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Iron Deficiency Anemia and Associated Factors Among Pregnant Women Attending Antenatal Care at Nekemte Comprehensive Specialized Hospital, Nekemte, Western Ethiopia, 2023: A Cross-Sectional Study

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Abstract: Purpose: Iron deficiency Anemia (IDA) is the most widespread nutritional problem in the world causing 75% of anemia among pregnant women. Despite the wider scope of the problem, limited evidence has been documented to disclose the magnitude of Iron deficiency anemia and associated factors in women attending Antenatal care unit in Ethiopia, including the study area. **Methods:** Facility-based cross-sectional study was conducted among randomely selected 169 pregnant women attending antenatal care unit from July 01 to August 30, 2023 in Nekemte Comprehensive Specialized Hospital, Nekemte, Western Oromia. The data was collected using pretested structured questionnaires. Hemolobin, mean cell volume and mean cell hemoglobin concentration were measured using automated, quality-controled hematology analyzer (Japan, Sysmex corporation). After collection, the data was entered into Epi Data version 4.6 and analyzed using Statistical Software for Social Sciences (SPSS) version 24. Bi-variable and multivariable binary logistic regression analysis were performed to identify predictors of IDA. Adjusted odd ratios (AOR) with 95% confidence intervals (CIs) were computed to measure the strength of the association between dependent and independent variables. Level of statistical significance was declared at p-value <0.05. Finally, the results were presented using text, tables, and charts. **Result**: The magnitude of iron deficiency anemia using a cut off level mean cell volume (MCV)<80fl and mean cell hemoglobin concentration (MCHC) < 32g/dl was 10.06% (95%CI: 6.2%-15.3%). History of chronic illness (AOR=4.62; 95%CI: 1.54-13.81), undernutrition (MUAC<23) (AOR=3.84; 95%CI: 1.14-12.94)] and initiation of ANC at second trimester (AOR=4.94; 95%CI: 1.37, 17.79) showed significant association with iron deficiency anemia among pregnant Women. **Conclusion**: The magnitude of iron deficiency anemia among pregnant women in this study was mild. Having history of chronic illness, mid-upper arm circumference (MUAC) <23cm and initiation of antenatal care at second trimester were significant predictors of IDA among pregnant women. Thus, regular medical checkup, early initiation of antenatal care and providing information on dietary diversity practice are vital to prevent IDA among pregnant women in the study area.

Keywords: iron deficiency anemia; pregnant women; Nekemte comprehensive specialized hospital; Ethiopia

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Introduction

Iron deficiency anemia is a reduction in the amount of red blood cells, which is caused by a lack of iron and which decreases the amount of oxygen transported to the cells of the body [1]. In an individual with iron deficiency anemia, red blood cells are generally smaller than normal (Microcytic) and paler than normal (hypochromic). Complete blood count (CBC) usually shows reduced hemoglobin with low MCV, low MCHC, and mild thrombocytosis. Iron deficiency is not clinically apparent until anemia is severe even though functional consequences might already exist [2].

Physiologic anemia of pregnancy due to relatively higher expansion of blood volume in comparison with elevated red blood cell (RBC) mass also occurs frequently. In normal pregnancy, mass of red blood cells increases by 20–50%, whereas the plasma volume increases by 40–60%. As a result, a physiologic anemia, develops, resulting in a normal hematocrit percentage of 30–32%. When hemoglobin levels fall below 10 g/dL, a pathologic condition, like a dietary deficiency, may be present. Pregnancy-related anemia prevalence rises from 8% in the first trimester to 12% and 34% in the second and third trimesters, respectively [3].

There are significant daily iron requirements during pregnancy due to several reasons. In the first place, Iron is needed in greater amounts for the increased RBC mass observed early in pregnancy, as well as for fetal RBC production and placental expansion, because it is a necessary component of hemoglobin, myoglobin, and cytochromes. Additionally, cytochromes' iron is essential for the production of Adenosine Triphosphate (ATP). Pregnancy also increases the need for ATP to promote the development of the organs, especially the brain. Consequently, the need for iron rises to 4-5 mg per day by the second trimester. On the other hand, since placenta is large in size and metabolically active, it has ability to store iron and delivery leads to loss of approximately 250 mg of Hg [4].

There is a broad spectrum of IDA symptoms. Reduced blood oxygen levels can cause angina, tachycardia, palpitations, exhaustion, and shortness of breath. A compensatory reduction in intestinal blood flow brought on by the ensuing hypoxemia may result in motility disorders, poor absorption, nausea, weight loss, and abdominal pain [5]. Reduced thermoregulation, exhaustion, impaired concentration, decreased working capacity, decreased production of breast milk by the mother, and depletion of the mother's iron stores during the postpartum phase are further consequences of IDA [6]. In addition, increased risk of developing perinatal infection, preeclampsia, bleeding, postpartum cognitive impairment, behavioral difficulties , premature birth and low birth weight are consequences of IDA [7,8]. Furthermore, IDA in the mother is linked to neurological abnormalities in the infant as well as long-term effects like schizophrenia, autism, and memory problems [9].

Globally, about bout 38% (32 million) pregnant women are found to be anemic among which Africa accounted for 46.2% (9.2 million) [10]. In addition, about 30 – 40% of pregnant women are iron deficient and about half of them are anemic worldwide [11]. Trends and prevalences of IDA vary from region to region and among countries. Study findings from China, Thailand, Jordan, India, Somali and Nigeria revealed prevalences of IDA accounting for 8.6% [12], 13.2% [13], 21.7% [14], 52% [15], 36% [16] and 7.1% [17], respectively. In Ethiopia, studies on IDA and its associated factors are very limited. Findings from Eastern Ethiopia, Harar, Eastern Ethiopia, Haramaya district, West Arsi, Dodola and southern Ethiopia, Wolaita reported the prevalence of IDA were 32,1% [18], 28.03% [19], 19.3% [20] and 11.3% [21], respectively.

The causes of IDA during pregnancy in developing nations are complex and include nutritional deficiencies in iron and infections from hookworm and malaria [22]. In addition, poor iron absorption of iron from diet, heavy blood loss, cancer, tuberculosis and human immunodeficiency virus (HIV) are also risk factors for IDA [23]. On the other hand, study findings revealed that short birth interval, not following ANC, and MUAC<23 cm are also risk factors for IDA among pregnant women [24]. Furthermore, multiparity, third trimester pregnancy, low educational level and low socioeconomic status are another risk factors contributing to IDA [25].

Despite the wider scope of the problem, limited research findings have been documented to disclose the magnitude of IDA in women attending Antenatal care in Ethiopia, especially in the study

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area. Hence, the aim of this study was to assess the magnitude of IDA and associated factors among pregnant women attending ANC at Nekemte Comprehensive Specialized Hospital, Nekemte Town, Western Ethiopia.

Methods And Materials

Study Area, Period and Design

Nekemte Comprehensive Specialized Hospital is located in Nekemte town, East Wallaga zone, Oromia Region at distance of 328 kilometers from capital city Addis Ababa. It is one of the oldest Hospitals within the region responsible for providing a comprehensive package of preventive, promotive, curative and rehabilitative health services to the community at large. Currently, the Hospital renders the service for 3.5 million catchment population, serving as a referral center for the western part of Ethiopia. The hospital has different departments, of which the obstetrics and gynecology department is one of the main departments. This department gives antenatal care (ANC), pregnancy-related problem diagnosis and management, delivery and post delivery services. This study was conducted from July 01 to August 30, 2023. An institutional-based cross-section study was conducted.

Population and Eligibility Criteria

All pregnant women attending ANC services at Nekemte Comprehensive Specialized Hospital, were the source population. On the other hand, systematically selected pregnant women who fulfilled inclusion criteria and available during data collection were study population. Pregnant women aged ≥18 years were included while those who were seriously ill and unable to respond to the interview were excluded.

Sample Size Determination **and** Sampling Procedures

Sample size was calculated using single population proportion by considering $Z\alpha/2$, 95% confidence level, marginal error and proportion of iron deficiency anemia (11.3%) from previous study [21].

$$n = \frac{(Z\alpha/2)2p(1-p)}{d^2} \qquad n = \frac{(1.96)^2\, p(1-p)}{(0.05)^2} = \frac{0.38416 \times 0.113 \times 0.887}{0.0025} = 154$$

By adding 10% for non-response rate, the final sample size was 169. Study participants were recruited by systematic random sampling until 169 pregnant women were attained.

Study Variables

Iron deficiency anemia was dependent variable. In addition, sociodemographic factors, obstetric factors, health/environment related factors and nutritional factors were independent factors.

Data Collection Tool and Procedure

Data were collected using an interviewer-administered structured questionnaire and laboratory investigation. The questionnaire was prepared from similar studies conducted before and modified based on the local context. It was prepared in English and translated to the local language (Afan Oromo) and then re translated to English to check its consistency. The questionnaire addressed; socio-demographic factors, obstetric related factors, health related factors, nutritional and environmental factors. Clinical data were collected by two BSc nurses. The Minimum dietary diversity (MDD) was assessed using 24hours recall method. Consumption of ≥5 food items from the ten [10] food category within 24hours was considered adequate, whereas < 5 food items was considered inadequate whether she drinks or eats from her own home or outside her home. The nutritional status of the participants was assessed by measuring MUAC halfway between the olecranon and acromion process using non-stretchable tape to the nearest 0.1 cm. Under nutrition is defined as MUAC less than < 23 cm while normal nutritional status considered to be ≥ 23 cm or more.

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Blood Sample Collection and Analysis

Blood sample collection and laboratory testing were performed by two laboratory technologists following available standard operating procedure. Using sterile 5 ml disposable syringe, 3ml of venous blood was collected in Ethylenediamine tetra acetic acid (EDTA) aseptically. The collected blood sample was then transported to Nekemte Public Health Research Laboratory Center for analysis. Using automated hematology analyzer (Sysmex KX-21N), Hg, MCV and MCHC were measured. Furthermore, standard operational procedures were followed during all laboratory sample collection, analysis and recording.

Data Management and Quality Assurance

Data Management

Training was given for data collectors, sample collectors and supervisors on the objective of the study and how to collect the data. Information on the objective and relevance of the study was explained to all study participants. The tool was pretested with 5% of the sample size at Wallaga University Comprehensive Specialized to evaluate for its reliability. Data were checked for completeness and consistency, and any incomplete information was checked and corrected. To ensure consistency, coding, a double entry and cleaning was performed. The whole data collection process was guided by the principal investigator.

Operational Definitions

Iron deficiency anemia: is Microcytic Hypo chromic Anemia in which RBC are smaller than normal (MCV<80fl) and have decreased red color (MCHC<32g/dl)

Mean Corpuscular Volume: is a measurement of the average size of red blood cells in a sample of blood.

Mean corpuscular hemoglobin concentration: is the average concentration of hemoglobin contained in a red blood cell.

Microcytic anemia: are characterized by red blood cells with a mean corpuscular volume of less than 80 fl.

Hypo chromic anemia: is a type of anemia in which the red blood cells are paler than normal and is MCHC<32g/dl.

Microcytic Hypo chromic Anemia: is the type of anemia in which the circulating Red blood cells are smaller than the usual size and have decreased red color

Anemic pregnant women: Pregnant women that have blood hemoglobin concentration below 11 g/dl[40].

Mild anemia in pregnancy: Blood hemoglobin concentration between 10-10.9 g/dl.

Moderate anemia in pregnancy: Blood hemoglobin concentration between 7-9.9 g/dl.

Severe anemia in pregnancy: Blood hemoglobin concentration less than 7 g/dl

Minimum Dietary Diversity for Pregnant Woman: Consumption of at least 5 food items from the ten [10] food category with in 24hours whether she drinks or eats from her own home or outside her home

Quality Assurance

Prior to data collection, data collectors were trained, study participants were informed and asked for their consent. Practical exercise on MUAC measurement was practiced by data collectors to ensure the quality and minimize technical and observation biases. Measurements were checked with a calibrated ruler, starting at the arrows and continuing to the end of the tape. All the mm and cm markings were precise, accurate and clearly legible.

In the preanalytical phase of the laboratory testing process, study participants were identified and blood specimens were collected at reception room. Specimen containers (EDTA tubes) were

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properly labeled with participant identifier code, collector initial and collection date and time. All reagents were checked for integrity before working with them. Then, the collected specimens were transported immediately to Nekemte Public Health Research and Referral Laboratory Center for analysis. All patient information were checked for their clarity and completeness.

In the analytical phase, fully automated Sysmex KX-21N hematology analyzer was used. This analyzer is a quality-controlled equipment and generates accurate and reliable results. In addition, regular maintenances were performed as one of elements for good equipment management. Furthermore, in post analytical phase of the process, reported results were cross-checked by laboratory experts in the department. The reported test result was verified by formally assigned result verifier in the laboratory. Laboratory results were recorded carefully on test result form and separate registration book. Specimens were stored in appropriate refrigerator as per specimen retention policy of the laboratory for specified period of time.

Data Processing and Analysis

The data were checked for completeness and consistencies during the data collection. The collected data were coded and entered in to Epi-Data v4.6 and exported to SPSS v24.0 for analysis. Descriptive statistical analysis was conducted using frequency and percentage. Summary tables and charts were used to describe the study population by explanatory variables.

Both bi-variable and multivariable binary logistic regression analysis were performed to determine the association between explanatory and outcome variables. First a bi-variable analysis was done to assess candidate variables for multivariate analysis. Then, variables with p-value below 0.25 were considered candidates for multivariate analysis. In the multivariate analysis, the strength and significance of association was determined by AOR and p-value below 0.05, respectively.

Results

Socio-Demographic Characteristics of the Study Subject

A total of 169 pregnant women attending antenatal care were included in the study making a response rate of 100%. About 92 (54.4%) of the study participants were found in the age group of 25–35 years. Almost all, 165(97.6%) of the respondents were married and most, 122(72.2%) of them were protestant religious followers, followed by orthodox 31 (18.3%), and 128(75.8%) of the respondents had attended secondary school and above (Table 1).

Table 1. Sociodemographic characteristics of pregnant women attending antenatal care at Nekemte Comprehensive Specialized Hospital, Nekemte, Western Ethiopia, 2023.

Variables	Category	Frequency	Percent (%)
Age(years)Mean(±SD)	25.38(±4.44) 18-24	76	45.0
	25-35	85	50.3
	>35	8	4.7
Marital Status	Married	165	97.6
	Single	4	2.4
Occupation	House wife	86	50.9
	Employed	43	25.4
	Merchant	31	18.3
	Student	9	5.3
Religion	Orthodox	31	18.3
	Muslim	16	9.5
	Protestant	122	72.2
Educational Level	Unable to read and write	6	3.6

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	Primary education (1-8grade)	35	20.7
	Secondary education (9-12)	53	31.4
	College and above	75	44.4
Family size	<5	147	87.0
	≥5	22	13.0

Reproductive Characteristics of Respondents

Of the study participants, more than two-third, 125 (74%), were multigravida and almost all, 142 (84%) had history of contraceptive use. Majority 144 (85.2%) of them were using iron supplementation during the study period. Concerning gestational age, 11 (6.5%), 58 (34.3%), and 100 (59.2%) were in first, second, and third trimester of pregnancy respectively. More than half 89(52.7%) of the study participants start their ANC visit at first trimester (Table 2).

Table 2. Obstetrics and gynecologic related factors of pregnant women attending antenatal care at Nekemte Comprehensive Specialized Hospital, Nekemte, Western Ethiopia, 2023.

Variables	Category	Frequency	Percent (%)
Gravidity (1.72(±0.45)	Primigravida	44	26.0
	Multigravida	125	74.0
Parity (1.99(±0.83)	Nullipara	58	34.3
	Primipara	54	32
	Multipara	57	33.7
History of Contraceptive use	Yes	142	84.0
	No	27	16.0
IFA supplementation	Yes	144	85.2
	No	25	14.8
History of Abortion	Yes	30	17.8
	No	139	82.2
Trimester at first ANC	1st Trimester	105	62.2
	2nd trimester	64	37.9
Gestational age	1st Trimester	11	6.5
	2nd trimester	58	34.3
	3rd trimester	100	59.2
Birth interval	<2years	26	15.4
	≥2years	96	56.8
	Primigravida	44	26.0

Nutritional and Health Related Factors of Respondents

From all study participants, 116(68.6%) had no history of chronic illnesses and almost all 157(92.2) had no history of malarial attack during the study period. Majority, 122(72.2%) of pregnant women had been dewormed in the last six months and 163(96.45%) know their HIV serostatus, with 161(95.3%) and 2(1.2%) negative and positive, respectively (Table 3).

Table 3. Nutritional and Health related factors of pregnant women attending antenatal care at Nekemte Comprehensive Specialized, Nekemte, Western Ethiopia, 2023.

Variables	Category	Frequency	Percent (%)
Malarial attack in the last 12 months	Yes	12	7.1
	No	157	92.9
History of Chronic illnesses	Yes	23	13.6
	No	146	86.4
Deworming in the last 6 months	Yes	47	27.8

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	No	122	72.2
HIV status	Positive	2	1.2
	Negative	161	95.3
	Unknown	6	3.6
Nutritional status	MUAC<23	33	19.5
	MUAC>=23	136	80.5
MDDS	Adequate	95	56.2
	Inadequate	74	43.8
Source of drinking water	Protected	150	88.8
	Unprotected	19	11.2

Laboratory Findings

Majority 147 (87.0%) of the mothers had hemoglobin levels above 11 g/dl, Normocytic (MCV 80-100fl), 152(89.9%), Normochromic (MCHC 32-36g/dl), 152(89.9%) and a few, 17(10.06%) had Microcytic Hypochromic (Table 4).

Table 4. Laboratory result of pregnant women attending antenatal care at Nekemte Comprehensive Specialized Hospital, Nekemte, Western Ethiopia, 2023.

Variables	**Category**	**Frequency**	**Percent (%)**
Hemoglobin (Mean(±SD)	(25.38(±4.4) Mild Anemia(10-10.9g/dl)	10	5.9
	Moderate Anemia(7-9.9g/dl)	12	7.1
	No Anemia	147	87.0
MCV	Normocytic(80-100fl)	152	89.9
	Microcytic (<80fl)	17	10.06
MCHC	Normochromic(32-36g/dl)	152	89.9
	Hypochromic(<32g/dl)	17	10.06
MHCA	Microcytic & Hypochromic	17	10.06
NNCA	Normocytic & Normochromic	5	3.0

Magnitude and Severity of Iron Deficiency Anemia among Pregnant Women

In this study, the overall magnitude of anemia using a cut off level hemoglobin < 11 g/dl were 13.0% and Iron deficiency anemia (IDA) using mean corpuscular volume (MCV)<80fl and mean corpuscular hemoglobin concentration (MCHC)<32g/dl were 10.06% (95% CI: 6.2%-15.3%). Out of all study participants, about 5.9% were mildly anemic, 7.1% were moderately anemic (Figure 1).

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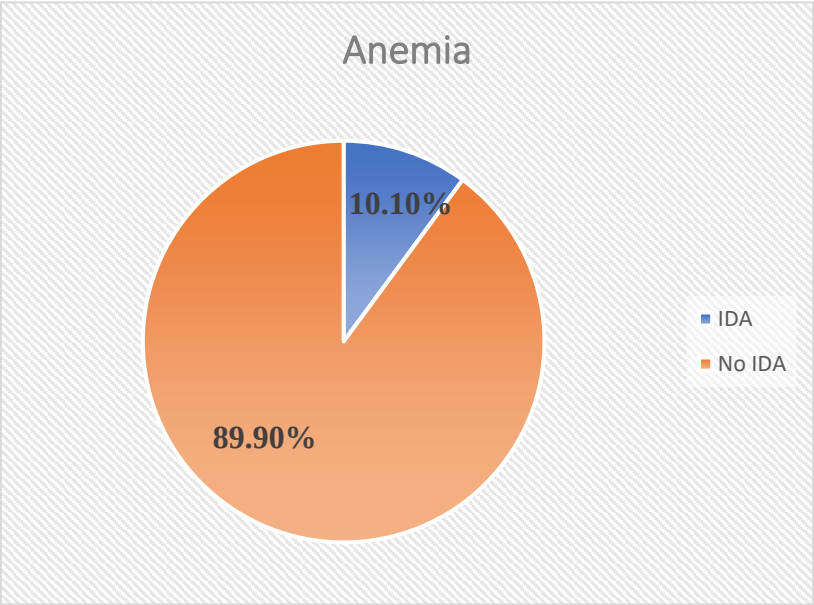

Figure 1. Magnitude of iron deficiency anemia among pregnant mothers attending antenatal care at Nekemte Comprehensive Specialized Hospital, Western Ethiopia, 2023.

Factors Associated with Iron deficiency Anemia among Pregnant Women

The multivariate logistic regression revealed that history of chronic illness under nutrition and initiation of ANC at second trimester showed significant association with maternal iron deficiency anemia. Pregnant women who had history of chronic illness were 4.62 times more likely to develop IDA compared to those who had no history of chronic illness [4.62(1.54, 13.81)]. In this study, pregnant women with MUAC<23 were 3.84 times more likely to develop IDA compared to those with MUAC >23 [3.84(1.14, 12.94)]. Pregnant women who initiated ANC at their 2nd trimester were 4.94 times more likely to develop IDA compared to those who initiated their ANC at their 1st trimester [4.94(1.37, 17.79)] (Table 5).

Table 5. Results of binary and multivariate logistic regression analysis of factors associated with iron deficiency anemia among pregnant women attending antenatal care at Nekemte Comprehensive Specialized Hospital, Nekemte, Western Ethiopia, 2023.

Variables	Category	IDA		COR(%CI)	AOR(%CI)	P-value
		Yes	No			
Family size	<5	10	137	1	1	
	≥5	7	15	6.39 (1.27, 2.88)	2.47 (0.47,12.93)	0.28
Gravida	Primigravida	5	42	1	1	
	Multigravida	12	110	0.92 (0.63,13.062)	1.08 (0.15,7.96)	0.94
Parity	Nullipara	5	53	1	1	
	Primipara	5	51	1.04 (0.142, 2.745)	1.19 (0.21,6.60)	0.85
	Multipara	7	48	1.55 (0.62, 6.35)	1.99 (0.62, 6.35)	0.25
Birth interval	<2years	7	19	3.46 (1.15, 13.65)	0.84 (0.03,26.16)	0.92
	≥2years	5	86	0.55 (0.11, 1.71)	0.28 (0.01,8.71)	0.47
	Primigravida	5	47	1	1	
Trimester at 1st ANC started	First trimester	5	100	1	1	
	Second trimester	12	52	4.62(1.54, 13.81)	4.94 (1.37,17.79)	**0.014***
History of chronic illness	Yes	12	41	6.49(2.16,19.58)	4.62 (1.54,13.81)	**0.033***
	No	5	111	1	1	
	MUAC<23	11	22	10.83(1.53,12.04)	3.84 (1.14,12.94)	**0.030***

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Nutritional status	MUAC≥23	6	130	1	1	
Tea/Coffee consumption	1-3(low users)	6	96	1	1	
	>=4(heavy users)	11	56	3.14(1.10,8.96)	3.0 (0.66,13.71)	0.16

*Significant variables, at p-value <0.05.

Discussion

This study revealed the magnitude of IDA and associated factors among pregnant women who were attending ANC at Nekemte Comprehensive Specialized Hospital. It was found that having history of chronic illness, late initiation of ANC, and under nutrition (MUAC<23) were significantly associated with anemia during pregnancy.

The magnitude of IDA among pregnant women in this study was 10.06% (95% CI: 6.2%- 15.3%). This findings was almost similar with the study conducted in Wolayita Zone, Southern Ethiopia (11.3%) [21], Kalale District of Northern Benin (11.3%) [26], Northeast Thailand (13.2%) [13] and in Chinese women 13.9% [27], but lower than the prevalence of IDA among pregnant women in Public Hospital of Harar town, Eastern Ethiopia (32%) [18], Dodola General Hospital, West Arsi Zone, South East Ethiopia (19.3%) [20], Mardan, Pakistan 76.7% [28], and in Malaysia it ranges from 31.6% to 34.6% [29]. In North America, the prevalence of gestational IDA was very low (2.7%, 2.2%) in the first, second trimester of pregnancy respectively, compared to the study findings [30]. This difference might be due to the geographical location, Socioeconomic status and the difference of feeding habits and related factors.

Analysis of risk factors revealed that having history of chronic illness showed statistically significant association with maternal IDA. In this study, pregnant women who had history of chronic illness were 4.62 times more likely to develop IDA compared to those who had no history of chronic illness. This may be due to the fact that those who had history of chronic illnesses had poor appetite which leads to low intake of iron rich foods, malabsorption and subsequently depletion of iron storage later develops IDA compared to those who had no history of chronic illnesses [5,31].

Pregnant women who initiated ANC at their second trimester were 4.94 times more likely to develop IDA compared to those who initiated their follow up care (ANC) at first trimester of pregnancy. This finding is consistent with study conducted in Malaysia among pregnant women attending ANC in which late antenatal booking is significantly associated with IDA [29]. Similarly, study conducted in West Ganja District, Ghana, showed that initiation of ANC within first trimester reduced the odds of IDA among pregnant women [32]. This may be associated with late supplementation of iron and late initiation of counseling service including health education on appropriate feeding practice and dietary diversity during pregnancy.

Pregnant women with MUAC<23cm has strong association with IDA. They were 3.84 times more likely to develop IDA compared to those who had MUAC >23 cm. This finding is consistent with study conducted in Bolosso Bomibe district, Wolayita Zone, Southern Ethiopia [21]. Similarly, study conducted in Central Ethiopia, MUAC <23 cm were found to be determinants of IDA [33]. This might be due to under-nutrition resulted in low intake of iron-rich diets, mal absorption, low storage of iron which resulted in low serum iron and hemoglobin in the blood. They also have strong loss of appetite which correlates with inadequate intake of iron rich foods.

Limitations

- Serum ferritin level which is the most appropriate test for the diagnosis of IDA was not measured, because of its cost and unavailability of the test in our set up.
- Dietary intake was assessed by using food frequency questionnaire which is less sensitive to measures absolute intake of specific nutrients and it mostly relies on respondent's memory so it is prone to recall bias.

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- As this study was institutional-based and cross-sectional nature of the study design, an adjustment was not made for altitude because the participants come from different areas.

Conclusions

The overall magnitude of anemia in this study suggested that IDA is a mild public health problem among pregnant women attending ANC at Nekemte Comprehensive Specialized Hospital, West Ethiopia. The risk factors for IDA in this study were under nutrition (MUAC<23), having history of chronic illness and late initiation of antenatal care.

Recommendations

Based on this study, those pregnant women having history of chronic illness, under nutrition (MUAC<23cm) and late initiation of ANC were at risk of developing IDA. Accordingly, the following were recommended:

To Nekemte Comprehensive Specialized Hospital, management staffs:

- Nekemte Comprehensive Specialized Hospital management should strengthen a follow up mechanism to ensure quality service given to pregnant women attending ANC.

To Nekemte Comprehensive Specialized Hospital, Maternal and Child Health (MCH) staffs:

- They should provide information on the importance of regular medical checkup in order to take preventive measures and stay health throughout pregnancy.
- They should provide timely and appropriate information on the importance of timely initiation of ANC and diversified feeding practice for all pregnant women attending ANC at their Hospital.

To Town Health Extension Workers (HEWs):

- Appropriate information on the importance of timely initiation of ANC, regular medical checkup and diversified feeding practices for the community especially for all reproductive age groups should be provided.
- Health education and counseling services should be provided for all pregnant women at the community level to stay health throughout pregnancy.

For pregnant women:

- They should strictly follow the information provided by Health Professionals on identified interventions.

For researchers:

- Further research on risk factors of IDA which include micro-nutrient deficiencies to identify the underlying problems and its effect on pregnant women and fetal outcome is needed.

Author Contributions: AK, the corresponding author, conceived and designed the study. All authors were involved in the result write up, statistical analysis and result interpretation. ET drafted the manuscript, which was reviewed for intellectual content by AK, GK and WO. All authors read and approved the fnal version for submission and agreed to be accountable for all aspects of the article.

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Institutional Review Board Statement: Ethical approval was secured from Ethical review committee of the Wallaga University, Institute of health sciences (WU/RD/690). Since it was conducted on human data, this study adhered to Declaration of Helsinki (http://www.wma.net/en/30publications/10policies/b3/index.html). Permission was obtained from Nekemte Comprehensive Specialized Hospital and Nekemte Public Health Research and Referral Laboratory Center to conduct this study. Written informed consent was obtained from study participants after explaining the purpose and objective of the study, the benefits and risks (if any) associated with the study and their right when taking part in the study. All the information obtained from the study participants were kept confidential. The data from study participants and blood specimens obtained were used only for this research purposes.

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Data Availability Statement: All data are available within the manuscript. Additional data can be obtained from the corresponding author on a reasonable request.

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Conflicts of Interest: The authors report no conflicts of interest in this work.

Abbreviations/Acronyms

ANC	Antenatal Care
AOR	Adjusted Ods Ratio
ATP	Adenosine Triphosphate
CBC	Complete Blood Count
CI	Confidence Interval
EDTA	Ehylene Diamine Tetra Acetate
Hgb	Hemoglobin
HIV	Human Immunodeficiency Virus
IDA	Iron Deficiency Anemia
MCH	Maternal and Child Health
MCHC	Mean Cell Hemoglobin Concentration
MCV	Mean Cell Volume
MDD	Minimum Dietary Diversity
MUAC	Mid Upper Arm Circumference
RBC	Red Blood Cell
SPSS	Statististical Software for Social Science

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