnancy is a critical period for both maternal adaptation to pregnancy and fetal organogenesis, making adequate maternal oxygen transport essential. Anemia compromises this process, with potential short- and long-term consequences for both mother and fetus(8). Anemia in the 1st trimester of pregnancy holds critical indication for both maternal and fetal health, as this period is fundamental for fetal growth and maternal physiological adjustments to pregnancy. During the first trimester, the body undergoes significant hematological changes to support pregnancy, including elevated blood volume and plasma expansion, which can aggravate pre-existing nutritional deficiencies and lead to hemodilution(9,10). The clinical presentations and complications of anemia depends on its type and degree of severity(11).

1.2 Statement of the problem

Anemia is a global public health concern affecting both developing and developed countries(12). It affects all population regardless of their age, sex and other factors but, it is more prevalent in pregnant women and young children(13). WHO estimates the prevalence of anemia to be 38.2% globally among pregnant women(14). The prevalence of anemia varies in different regions of the world being highest in developing countries contributing for about 52% of the global burden(15). According to a 2021 systematic review, the prevalence of anemia among pregnant women in Africa was 41.7% (16) and for Sub-Saharan it was 35.6% (17). Similarly, about 26.4 % of pregnant women in Ethiopia were anemic in 2022 (18). Studies conducted in different parts of Ethiopia shows different magnitude of anemia among pregnant women. The highest prevalence of anemia 60% was observed in the Somali region followed by that of the Afar region 45%, while the lowest prevalence 16.3% was reported in Addis Ababa(19).

Anemia during the first trimester of pregnancy brings a significant risk for both maternal and fetal health, affecting outcomes throughout gestation and beyond. For the mother, anemia can lead to a range of complications, from fatigue and reduced immunity to increased susceptibility to infections, all of which may compromise her ability to adapt to pregnancy demands(20). Studies have shown that maternal anemia, especially when severe, it is associated with an increased risk of fetal growth restriction, low birth weight, and preterm birth. Furthermore, maternal iron deficiency may impair the development of the fetal brain, potentially impacting cognitive function and behavioral outcomes in childhood(8).

Despite the reported global, continental, regional and national prevalence and likely profound consequences linked with it, only a few studies tried to explore the magnitude and risk factors for anemia in first trimester pregnant women. Thus, there is quite limited data, pertaining to its magnitude and associated factors in Ethiopia and particularly in Tigray. Moreover, there are inconsistencies with respect to some of the determinant factors in different contexts and little research has been done on mothers' experiences of pre-conception care in relation to anemia. Determining the prevalence, severity, and predictors of anemia in the first trimester of pregnancy is critical for devising preventive measures that effectively mitigate its detrimental impact on both the mother and the fetus. Therefore, this study aimed at determining the magnitude of anemia and identifying its risk factors among first trimester pregnant women in Ethiopia.

1.3 Significance of the study

Determining the magnitude and severity of anemia in this study will help the pregnant mothers understand their condition early and take appropriate steps to control it or prevent it from worsening. Furthermore, it is extremely beneficial for healthcare providers to boost their efforts to cure mothers who have the condition and prevent others from contracting it by improving their counseling services in light of the recognized risk factors. It also allows program and policy makers to plan and allocate resources contingent on an evidence base. Furthermore, the determinants identified in this study will help programmers and policymakers prioritize anemia-prevention interventions based on the potential contribution of each component. Last but not least, the findings will serve as a springboard for researchers seeking to establish a cause-effect relationship between the identified factors and anemia using longitudinal study designs.

2. LITRATURE REVIEW

2.1 Pathophysiology (mechanisms) of anemia in pregnancy

Anemia during pregnancy is basically characterized by a reduction in hemoglobin level, leading to diminishing oxygen-loading capacity in the blood. The mechanisms underlying anemia in pregnancy are multifaceted, involving physiological adaptations, nutrition related deficiencies, and pathological diseases that collectively affect blood formation and iron metabolism(12).

2.1.1. Physiological hemodilution

One of the fundamental features of pregnancy is the expansion of plasma volume, which typically increases by 30% to 50% by the 3rd trimester. This hemodilution effect can eventually end up with a relative decrease in hemoglobin concentration, leading to physiological anemia of pregnancy. Although this dilution does not necessarily indicate a true deficiency in RBC mass, it can complicate the diagnosis of anemia, as hemoglobin levels may fall below the normal threshold. This physiological adaptation is essential for accommodating the increased blood flow demands of the growing fetus and other tissues, but it can hide underlying hematological issues(21).

2.1.2 Increased iron demand

The requirement for iron significantly rises during pregnancy due to the expansion of maternal blood volume, increased RBC production, and the needs of the developing fetus. Pregnant women require about 1g of additional iron to meet these demands, primarily sourced from dietary intake and, in some cases, supplementation. Poor dietary iron intake or malabsorption can lead to iron deficiency anemia (IDA), which is the most common type of anemia in pregnant women. The body's ability to absorb iron is also affected by factors such as the presence of inhibitors (e.g. phytates and polyphenols in certain foods) and enhancers like ascorbic acid of iron absorption(22).

2.2 Incidence and prevalence of anemia in pregnancy

A cross-sectional study conducted among first trimester pregnant women in turkey showed that the overall prevalence of anemia at the time of pregnancy detection was 20.0% and prevalence of mild, moderate, and severe anemia was 16.64%, 3.07%, and 0.28% respectively(23). Which is inconsistent with the findings of cross sectional study done in India that reported 37.5% of first trimester pregnant women were anemic with mean Hb concentration estimated to be 11.3 ± 1.3 g/dL(24).

A retrospective cross sectional study in Turkey stated that the prevalence of anemia in first trimester pregnant women was 20.6%(25). Which is similar to a cohort study conducted in

India among the first trimester pregnant women reported that the prevalence of anemia in early pregnancy was 18%(26). On contrary to this a study conducted in Krishana India revealed 93.26 % of first trimester pregnant women were anemic and their mean Hb level was 10.37 ± 0.94 g/dl, mean corpuscular volume (MCV) was 72.65 ± 6.53fl and their mean MCH was 26.75 ± 2.75 pg. Among them, 73.07% had mild anemia, 20.19 % had moderate anemia & none had severe anemia. Anemia in 1st trimester of pregnancy was endemic and microcytic anemia is most common in this region(27).

This finding contradicts to a prospective cohort study done in Korean first trimester pregnant women stated that only 2.9% of them were diagnosed with anemia during the first trimester of pregnancy(28) and retrospective cohort study conducted in Chinese women(29). A cohort study conducted in New Zealand stated that 2.2% first trimester pregnant women found to be anemic (30). On the other hand, cohort study conducted in Sri Lanka among first trimester pregnant women claimed that 14.4% were found to be anemic and their hemoglobin ranged between 7.4 to 19.6 g/dl. Of these 10.6% had mild anemia and hemoglobin ≥13 g/dl was observed in 12.7% of the participants (31).

The result of this study is nearly in line with the prospective cohort study done in China that stated 16.3% participants were diagnosed with anemia in the first trimester pregnancy(14). The prevalence of mild, moderate and severe anemia was 10.9%, 5.2% and 0.3% respectively. Which is lower than a longitudinal observational conducted study in China that showed the prevalence was 21.6% in the first trimester and being in first trimester were more likely to be anemic(32).

A cross-sectional study conducted in Ranchi, India stated that out of total 149 pregnant women anemia was found to be present in 66.4%. Out of these 25 (16.8%) were mild degrees of anemia and 74 (49.6%) were moderately anemic. None of the subjects were found to be severely anemic. The overall mean of Hb was 10.17g/dl (SD 1.278) with a range from 7.5 to 12.8g/dl (15). On the other hand, findings found in cross-sectional research done in Katihar India was very high that reported 88.5 % of pregnant were found to be anemic(33).

A systematic review and meta-analysis conducted in Iran stated that the pooled estimate of anemia in first trimester of pregnancy was 22%(34). While a cross-sectional study done in south Africa stated that 43.1% of pregnant women were anemic and the rates of mild, moderate and severe cases were 21.3%, 21.1% and 0.7% respectively(35). Which is higher as compared to the findings of cross-sectional research done in southern Ethiopia, Arbaminchi, that stated the prevalence of anemia among antenatal care attendant pregnant women was 32.8%(36). It

was two times higher than the results of cross-sectional study done in southwest Ethiopia showed that the overall magnitude of anemia (hemoglobin level < 11 g/dl was found to be 16.8%(37). A cross sectional study conducted by Kuma, Tamiru and Belachew in southwest Ethiopia revealed that the prevalence of anemia among first trimester pregnant women was 23.16%(38).

2.3 Sociodemographic characteristics

Maternal age was significantly associated with anemia in pregnancy in a cross sectional study conducted in in Katihar India(33) and another cross-sectional studies done in south Africa, Jigjiga Somali region and Bahir Dar (39–41) also found similar finding. A study conducted in southern Ethiopia among pregnant women also revealed that not having a marital partner was identified as independent risk factors for having anemia during the first trimester in the study(19). Household monthly income was significantly associated in a systematic review conducted in China(42), Iran(34), Mali(43), Ethiopia (44) and Bahir Dar(40) found similar findings.

In a systematic review conducted in Iran revealed that maternal educational status was found to be significant predictor of anemia in pregnancy(34) which is comparable to the studies conducted in Dahka city Bangladesh (45), Nigeria in west Africa (46), Adama in Ethiopia (47) and in north west Tigray Shire(48). A systematic review conducted in China stated that rural residence increases the risk of developing anemia in pregnancy (49), Other similar studies conducted in Dahka city Bangladesh(45) ,South Africa (35) and studies in Ethiopia in Bahirdar (40) and Shire(48).

A cross sectional study done in Adama among 329 pregnant women showed that occupational status was one predictor of anemia in pregnancy(47) which is similar to the finding found in from 731 study participants in shire(48). Other cross sectional study carried out in Saudi Arabia among 390 pregnant mothers claimed that family size was associated with anemia in pregnancy(50)**,** another studies done in Ethiopia in Arbaminchi (36) and Jigjiga (40).

2.4 Maternal obstetrics and gynecological conditions

Parity of the pregnant women was also significantly associated with anemia as reported from cross sectional study done among 149 pregnant women(15) which is in line similar to the findings in Katihar India(33) and in Chinese women(49).

A retrospective cross sectional study among 300 study subjects in India reported that gravidity was significant predictor of maternal anemia(49). A cross sectional anemia Ranchi India stated that interpregnancy interval was significantly associated with anemia in pregnancy(15)

supported by other studies in the same country in India also stated similar findings(51), and study conducted in Ethiopian Arbaminchi (36).

A systematic review conducted in China revealed that no ANC was significantly associated with anemia in pregnant women (49). Other studies conducted in Harar reported no antenatal care follow up increased risk of anemia (AOR: 3.4; 95% CI: 1.34, 8.79)(52) and in two most anemic regions of Ethiopia having no ANC follow-up (AOR: 1.9, 95% CI: 1.6, 2.3)(53).
A study conducted in Saudi Arabia had found that history of heavy menstrual cycle and history of bleeding during pregnancy were independent predictors of anemia in pregnant women(50). Another cross sectional study conducted in Mizan tepi teaching hospital reported that excessive menstrual cycle (AOR=3.361, CI [1.375, 8.217) and history of abortion (AOR=4.562, CI: [2.212, 9.412]) had significant association with anemia(54). In addition to this a cross sectional study in Shashamene among 391 pregnant women had reported that no history of excessive menstrual cycle (AOR = 0.162, 95% CI 0.076–0.345) and use contraceptive were significantly associated with maternal anemia in pregnancy(55).

2.5 Maternal health status related variables

A cross sectional study conducted in South Africa among 2000 pregnant women revealed that the prevalence of anemia was significantly higher in HIV-positive compared with HIV-negative pregnant women (71.3% v. 28.7%; p<0.0001)(56). A study conducted in China stated that history of anemia was associated with anemia in pregnancy (a OR=2·60)(57). Other study conducted among 550 pregnant women in south Africa stated that having anemia 6 months before pregnancy (OR: 4.64; CI: 1.15–18.71) was significantly associated with anemia in pregnancy(35,50).
A meta-analysis done in Ethiopia in 51 studies showed that malaria infection during pregnancy (RR:1.94 (95% CI: 1.33, 2.82)) had higher risk to develop anemia(58). Additionally a cross sectional study conducted in Mizan Tepi Ethiopia reported that history of malaria attack (AOR=7.936, CI: [3.807, 16.546] was significantly associated with anemia in pregnancy (54). A cross sectional study in southern Ethiopia showed that parasitic infection [AOR=6.39, 95% CI: 1.226–33.362](19) and a study cross sectional study in Adiss Ababa stated that parasitic infection was associated with anemia in pregnancy(59). Other community based cross sectional study conducted in southern Ethiopia stated that hookworm infection (AOR = 2.69, 95%CI: 1.345.39) was associated with anemia in pregnant women(60).

2.6 Maternal nutritional status related variables

A case control study in Bahirdar revealed that MUAC was significantly associated with (AOR = 5.0, 95% CI: 2.0–12.7)(61). Another similar cross sectional study conducted among 417 pregnant women in Jigjiga city stated that MUAC(<23) was significantly associated with anemia in pregnancy(AOR=0.57; 95% CI: 0.20-0.89)](41). A meta-analysis in sub Saharan Africa the result showed that a pregnant women who had no iron and folic-acid supplementation were 1.82 times more likely to develop anemia compared to those women who had iron and folic-acid supplementation {OR:1.82, 95% CI (1.22,2.70](17). Other systematic review and meta-analysis in Ethiopia also showed similar finding(53). The study in Jiggiga showed us also iron folic acid supplementation during pregnancy reduces risk of anemia (AOR=1.30; 95% CI=1.01-4.01) (41).

A cross sectional study in Harar stated that meal frequency was an independent risk factor of anemia in pregnancy(52). Another cross-sectional study conducted among 638 pregnant mothers also showed that meal frequency three times or less meal frequency (AOR = 1.89, 95% CI: 1.02, 3.5) was significantly associated with maternal anemia(48).

A systematic review conducted in China showed that dietary diversity was significantly associated with anemia in pregnancy(42). A meta-analysis in sub- Saharan Africa stated that women who had low dietary diversity score were 3.59 times more likely to develop anemia compared to those who had high dietary diversity score [OR: 3.59, 95% CI (2.44, 5.28](17). Other cross sectional study conducted in St. Pauli among 420 pregnant women stated that poor minimum dietary diversity score [AOR = 3.54, 95% CI = 1.58-7.95], undernourished [AOR = 4.09, 95% CI = 2.19-7.64] were significantly associated with anemia in pregnant women(40).

A cross-sectional study done in Kenya among 191 pregnant women showed that factors associated with reduced odds of anemia were; food frequency (AOR 0.23, 95%CI: 0.1-0.51, P < 0.01), increased intake of vegetables and fruits (AOR 0.47, 95%CI: 0.34-0.47, P < 0.001), and red meat (AOR 0.39, 95%CI: 0.23-0.67, P < 0.001)(62). Other study in Tanzania stated that similar finding consume at least once a day dark green leafy vegetables [adjusted OR = 0.53, 95% CI (0.30, 0.94)](63). A cross sectional study conducted in keffa zone southwest Ethiopia reported that coffee drinking was significantly associated with anemia in pregnancy(64) and similar result was found in Adama(12).

2.7 Maternal awareness related variables

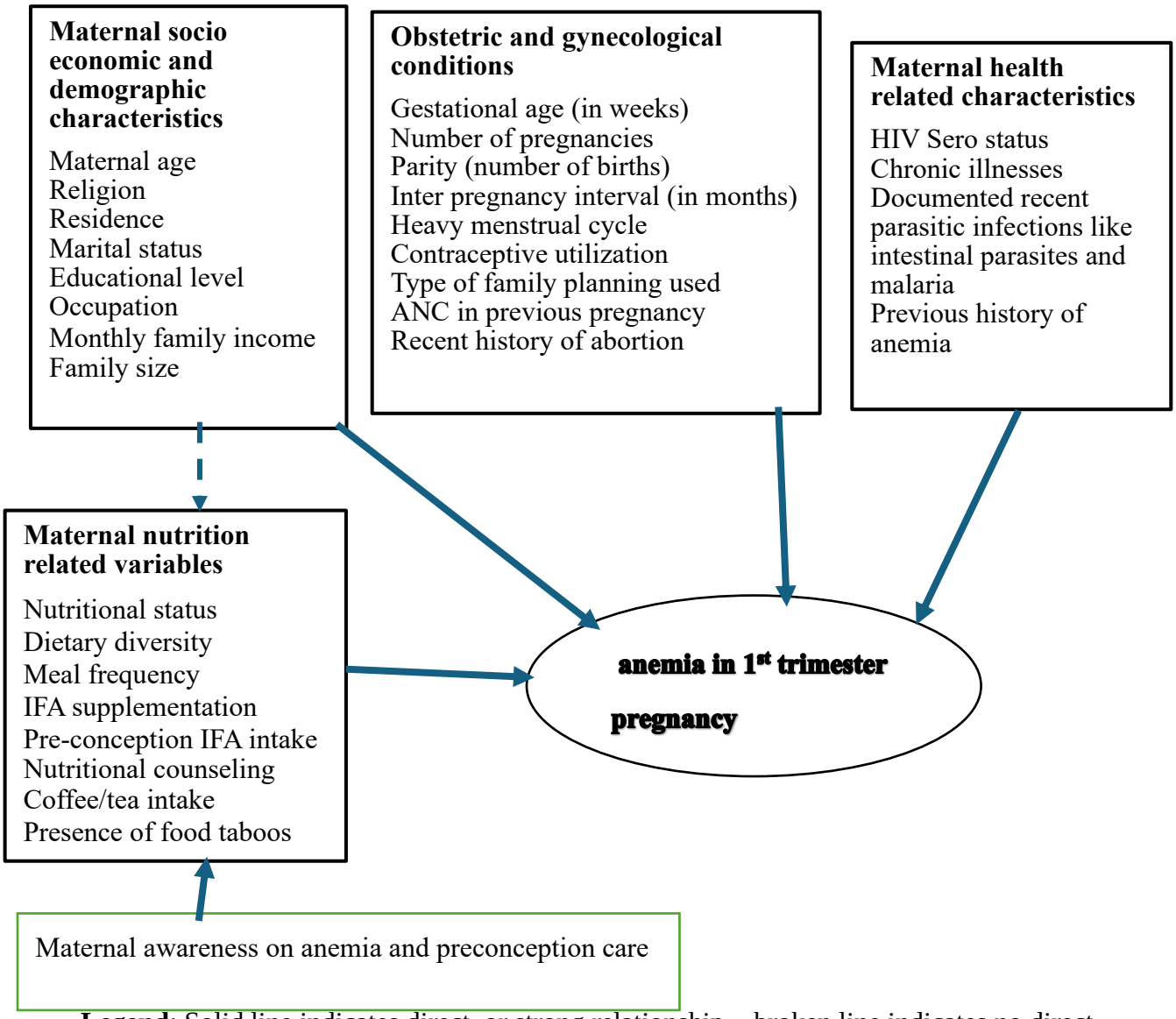
A cross-sectional, descriptive institution-based study conducted at Sri Manakula Vinayagar medical college hospital, Puducherry, India revealed that only 39.87% of the participants were aware of and understood the term anemia. 53.8% of the participants accepted that pregnant

women were more vulnerable to anemia and 66.1% responded correctly that the fetus will be affected by severe anemia(65).

A cross-sectional study in Bahir Dar University, Ethiopia found that almost half, 216 (52.7%) [95% CI = 47.8-57.5] of the pregnant women had good knowledge of anemia(66). A systematic review and meta-analysis conducted in Indonesia reported that having poor maternal knowledge about anemia (OR=1.70 [95% CI: 1.17–2.49]) was significantly associated with anemia in pregnancy(53). Another conducted in Pawi district north west Ethiopia stated that poor knowledge of anemia [AOR = 3.19, 95% CI = 1.72-5.93] were significantly associated with anemia in pregnant women(66). A descriptive cross sectional study in Nepal reported that more than half (51%) of the respondents had inadequate level of knowledge as followed by those having moderate (42%) level of knowledge and adequate 7% knowledge regarding preconception care(67).

Conceptual framework

This conceptual framework was developed for the assessment of magnitude and associated factors of anemia in first trimester pregnant women by reviewing several relevant previous studies done in the different parts of the world (33,34,39-68).



Legend: Solid line indicates direct, or strong relationship broken line indicates no direct relationship or weak association

Figure 1: Conceptual framework for the magnitude and associated factors of anemia among first trimester pregnant women attending ANC follow up at public hospitals in Mekelle city, Tigray, Ethiopia, 2025

3. OBJECTIVES

3.1 General objective

To assess the magnitude and associated factors of anemia among first trimester pregnant women attending antenatal care at public hospitals in Mekelle city, Tigray, Ethiopia, 2025.

3.2 Specific objectives

To determine the prevalence of anemia among first trimester pregnant women who have antenatal care follow up at public hospitals in Mekelle city, Tigray, Ethiopia 2025.

To identify the risk factors associated with anemia in first trimester pregnant women who attend antenatal care at public hospitals in Mekelle city, Tigray, Ethiopia, 2025.

4. METHODS AND MATERIALS

4.1 Study area (setting)

This study was carried out in antenatal care units of public hospitals in Mekelle city. Mekelle city is the capital city of Tigray regional state and is located 783 km far from Addis Ababa, the capital city of Ethiopia, to the Northern part of the country. The city is situated at an altitude of 2254 meters high above sea level. The city owns 4 public hospitals. Of these, one is a specialized teaching hospital, two are general hospitals and one is primary hospital. Namely, Ayder comprehensive specialized hospital, Mekelle general hospital, Quiha general hospital and Lekatit 11 primary hospital. All these hospitals provide focused antenatal care services. The annual ANC service delivery in ACSH, Quiha general hospital, Lekatit 11 primary hospital and Mekelle general hospital were 3288, 1988, 2694 and 2220 clients respectively (Annual institutional reports of 2023/2024 G.C).

4.2 Study design and period

A hospital-based cross-sectional study was conducted. The data was collected from January to February 2025.

4.3 Population

`4.3.1 Source population

All first trimester pregnant women (gestational age less than 12 weeks) who attended antenatal care follow up at public hospitals in Mekelle city.

4.3.2. Study population

All first trimester pregnant women who attended antenatal care at public hospitals in Mekelle city during the data collection period (from January to February 2025) and who met the inclusion criteria were included.

4.3.3 Study unit

An individual first trimester pregnant woman who was recruited for this study.

4.4 Eligibility criteria

4.4.1 Inclusion criteria

All first trimester pregnant women who attended ANC at public hospitals in Mekelle city.

4.4.2 Exclusion criteria

First trimester pregnant women who were seriously ill (unable to give response) were excluded from this study.

4. 5 Sample size determination

The required sample size was determined by using a single population proportion formula with assumptions of 95% confidence level (CL), 5% margin of error, and by taking the proportion of anemia in first trimester pregnant women from previously conducted study in India which was 37.5% (24). $n= Z_{\alpha/2}{}^2P(1-P)/d^2$

Where, n is the required sample size

Z is the Z-score corresponding to the chosen confidence level (for a 95% confidence level, $Z_{\alpha/2} \approx 1.96$)

P is the estimated proportion of anemia (37.5%)

d is the margin of error (5%)

Z = 1.96, P=0.375, Q=1-p=1-0.375=0.625 d= 0.05 by substituting these values,

$n= (1.96)^2*0.375*0.625/ (0.05)^2$

=360 study participants

Using the above formula, the calculated sample size was 360 first trimester pregnant women. Then by adding 10 % allowance for non-response rate, which was (10%=36). The desired minimum sample size became 396(360+36). Hence, 396 study participants were enrolled in this study.

4.6 Sampling method and procedure

All first trimester pregnant women (gestational age < 12 weeks) who visited the antenatal care unit of all the four public hospitals in Mekelle city, during the data collection period were enrolled consecutively to participate in the study until the required sample size had been achieved. In this study 115 from Mekelle general hospital,112 from Ayder comprehensive specialized hospital, 76 from Quiha general hospital and 93 study from Lekatit 11 primary hospital study participants were included.

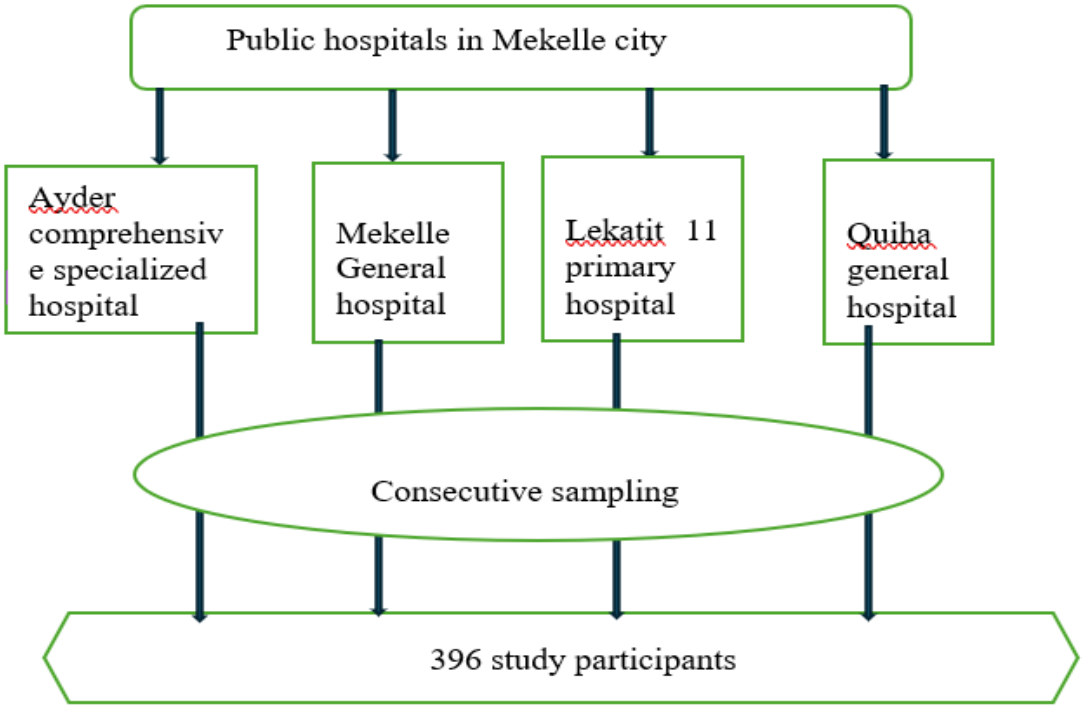


Figure 2: Shows the sampling procedure for the assessment of magnitude and associated factors of anemia among first trimester pregnant women attending ANC follow up at public hospitals in Mekelle city, Tigray, Ethiopia, 2025

4.6 Study variables

4.6.1 Dependent variable

Anemia status (Yes/No)

4.6.2 Independent variables

Sociodemographic and economic characteristics

Age, religion, residence, family size, marital status, educational level, occupational status, monthly family income

Maternal obstetric and gynecological conditions

Gestational age, gravidity, parity (number of births)

Inter pregnancy interval (in months)

Previous pregnancy antenatal care

Contraceptive utilization

History of heavy menstrual cycle

Recent history of abortion

Nutritional and maternal health related factors

Nutritional status, dietary diversity, meal frequency, coffee/tea consumption, tea and coffee intake immediately after meal, iron folic acid supplementation during pregnancy, pre conceptional iron folic acid supplementation, presence of food taboos,

HIV status of the mother documented recent parasitic infections (malaria and hook worm), previous history of anemia and chronic diseases (chronic kidney diseases and diabetes mellitus).

Maternal awareness of anemia

Maternal awareness about anemia

Maternal awareness on preconception care

4.7 Operational definitions and measurements

Well nourished: If mid upper arm circumference (MAUC) is ≥ 23 cm.

MAM: If the MUAC of the pregnant women is 21-22.9 cm.

SAM: If the MUAC of the pregnant women is <21 cm.

Dietary diversity score (DD): the number/types of different foods or food groups consumed in the previous day (24 hours from sunrise yesterday to sunrise today) at home or outside and quantity was also considered.

Low dietary diversity: Dietary diversity scores less than five food group consumption.

High dietary diversity: Dietary diversity scores greater than or equal to five food group consumption daily.

Poor awareness on anemia: If she correctly answers <4 questions about anemia out of 8 anemia related basic questions (from the questionnaire).

Good awareness on anemia: If she correctly answers ≥ 4 questions about anemia out of 8 anemia related basic questions (from the designed questionnaire).

4.8 Data collection methods and procedures

The data were collected using structured questionnaire that was pre-tested and designed specifically for this study. The questionnaire was adapted by reviewing relevant previously done literatures and then tailored to the local context to ensure the collection of pertinent information about anemia in first trimester pregnant women. The questionnaire comprised questions regarding socio-economic and demographic characteristics, gynecological and obstetric conditions, nutritional and dietary diversity related variables and maternal awareness on anemia and preconception care related variables. The Questionnaire was filled while waiting for their laboratory results.

Laboratory analyses were performed to determine the hematological parameters hemoglobin, hematocrit, red blood cells and RBC indices of the study participants. In addition to the above, a review of medical records was used to collect the necessary data regarding medical histories like chronic illnesses, previous history of anemia and recent parasitic infections like intestinal parasites and malaria.

Four trained BSc midwives were recruited as data collectors to complete the questionnaires. While the hematological laboratory analyses were performed by 4 trained and qualified BSc laboratory technologists, and they were given training on the sample collection, sample storage, procedures and analysis of the specimen to generate reliable results. One senior health officer was assigned as a supervisor to monitor all the ongoing activities. The laboratory investigation was determined using an automated hematological autoanalyzer.

Mid upper arm circumference (MUAC) was measured using adult MUAC tape based on the WHO guideline to evaluate the nutritional status of the pregnant women measured with 1cm nearly accuracy. Dietary diversity history was taken from the food and agricultural organization (FAO) minimum dietary diversity indicator for women (MDD-W). Intake of ≥ 5 food groups was a proxy indicator for micronutrient adequacy.

The data was validated with non-quantitative 24-recall of foods eaten the day and night prior to the data collection day and consumption of five out of 10 FAO defined food groups was used to assess nutritional diversity of pregnant women. The level of dietary diversity score (DDS) was computed out of 10 and was classified as high (DDS ≥ 5) and low (DDS < 5) according to the recommendation of the food and agriculture organization of the United Nations(68).

Venous blood specimen was drawn by a phlebotomist and the laboratory analysis was carried out for hematological determination. Hematological testing was performed in pre calibrated and quality controlled hematological autoanalyzer. A standardized operating procedure (SOP) was strictly followed while specimen collection, storage and analyses.

Sample blood collection

A 4 ml venous blood sample was collected aseptically from each study participant into an ethylenediaminetetraacetic acid (EDTA) anticoagulated test tube. Following that the specimens were mixed with the anticoagulant by gentle inversion of the test tube and clearly labeled with the patient's unique code given on the questionnaire and medical record number. Laboratory analysis was carried out as soon as possible and the blood samples were kept at room temperature until then.

Laboratory procedures and analysis

After adequate venous blood specimen was collected from each study participant. The hemoglobin test was performed using a pre-calibrated hematology autoanalyzer's, an instrument designed for measurement of hemoglobin concentration. This machine has the capacity to test 19 parameters per sample including hemoglobin concentration, Hct, MCH, MCV, MCHC and RBCs. Approximately 20 μL of blood were aspirated by allowing the analyzer's sampling probe into the blood sample and depressing the start button.

Standardization, calibration of the instrument, and processing of the samples was done according to the manufacturer's instructions. Results of the analysis were displayed after about 30 seconds, after which the analyzer generated a paper copy of the results on thermal printing paper. Laboratory results were recorded immediately.

4.10 Data processing and data analysis

Data collected from the questionnaire and laboratory tests were carefully checked for completeness and consistency. The data were exported, cleaned, coded and analyzed using statistical package for the social science (SPSS) version 27.0 statistical software. Descriptive statistics of the data were indicated by using mean, standard deviation for normally distributed continuous variables. Frequencies and percentages were employed to report categorical variables. The data were presented using appropriate tables and graphs like pie charts, bar graphs for categorical variables and histogram and numerical measures for continuous variables like mean and standard deviation.

Bi-variable and multi-variable binary logistic regression model was used to identify predictor variables associated with the dependent variable (anemia status). Independent variables were checked for multicollinearity before running into multi-variable regression model using variance inflation factor (VIF) to see whether they are highly correlated to each other. The variance inflation factor was <10. Model goodness of the fit test of the final logistic regression model was cheeked using Hosmer and Lemes how test to assess the fitness of the model (good fitted with a p-value of 0.682).

In this study, variables associated with the magnitude of anemia among the first trimester pregnant women were analyzed using bivariable binary logistic regression analysis first. Then, those variables that had a P-value less than 0.25 on bi-variable logistic regression analysis were considered as candidates for multivariable logistic regression analysis to identify the independent predictors of anemia among pregnant women. An adjusted odds ratio with 95% confidence interval was used to measure the strength of association between the dependent and independent variables. Finally independent variables with P-value less than 0.05 in the multi-

variable logistic regression model were considered statistically significant in the final logistic model.

4.11 Data quality assurance

To maintain the quality of data the questionnaire was initially prepared in English language and translated into Tigrigna (local language). Before commencing the actual data gathering process, the data collection tool was pretested among 5% (20) of the sampled pregnant women with the same eligibility criteria but in other site out of the study area. The questionnaire was adjusted accordingly.

To maintain data quality and accuracy, qualified and experienced data collectors were recruited. All data collectors and the supervisor were given a comprehensive one-day training session on the questionnaire developed by the principal investigator. This training was conducted to ensure that all data collectors are familiar with the study objective and competent to fill the data collection tools and thus reduce potential technical errors and biases.

During the data collection period, daily basis and ongoing supervision was undertaken by the supervisor and principal investigator during the data collection process and daily support was provided to the data collectors. In addition, the filled questionnaires were reviewed strictly by both the supervisor and the principal investigator to verify the completeness and consistency of the collected data. Any problems identified during the data collection were discussed timely and corrective feedback and guidance were provided to the data collectors. For the laboratory data collection calibration and quality control was performed on the hematological autoanalyzer. All laboratory procedures and specimen analyses were performed in accordance with the relevant standard guidelines, regulations and standard operating procedures (SOPs). All reagents were checked for expiry date prior to utilization.

4.12 Ethical considerations

This study was ethically reviewed and approved by the institutional review board (IRB) of College of Health Sciences, Mekelle University and ethical clearance was obtained (Ref No. MU-IRB2438/2024) and letter of support was given by Institute of biomedical sciences to regional health bureau (Ref No. BMD-141/2017). The official letter of permission was given by Tigray regional health bureau (Ref No.3/22/7767/17) and letter of support was written by the department of medical biochemistry and molecular biology to the Gynecology and obstetrics department of ACSH (Ref No. BMD/269/2025). A formal letter of permission was delivered to the authorities of the respective public institutions, and they were briefed on the purpose and implications of the study as well.

An informed and written consent was obtained from each study participant after providing all the necessary information regarding the purpose, potential risks of the study and their right to interrupt this study at any time if they are not comfortable. Confidentiality was maintained and the specimen collected was analyzed only for the intended purpose. Codes were used instead of participant's names to avoid the disclosing of participant's names and information without their willingness. The privacy and dignity of respondents were kept.

4.13 Plan for dissemination of findings

The findings of this research will be presented and submitted to Mekelle university, college of health sciences, department of medical biochemistry and molecular biology. The summarized findings will be communicated to the four participating public hospitals. The findings will be also distributed to concerned bodies like Tigray Regional Health Bureaus and non-governmental organizations working on maternal and child health. Besides, after incorporation of essential comments manuscript will be developed and efforts will be made to publish it in reputable scientific journals.

5. RESULTS

5.1 Socio-demographic and Economic Characteristics of study participants

In this study, 396 first trimester pregnant women were included. The mean age of the first trimester pregnant women was 28.5± (5.80). Majority 272 (93.9%) were married, 15 (3.8%) were single and the rest 9(2.3%) were divorced/separated. Regarding the family size, only 123(29.8%) had family size five and above. Three hundred forty-eight (87.9%) of the pregnant women lives in urban and 48(12.1%) came from rural areas. About one hundred and forty-nine (37.6) completed secondary school, 21.5% had diploma and above and 14.4% (57) were uneducated. Out of the total participants 178(44.9%) were housewives at the time of study. Regarding participant's household economy, the majority 236(59.6%) had 5000-10000 Ethiopian birr monthly family income (As shown in **table 1**).

5.2 Gynecological and obstetrics, diseases and health service-related factors

Gynecological and obstetric factors are some of the factors that may have effect on the magnitude of anemia among first trimester pregnant women. When we look at the gynecological and obstetric characteristics of the study participant, 112(28.2%) of them were primigravida. The majority, 262(92.3%) had less than five deliveries, the rest 22 (7.7%) were grand multipara. Regarding the interpregnancy interval, only 65(22.9%) had less than 24 months difference between the previous and the current pregnancy. A majority of 234(82.4%) had ANC follow up. Out of those who had ANC follow up in their previous pregnancy 53(22.6 %) of those had irregular ANC follow up and 158(67.5 %) received nutritional counselling during their ANC follow up. Regarding the history of menstrual bleeding only 51(12.9%) had heavy menstrual bleeding before the current pregnancy. Concerning the history of abortion, 31(7.8%) had a recent history of abortion. Regarding the history of contraceptive use, 278(70.2%) of the respondents use contraceptives (As shown in **Table 1**).

Table 1: Socio-demographic and gynecological and obstetrics characteristics of the study participants attending ANC follow up at public hospitals in Mekelle city, Tigray, Ethiopia 2025(n=396)

Variables(n=396)	Category	Frequency	Percentage
Maternal age in years	≤19	14	3.5
	20-24	89	24.5
	25-29	134	33.8
	30-34	91	23.0
	≥35	68	17.2
Religion of the mother	Orthodox	351	88.6
	Muslim	24	6.1
	Catholic	12	3
	Protestant	9	2.3
Residence	Urban	348	87.9
	Rural	48	12.1
Marital status	Married	372	93.9
	Single	15	3.8
	Divorced/Separated	9	2.3
Family size	<5 members	278	70.2
	≥5 members	118	29.8
Educational level	No formal education	57	14.4
	Elementary school	105	26.5
	Secondary school	149	37.6
	Diploma and above	85	21.5
Occupation	Housewife	178	44.9
	Self-employed	89	22.5
	Governmental employed	82	20.7
	Daily laborer	21	5.3
	Farmer	15	3.8
	Others	11	2.8
Monthly Family income	<5000	46	11.6
	5000-10000	236	59.6
	≥10000	114	28.8
Gravidity	Premi gravida	112	28.2
	2 to 4	223	56.3
	≥5	61	15.5
Parity(n=284)	Less than five	262	92.3
	Five and above	22	7.7
Interpregnancy interval(n=284)	<24 months	65	22.5
	≥24 months	219	77.1
ANC follow up(n=284)	Yes	234	82.4
	No	50	17.6
	Regular	181	77.4

Regularity of ANC follow up (n= 234)	Irregular	53	22.6
Nutritional counselling in previous pregnancy (n= 284)	Yes	158	67.5
	No	76	32.5
Recent history of heavy menstrual cycle	Yes	51	12.9
	No	345	87.1
Family planning utilization	Yes	278	70.2
	No	118	29.8
Recent history of abortion	Yes	31	7.8
	No	365	92.2
HIV Sero status	Positive	3	0.75
	Negative	393	99.25
Recent history of parasitic infection	Present	32	8
	Absent	364	92
Recent history of malaria	Present	34	8.6
	Absent	362	91.4
Previous history of anemia	Present	11	2.8
	Absent	385	97.2
Maternal knowledge about anemia	Have no knowledge	288	72.7
	Poor knowledge	66	16.7
	Good knowledge	42	10.6
Maternal awareness on preconception care	Have no awareness	356	89.9
	Have awareness	40	10.1

Abbreviations: ETB-Ethiopian Birr, n=Sample size

5.3 Nutritional- related characteristics of the 1st trimester pregnant women

Out of the total 396 study participants 245(61.9%) feeds three and less than three times per day. Concerning the nutritional status, 39(9.8%) and 82(20.8%) were severely and moderately malnourished respectively. About 234(59%) of study participants had low dietary diversity scores. Two hundred and seventy-five (69.4%) were coffee/tea consumers. 123 (44.7%) took it immediately after the meal within 30 minutes. About 73%, 38.6% took dark green leafy vegetables and animal products (meat, fish and egg) respectively. The presence of food taboos was only 2% in the study area. Regarding iron folic acid supplementation, 305(77%) had taken iron folic acid supplementation (As shown in **Table 2**).

Table 2: Nutrition related characteristics of first trimester pregnant women attending ANC follow up at public hospitals of Mekelle city, Tigray, Ethiopia, 2025

Variables	Categories	Anemia status		Total (%)
		Yes (n (%)	No(n(%)	
Feeding frequency(n=396)	≤Three times /day	46(18.8)	199(81.9)	245(61.9)
	> Three times/ day	7(4.6)	144(95.4)	151(39.1)
MUAC(n=396)	SAM (< 21 cm)	15(38.5)	24(61.5)	39(9.8)
	MAM (21 -22.9 cm)	10(12.2)	72(87.8)	82(20.8)
	Normal nutrition (MUAC ≥23 cm)	28(10.2)	247(89.8)	275(69.4)
Coffee intake(n=396)	Yes	46(16.5)	229(83.5)	275(69.4)
	No	7(5.8)	114(94.2)	121(30.6)
Taking coffee/tea immediately after meal (n=275)	Yes	20(16.3)	103(83.7)	123(44.7)
	No	17(12.1)	124(87.9)	141(51.3)
Dietary diversity score(n=396)	Low	47(20.1)	187(79.9)	234(59)
	Adequate	6(3.70)	156(96.3)	162(41)
Taking dark green leafy vegetables (396)	Yes	32(11.1)	257(88.9)	289(73)
	No	21(19.6)	86(80.4)	107(27)
Taking fruit immediately after meal(n=396)	Yes	10(4.7)	203(95.3)	213(53.8)
	No	43(23.5)	140(86.5)	183(46.2)
Animal products (meet, egg	Yes	12(7.8)	141(92.2)	153(38.6)
	No	41(16.8)	202(83.2)	243(61.3)
Dairy product consumption like Milk and others(n=396)	Yes	29(11.3)	228(88.7)	257(65)
	No	24(17.3)	115(82.7)	139(35)
Presence of food taboos(n=396)	Yes	0(0)	7(100)	7(1.8)
	No	53(13.6)	336(86.4)	389(98.2)
Iron folic acid supplementation(n=396)	Yes	38(12.5)	267(87.5)	305(77)
	No	15(16.5)	76(83.5)	91(23)
Pre-conception iron folic acid supplementation(n=396)	Yes	2(11.8)	15(88.2)	17(4.3%)
	No	51(13.5)	328(86.5)	379(95.7)

5.4 Maternal knowledge about anemia and preconception care related variables

Out of the total, 134(34.8) of pregnant women had ever heard about anemia, in which health professionals were the main source of information accounts for 86(64.2%), 34(25.3%) and others 14(10.5%). From the pregnant women who heard about anemia about 82(61.2%) of pregnant women correctly defined what anemia mean. Out of the 82 who correctly define anemia only 35(42.6%) mentioned the common symptoms of anemia(fatigue). Out of the 82 who correctly define anemia, about 36(43.9%) of the respondents knew that anemia is preventable diseases and 25(69.4%) of them mentioned consuming rich iron foods as methods of prevention of anemia. Regarding maternal knowledge about anemia, the majority of 288(72.7%) had no knowledge about anemia and only 10.6% had good knowledge about anemia **(**As shown in **Figure 3)** Concerning knowledge on preconception care three hundred and fifty-six (89.9) had no awareness, while only 40(10.1%) had good awareness. **(Figure 4)**

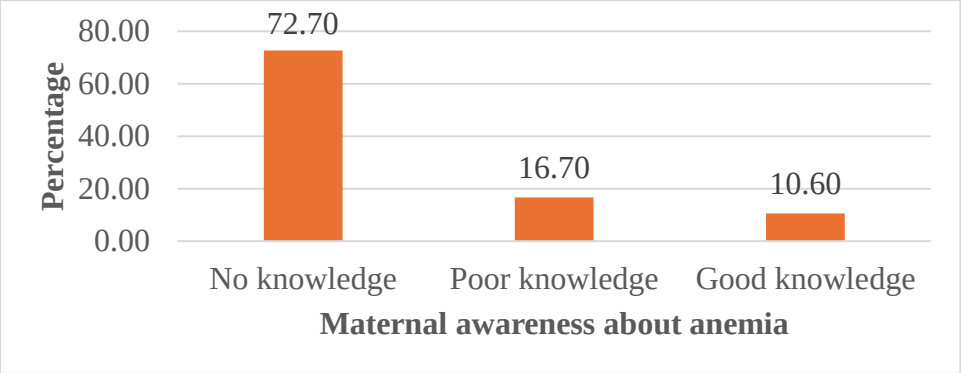


Figure 3: Maternal awareness about anemia among first trimester pregnant women attending ANC follow up at public hospitals in Mekelle city, Tigray, Ethiopia,2025 (n=396)

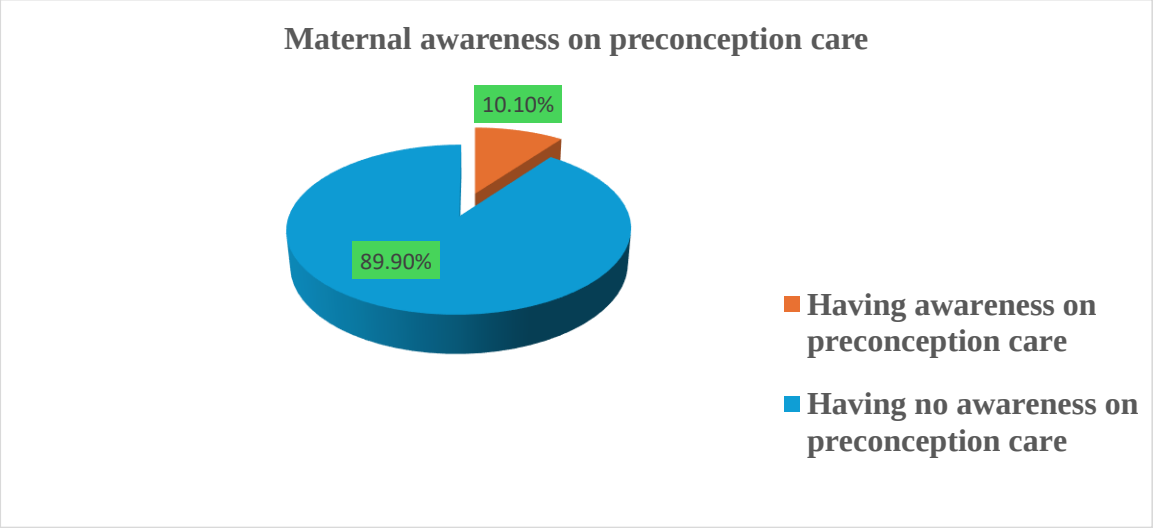


Figure 4: Maternal awareness about preconception care among first trimester pregnant women attending ANC follow up at public hospitals in Mekelle city, Ethiopia, 2025 (n=396)

5.5 Magnitude and severity of Anemia in First Trimester Pregnant Women

The WHO hemoglobin cutoff value for the gestational age and degree of severity criteria was used. The Hgb value less than 11.0g/dL was defined as anemic and based on the severity, women with Hgb value of (10g/dL ≤ Hgb < 11g/dL) , (7.0 g/dL ≤ Hgb < 10 g/dL) and Hgb < 7g/dL) were categorized as mild, moderate and severe anemia, respectively(2). WHO reference ranges were used to define the normal ranges for MCV (80.0–100.0fl), MCH (27.0–33.5pg), and MCHC (32.0–36.0g/dL) and 3.8 -5.2 cell/mm^3 for RBCs.

The overall prevalence of anemia among pregnant women who were attending their ANC follow-up at public hospitals of Mekelle city, Tigray region was 53(13.4%) (95% CI; 10.2-17.1) (**Figure 3**). The mean and standard deviation (SD) of hemoglobin level was 12.33(± 1.48) g/dl and was distributed between 5.5g/dl to 17.4 g/dl. The mean values of RBCs were 4.05(±0.64) while, the mean values of red blood cell indices were 86.7fl (±5.23), 30.65(±2.7), 35.0(±2.5) for MCV, MCH, MCHC respectively. (As shown in Table 3)

Table 3: Hematological profiles of first trimester pregnant women attending ANC follow up at public hospitals in Mekelle city, Tigray, Ethiopia, 2025(n=396)

Haematological parameters	Minimum	Maximum	Normal range	Mean	SD
Haemoglobin in g/dl	5.5	17.4	11-15	12.32	1.48
Haematocrit (%)	18.7	52.2	33-45	35.59	4.31
MCV in Fl	69.6	101	80-100	86.7	5.23
MCH in pg.	21.2	36.9	27-31	30.65	2.7
MCHC g/dl	27.03	40.76	32-36	35.07	2.5
RBCs cells/mm^3	1.98	6.7	3.8-5.2	4.05	0.64

MCV- Mean corpuscular volume, MCH-Mean corpuscular haemoglobin,
MCHC-Mean corpuscular haemoglobin concentration, SD- Standard Deviation
RBC-Red blood cells

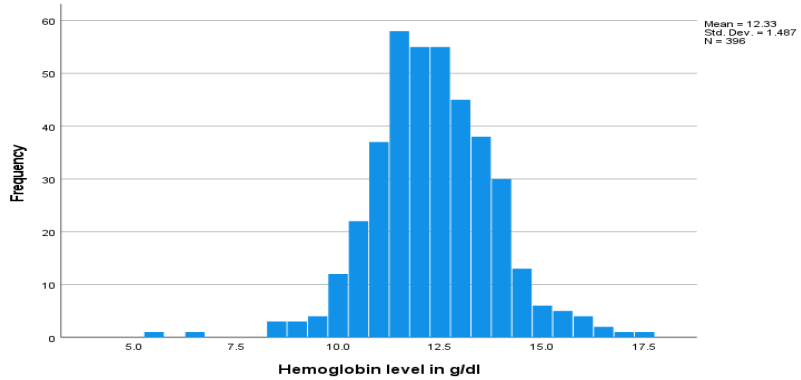


Figure 5: Hemoglobin distribution among the 1st trimester pregnant women attending ANC follow up at public hospitals in Mekelle city, Tigray, Ethiopia,2025 (n=396)

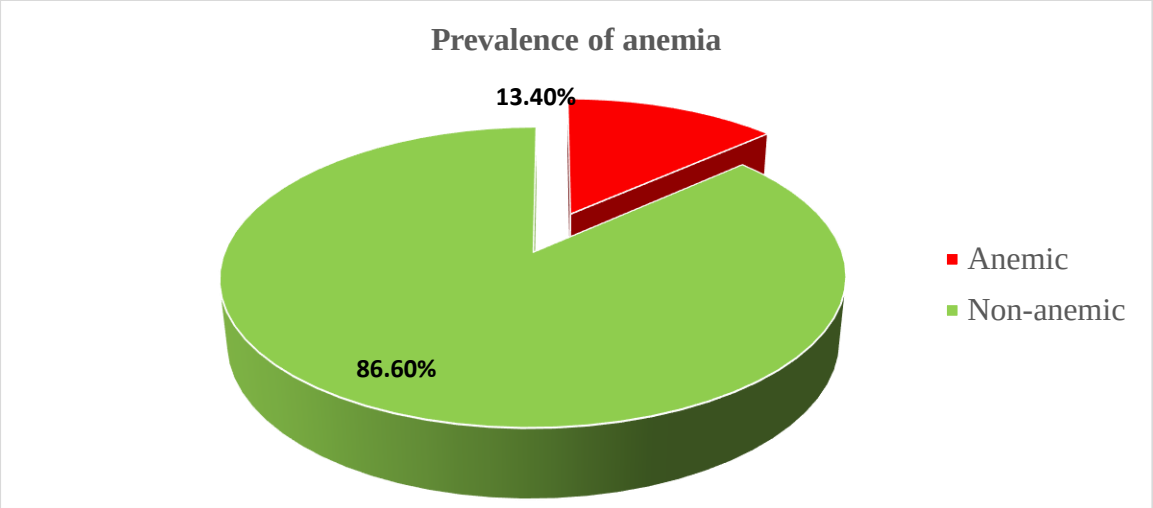


Figure 6: Prevalence of anemia among first trimester pregnant women attending ANC follow up at public hospitals in Mekelle city, Tigray, Ethiopia, 2025 (n=396)

Regarding the severity of anemia, 38(71.7%) anemia cases were mildly anemic while, 13 (24.5%) and 2(3.8%) were moderately anemic and severely anemic respectively according to WHO classification for severity of anemia (**figure 7**).

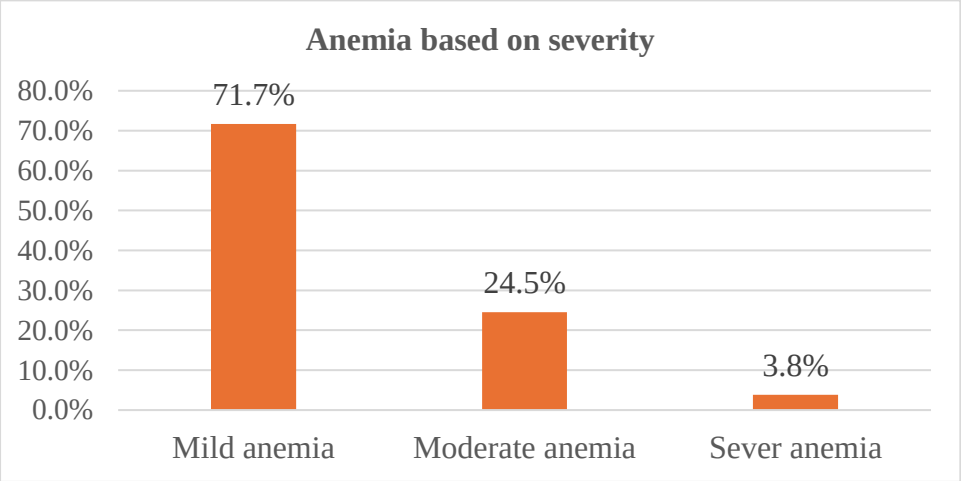


Figure 7: Distribution of anemia by severity among the anemic first trimester pregnant women attending ANC at public hospitals in Mekelle city, Ethiopia,2025(N=53).

5.6 Associated factors with Anemia in first trimester pregnancy

In bi-variable logistic regression analysis dietary diversity, feeding frequency, maternal knowledge on anemia, poor nutritional status, estimated household monthly income, coffee/tea consumption, iron folic acid supplementation and recent history of abortion showed an association with the dependent variable anemia at P-value < 0.25. All variables with P ≤ 0.25 in the bivariate analysis were included in the final model of multivariate analysis to control all possible confounders.

In multi-variable logistic regression analysis, Low dietary diversity (AOR=4.36, 95% CI: 1.74, 1..87), feeding frequency (AOR=2.43, 95% CI: 1.03, 5.72), coffee/tea consumption (AOR = 2.81, 95% C:1.22, 6.48), low mid-upper arm circumference (AOR=3.34, 95% CI:1.23,9.00), and monthly household income (AOR= 2.46, 95% CI: 1.05,5.72) were found significantly associated with anemia in first trimester pregnancy at P-value less than 0.05.

The odds of experiencing anemia among pregnant women with low DDS were 4.4 (AOR=4.42 95% confidence interval (CI) (2.03, 9.63) times higher than the pregnant women with high DDS holding other variables constant. In addition, the odds of anemia in the first trimester of pregnancy with feeding frequency three and less than three times per day were 4 times (AOR (3.96(1.63,9.61)), more likely to be affected by anemia keeping other variables constant.

The present study showed that the odds of anemia among the first trimester pregnant women exceeds 3.4 times AOR (3.80(1.35,10.73) and 2.93 (AOR 2.67(1.21,7.08) in MUAC <21 cm and MUAC 21-22.9 cm than those pregnant women with MUAC of greater than or equal to 23. Diet diversity score was also found to be statistically significant with anemia among pregnant women keeping other variables constant. First trimester pregnant who had low household monthly income (< 5000 ETB) were 2.8(AOR=2.80(1.17,6.70) times more likely to be anemic than those who had an estimated household monthly income (≥ 10,000) by holding other variables constant. Furthermore, the odds of anemia were 3.6(AOR =3 .63, 95% CI: 1.48, 8.88) times more in pregnant women with consumption of coffee/tea than pregnant women who did not take coffee/tea keeping other variables constant (**Table 4**).

Table 4: Shows a bivariable and multi-variable logistic regression analysis of the factors associated with anemia among first trimester pregnant women attending ANC at public hospitals, in Mekell, city, Tigray, Ethiopia2025(n=396)

Variable (n=396)	Categories	Anemia		COR (95% CI)	AOR (95% CI)	P-value
		Yes (%)	No (%)			
Household monthly income In ETB	< 5000	13(28.9)	32(71.1)	3.93(1.38,6.21)	2.46(1.05,5.72)	0.036 *
	5000-10000	29(12.2)	209(87.8)	3.77(1.53, 8.92)	2.48(0.90,6.48)	0.077
	≥ 10000	11(9.7)	102(90.3)	1	1	
Feeding frequency	≤ 3 times	46(18.8)	199(81.9)	4.07(1.86,8.89)	2.43(1.03,5.72)	0.042 *
	> times	7(4.6)	144(95.4)	1	1	
Maternal knowledge	No	44(18)	244(82)	2.91(1.00,8.392)	1.85(0.57,5.96)	0.3
	Poor	4(6)	62(94)	2.25(0.66,7.62)	1.96(0.50,7.62)	0.33
	Good k	5(11.9)	37(88.1)	1	1	
MUAC	< 21 cm	15(38.5)	24(61.5)	4.67(1.87,11,63)	3.34(1.23,9.00)	0.017 *
	21-22.9 cm	10(12.2)	72(87.5)	7.68(3.49,16.89)	3.18(1.31,7.68)	0.01*
	≥ 23	28(10.2)	247(89.8)	1	1	
Dietary diversity score	Low	47(20.1)	187(79.9)	6.53(2.72,15.69)	4.36(1.74,10.87)	< 0.002 *
	Adequate	6(3.7)	156(96.3)	1	1	
Consumption of coffee	Yes	46(16.5)	229(83.5)	2.8(1.28,6.14)	2.81(1.22, 6.48)	0.015 *
	No	7(5.8)	114(94.2)	1	1	
Iron folic acid supplementation	Yes	38(12.5)	267(87.5)	1	1	
	No	15(16.5)	76(83.5)	2.64(1.45,4.82)	1.85(0.92,3.70)	0.08
Recent history of abortion	Yes	8(25.8)	23(74.2)	2.47(1.04,5.86)	2.01(0.74,5.46)	0.168
	No	45(12.3)	320(87.7)	1	1	

NB: * p-value < 0.05

Abbreviations: ETB: Ethiopian Birr MUAC: Mid upper arm circumference AOR: Adjusted odds ratio CI: Confidence interval SAM: Sever acute malnutrition MAM; Moderate acute malnutrition 1: Reference

6. DISCUSSION

Maternal anemia in early pregnancy is a public health concern due to its impact on both maternal and neonatal health. In this study, the overall magnitude of anemia in first trimester pregnant women was 13.4% (95% CI: 10.2-17.1). According to the WHO classification of the public health importance of anemia, it is a mild public health problem. The magnitude of anemia in first trimester pregnant women in this study area align with previous studies conducted in Sri Lanka14.4%(69), China(prospective cohort study) 16.3%(14), and Hawassa, Ethiopia(11.5%)(60).

Besides, our finding is lower as compared to other studies reports conducted by Chauhan et al. (2024) in India(prospective cohort study) which claimed 18%(26),in Turkey by Aytaj Jafarzade(2025) 20.6%(25), in China(longitudinal observational study) 21.6%(32), in India 37.5%(24), Krishan India 93.26%(27), in Turkey 20.0%(23), systematic review in Iran 22%(34), in southwest Ethiopia (23.2%)(38).

The lower prevalence of anemia in our study area may be attributed to the city's urban nature where pregnant women might have better nutrition awareness and access to nutritious diet. However, the results of our study were higher than to the findings reported from New Zealand 2.2% (30), China 2.7%(29),Iran 8.2%(70) and Somaliland 9.4%((71). This discrepancy may arise from differences in the dietary diversity, socioeconomic status, and geographic location of our study participants compared to those in the previously stated studies. Variations in the study's duration and design may also be implicated.

Concerning the severity anemia among 1st trimester pregnant women this study reveals that about 38(71.7%) anemia cases were mildly anemic while, 13 (24.5%) and 2(3.8%) were moderately anemic and severely anemic respectively. A similar finding was reported in a study conducted in Andra pradish India, which reported 73.07% mild anemic, 20.19 % moderate anemic women(27). However, this Indian study conducted didn't report severe anemia cases as opposed to 4.0 % identified in this study. Contrary to this, Turkish study stated that mild, moderate, and severe anemia was observed among 16.64%, 3.07%, and 0.28% studied participants respectively(23) which is much lower than the findings from this study.

This present study revealed a significant association between low dietary dietary and anemia in first trimester pregnancy. The odds of having anemia were 4.4 (AOR = 4.36, 95% CI: 1.74,10.87) times likely among 1st trimester pregnant women with a low dietary diversity as compared to pregnant women with adequate DDS. This finding is consistent with other studies conucted in Sheshemene, Ethiopia (69), and by Lebso and loha (2017) in Hawassa, Ethiopia(60). This could be due to pregnancy requires physiologically high nutritional diversity

and nutritional requirements also increase dramatically during gestation not only to nourish the pregnant women but also for the growing fetus. Poor dietary diversity might also lead to a deficiency of micronutrients such as vitamins, minerals, and others trace elements that lead to insufficient dietary iron intake. Consequently, the iron store reserves levels will be decreased and ultimately anemia will appear.

This study pointed out that 1st trimester pregnant women with estimated household monthly income less than 5000 ETB (Adjusted odds ratio (AOR) = 2.46; 95% CI: 1.05, 5.72) were 2.5 times more likely to be anemic as compared to those who had an estimated household monthly income of greater than 10,000 ETB keeping other variables constant. This finding is line with studies done by Chowdhury et al (2015) in Dhaka city Bangladesh(45), in Turkey(25), Kunming, China (42),and Andra Pradish India(27) and Hawass Ethiopia(60). This might be due to the reason that having a low monthly household income limits the household's food purchasing capacity which affects the pregnant women's access to diverse diets and doomed nutrients insecure.

Nutritional status was another factor found to have a significant influence on anemia status in this study. First trimester pregnant women having MUAC <21 cm had 3.4 times (AOR=3.34; (1.23,9.00) higher risk of becoming anemic as compared to well-nourished women. Likewise, being first trimester pregnant women with MUAC 21-22.9 cm was linked with having about 2.90 times (AOR= 3.18(1.31,7.68) more risk of developing anemia as compared to the well-nourished (MUAC ≥23 cm) holding other variables constant. This finding is consistent with studies conducted in Kunming, China(42), Sub Saharan Africa, rural southwest Ethiopia and Ethiopian Somali region (17,38,41). This relationship between poor nutritional status and anemia could be explained by the fact that both result from inadequate dietary intake.

Our present study results showed that feeding frequency is less than or equal to three times per day significantly associated with anemia in the first trimester pregnancy with AOR= 2.43(1.03,5.72) holding other variables constant. this finding is in line with the studies conducted in Kunming, China(42) and a study in eastern Ethiopia(52). The possible reason could be that increasing feeding frequency increases the micronutrient intake like iron, folate and Vitamin B_{12} reduces the nutritional anemias.

Moreover, our study finding revealed that, the consumption of coffee/tea is associated with anemia in first trimester pregnant women. Those who drink coffee were 2.8 times (AOR=2.81(1.22,6.48) more likely to become anemic as compared to their counterparts who didn't take coffee. In agreement with this finding, a study done in Keffa zone found that

pregnant women who drank coffee or tea after a meal were twice as likely to experience anemia than those who did not consume coffee/tea(64). Besides, this was in line with similar studies from Kacha Birra District southern Ethiopia (38), and Adama town(12) and , Punjab, India(51). This might be due to the high caffeine and tannin contents of coffee and tea respectively which form insoluble complexes with non-heme iron and interfere with its absorption and reduce its bioavailability.

7. STRENGTHS AND LIMITATIONS

7.1 Strengths of the study

As strength of the study, primary data was collected with a high response rate.

Data collection was carried out by electronic application called kobo toolbox. This primary data may increase the accuracy of the data. The study is the of its kind to detect anemia and identify its causes at early pregnancy. Moreover, evaluating the preconception care experience and dietary diversity of the mothers was another strength.

7.2 Limitations of the study

A cross-sectional study design was utilized in this study which limits the ability to establish cause-and-effect relationship between the factors and anemia. This is hospital-based study exclusively included pregnant women who had antenatal care follow-ups, which may restrict the generalizability of the study findings to the broader populations.

8. CONCLUSION

The overall prevalence of anemia in this study using a cut off level of hemoglobin <11 g/dl (<33% hematocrit) was 13.4% which is considered a minor public health problem according to WHO cut off values for public health significance. The majority (71.7%) of them had mild anemia (hemoglobin: 10-10.9 g/dl). Dietary diversity, nutritional status, Consumption of coffee/tea, feeding frequency and socioeconomic status were found to be significantly associated with anemia in first trimester pregnant women.

9. RECOMENDATIONS

Health care providers should strengthen their counselling efforts to the first trimester pregnant women on consuming iron-rich foods, enhancement of dietary diversification, increasing their meal frequency, and delaying coffee/tea consumption after meal that inhibits iron absorption.

Health institutions should promote and enhance their capacity in educating the women of reproductive age in the community on dietary diversification, meal frequency and reduction in coffee intake in pregnant woman during their follow up because having poor nutritional status leads to anemia.

Concerned bodies and NGOs and other civic societies should try to empower women in income and decision-making power. Furthermore, this study highlights the need for preconception care therefore, regional and federal ministries of health would be better if they focus their work on iron fortification and pre-conceptional iron folic acid supplementations to address anemia at large because most of the early pregnancy anemias occur when they enter a pregnancy state with low or marginal hemoglobin level.

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8.ANNEXES

8.1 Annex i: English version participant information sheet

Research title: Magnitude and associated factors of anemia among first trimester pregnant women attending antenatal care at public hospitals in Mekelle city, Tigray, Ethiopia.

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Main Advisor: Dr. Hagos Amare (PhD)

Co-advisors: 1**.** Mr. Mulugeta Hiruy (Assistant professor) 2. Mr. Kahsu Girmay

Sponsor: Adigrat university

Introduction

Hello, my name is **Abrahaley Hadush**, and I am working at Adigrat university after I graduated with my BSc. degree in the field of public health at Adigrat university. Now I am an assistant lecturer at Adigrat university. I am planning to conduct a study on assessing the magnitude and associated factors of anemia among first trimester pregnant women attending antenatal care services at public hospitals antenatal care clinic in Mekelle city. Whatever information you provide will be kept confidential. I will not record your name on the questionnaire. Your name will not be identified in any output of this study. You have full right to withdraw from this study at any time if you are not comfortable without the need to mention the reason why you wanted to withdraw. We value your input to make this study successful.

Purpose of the study

The main purpose of this study is to assess the magnitude and associated factors of anemia among first trimester pregnant women attending antenatal care clinics at public hospitals in Mekelle city. The information that you will provide us will help us to design better policies and intervention strategies for prevention and management of anemia in the study area and in Ethiopia in general.

Procedures: If you agree to participate in this study, I will interview you about my study.

Potential risks and discomfort of participating in this research project: You may have some discomfort and there are no or minimal anticipated risks but there may be mild pain while drawing blood for laboratory tests and taking about 15 minutes for interview.

Benefits: There may not be any direct benefits to you from giving us information for the study. But, in the future if anemia prevention and control service coverage is increased you may indirectly benefit due to the healthy conditions of you and your community.

Confidentiality and privacy: The records of this study will be stored securely. All information obtained from you will be kept confidentially and cannot be disclosed without your permission. All publications will exclude any information that will make it possible to identify you as a subject.

Contacts and Questions: If you have any questions about the study please ask me now. If you have questions later, when you want additional information, or wish to withdraw, call the researcher conducting the study. If you have questions about the research, please contact Abrahaley Hadush, who is the principal investigator of this study in the University of Mekelle via his phone number 0987904419. You are deciding about allowing participation in this study. Your signature below indicates that you have read or have read to you the information provided above and has decided to participate in the study. If you later decide that you wish to withdraw to participate in the study, simply tell me. You may discontinue your participation at any time.

8.2 Annex ii: Participants informed consent form

I understand that the purpose of the study is to collect information regarding the magnitude and associated factors of anemia in first trimester pregnant women at public hospitals in Mekell city, Tigray, Ethiopia. I have read the above information, or it has been read to me. I have had the opportunity to ask questions and any questions that I have asked and have been answered to my satisfaction. I give my consent voluntarily to participate in this study, and I understand that I have the right to withdraw at any time without affecting my social life or medical care in any way.

1. Yes, of course ☐
2. No. ☐

8.3 Annex iii: Questionnaire

This structured questionnaire was used to collect the necessary data on magnitude and associated factors of anemia among first trimester pregnant women who have ANC follow up at public hospitals in Mekelle city, Tigray, Ethiopia 2024/2025 G.C. The questionnaire contains English and Tigrigna (local language) separately. These questionnaire Contains Socioeconomic and demographic characteristics related variables, maternal obstetrics and gynecological related conditions, maternal nutrition and dietary habits related questions, maternal awareness on anemia and preconception care related questions, maternal awareness on anemia and preconception care related questions, maternal health related variables and laboratory data.

English version data collection tool

Indicate the response by encircling the given alternatives/filling the blank spaces.

Questionnaire code	
Name of hospital	1. ACSH
	2. Mekelle general hospital
	3. Quiha general hospital
	4. Lekatit 11 primary hospital
Name of service delivery unit	ANC clinic/unit
Mother's MRN	
Date of data collection	
Name of data collector	
Phone number	
Part i: Socioeconomic and demographic characteristics related variables	
1.What is your age? In completed years	
2. What is your religion?	1.Orthodox
	2. Muslim
	3. Protestant
	4. Catholic
	5. Others
3. Where is your residence?	1. Urban 2. Rural
4. What is your marital status?	1. Single
	2. Married
	3. Divorced
	4. Widowed/separated
5. How many family members do you have?	
6. What is your higher educational level?	1.No formal education
	2. Elementary school
	3. Secondary school
	4. Diploma and above

7. What is your main occupation?	1.Housewife
	2.Government employed
	3.Self- employed
	4.Farmer
	5.Daily worker
	6.Others
8.What is your average estimated monthly household income (in ETB)	
Part ii. Maternal obstetrics and gynecological related conditions	
9. Gestational age in completed weeks (from the LNMP or early ultrasound)	
10. For how many times is your current pregnancy?	
11. How many times did you give birth?	
12. What is your current interpregnancy interval? (in months)	
13.If multipara, did you have ANC follow up in previous pregnancy?	1. Yes
	2. No
14. If the answer for number 13 is yes, was your ANC follow up regular/irregular?	1.Regular
	2.Iregular
15. If number 13 is yes, did you have nutritional counseling by health providers during that time?	1. Yes
	2. No
16. Did you use contraception before conception?	1. Yes
	2. No
17. Have you had a history of heavy menstrual bleeding prior to the current pregnancy?	1.Yes
	2. No
18. Did you have a history of recent abortion? With in 6 months	1.Yes 2. No
Part iii: Maternal nutrition and dietary habits related questions	
19. How many times did you feed per day?	1. ≤3 times/day 2. >3 times per day
20. MUAC (in cm)	
21.Did you take coffee/tea currently?	1.Yes 2. No
22. Did you take the tea/coffee immediately after meal?	1. Yes 2. No
23. Do you feed on vegetables?	1.Yes 2. No
24. Do you feed on fruits?	1.Yes 2. No
25. Do you eat (meat, fish or egg)?	1. Yes 2. No
26. Do you consume milk, cheese and/or yogurt?	1.Yes 2. No

27. Did you eat the following foods in the previous 24 hours (day and nighttime) weather at home or outside the home? Please consider a quantity of 15 g or more intakes for a food group to account for the dietary diversity of pregnant mothers. For many foods, 15 g is about one tablespoon.
In case of milk one cup is about 240 grams.

S.no	Food group consumption	Response	
1	Grains, roots and tubers, and plantains	1.Yes	2. No
2	Pulses (beans, peas, and lentils)	1.Yes	2. No
3	Nuts and seeds	1.Yes	2. No
4	Dairy products	1.Yes	2. No

5	Meat, poultry, and fish	1.Yes	2. No
6	Eggs	1.Yes	2. No
7	Dark green leafy vegetables like kale, spinach and salad etc	1.Yes	2. No
8	Vitamin A rich vegetables and fruits Carrot, Pumpkin, papaya and sweet potato	1.Yes	2. No
9	Other vitamin A rich vegetables like tomato and onion etc.	1.Yes	2. No
10	Other vitamin A rich fruits like banana, unripe mango and pineapple	1.Yes	2. No
28. Are there any food taboos for pregnant women in your locality?		1.Yes 2. No	
29. Did you take iron folic acid supplementation in the period 3 months before your conception?		1.Yes	
		2.No	
30. Do you take iron folic acid supplementation currently?		1. Yes	
		2.No	
Part iv: Maternal awareness on anemia and preconception care related questions			
31. Have you ever heard about anemia?		1. Yes 2. No	
32. If you heard, how did you hear?		1.Health professionals	
		2.Mass media	
		3.Others	
33. What is anemia?		1.Low level of RBCs/Hgb	
		2.Other	
34. What are the causes of anemia?		1. Malnutrition	
		2.Intestinal parasite	
		3.Malaria	
		4.Bleeding	
		5.Chronic illness	
		6.Others	
35. What are the symptoms of anemia?		1.Short ness of breath	
		2.Fatigue	
		3.Pallor	
		4.Pica	
		5.Fainting	
		6.I do not know	
36.What are the complications of anemia in pregnancy		1.Low birth weight	
		2. preterm labor	
		3. Increased fetal and neonatal death	
		4. Increased maternal mortality	
		5. Others	
37. Is anemia preventable?		1.Yes 2. No 3. I do not know	
38. If yes, what are the methods of prevention?		1.Consuming iron rich foods	
		2.Taking IFA tablets	
		3.deworming	
		4.birth spacing	
		5.I do not know	
39. Are pregnant mothers susceptible to anemia?		1.Yes 2. No 3.I do not know	

40. Is anemia treatable?	1.Yes 2. No 3.I do not know	
41.Did you know about preconception care?	1.Yes 2. No	
42. What is preconception care?	1.A health care given to the mother bef she becomes pregnant	
	2.Others	
43. What are the components of preconception care?	1.Assessing for chronic diseases	
	2.Avoiding use of harmful substances	
	3.Maintaining healthy weight	
	4.Improving nutritional status including IFAs	
	5.Health education and counseling	
	6.Others	
44. Does preconception care have importance?	1.Yes 2. No	
45. If the response to Q. no 44 is yes, for whom is the importance?	1.For the mother only	
	2.For the fetus only	
	3.For both the mother and fetus	
46. If the response for Q. no 49 is yes, what are the advantages of preconception care?	1. To prevent maternal complications during pregnancy	
	2. To have normal birth weight of the Baby	
	3.To prevent birth defects to the fetus	
	4.To reduce preterm birth	
	5. Others	
Part v: Maternal health related variables (data extraction sheet)		
47. HIV serostatus of the mother	1.Positive	2.Negative
48. Other chronic diseases like DM, CKD, Cancer	1.Present	2. Absent
49. Documented history of malaria	1. present	2. Absent
50. Documented recent history of intestinal parasitic	1.Yes	2. No
51. Do you have previous history of anemia?	1.Yes	2. No
Part vi: Laboratory data		
52. Hemoglobin level in g/dl	g/dl	
53. Hct in %	In %	
54. MCV in	Fl	
55.MCH	Pg	
56. MCHC	g/dl	
57. RBCs	Millions/cm3	

Thank you for your participation!!!

ቃለ-መሕትት (ብቋንቋ ትግርኛ)

ሽመይ----------ይባሃል። ኣብ----------እየ ዝሰርሕ ብፍላይ ድማ ኣብ ቅድሞ ወሊድ ክትትል ክፍሊ ግልጋሎት ኣየ ግልጋሎት ዝህብ።ንሕና ነካይዶ ዘለና መጽናዕቲ ብዛዕባ ዋሕዲ ደም ኣብ ትሕቲ 3ተ ወርሒ ጥንሲ ዘለወን እዴታትን መንቅሊታቱን ኣብ መቀለ ከተማ ኣንትከውን። እዚ ትህብና ሓበሬታ ድማ ኣብቲ ንገብሮ መጽናዕቲ ብጣዕሚ እድላዩ እዩ በዙይ ኣቢሉ ድማ ኣብቲ ሕ/ሰብና ዘሎ ጸግም ንምፍታሕ ክንጥቀመሉ ኢና። ስለዚ ብዛዕባ ማህበረ_ቁጠባዊ፡ ጥንስን ሕርስን፡ ስርዓተ እመጋግባ፡ ተዛመድቲ ሕዱር ሕማማትን ኣፍልጦ ዋሕዲ ደምን ዝተኣሳሰሩ ሕቶታት ክሓተኪ አየ። ብተወሳኪ ድማ 4 ሚ/ሊትር ዝከውን ደም ንላባራቶሪ ምርመራ ክትህብኒ ኢኪ። ኣቲ ቃለ መሕትት ን ኣስታት 30 ደቃይቅ ዝወስድ ኣንትከውን ኣቲ ትህብና መረዳኣታ ድማ ብ ሚስጥር ክንሕዞ ኢና። ብዘይ ናትኪ ፍካድ አውን ንዝኾነ ይኹን ኣካል ኣሕሊፍካ ኣይዋሃብን። ኣብዚ መጽናዕቲ ንምስታፍ ፍቃደኛ ዲኪ?

1. እወ **2. ኣይፋሉን**

1	መሕተቲ ኮድ	
2	ሽም ሆስፒታል	1.ዓይደር ሪፈራል ሆስፒታል
		2.መቀለ ሓፈሽዊ ሆስፒታል
		3.ኩሓ ሓፈሽዊ ሆስፒታል
		4. ለካቲት 11 መባእታዊ ሆስፒታል
3	መውሃቢ ግልጋሎት ክፍሊ	ቅድመ ወሊድ ክትትል ክፍሊ
4	ናይ ተገልጋሊት መለለዩ ካርዲ	
5	ቅጥዒ ዝተኣከበሉ ዕለት	
6	ሽም ኣካቢ ሓበሬታ	
7	ቁጽሪ ቴለፎን	
ቀዳማይ ክፋል : ማሕበረ-ቁጠባውን ስነ ህዝባውን ባህርያታት		
1	ዕድሜኪ ክንደይ አዩ? ብሙሉእ ዓመታት	
2	ሃይማኖትኪ እንታይ አዩ?	1. ኦርቶዶክስ ክርስትና
		2. ሙስሊም
		3. ፕሮቲስታንት
		4. ካቶሊክ
		5. ካለኦት ግለጽ/ጺ
3	ነባርነትኪ ኣበይ እዩ?	1. ከተማ
		2. ገጠር
4	ኩነታት ሓዳርኪ እንታይ እዩ?	1.ዘይተመዓወት
		2.በዓል ሓዳር
		3.ዝተፋተሐት

		4.ማእምን/ዝተፋላለየት
5	ጠቅላላ በዝሒ ኣባላት ስድራቤትኪ ክንደይ እዮም?	
6	ዝለዓለ ደረጃ ት/ትኪ ክንደይ እዩ?	1.ዘይተማሃረት
		2. ቀዳማይ ደረጃ ት/ቲ
		3. ካል ኣይ ብርኪ ት/ቲ
		4. ዲፕሎማን ልዕሌኡን ዝኮነት
7	እቲ ቀንዲ ስራሕኪ እንታይ እዩ?	1.ኣላይት ገዛ
		2.መንግስቲ ስራሕተኛ
		3.ናይ ባዕላ ትስርሕ
		4.ገባረይቲ
		5.ማዓልታዊ ስራሕተኛ
		6.ካለኣ ግለጺ
8	ብማእከላይ ወርሓዊ ናይ ገዛኩም/ኪ ኣታዊ ክንደይ እዩ? ብናይ ኢትዮጵያ ቅርሺ	
ካልኣይ ክፋል፡ ምስ ኩነታት ጥንስን ሕርስን ኣደ ዝተኣሳሰሩ ሕቶታት		
9	ካብ ትጠንሲ ክንደይ ሰሙን ገይርኪ? ካብ ኣልትራሳውንድ/ ወርሓዊ ኣበባ ዝስላሕ	
10	ጥንሲ ንመበል ክንደይ ግዜኪ እዩ?	
11	ዝወለደት እንተኮይና ክንደይ ግዜ ወሊድኪ?	
12	እንድሕር ዝወለድኪ ኮይንኪ በቢ ክንደይ ግዜ ኣፋላላይ ትጠንሲ? ብኣዋርሕ	
13	ቅድሚ ሕዚ ወሊድኪ እንተንይርኪ ጥንሲ ክትትል ነይሩኪ ዶ?	1.እወ 2. ኣይፋሉን
14	መልሲ ቁጽሪ 13 እወ እንድሕር ኮይኑ ብ ስሩዕ ዶ ትከታተሊ ነይርኪ?	1.ብስሩዕ
		2.ብዘይስሩዕ
15	ኣብ እዋን ጥንሲ ክትትልኪ ብዛዕባ ስነ ማዓዛ ኣስተምህሮ ዶ ተዋሂቡኪ ነይሩ	1.እወ
		2.ኣይፋሉን
16	ቅድሚ ምጥናስኪ መከላከሊ ጥንሲ ዶ ትጥቀሚ ኔርኪ?	1.እወ
		2.ኣይፋሉን
17	ቅድሚ እዚ ጥንሲ ወርሓዊ ጽግያትኪ ይበዝሓኪ ነይሩ ድዩ?	1.እወ
		2.ኣይፋሉን
18	ኣብዚ ቀረባ ግዜ ጥንሲ ከይዱኪ ድዩ/ሰዲድኪ ዲኪ?እብ ውሽጢ ሽዱሽተ ወርሒ	1.እወ
		2.ኣይፋሉን
ሳልሳይ ክፋል፡ ስነ ማዓዛን ኩነታት ኣመጋግባን ኣደ ዝምልከቱ ሕቶታት		
19	እብ ማዓልቲ ክንደይ ግዜ ትበልዒ?	1.ልዕሊ ስለስተ ግዜ
		2.ስልስተ ግዜን ትሕቲኡን
20	መጠን ላዕለዋይ ቅልጽም ኢድ? ብሙዋክ	
21	ሽሂ/ቡና ትወስዲ ዲኪ ኣብዚ ሕዚ ኣዋን?	1.እወ
		2.ኣይፋሉን
22	ቁጽሪ 21 እወ እንድሕር ኾይኑ ወድያውኑ ድሕሪ ምግቢ ዲኪ ትወስድዮ?	1.ኣወ
		2.እይፋልን
23	ኣትክልቲ ትምገቢ ዶ?	1.እወ

		2.ኣይፋሉን		
24	ፍራምረ ትምገቢ ዶ?	1.እወ		
		2.ኣይፋሉን		
25	ስጋ፣ ዓሳ ኣንቋቁሑ ትምገቢ ዶ?	1.እወ		
		2.ኣይፋሉን		
26	ጸባን ውጸኢት ጸባን ትምገቢ ዶ?	1.እወ		
		2.ኣይፋልን		
27	ኣብ ውሽጢ 24 ሰዓት ማለት ቀትርንለይትን እዞም ዝስዕቡ ምግብታት/ዝስተዩ ኣብ ገዛ ኮነ ኣብ ደገ በሊዕኪ ዶ ነይርኪ?ልዕሊ 1 ማንካ(15 ግ) ሽኮር ንዝብልዑ፣ንዝስተኡ ድማ ኣብነት ከም ጸባ ዝበሉ 1 ኩባያ(200 ግ)				
	ተቁ	ዓይነት ጉጅለ ምግብታት	መልሲ		
	1	ኣዝርእቲ	1.እወ	2.ኣይፋሉን	
	2	ናይ ጸብሒ ጥራምረ	1.እወ	2.ኣይፋሉን	
	3	ለውዝ፣ ኦቾሎኒ	1.እወ	2.ኣይፋሉን	
	4	ጸብን ውጸኢት ጸባን	1.እወ	2.ኣይፋሉን	
	5	ስጋ፣ደርሆ፣ዓሳ	1.እወ	2.ኣይፋሉን	
	6	ኣንቋቁሑ	1.እወ	2.ኣይፋሉን	
	7	ጸሊም ሕብሪ ዘለዎም ኣሕምልቲ ስላጣ፡ ቼስጣ፣ሓምሊ	1.እወ	2.ኣይፋሉን	
	8	ብ ቫይታሚን ኤ ዝማዕበሉ ኣሕምልትን ፍራምረን ከም ካሮት፣ፓፓያ	1.እወ	2.ኣይፋሉን	
	9	ካለኦት ብ ቫይታሚን ኤ ዝማዕበሉ ኣሕምልትን ኮሚደረ፣ ሽጉርቲ	1.እወ	2.ኣይፋሉን	
	10	ካለኦት ብ ቫይታሚን ኤ ዝማዕበሉ ፍራምረ ባናና፣ዱባ፡ማንጎ	1.እወ	2.ኣይፋሉን	
28	ንጥንስቲ ዝክልከሉ ምግብታት ኣብ እትነብርሉ ከባቢ ኣለዉ ድዮም?	1.ኣሎ		
		2.የለን		
29	ቅድሚ ምጥናስኪ ኣይረን ንጥረ ነገር ትወስዲ ነይርኪ ዲኪ?	1.እወ 2. ኣይፋሉን		
30	ሕዚ ኣይረን ፎሊክ ኣሲድ ትወስዲ ኣለኪ ዶ?	1.እወ 2. ኣይፋሉን		
ራብዓይ ክፋል፡ ናይ ኣደ ኣፍልጦ ብዛዕባ ዋሕዲ ደም ዝምልከቱ ሕቶታት				
31	ብዛዕባ ዋሕዲ ደም ሰሚዕኪ ዶ ትፈልጢ?	1.እወ 2. ኣይፋሉን		
32	ኣንተሰሚዕኪ ካብ ምንታይ ሰሚዕኪ?	1. ብጥዕና ባዓል ሞያ		
		2. ካብ መራከቢ ሓፋሽ		
		3. ካብ ካለኦት ግለጺ		
33	ዋሕዲ ደም እንታይ ማለት እዩ?	1.ዋሕዲ ቀያሕቲ ዋህዮታት ደም/ ሄሞግሎቢን ምንኣስ		
		2. ካሊእ		
34	መንቀልታት ዋሕዲ ደም ትፈልጥዮም ዶ? ካብ ሓደ ብላዕሊ መልሲ ምቅማጥ ይካኣል ኣዩ?	1. ሕጽረት ምግቢ		
		2. ጽግዕተኛ ሓሳኩ		
		3. ዓሶ		

		4. መድመይቲ
		5.ሕዱር ሕማማት
		6. ኣይፈልጥን
35	ዋሕዲ ደም ዘለዎ ሰብ ኣንታይ ኣንታይ ምልክታት የርኢ?	1. ሕጽረት እስትንፋስ
		2. ሓያል ድካም ስሚዒት
		3.ምጽዕዳው ቆርበት
		4 ውነ ምስሓት
		5. ኣይፈልጥን
36	ሳዕቤናት ዋሕዲ ደም እንታይ እንታይ እዮም?	1.ትሕቲ ክብደት ዝኮነ ህጻን ምውላድ
		2.ግዚኡ ዘይኣከለ ሕርሲ
		3.ሞት ዕሽላት ይውስክ
		4.ሞት ኣዴታት ይውስክ
		5.ካሊእ
37	ዋሕዲ ደም ክንከላከሎ ንክእል ዶ?	1.እወ
		2. ኣይፋሉን
		3. ኣይፈልጥን
38	መካላከሊ መንገድታት ዋሕዲ ደም እንታይ ኣንታይ ኣዮም?	1. ኣይረን ዝሓዙ ምግብታት ምምጋብ
		2. ኣይረን ክኒና ምውሳድ
		3. ጽረ -ሓሳኩመድሓኒት ምውሳድ
		4. ኣራሓሒቂቅካ ምውላድ
		5. ኣይፈልጦን
39	ጥንስቲ ኣዶ ን ዋሕዲ ደም ተቃላዒት ኣያ ኢልኪ ዶ ትሓስቢ?	1.እወ
		2. እይፋሉን
		3. ኣይፈልጦን
40	ዋሕዲ ደም ክሕከም ይካኣል ዶ?	1.እወ 2. ኣይፋልን
41	ብዛዕባ ቅድሚ ጥንሲ ክንክን ጥዕና ትፈልጢ ዶ?	1.እወ 2. ኣይፈልጥን
42	ቅድመ ጥንሲ ዝግበር ክንክን ጥዕና እንታይ ማለት እዩ?	1.ሓንቲ ኣደ ቅድሚ ምጥናሳ ክትገብሮም ዝግባኣ ናይ ጥዕና ክንክናት
		2.ካሊእ መልሲ
43	ቅድሚ ጥንሲ ዝግበር ክንክን ጥዕና እንታይ እንታይ ዝሓዘ አዩ?	1.ምርመራ ሕዱር ሕማማት
		2.ምውጋድ ዘየድዩ ወልፍታት
		3.ጥዕና ዘለዎ ክብደት ምህላው
		4.ምምሕያሽ ስርዓተ ኣመጋግባ
		5.ጥዕና ኣስተምህሮን ምክርን
		6.ካሊእ
44	ቅድሚ ጥንሲ ክንክን ጥዕና ጥቅሚ ኣለዎ ዶ?	1.እወ 2. እይፋሉን
45	መልሲ ቁ 44 እወ ኣንተኮይኑ ቅድመ ጥንሲ ክንክን ጥዕና ንመን ይጠቅም?	1. ን ኣደ ጥራሕ
		2.ንዕሽል ጥራሕ

		3.ንክልቲኦም ንኣደን ንዕሽልን	
46	መልሲ ቁ 44 እወ አንተኮይኑ ቅድመ ጥንሲ ክንክን ጥዕና እንታይ እንታይ ጥቅምታት ኣለውዎ?ካብ ሓደ ብላዕሊ መልሲ ምቅማጥ ይካኣል እዩ?	1.ናይ ኣደ ዝተሓላለኩ ጸገማት ይቅንስ	
		2.ስሩዕ ክብደት ዘለዎም ህጻናት ንክንወልድ ይሕግዘና	
		4.ዘይንቡር ኣፋጣጥራ ዕሽላት የትርፍ	
		5.ኣብ ዘይግዝየኡ ዝመጽእ ሕርሲ ይከላከል	
		6.ካሊእ	
ሓምሻይ ክፋል፡ ናይ ኣደ ሕማማት ዝምልከቱ ሕቶታት(ካብ ማህደር ተሓካሚት ዝምላእ)			
47	ኤች ኣይ ቪ ኤድስ ኣብ ደም ናይ ምህላው ኩነታት?	1. ኣለዋ	2. የብላን
48	ካለኦት ሕዱር ሕማማት ኣለዉ ድዮም? ሽኮርያ፣ ኩላሊት)	1.ኣለዋ	2. የብላን
49	ኣብ ቀረባ እዋን ኣብ ማህደር ዝሰፈረ ናይ ሕማም ዓሶ ምህላው	1.ኣሎ	2. የለን
50	ኣብ ቀረባ እዋን ኣብ ማህደር ዝሰፈረ ናይ ጽግዕተኛ ሓሳኩ ሕማም	1.ኣሎ	2. የለን
51	ቅድሚ ምጥናሳ ዝነበረ ዋሕዲ ደም	1.ኣለዋ	2. የብላን
ሻድሻይ ክፋል፡ ናይ ላቦራቶሪ ዳታ ዝምልከት			
52	ሄሞግሎቢን	ብ ግ/ዴ/ሊትር	
53	ሄማቶክሪት	ብ %	
54	ኤም ሲ ቪ	ብፌሞሊትር	
55	ኤም ሲ ኤች	ብፒግ	
56	ኤም ሲ ኤች ሲ	ግ/ዴ/ሊትር	
57	ኣር ቢ ሲስ	ብሚልዮን/ሚ/ሜ^3	

ንተሳትፎኺ ኣዝየ የመስግን!!!

8.3 Annex iv: Hematological parameter testing principles

Hemoglobin measurement principle

The hemoglobin measurement principle by Sysmex hematology autoanalyzer was based on sodium lauryl sulphate (SLS)-hemoglobin method. Which is a cyanide free hemoglobin measurement technique. This method measure absorption value of transmitted light at 555nm wavelength for diluent from that for Hb sample(72)

The Sysmex autoanalyzer measures hemoglobin by cyanide free method. It measures the absorption value of transmitted light at 555nm for diluent every measurement and calculates Hb values that is determined by deducting the absorption value of transmitted light at 555nm for diluent from that for Hb sample (Colorimetric Method). LED and photodiode are used as a light source and a photo detector, respectively. Measurement method is SLS-Hb method. The sodium lauryl sulphate (SLS)-Hemoglobin (SLS-Hb) detection method uses cyanide-free SLS. The reagent lyses red and white blood cells in the sample.

The chemical reaction begins by altering the globin and then oxidizing the heme groups. Then the hydrophilic portions of the SLS bind to the heme group and form a stable, colored complex (SLS-Hb), which is analyzed using a photometric method. An LED sends out monochromatic light and by moving through the mixture, light is absorbed by the SLS-Hb complexes. The absorbance is measured by a photo sensor and is proportional to the hemoglobin concentration of the sample. This method is usually less influenced by specimen turbidity caused by interferences such as lipemia and leukocytosis.(72–74).

Testing principles for RBCs and RBC indices

Hematology automated hematology analyzers use a combination of techniques, primarily electrical impedance and light scattering, to analyze blood samples and determine hematological parameters like red blood cell (RBC) indices. The analyzer measures RBC count, size, and hemoglobin content, and then calculates indices like mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC)(75).

8. 4 Annex v: SOP for hemoglobin measurement using hematological autoanalyzer

1. Whole blood anticoagulated with potassium EDTA is preferred. Sodium citrate may be used when EDTA platelet clumping is noted on the EDTA specimen.
2. A minimum volume of 1mL is required for Sampler (Auto) Mode.
3. An EDTA micro-container filled above the 250 pL line is adequate for testing in open mode. Clotted samples, Grossly Hemolyzed samples, Samples drawn from IV/Diluted samples.
4. Specimens should be Stored at 4°C, EDTA samples with normal results may be analyzed up to 36 hours without significant loss of differential stability
5. Allow refrigerated specimens to come to room temperature and mix well before analysis.
6. Reagents Sysmex reagents are stored at room temperature out of direct sunlight.
7. Reagents are stable unopened until manufacturer's expiration date or 60 days after being opened.
8. Standard precautions are used when handling bleach and reagents to prevent potential contamination of reagents or harm to technologists.
9. Use appropriate reagents like diluent, stromatolyser-4DL, stromatolyser-4DS, sulfolyser and cell clean.
10. Perform the laboratory analysis.
11. Results Reporting and verification. Results will print automatically. If values fall in critical range, i.e., Hb < 8.o g/dL or > 18 g/dL urgently inform nursing staff or doctor.
12. Perform calibrations and quality control accordingly.
13. Shut Down - performed every 24 hours.

Annexed table 1: Collinearity diagnostics of the multi-variable logistic regression model among the predictor variables of anemia among first trimester pregnant women

Collinearity diagnostics

Model	**T**	**Sig**	**Collinearity statistics**	
			Tolerance	VIF
1.(Constant)	6.652	.000		
MUAC	2.924	.004	.849	1.178
Feeding frequency	1.673	.095	.858	1.165
Coffee drinking	2.519	.012	.990	1.010
Household monthly income	1.333	.183	.928	1.078
Knowledge	.982	.326	.940	1.064
Recent history of abortion	1.570	.117	.989	1.011
Dietary diversity	3.765	.000	.954	1.049
Iron folic acid supplementation	-1.738	.083	.914	1.095

Abbreviation: VIF: Variance inflation factor Sig: Significance

Annexed table 2: Hosmer and Lem show test

Step	Chi-square	Degree of freedom	Sig
1	5.688	8	0.682

This Hosmer and Lem show test indicates that the model was fitted since the p-value is greater than α-value (0.05).