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Determinants of Dietary Diversity Consumption and Nutritional Status of Pregnant Women Attending Armed Forces Comprehensive Specialized Hospital, Addis Ababa, Ethiopia

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ABSTRACT

The nutritional status of a woman during pregnancy is important as a suboptimal diet impacts negatively on the health of the mother, the fetus and the newborn. There is limited knowledge in the area of malnutrition and factors' affecting it among pregnant women despite evidence showing that maternal nutrition has important direct and/or indirect consequences for all other age. The objective of the study was to assess the determinants of dietary diversity and nutritional status of pregnant women attending antenatal clinic at Armed Forces Comprehensive Specialized Hospital. The study was cross-sectional and conducted by using both quantitative and qualitative methods. A multistage sampling procedure was employed to draw 320 samples, pregnant women. The women were selected in random through balloting among the first five pregnant women to arrive at the antenatal clinic and thereafter systematic sampling was used and every fourth woman that arrived were sampled until the sample size is met. The data were analyzed by using a software STATA version 14. Descriptive statistics to determine the dietary diversity and nutritional status were done and also to characterize the nutritional status. The statistical model namely, logistic and ordered logistic regression was used for factors affecting the dietary diversity and nutritional status. A P value of <0.1 was considered statistically significant. According to the logistic model interpretation, negative relation implies that the dependent and independent variables are inversely related; while the positive association is the outcome and independent variable have direct relations. The findings of the descriptive analysis indicated that low dietary diversity was experienced by 61.56 percent of the respondents and the rest of the study population was in a high dietary diversity. Based on Mid-upper arm circumference cut-offs 0.31 percent were severely malnourished, while 3.44 percent were moderately malnourished and 96.25 percent were well nourished. Findings from logistic regression revealed that income, meals that were eaten in the last 24 hours, and anemia have positively and significantly affects dietary diversity while not taking iron-fortified foods affects negatively. The results from the ordered logit model indicate that severe undernutrition is determined by not taking micronutrient daily positively where ever income and cleaning utensil properly impact negatively, although moderate undernutrition is associated with not taking micronutrient daily positively and negatively with cleaning utensil properly. Though being nourished is affected by not taking micronutrient daily negatively and positively by cleaning utensil properly. Whereas by World Health Organization hemoglobin cut-offs 2.50 percent, 11.56

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percent, and 85.94 percent were in severe anemia, moderate anemia, and normal hemoglobin level respectively. The results from the multinomial regression model reveal that severe anemia is negatively associated with dietary diversity. At the same time, moderate anemia is affected positively by not taking micronutrient daily and negatively by age, dietary diversity score and morbidity status of the pregnant women. Similarly being in normal hemoglobin cut-off was affected positively by age, dietary diversity and morbidity, negatively affected by not taking micronutrient daily. Finally, the findings conclude that dietary diversity and nutritional status were very poor and socio-demographic, socio-economic, micronutrient supplementation, morbidity, environmental factors, and dietary diversity influence the nutritional status of pregnant women. It is recommended that promotion of dietary diversity and modification of diets be carried out through practical demonstrations in the community and health facilities and there should be income generation practices and entrepreneur encouragements should be practiced.

KEYWORDS

Antenatal clinic; Undernutrition; Anemia; Hemoglobin; Mid-upper arm circumference

1. INTRODUCTION

Malnutrition has been identified as the leading global developmental challenge affecting nearly half of the world's population and also the major underlying contributing factor for nearly half (45%) of all child and a fifth of maternal deaths [1]. Malnutrition is a lack of healthy foods in the diet/an excessive intake of unhealthy foods which leads to physiological harm. Maternal undernutrition is a serious developmental challenge contributing a large share to the global disease burden. It is a major reason for the increased risk of adverse pregnancy outcomes, poor infant survival, and elevated risks of chronic diseases at later stages of life [2]. The majorities likely to suffer from deficiencies include infants and young children, adolescent girls and women of reproductive age (WRA). These in danger populations have been found to switch to cheaper foods that will give a feeling of completeness in their stomachs without regard to how nutritious the foods are [3]. Pregnancy is a unique and critical stage of life during which extensive anatomical, physiological, biochemical and several other related changes take place. Maternal individual, genetic and environmental factors determine whether this dynamic change ends with healthy or adverse outcomes. Nutritional and hormonal factors in pregnancy pressure, not only direct fetal effect but also morbidity and mortality in afterward life [4]. Dietary diversity (DD) is the consumption of an adequate variety of food groups; human health is heavily dependent upon the intake of adequate quantity and quality of food [5]. As dietary factors are associated with increased risk of chronic diseases and undernutrition, local and international dietary guidelines recommend improving the diversity of the diet. Nutrition during pregnancy is among the leading factors strongly associated with adverse pregnancy and prenatal outcomes [6]. For a pregnancy to have a healthy outcome, the nutritional status of a woman before and during pregnancy needs to be good [7].

Deficient in variety has been identified by other studies to be particularly a severe problem among poor populations in the developing world, whose diets are predominantly starchy staples and the consumption of animal products, seasonal fruits and vegetables are generally absent or minimal [8]. The elevated nutrient demands of pregnancy put women of reproductive age at high risk because of use of low-quality, repetitive diets and thus these women will have a risk of a variety of micronutrient deficiencies [9]. During the third trimester of pregnancy, in particular, the requirements for energy and some nutrients like iron, zinc, calcium, folic acid and

others increases [10]. An expectant woman requires a selective and diversified diet to meet her nutritional requirements and thus improve her nutritional status. It has been noted that a suboptimal diet that comprises inadequate intake of calories and nutrients, combined with a heavy workload, has adverse impacts on the health of the mother, the developing fetus and the newborn. Besides, the mother is often the last to benefit in a household even when there is an improvement in household income, but the first to sacrifice. This creates a cycle of disease and illness. Even when enough food is available, the majority of women do not receive adequate nutrients during pregnancy attributable to poor knowledge of what constitutes an adequate diet [11]. Lack of education and awareness leads women to believe that they have eaten enough without considering the dietary requirements. Simple, rapid, and useful proxy measures and indicators like the FAO's scoring system for measuring Women's Dietary Diversity Score (WDDS) have shown to be valid proxy indicators for various nutritional monitoring activities. However, little is known on whether the WDDS is associated with maternal anemia and pregnancy outcomes. Furthermore, a non-diversified diet can have negative consequences on individuals' health, well-being, and development, mostly by reducing physical capacities and resistance to infection. Besides, cognitive development, reproductive and even social capacities may also be impaired [12].

Maternal undernutrition ranges from 10 percent to 19 percent in most countries across the world. A solemn problem of maternal undernutrition is obvious in most countries in sub-Saharan Africa, South-central and Southeastern Asia, and in Yemen, where more than 20 percent of women are malnourished. Across Africa, it is estimated that 27 percent - 51 percent of women of reproductive age are underweight [13]. Macro and micronutrient deficiencies are major public health concerns in most developing countries including Ethiopia, partly due to a monotonous, cereal-based diet that lacks diversity. Ethiopia has an inappropriately high burden of maternal and neonatal morbidity and mortality rates [14]. High level of various micronutrient deficiencies and thinness (underweight) among mothers, childhood stunting and wasting are key malnutrition associated features suggesting the extent and depth of nutritional problems in the country. High burden of adverse prenatal outcomes such as low birth weight, preterm, and stillbirth are common [15]. Some factors influence the nutrition status of a pregnant woman, for instance, iron status in pregnancy are influenced by the demands of the fetus, momentary changes in blood volume and body mass, alterations in absorptive capability, and on the bioavailability of iron in a largely vegetarian diet. Too little nutrient intake may affect maternal health and the health of the infant. For example, inadequate intake of iron in pregnancy can lead to maternal anemia and increased risks of maternal mortality if the anemia is severe [16]. Universal, anemia contributes to 20 percent of all maternal deaths and is responsible for 40 percent to 60 percent of maternal deaths in non-industrialized countries [17]. It is estimated that anemia accounts for 3.7 percent and 12.8 percent of maternal deaths during pregnancy and childbirth in Africa and Asia, respectively. Anemia has also been found to lead to premature births, low birth weight, fetal impairment and infant deaths [18].

Maternal factors have been linked with intrauterine development jointly with infant nutrition. It has been associated with reduced capacity in adult life, including reduced stature, lower bodily work capacity, impaired cognitive function and educational attainment for the fetus while for the women there is an increased risk of low birth weight in the next generation [19]. Improving dietary quality for the mother increases fetal growth, moreover, adequately provide the required nutrients and avert maternal malnutrition which impacts the health of the mother and may lead to mortality. In Ethiopia nationwide, nearly 17% of women are anemic from this

22% are pregnant which is an indicator of the presence of malnutrition [20]. However, little is known about the causes, determinants, and responses to maternal malnutrition and the associated adverse outcomes in Ethiopia. Thus the aim of this study was determining dietary diversity and nutritional status and factors influencing the consumption and the nutritional status among pregnant women attending at Armed Forces Comprehensive Specialized Hospital, Addis Ababa to increase knowledge in the area and thus improve the practice.

Conceptual framework

The conceptual framework used for this study was adopted and modified from UNICEF's conceptual framework on the determinants of malnutrition [21]. Maternal health status is greatly influenced by the dietary diversity. Dietary diversity is in turn influenced by maternal demographic factors such as age, parity, gestation age, level of education, and morbidity or physiological status of the mother and environmental factors which are the immediate causes. When the dietary diversity is poor it affects the woman's morbidity status as there is reduced immunity and increased chances of developing infections. On the other hand, morbidity status in pregnancy, affects dietary diversity either due to poor appetite which leads to only likable foods being selected which affect nutrient intake. Socio-economic as measured by income and occupation has been found as a factor that influences the dietary diversity and in turn the nutrition status. Cultural factors and individual food security situation have been identified as underlying factors that influence the nutritional status [22]. Environmental factors such as source of water, latrine and sanitation, and food safety are a common cause of disease by affecting the immune system and have an effect on nutritional status.

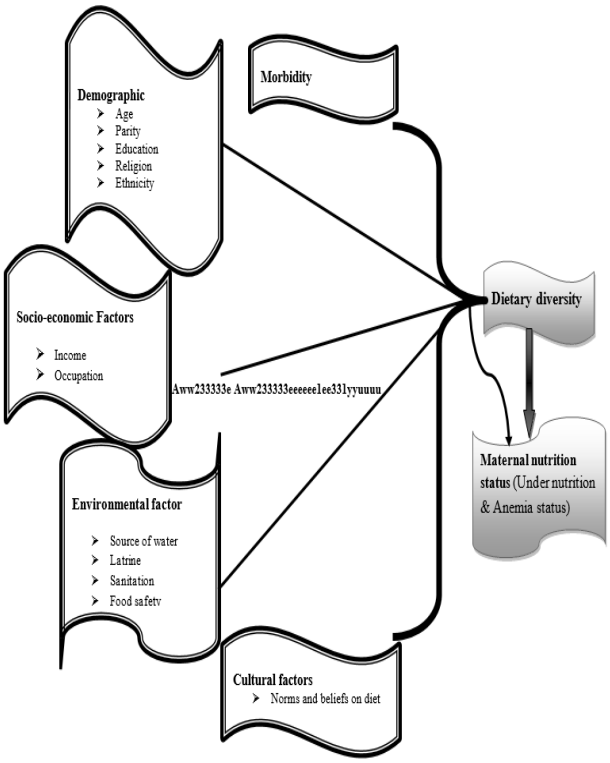

Figure 1: Conceptual framework on factors affecting dietary diversity.

Source: Researcher modified from UNICEF (1998).

2. METHODS AND DESCRIPTION OF THE STUDY AREA

Description of study area

Addis Ababa is the capital city of Ethiopia. The total number of Hospitals in Addis Ababa city is 51 Health indicators, (FMoH; EFY, 2001) out of the total 41 hospitals, about 10 of them are public, the rest, about 31 hospitals, are run by private investors and non-profit organizations. This research is selected to be carried out at Armed Forces comprehensive specialized Hospital (AFCSH). Which is formerly, known as Princess Tsehay Memorial Hospital founded by Emperor Haile Selassie in memory of his daughter. She died of illness in 1942. AFCSH got its current name after the 1974 revolution. The hospital is found in lideta sub-city which is one of the 10 sub-cities in Addis Ababa. In this sub-city there are two governmental and 5 non-governmental hospitals. As of 2019 its population was 214,496 from this 102,513 are male and 112,283 are female, [23]. The district is located in the central-western area of the city, nearby the

centre. It borders with the districts of Addis Ketema, Arada, Kirkos, kolfe-keraniyo and Nifas Silk-Lafto sub-city. In Armed Forces comprehensive specialized Hospital approximately 50 pregnant women attend each day at Antenatal Care (ANC).

Study design

The study used institutional based cross-sectional analytical design. This methodology was chosen as it would show the dietary diversity status, factors affecting it and also the nutritional status of the pregnant women at a point in time. The study design was used both qualitative and quantitative research approach to assess the complex variables of the dietary diversity and nutrition status of pregnant women at the study area.

Study variables

Response variable

Dietary diversity and Nutritional status of pregnant women was shown by dietary diversity score, mid upper arm circumference (MUAC) and hemoglobin level.

Explanatory variables

The determining factors for dietary diversity and nutritional status of pregnant women were composed of socio economic and demographic (Mothers age, Gestation age, Parity, Occupation, Level of education, ethnicity, religion), morbidity pattern, environmental and cultural factors are used as independent variables.

Data sources

The data was collected from primary and secondary data sources. Primary data was collected from the sample respondents through questioner and focus group discussion. Secondary data was obtained from patient registration and medical history review. And also data was collected from statistical report like EDHS and official world wide websites like WHO, FAO and MoH.

Source and target population

The source population was pregnant women attending at armed forces comprehensive specialized hospital. While the study population was pregnant women attending antenatal clinic at armed forces comprehensive specialty hospital. The reason for this is during pregnancy there will be high nutritional demand due to the progressive development of the foetus and the mother.

Inclusion and exclusion criteria

Inclusion criteria

The inclusion criteria were pregnant women who was volunteer to participate in the study and who are at follow up in Armed Forces Comprehensive Specialized Hospital.

Exclusion criteria

The Exclusion criteria was pregnant women with disabilities and chronic diseases such as hypertension, diabetes, Tuberculosis and HIV/AIDS; those enrolled in intervention programs such supplementary feeding or general food distribution as this intervention would have an impact on the nutrition status and dietary diversity and thus bias the results of the study.

Sample size determination and sampling techniques

Armed Force Comprehensive Specialty Hospital was purposively chosen because it was the main hospital in the City it combines both the army family and the civilian family. We used Hospital records of the previous three years preceding the study and calculate the average monthly attendance. The antenatal attendance at the Hospital was averagely 1200 pregnant women per month. We used formula by Cochran (1963:75), to determine the sample size.

$$\boldsymbol{n_0 = \frac{Z^2 pq}{e^2}}$$

Whereas:

n_0: the desired sample size; Z: the standard normal deviate at 95% confidence level (1.96); p: the proportion of the target population estimated to have characteristic

being measured; q: 1-p; and e; the level of statistical significance set.

The prevalence of under nutrition among women in the study site has no reference to use as p-value. Then when such evidence is not available 50% is considered as maximum prevalence of under nourished mothers. So taking 50% as p-value with 95% confidence interval, 5% marginal error and none responsive rate of 10%.

$$\boldsymbol{n_0} \approx 384$$

Finite population correction was done to produce a sample size that was proportional to the population therefore the sample size (n) was calculated as;

$$n = \frac{\boldsymbol{n_0}}{1 + \frac{(\boldsymbol{n_0}-1)}{N}}$$

Where, N = the estimate of the population size (1200 ANC attendants per month).

A sample size of 291 pregnant women was calculated for the study. Due to the possibility of non - response 10% was added to make a sample of 320.

AFCSH was purposively chosen because it is the main hospital in the city it combines both the army family and the civilian family. The first respondent was selected randomly through balloting from among the first five pregnant women to arrive at the antenatal clinic and thereafter systematic sampling was used. To find the sampling interval, the average monthly attendance (1200) was divided by the required sample size. Every 4th pregnant woman to arrive were interviewed until the sample size achieve. This was done daily during the weekdays for one month until the target sample size met. Data was collected within a month to avoid bias which would be brought by pregnant women who would revisit the clinic for follow up in the following month.

Selection and training of research assistants

Two research assistants were nurses recruited to assist in the study. The researcher trained the research assistants for two days and the third day was used for practical experience. They were trained on the objectives of the research and data collection procedures. Any questions and clarifications were done. They were also taken through taking of MUAC using the actual tapes which were to be used for the study. Interview techniques and confidentiality were also discussed during the training. Several methods of training were used during the training such as demonstrations where the researcher demonstrated how to take the MUAC measurements.

Tools of data collection

Questionnaires

An individual dietary diversity questionnaire recommended by FAO [24] was adopted and modified to collect data on dietary diversity, socio demographic and other factors influencing nutritional status. The questionnaire was divided into: socio-demographic information, 24 hours recall, dietary diversity, micronutrient supplementation, ANC attendance and morbidity, socioeconomic characteristics, environmental factors, cultural beliefs and anthropometry in which MUAC and hemoglobin levels were measured and used to determine the nutritional status of the pregnant women. The socio-demographic data required were:- age, parity, gestation in weeks, marital status, level of education and main occupation of the respondent and the husband if married.

24 hours dietary recall was administered and was used as it minimizes recall bias and it conforms to recall time period used in many other studies [12,25]. The 24 hours dietary recall involved asking the respondents to recall all the drinks and food eaten the previous day in chronological order starting with the food eaten in the morning through the day up to the time the respondents went to sleep. Probing was done to ensure no foods or drinks were omitted. In addition, the respondents were asked to provide information on whether they ate outside the home.

Focus group discussion guides

A focus group discussion (FGD) guide was used to collect information on attitudes and beliefs of pregnant women on foods, how the beliefs affected food choices and dietary diversity practices so as to give an in-depth understanding on the status of dietary diversity and explain or complement some of the quantitative findings. Two focus group discussions were held with selected groups of women at the end of the study period. The discussion was held in a private room with just the participants, researcher, research assistant and observer from the nurses at ANC clinic present. Participants were assured that the information they shared during these discussions is confidential and was encouraged to give their answers as freely as possible.

Data validity and reliability

Reliability

The questionnaires were pre-tested to check on the length, content, question wording and language. The questionnaire was administered to 32 respondents (10 percent of the sample size), who are attending ANC at AFCSRH. This allowed modifications on the questionnaires by correcting mistakes and inclusion of foods that have been missed out or elimination of foods that are not applicable in the community. Ambiguous questions was corrected to ensure clarity and to elicit the required information therefore enhancing reliability.

Validity

To ensure validity, the questionnaire was tested and validated by advisors peers and other technical persons so as to ensure that the questions elicited the required answer.

Data collection procedures and techniques

Data were collected on a daily basis during the five working days (i.e. Monday to Friday). The research team reported to the ANC and with assistance of the nurse on duty, identified and sampled the target population. Standard Mid Upper Arm Circumference (MUAC) adult tapes was used to take measurements and the ANC follow up lab-chart was used to determine the ANC attendance and hemoglobin levels of the pregnant women to assess their nutritional status. The respondents were interviewed after they had received their routine clinic services in a private room. Anthropometry measurements of MUAC were taken using a standard MUAC tape and this was used to determine nutritional status. MUAC of the left arm was taken to nearest 0.1 cm with no clothing on the arm and this was done twice for each respondent to ensure accuracy. The left arm was used as it shows malnutrition while the right arm which is frequently used will show lean muscle mass as a result of work. The results for hemoglobin levels of each respondent were collected from recorded clinical data with a permission of the patient and the staffs.

There is no clear definition of low MUAC or established universally accepted international MUAC cutoffs for pregnant women. However, because MUAC is simpler to measure than other indicators and is not affected by pregnancy status, several countries have established their own cutoffs for classifying malnutrition in women who are pregnant. Although there is limited evidence to support these cutoffs, they help determine eligibility for nutrition support programs. Currently, there are no specific recommendations for MUAC cutoffs for pregnant adolescents, and several countries stipulate that their cutoffs for pregnant women also apply to pregnant and postpartum adolescents. Ethiopia also has her own MUAC cutoffs for pregnant women which is MUAC measurement <180 mm is considered Severe Malnutrition, while ≥180 mm to <210 mm is Moderate Malnutrition and ≥210 mm Normal [26]. According to World Health Organization (WHO), pregnant women with hemoglobin levels >11mmols/l are normal <11.0 mmols/l are considered anemic while those with hemoglobin levels of <7.0 mmols/l are considered to

have severe anemia and therefore these cut offs will be used in this study WHO.

Techniques of data analysis

Completed questionnaires were checked daily for accuracy and completeness in recoding of responses. Data was entered by using SPSS version 20 and then imported to STATA version 14. For dietary diversity analysis, women dietary diversity were categorized as consumption of foods from <4 food groups were considered as low dietary diversity, while consumption of food items from ≥4 food groups in 24 hours prior to the interview was considered as high dietary diversity [24]. Responses from FGDs were arranged in general categories identified in the discussion guideline then were coded. Descriptive statistics such as frequencies and percentages for discrete data (non-continuous) and the mean values for continuous data was computed. Chi square tests were done to assess differences between the categorical variables with groups. T-test was done to compare means between groups. A P-value of <0.10, <0.05 and <0.01 was used as the criterion for statistical significance.

Econometric model specification

Binary logistic regression model is used when the dependent variable is articulated in two categories and multinomial logistic regression model is useful when the dependent variable is expressed by more than two categories [27]. Regression methods such as linear, logistic, and ordinal regression are useful tools to analyze the relationship between multiple explanatory variables. These methods also permit researchers to estimate the magnitude of the effect of the explanatory variables on the outcome variable. Both binary and multinomial logistic regressions were used to estimate the relationship between dependent and independent variables of the study.

Multinomial logistic regression is preferred when multiple classes of the dependent variable ranked and we use ordinal logistic regression. The application of the ordinal regression model is dependent, in large part, on the measurement scale of the variables and the underlying assumptions. Ordinal logistic regression model is a type of logistic regression model that are used to analyze ordinal dependent variables. For instance, if the dependent variable (outcome variable) is in ordinal scale (ordered pregnant women nutritional status as normal, moderate and severe malnutrition as in this study), the ordinal regression model is a preferred modeling tool which does not assume normality or constant variance, but requires the assumption of parallel lines across all levels of the outcome variable (Table 1).

When the dependent variable has a dummy form, taking 0 and 1 values, there is a need of a probability model that fulfill these two features: (1) as Xi increases, Pi = E(Y = 1 | X) increases but never predict values outside the 0-1 intervals and (2) the relationship between Pi and Xi is nonlinear [27].

Independent variable	Nature of variable	Outcome	Statistical test
Mothers age	Continuous	+	Means, standard deviation, Frequencies, percentages, Logistic & Ordinal regression
Gestation age	Categorical	+	
Parity	Continuous	+	
Marital status	Categorical	+	
Level of education	Continuous Categorical	+	
Occupation	Categorical	-	
Occupation of Husband	Categorical	-	
Women dietary diversity score	Continuous Categorical	+	
micronutrient supplementation	Categorical/dummy	+	
Morbidity patterns	Continuous/Categorical/dummy	-	
Household income	Continuous/ Categorical	+	
Cultural factors		-	
Environmental factors	Categorical	+	
Hemoglobin/MUAC	Continuous Categorical		

Table 1: Summary of variables.

Model specification

Binary logistic model

Binary logit is preferred to others because it gives standard result for discrete choice estimation.

$$logit(p_i) = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \cdots + \beta_n x_{ni} + e_i$$

Where: p_i is the probability that the i^{th} value of the dependent variable, X is the i^{th} value of the independent variable, e_i is the "error" variability of the dependent

variable not explained by the independent variable; *n* is the number of independent variables.

Thus, the Logit (Natural log of odds) of the unknown binomial probabilities are modeled as a linear function of the *Xi*:

$$logit(p_i) = ln\left(\frac{p_i}{1+p_i}\right) = \beta_0 + \sum_{j=1}^{n} \beta_j x_{ji}$$

The Logit model assumes that underlying stimulus index *Logit* (p_i) is a random variable, which predicts the probability of being nutritional diversify. *Pi* is the probability of being in high dietary diversity, while *(1-Pi)* is the probability of low dietary diversity.

Probability of being dietary diversify $p_i = \left(\frac{1}{1+e^{-logit(p_i)}}\right) = \left(\frac{e^{logit(p_i)}}{1+e^{logit(p_i)}}\right) = \left(\frac{e^z}{1+e^z}\right)$

Where *Z* is cumulative function, $\beta_1 + \beta_2 x_i$ that ranges from - ∞ to + ∞, while P_i ranges between 0 and 1. The maximum likelihood estimation approach is used to estimate the equation. STATA Version 14 software is employed to compute estimates.

Ordinal regression model

The application of the ordinal regression model is dependent, in large part, on the measurement scale of the variables and the underlying assumptions. Ordinal logistic regression model is a type of logistic regression model that are used to analyze ordinal dependent variables. For instance, if the dependent variable (outcome variable) is in ordinal scale (ordered nutritional status as severely undernourished, moderately undernourished, and nourished as in our case), the ordinal regression model is a preferred modeling tool which does not assume normality or constant variance, but requires the assumption of parallel lines across all levels of the outcome variable [28].

The ordinal logistic regression procedure empowers one to select the predictive model for ordered dependent variables. It describes the relationship between an ordered response variable and a set of explanatory variables which may be continuous or discrete Ordinal regression model is embedded in the general framework of generalized linear models for analyzing ordinal response variables. Different models can be resulted from the use of different link functions. Among different link functions, *logit* and *cloglog* links are the two major link functions.

In this particular study, we would use *logit* link function. The *logit* link is generally suitable for analyzing the ordered categorical data when all categories are evenly distributed. The *cloglog* link may be used to analyze the ordered categorical data when higher categories are more probable. If the logit link is applied, the general form of ordinal regression model may be written as follows:-

$$f(y_i(x)) = log\left(\frac{f(y_i(x))}{1-f(y_i(x))}\right) = log\left(\frac{pr(y \le j \backslash x)}{pr(y > j \backslash x)}\right)$$

$$= \propto_j + \beta x, j = 1, \dots k-1$$

$$\boldsymbol{y_j(x) = \frac{e^{\propto_j + \beta x}}{1 + e^{\propto_j + \beta x}}}$$

Where j indexes the cut-off points for all categories (*k*) of the response variable, the function $f(y_i(x))$ is the link function that connects the systematic components (i.e. $\propto_j + \beta x$) of the linear model, the alpha *j* a represents a separate intercept or threshold for each cumulative probability and b represents the regression coefficient [28]. If multiple explanatory variables are applied to the ordinal regression model, b*X* is replaced by the linear combination of $(\alpha_j + \beta_1 x j_1 + \beta_2 x_{j2} + \dots + \beta_p x_{jp})$.

Operational definition

Malnutrition

A state in which the physical function of an individual is impaired to the point where he or she can no longer maintain adequate bodily performance process such as growth, pregnancy, lactation, physical work and resisting and recovering from disease [29].

Maternal factors

Included age, parity education, occupation, ANC attendance.

Age and parity of the mothers

Women's age and parity are important factors that affect maternal depletion, especially in high fertility countries. Both are continuous variable and measured in years and number of children alive respectively. Local studies in Ethiopia also showed that women in the youngest age group (15 years - 19 years) and women in the oldest age group surveyed (45 years - 49 years) are the most affected by under nutrition [30].

Education

A continuous variable measured in number of years in schooling. Women who receive even a minimal education are generally more aware than those who have no education of how to utilize available resources for the improvement of their own nutritional status and that of their families. Education may enable women to make independent decisions, to be accepted by other household members, and to have greater access to household resources that are important to nutritional status. A study in the Ethiopia showed that the higher the level of education, the lower the proportion of undernourished women [31].

Occupation

Women's employment increases household income, with consequent benefit to household nutrition in general and the woman's nutritional status in particular. Employment may increase women's status and power, and may bolster a woman's preference to spend her earnings on health and nutrition. Though employed, women without control over their income and decision making authority within the household are deprived of economic and social power and the ability to take actions that will benefit their own well-being [32].

Marital status

Marital status of the women is associated with household headship and other social & economic status of the women that affects their nutritional status. Nutritional and social security could be endangered by a negative change in marital status. A study showed that women's malnutrition is significantly associated with marital status indicating that compared to married women malnutrition is higher among unmarried rural and divorced/separated urban women compared to married ones [30].

Women dietary diversity score

Defined as the number of different foods or food groups consumed over a given reference period (FAO) [24]. In the study will be created by summing up the number of food groups consumed over a 24 hours period by an individual.

Morbidity patterns

A dummy variable in this study that directly affects the nutritional status of an individual and has been found to be an immediate cause of malnutrition. Pregnant women with IPIs were 2.5 times more likely to be anemic compared to their non-infected counterparts [32].

Socio-economic factors

In the study were defined by proxy indicators such as occupation, income.

Household income

Treated as a continuous variable measured in the amount of money a given household generates from different work participation. The economic status of a household is an indicator of access to adequate food supplies, use of health services, availability of improved water sources, and sanitation facilities, which are prime determinants of maternal nutritional status. A study in the Southern Nations, Nationalities and Peoples Region (SNNPR) of Ethiopia [30] showed that women from low economic status households were the most affected by malnutrition.

Cultural factors

It is dummy and categorical variable refer to beliefs and norms about foods and dietary diversity practices.

Environmental factors

This category has categorical and dummy variable. Unfavorable health environment caused by inadequate water and sanitation can increase the probability of infectious diseases and indirectly cause certain types of malnutrition. In Ethiopia studies showed that unprotected water source and non-availability of latrine were associated with low nutritional status.

Nutritional status

A measurement of the extent in which individuals physiological needs for nutrients are being met and was measured using MUAC.

Anemia in pregnancy

It is defined as a hemoglobin (Hb) concentration of <11 g/dL of blood and in this study it was determined by using the hemoglobin levels [14].

Ethical consideration

Ethical clearance was obtained from the graduate school of AAU Ethical Review board and to carry out the research was granted. And permission was acquired from Armed Forces Comprehensive Specialty Hospital. The questionnaires administered to the respondents upon obtaining an informed written or thumb print consent. Before consent was obtained, the researcher and the research assistants explained the purpose of the study and respondents were assured of confidentiality of the information they give then require their permission. To ensure privacy, names and other means of identity was not used during the data collection. The researcher ensured that all information obtained will be kept in strict confidence and will be used only for the purpose of the study.

3. RESULTS AND DISCUSSIONS

Descriptive results of the respondents

Socio-demographic characteristics and undernutrition

Socio-demographic categorical variables of the study are gestation in weeks, marital status, level of education, the main occupation of the respondent, the main occupation of the husband, and religion were analyzed by using a chi-square test for a possible difference between severe, moderate and normal nutritional status. The finding of the results shows only gestational age was statistically significant. Based on the gestation categories, a woman is considered to be in the first, second or third trimester when she is at her 0 weeks - 12 weeks, 13 weeks - 28 weeks and 29 weeks - 40 weeks pregnant respectively. Data on the gestation in weeks were collected from the ANC book.

In this study from the sampled women 320, 87(27.19%) of them were found to be in their third trimester, 75(23%) of them were found in the second trimester and about 158(49.38%) of the respondents were in their first trimester (Table 2). Of those in the third trimester, 1(1.15%) of women was found severely undernourished and the other 86(98.85%) were in normal range. Of the women who were in their second trimester, 6(8%) were moderately anemic and 69(92%) had normal hemoglobin level. While, those who found in their first trimester 5(3.16%) and 153(96.84%) experienced moderate and normal range for hemoglobin, respectively. The result showed gestational age is statistically significant at 5% level of significance and this showed there is a possible difference in pregnant women being in severe, moderate and normal anemia with a P-value of 0.033 (Table 2).

Name of		Severe Under Nutrition		Moderate Under Nutrition		Normal		Total		P-value
Variable	Category	Count	%	Count	%	Count	%	Total count	Total %	
Gestation	0 - 12	0	0	5	45.45	153	49.68	158	49.38	0.033**
	13 - 28	0	0	6	54.55	69	22.4	75	23.44	
	29 - 40	1	100	0	0	86	27.92	87	27.19	
Morbidity	Yes	1	100	1	9.09	35	11.36	37	11.56	0.021**
	No	0	0	10	90.91	73	88.64	283	88.44	
Water Source	Pipe	0	0	11	100	281	91.23	292	91.25	0.018**
	Public tab	1	100	0	0	27	8.76	28	8.75	
Waste Dispose	Filed	0	0	0	0	8	2.6	8	2.5	0.041**
	Dump pit	0	0	10	90.91	272	88.31	282	88.13	
	Burn	1	100	1	9.09	28	9.09	30	9.38	

Table 2: Chi-square test results of the respondents based on MUAC.
Source: Analyzed from researcher surveyed data (2019).
Note: ** is significant at 5%.

ANC attendance and morbidity and nutritional status

ANC attendance and morbidity category of the interview categorical and dummy variables were morbidities, type of illness, seeking medical assistance, and type of medical institution. They were analyzed by using a chi-square test for a possible difference between severe, moderate and normal nutritional status only morbidity status was found significant. The proportions of pregnant women who have been sick during the pregnancy time was 37(11.6%), the remaining were not sick.

As presented in table 2 from the pregnant women who have been sick (n = 37), 1(2.7%) was severely malnourished, 1(2.7%) moderately malnourished and 35(94.6%) were found in the normal range as measured by MUAC. Among those who have not been sick, none were in a range of severe malnutrition, 10(3.5%) out of the 283 were moderately malnourished and the remaining 273(96.5%) were in the normal category of the MUAC interpretation for nutrition. Moreover, the Chi-square test of the respondent pointed out that there a 5% statistically significant difference in the morbidity status of the respondent and the MUAC measurement with a P-value of 0.021 (table 2).

Environmental factors and undernutrition

Main water source for drinking, type of toilet, household waste disposal, cleaning food preparation materials, storage for fresh perishable foods, and hand washing practice were the environmental factors that have been analyzed for chi-square test to assess the possible differences between the study population with undernutrition and the variables that shows difference was source of drinking water and west disposal practice.

When asked about the source of drinking water a total of 292(91.25%) respondents use pipe water for drinking while 27(8.4%) of them use public water and the rest of the respondents use other sources as options. As we can see from the table 2 the respondents who use pipe water experienced moderate undernutrition by 3.8(11%), the rest 281(96.2%) of them were in normal MUAC measurement. The study population who prefer to use the public water 1(3.7%) out of the 27 have severe malnutrition and the 26(96.3%) were in normal measurement. Source of water for drinking and its access is the major cause of being affected by a disease that is more communicable and will be a reason for seeking medical assistance and may cause the mother and the fetus at risk. The result shows the source of drinking water is statistically significant with a P-value of 0.018.

Another significant variable with a P-value of 0.018 is the type of waste disposal. 8(2.5%) out of 320 pregnant women dispose of their west material on the field, while 282(88.13%) of them use a dump pit and the 30(9.37%) women burn their waste products. 1(0.31%) women found in severe anemia, 11(3.44%) of them were in moderate anemia and 308(96.25%) of them were at a normal level. This shows us there is a possible difference between the women regarding undernutrition.

Descriptive results of the categorical variable with anemia

Dummy and categorical explanatory variables were analyzed by using the chi-square test to establish for possible differences between respondents with severe anemia, moderate anemia and normal hemoglobin level. Independent variables that show a difference at 1% significant was type illnesses, 5% significant level was morbidity, Place of medical assistance, type of wall of the house made of, and type of floor of the house. On the other hand, variables that show a difference at 10% significant level were educational level, micronutrient supplementation seek medical assistance, type of toilet, and where to store fresh foods. The results are presented in Table 3.

Name of variable		Severe anemia		Moderate		normal		Total		P-value
		N	%	N	%	N	%	Total N	Total %	
Education	Don't attend	1	12.50	1	2.70	5	1.82	7	2.19	0.061 (*)
	Primary	0	0.00	5	13.51	34	12.36	39	12.19	
	Secondary	2	25.00	20	54.05	92	33.45	114	35.63	
	Diploma	1	12.50	3	8.11	63	22.91	67	20.94	
	Degree & above	4	50.00	8	21.62	81	29.45	93	29.06	
	Total	8	100.00	37	100.00	275	100.00	320	100.00	
Micronutrient Supplementation	Yes	6	75.00	24	64.86	222	80.73	252	78.75	0.083 (*)
	No	2	25.00	13	35.14	53	19.27	68	21.25	
	Total	8	100.00	37	100.00	275	100.00	320	100.00	
Morbidity	Yes	3	37.50	6	16.22	28	10.18	37	11.56	0.038 (**)
	No	5	62.50	31	83.78	247	89.82	283	88.44	
	Total	8	100.00	37	100.00	275	100.00	320	100.00	
Type Illnesses	Worm infection	1	33.33	0	0.00	3	11.54	4	11.76	0.007 (***)
	Respiratory	2	66.67	5	100.00	23	88.46	30	88.24	
	Total	1	33.33	0	0.00	3	11.54	4	11.76	
Seek Medical Assistance	Yes	2	25.00	3	42.85	15	68.18	20	54.05	0.073 (*)
	No	6	75.00	4	57.14	7	37.81	17	45.94	
	Total	8	100.00	7	100.00	22	100.00	17	100.00	
Place of Medical Assistance	Private	0	0.00	10	83.33	4	80	14	70	0.041 (**)
	Government	3	100.00	2	16.67	1	20	6	30	
	Total	3	100.00	12	100.00	5	100.00	20	100.00	
Wall of the House Made of	Iron	1	12.50	5	13.51	20	7.27	26	8.13	0.016 (**)
	Mud	1	12.50	11	29.73	53	19.27	65	20.31	
	Cement	6	75.00	15	40.54	191	69.45	212	66.25	
	Mud and Cement	0	00	6	16.22	11	4.00	17	5.31	
	Total	8	100.00	37	100.00	275	100.00	320	100.00	0.011 (**)
Floor of the House	mud	0	0.00	2	5.41	7	2.55	9	2.81	
	Cement	8	100.00	35	94.59	268	97.46	311	97.19	
	Total	8	100.00	37	100.00	275	100.00	320	100.00	
Type of Toilet	Flush	5	62.50	12	32.43	157	57.09	174	54.37	0.074 (*)
	Pit Latrine	3	37.50	25	67.57	118	42.91	146	45.62	
	Total	8	100.00	37	100.00	275	100.00	320	100.00	
Where to Store Fresh Foods	Refrigerator	5	62.50	30	81.08	211	76.73	246	76.88	0.091 (*)
	Covered	2	25.00	0	0.00	12	4.36	14	4.38	
	Separated	1	12.50	7	18.92	52	18.90	60	18.75	
	Total	8	100.00	37	100.00	275	100.00	320	100.00	

Table 3: Chi square test results of the respondents based on hemoglobin.
Source: Analyzed from researcher surveyed data (2019).
Note: *** is 1%, ** is at 5% and * is 10% significant.

Socio-demographic results and anemia

Gestation in weeks, marital status, level of education, the main occupation of the respondent, the main occupation of the husband, and religion were analyzed for a possible difference between pregnant women with anemia by using the chi-square test the finding of the results shows the level of education were statistically significant (Table 3). From the study population 7(2.19%) of them don't attend formal school because of different reason, 39(12.19%) of them attended primary school, 114(35.63%) have attended secondary school, 67(20.94%) have earned their diploma, and 93(29.06%) have got their degree and above degree. Out of the respondents who don't attend primary school 1(14.90%), 1(14.90%) and 5(71.43%) were in a severe, moderate and normal hemoglobin range, respectively.

There were 5(12.82%) moderately anemic respondents found from primary attended women and the other 34(87.18%) were in normal hemoglobin reading. Secondary school attended women who experienced severe anemia were 1.75(2%), while 20(17.54%) of them experienced moderate anemia and 95(80.70%) of them were in the normal range of hemoglobin cut-off. Out of the interviewed population who awarded diploma 1(1.49%), 3(4.48%) and 63(94.02%) were in severe, moderate and in the normal levels of anemia respectively. The degree and above owner who presented with severe anemia were 4(4.30%), and 8(8.60%), 87.09% were in moderate and normal range. Educational level was statistically significant with a P-value of 0.061 by a chi-square test and the result reveals that there is a difference between respondents.

Micronutrient supplementation and anemia

The categorical and dummy variable in this category computed by using chi-square for possible differences are micronutrient supplementation, type of micronutrient, dosage, the reasons for not taking the nutrients and access to fortified foods and the statistically significant variable found was micronutrient supplementation.

Of the pregnant women that were interviewed, 252(78.75%) had received and were consuming micronutrient supplements while 68(21.25%) have not received the supplements due to different reasons. Mainly iron and folic pills were the supplements being consumed as reported by 67.2% of the respondents. From the respondent who has been taking the supplements (78.75%), 6(2.38%) of them were in severe anemia, 24(9.5%) were in moderate anemia and 222(88.10%) were in normal hemoglobin reading. Of those who have not been taking the iron supplementation, 2(2.94%) of them were anemic, 13(19.2%) of them were moderately anemic and 53(77.94%) are in the normal range. The micronutrient supplementation during pregnancy has shown a 5% statistically significant possible difference

among the respondents with anemic status with a P-value of 0.083. Iron supplementation of women during pregnancy has been found to protect the mother and infant against anemia.

ANC attendance, morbidity, and anemia

Descriptive analysis by using chi square for a potential difference of categorical variables from ANC attendance and morbidity with nutritional status shows type illnesses, seeking medical assistance, and Place of medical assistance was found significant. The outcome of this study shows that from a total of 320 respondents, the proportion of pregnant women who have been sick during the pregnancy time is 37(11.6%) the others 283(88.4%) of them were not sick. The study population who have been sick found to be in sever anemic category 3(8.10%), in a moderate category 6(16.21%) and in a normal category 28(75.67%). The respondents who have not been sick were found to be severely anemic 5(1.77%), moderately anemic 31(10.95%) and in normal hemoglobin 247(87.28%). The morbidity status is statistically significant with a P-value of 0.038 and shows a likelihood of differences among respondents.

The second significant variable with a P-value of 0.007 in this category is the type of illnesses that the women got. Two types of disease, worm infection and respiratory diseases are the ones that the women mentioned. Respondents who suffer worm infection were 4(11.76%) and that of respiratory infection is 30(88.24%). Prevalence of anemia in a respondents who experience worm infection is 1(25%) severe anemia, and 3(75%) in a normal readings. Of the women who experience respiratory infections 2(6.67%) of them found to be in severe anemia 5(16.67%) in moderate anemia and 23(76.67%) were in a normal reading of hemoglobin levels (Table 3).

Similarly, the other statistically significant independent variable with a P-value of 0.073 is seeking medical assistance. As a result in table 3 shows from the study population who have been sick n = 37, 20(54.05%) of them show at medical assistance while the rest 17(45.94%) were not. Out of the respondents who seek medical advisory, 2(10%) of them were in severe anemia, 3(15%) of them were in moderate anemia while 15(75%) of them were in a normal reading for hemoglobin level. For those who didn't seek assistance, 6(35.29%) found to have severe anemia, 4(23.53%) moderate anemia and 7(41.18%) were found to have normal readings for hemoglobin.

The place of medical assistance is another statistically significant variable with a P-value of 0.041. Out of the women who were found to seek assistance 14(70%) of them attend private clinics while 6(30%) seek medical advice at government healthcare centers. The respondents who attend the private hospitals 10(71.43%) have been in moderate anemia and 4 (28.57%) were in a normal range of hemoglobin levels. Of those who attend government hospital 3(50%) of them were severely anemic, 2(35%) of them were moderately anemic, and 1(15%) of them were in a normal anemic condition.

Socio-economic characteristics and anemia

Type of residence, type of wall of the house, type of roof, type of floor, the main source of cooking, the main source of lighting are the categorical and dummy variables that have been analyzed for possible differences among the study population with respect to anemic status. The statistically significant variables are the type of wall of the house, and the type of floor the house made of. The wall of the house that the study population is living 26(8.13%), 65(20.31%), 212(66.25%) and 17(5.31%) are made of iron, mud, cement, and both (mud and cement) respectively. Out of the population that have iron made wall, 1(3.85%) is severely anemic, 5(19.23%) are moderately anemic and 20(76.92%) of them are in the normal range.

The study shows the ones who have their wall made of mud found to have 1(1.54%) severely anemic, 11(16.92%) moderately anemic and 53(81.54%) of them are in normal anemic level. The groups who have their walls made of cement have severe anemia 6(2.83%), moderate anemia 15(7.07%), and normal 191(90.09%). The women who live in a both mud and cement have experienced 6(35.29%) of them were moderately anemic and the rest 11(64.70%) were in a normal hemoglobin level. The type of wall of the house is statistically significant with a P-value of 0.016.

The type of floor of the house is another significant variable with a statistical significance a P-value of 0.011. The floor of their house is mainly made of mud and cement. The once that said it's made from mud are 9(2.81%) and the majority of the 311(97.19%) were made of cement. Out of the 9 respondent, 2(22.22%) were found in moderate anemia while 7(77.78%) of them were in the normal category. Out of the informants who live in a floor which is made of cement 8(2.57%) was in severe anemia, 35(11.25%) was in moderate anemia and 268(86.17%) of them was in a normal reading of hemoglobin level.

Environmental factors and anemia

As table 3 shows results from the analysis of the chi-square test of the environmental factors to differentiate for possible differences with anemia, the variable that shows a statistical difference were the type of toilet and storage for fresh perishable foods. The majority of the respondents 174(54.37%) use flushed toilets and the rest of them 146(45.63%) use a pit latrine toilet. Most of the respondents 157(90.23%) who use the flush toilet were in normal hemoglobin reading while 12(6.90%) of them was in a moderate category and 5(6.87%) were in severe anemia. The respondents who use pit latrine toilet experienced severe anemia 3(2.05%) moderate anemia 25(17.12%) and 118(80.52%) were normal. The type of toilet is significant at a P-value of 0.074.

Similarly, the other significant categorical variable storage for fresh perishable foods is statistically significant with a P-value of 0.091. Most of the respondents 246(76.88%) use a refrigerator to protect their food from contamination, whereas 14(4.38%) of them put their foods covered and 60(18.75%) of them put the food in a separate place for protection. The respondents who use refrigerators the bunch of them 211(85.77%) found to be in normal range, the other 30(12.20%) of them moderate, and 5(2.03%) of them severely anemic. The women who put their food covered 12(84.71%) of them were normal and 2(14.29%) of them were in severe anemia. From the study population who put their foods separated 1(1.67%) found severely anemic, 7(11.67%) moderately anemic and the rest 52(86.67%) found to be in a normal range.

Descriptive results for continuous variable

All continuous explanatory variables namely age, parity, educational level, the income of the household, women dietary diversity score, ANC follow up and pay for house rental were analyzed by using a t-test to prove for a possible mean difference between pregnant women with anemia and normal hemoglobin levels have been shown some significant results. From the seven variables three of them age is 5% significant, educational level 10% significant and women's dietary diversity score come with a 1% significant level. The results are presented in Table 4.

Name of Variable	Anemic		Normal		Total		T-value	P-value
	Mean	SD	Mean	SD	Mean	SD		
Age	27	4.745	28	4.267	28	4.361	-2.2142	0.0275**
Parity	1.86	1.025	2	1.001	2	1.004	-1.0586	0.2906
Education	10.96	3.646	11.9	3.327	11.7	3.383	-1.7642	0.0787*
Income	4211	1639	4698	2257	4631	2186	-1.3754	0.1700
WDDS	3	.9947	3	1.199	3	1.191	-3.2352	0.0013***
ANC follow-up	3	1.69	3	1.551	3	1.570	-0.7805	0.4357
House rental	1118	1444	1581	1986	1517	1925	-1.4841	0.1388

Table 4: T-test for continuous variable and anemia.

Source: Analyzed from researcher surveyed data (2019).
Note: *** is significant at 1%; ** is significant at 5% and * is significant at 10%.

The mean age of the study population for anemia was 27 and normal range was 28.8. There has been a 5% statistical significant mean difference with a p-value of 0.0275. Educational status is the second variable that was found to have a statistical mean difference with a P-value of 0.0787. The mean educational level that had anemia was 10.9 and normal range was 11.9. This result shows that there is a mean difference between the respondents and dependent variables. Women's dietary diversity score was another variable that shows a mean difference. Dietary diversity score mean for anemic women was 2 and for non-anemic were 3. The women dietary diversity is significant with a P-value of 0.0013.

Nutrition status of respondents by MUAC

Prevalence of undernutrition

From the total sample of the respondent 320, 12(3.75%) of respondents were undernourished from them 1(0.31%) of the respondents was found to be severely undernourished while 11(3.44%) of them are moderately under nourished and the remaining 308(96.25%) found normal. Maternal undernutrition has been linked to poor pregnancy outcomes such as poor fetal development, preterm births, small for gestational age, and low birth weight. In turn, these outcomes lead to increased infant morbidity and mortality. In low-resource settings, mid-upper arm circumference (MUAC) (Table 5) has been widely accepted as a measure of fat-free mass, and changes in MUAC tape measure can be a useful indicator of protein-energy malnutrition or starvation.

Nutrition Status	Count	%
Severe undernourished (<180 mm)	1	0.31
Moderately undernourished (≥180 mm to <210 mm)	11	3.44
Normal (≥210 mm)	308	96.25
Total	320	100.00

Table 5: Nutrition status of the respondents based on MUAC.

Source: Analyzed from researcher surveyed data, 2019.
MUAC: Mid-upper arm circumference.

Nutrition status by hemoglobin levels

Prevalence of anemia

In this research, from the total respondents 14.6% were anemic with hemoglobin factors less than 11 mmol/l out of this 8(2.5%) of respondent were severely anemic with a level of <7 mmol/l and 37(11.56%) were presented with moderate anemia a level between 7 mmols/l and 11 mmols/l. While 275(85.94%) found to be normal with hemoglobin factors greater than 11mmols/l. Anemia during pregnancy is defined by the Centers for Disease Control and Prevention (CDC) and World Health Organization (WHO) as a hemoglobin concentration less than11 g/dl (mmol/l). Also, anemia is considered as a condition in which the number and size of red blood cells, or the hemoglobin concentration, falls below an established cut-off value, as a result, leads to impairment of the capacity of the blood to transport oxygen around the body (table 6).

Anemia is observed as an indicator of both poor nutrition and poor health. It impairs health and well-being in women and increases the risk of maternal and neonatal adverse outcomes. During pregnancy anemia is responsible for a lot of complications in women. Some of those associated problems are less exercise tolerability, puerperal infection, thromboembolic problems, postpartum hemorrhage, pregnancy-induced hypertension, placenta previa, cardiac failure, low birth weight, preterm delivery, and prenatal death. Even if anemia is a worldwide public health problem affecting numerous people in all age groups, particularly then the burden of the problem is higher among pregnant women.

Anemia	Count	Percent
Severe Anemic(<7 mmols/l)	8	2.50
Moderately Anemic (≥7 mmols/l to 11 mmols/l)	37	11.56
Normal (>11 mmols/l)	275	85.94
Total	320	100.00

Table 6: Nutrition status of the respondents based on Hemoglobin.
Source: analyzed from researcher surveyed data (2019).

Anemia and dietary diversity

As the research finding shows from the pregnant women attending antenatal clinic at the study area 197(61.56%) of them are in the category of low dietary diversity that means they consumed less than 4 food groups, while the rest 123(38.44%) is in a higher dietary diversity score category which is greater than or equal to 4 food groups per 24hrs out of the nine food groups recommended for women dietary diversity scores (WDDS) see on (table 7).

Out of the 197 women, 7(3.6%) of them found to be severely anemic, 31(15.7%) were moderately anemic and 159(80.7%) were in a normal range of hemoglobin level. The women who diversify their diet more than and equal to four have experienced 1(0.8%) severe anemia, 6(4.9%) moderate anemia, 116 (94.3%) a normal range category for anemia. As we observe from the above table the chi-square test results show that dietary diversity statistically significant with a P-value of 0.003 with anemia status of the mothers.

WDDS	Anemia				
	Severe	Moderate	Normal	Total	%
Less than four food group	7	31	159	197	61.56
Greater than equal to four food group	1	6	116	123	34.44
Total	8	37	275	320	100.00

Table 7: Dietary diversity and anemia.
Source: Analyzed from researcher surveyed data (2019).

Dietary diversity and dietary intake of the respondents

Consumption of foods based on food groups

A total of 312(97.5%) of the study population had consumed cereals in the previous 24 hours which is predominant. The main cereal consumed was teff and wheat in the form of injera and bread respectively. Dark green leafy vegetables are consumed by 92(28.75%) of the study population. As we continue our assessments 119(37.2%) consume Vitamin A rich fruits white tubers and roots. Fruits and vegetables were consumed by 129(40.3%) of the respondents. During the focus group discussions held with the pregnant women, they affirmed that:

"Most people consume teff mainly because it's the most preferable food to bake injera the cultural favorable food. This is what easily available but those who have money may eat some meat as meat is considered as the sign of being wealthy."

Despite the high requirements for the intake of iron during pregnancy 9(2.8%) of the study population, had consumed organ meats which are presumed to be iron rich and contribute to the formation of blood and is expected to improve the hemoglobin status of an individual. Flesh meats, Fish were taken by 36(11.25%) of the respondents. Eggs were consumed by 53(16.6%) of pregnant women. 80.9% (n = 259) of the study population were reported taken legumes, nuts and seeds and milk and milk products were consumed by over 19% (n = 53). The consumption of organ meats iron-rich foods, flesh meats, and eggs which are good sources of the heme iron that is readily absorbed was very low and this, therefore, may explain the high prevalence of anemia among pregnant women (table 8). It is noticeable that the consumption of animal-based proteins was very low. During the FGDs, one respondent had the following to say concerning the consumption of meat:

"Most of the time, we slaughter animals or meat from the market when there is a special occasion such as holidays, wedding ceremonies, mehaber (socially gathered groups traditional) and special guests. However, some families slaughter especially those who are rich. But women will not eat organ meat because it is not recommended to eat raw meat at the time of pregnancy."

Food group	Count (N = 320)	%
Starchy Staples (Cereals and Vitamin A rich vegetables tubers)	312	97.5
Dark green leafy vegetables	92	28.75
Vitamin A rich fruits white tubers and roots	119	37.2
Fruits and vegetables	129	40.3
Organ meat (iron rich)	9	2.8
Flesh meats Fish	36	11.25
Eggs	53	16.6
Legumes, nuts and seeds	259	80.9
Milk and milk products	63	19.7

Table 8: Dietary diversity by food groups.
Source: Analyzed from researcher surveyed data (2019).

Women dietary diversity score based on 24 hours recall

The results (table 9) shows that from the pregnant women attending antenatal clinic at the study area 197(61.56%) of them are in the category of low dietary diversity that means they consumed less than 4 food groups, while the rest 123(38.44%) are in a higher dietary diversity score category which is greater than or equal to 4 food groups per 24 hours out of the nine food groups recommended for women dietary diversity scores (WDDS). According to FAO 2011 dietary diversity below 4 groups in 24 hours is considered as low dietary diversity range and equals or greater than 4 in 24 hours is considered as high score or normal dietary diversity.

WDDS	Count	%
Less than four food group	197	61.56
Greater than equal to four food group	123	38.44
Total	320	100.00

Table 9: Women dietary diversity categorized according to FAO.
Source: Analyzed from researcher surveyed data (2019).

Statistical analysis and discussion

The researcher further investigates the collected data with logistic and ordered logistic regression to determine if the variables affect dietary diversity and nutritional status respectively.

Model diagnosis test results

Multi-co linearity is a statistical phenomenon in which there exists a perfect or exact relationship between the predictor variables. When there is a perfect or literal connection among the predictor variables, it is difficult to come up with consistent estimates of their coefficients. This finally results in false conclusions about the relationship between the outcome variable and predictor variables.

There are several ways of diagnosing the presence of multi-co linearity: Examination of Correlation Matrix, link test, the goodness of fit test, Variance Inflation Factor (VIF) and Eigen system Analysis of Correlation Matrix. In this study, we used a Correlation Matrix, link test, goodness of fit and variance inflation factor. According to Gujarati [27] by the rule of thumb is that if the correlation coefficient between two explanatory variables is high, say, above of 0.8 and below -0.8, then multi-co linearity is a serious problem. With this approach correlation coefficient between two explanatory variables found to be by far below 0.8 in absolute terms indicating no serious problems of multi-co linearity between variables. Another use of correlation test is employed before regression.

The model goodness of fit test of the logistic regression justifies that the model is robust enough to explain the dependent variable. The Pseudo R2 statistic of the model is 0.5094 which lies between 0 and 1 an evidence that the variable is well fit for the model and the independent variable could explain the dependent variable.

Link test for model specification error is performed for the other ordered dependent variable with a null hypothesis shows there is no model specification error. If the p-value of hatsq is not significant then we reject the null hypothesis and confirm that our model is correctly specified. For factors affecting dietary diversity the P-value is 0.739 this indicates that the value is not

significant and we fail to reject the null hypothesis and accept that there is no model specification error. For the determinants of under nutrition the P-value is 0.222 this implies that the value is not significant and we reject the null hypothesis and confirm that there is no model specification error. Similarly, for determinants of nutrition by hemoglobin level, the P-value is 0.975 and also we reject the null hypothesis and accept that the model specification has no error at the same time.

Tests	Test Name	Determinants of WDDS (Logit)	Determinant of Anemia Ordered Logit	Determinant of Under Nutrition Ordered Logit
Gof	Pearsons (chi^2)	0.5094	–	–
Corr	Multi collinarity	Min = -0.1476	Min = -3637	Min = -0.1559
		Max = 0.2517	Max = 0.6376	Max = 0.6
Link test	hatsq	0.739	0.975	0.222
Vif	Mean vif	1.08	1.32	1.18

Table 10: Diagnostic test result for regression models.
Source: Analyzed from researcher surveyed data (2019).

Lastly, the VIF measures how much the variance of an estimated regression coefficient increases if your predictors are correlated. A VIF around 1 is very good. There are some guidelines we can use to determine whether VIFs are in an acceptable range. A rule of thumb commonly used in practice is if a VIF is >10, you have high multi co-linearity. In this case, with values around 1, we are in good shape and can proceed with our regression. In all the three models VIF value of 1.08, 1.32 and 1.18 for determinants of dietary diversity, for determinants of anemia and for determinants of undernutrition respectively, therefore, it can be concluded that there is no multi co-linearity between our variable.

Determinants of dietary diversity

The influence of independent variables on the probability of being in high and low dietary diversity was analyzed by using logistic regression. In other words, the variables age, frequency of meals per 24 hours, income, type of food consumed come from, antenatal follow-up, how to wash utensils, hemoglobin level, morbidity, and hand washing practice were computed to see if they are a factor for low and high dietary diversity.

The finding of the logistic regression shows (Table 11) that income, meals that were eaten in the last 24 hours, taking iron-fortified foods and anemia are the determinant factors.

Dietary diversity	Coef.	Std. Err.	Z	P>z	Marginal effect
Age	-0.0332291	0.0069	-1.11	0.266	-0.0076756
Income	0.0000978	0.00001	1.71	0.088*	0.0000226
In the last 24 hours	0.7962723	0.04716	3.90	0.000***	0.1839311
The food consumed	-0.2174324	0.07653	-0.66	0.512	-0.0502248
Morbidity	-0.2475938	0.09346	-0.61	0.541	-0.0571917
Iron-fortified food	-0.5428589	0.06131	-1.84	0.041**	-0.1253951
Anti-natal clinic	-0.1219145	0.01894	-1.66	0.137	-0.0281611
How to clean utensils	0.158987	0.06203	0.59	0.554	0.0367244
The steps to wash hand	0.1443558	0.04104	0.81	0.417	0.0333448
Hemoglobin	1.068671	0.08807	2.80	0.005***	0.2468526

Table 11: Logistic regression for determinants of dietary diversity.
Source: Analyzed from researcher surveyed data (2019).
NB: ***p<0.01, **p<0.05 and *p<0.1.

The marginal effect result reveals that as the meals that are eaten in 24 hours increases by one the likelihood of the food being diversified also increases by 16.17%. This implies that access to have more meals per day has a positive and significant outcome on dietary diversity. A study was done by Me´jean et al. [22] consumption of fewer than three daily meals was found to have an impact on dietary diversity. This shows us the result found from the study population similar to their study findings.

The same result is obtained from this research. The fact that income contributes positively to the dietary practice of the participant is a remarkable outcome of this study. It is found that the probability of highly diversified increases when income increases by one. This result is in

line with Weldehaweria et al. [33] which has found out that income has statistically positive significant outcomes. Researchers found out those families which have greater incomes and resources tend to have more diverse diets as food access is determined by income and the prices of foods [34].

Research done by Prentice et al. [35] found out that fortified iron foods are consumed less when there is organic diversified diet consumption. The results obtained from this study also imply the same as their findings. Iron-fortified foods are negatively associated with dietary diversity. When the women has the chance of consuming iron-fortified foods by one the probability of the women being in high dietary diversity decreases by 12.53%. This is maybe because the mothers are less introduced to iron-fortified foods or maybe they prefer to get foods that are not processed. The other reason behind also could be when the study population prefer to eat diversified diets there would be a likelihood of getting each and every nutrient that they need from the food they consume.

Similarly, the hemoglobin level of the respondents shows a positive relationship with dietary diversity. This finding of this study is the same as the result obtained in a study done by Desta et al. [36]. If hemoglobin increases by one the probability of the diet to be highly diversified also increases by 24.68%. This result shows us the more diversified the diet the more the women become healthy. A diversified diet has been associated with several improved outcomes in areas such as birth weight, child anthropometric status, and improved hemoglobin concentrations.

Determinants of nutritional status

Determinants of anemia

Age, educational level, occupation, occupation of husband, income, women dietary diversity score, micronutrient supplementation, taking the supplement daily, antenatal follow-up, morbidity, type of west disposal, how to wash utensils, and hand washing practice were computed to see if they are a factor for nutritional status by hemoglobin level. Sever, moderate, and normal anemia are nutritional indicators (table 12).

The marginal effect shows that age is negatively related to moderate anemia. This implies that when age increase by one the probability of being moderately anemic decreases by 0.5%. From the findings, we also can see the results of the marginal effect and they show that age is positively related to normal anemia or being nourished. In this research, it's found that when age increases by one the probability of being nourished decreases by 0.6%. Maternal factors like age have been shown to influence the dietary diversity and intern the anemic status the study done by Me´jean et al. [22] has a similar finding with the study results.

The finding of this study reveals women's dietary diversity is one of the factors for anemia. As the marginal effect result shows, the WDDS is both negatively and positively associated with anemia. This tells when WDDS increases by one the probability of being in a severe anemia decreases by 2.57% and the probability of being in moderate anemia decreases by 10.66%. But, a different effect is observed in the other result which is the probability of being in a normal range of hemoglobin level is positively associated with dietary diversity. That is, when WDDS increases by one the likelihood of being nourished also increases by 13.24%. The result findings are similar to research by Zerfu et al. [37]. The findings were women dietary diversity during pregnancy is associated with reduced risk of maternal anemia.

In this research, the marginal effect shows that when the probability of not taking iron supplementation daily increase by one the likelihood of being in moderate anemia also increases by 0.09%. In another way round it means not taking iron supplements daily has a negative

impact on anemic status. A different effect had been seen on being in normal anemic status. The variable is positively related means when the probability of taking iron supplements increases the likelihood of the mother being in normal range increases by 0.1%. This research finding relates to the findings of Taye et al. [38]. The findings were limited adherence is thought to be a major reason for the low effectiveness of iron supplementation programs.

Variables	Marginal Effect Severe Aneamia	Marginal Effect Moderate Aneamia	Marginal Effect Normal
Age	-0.0015(0.0009)	-0.0054(0.0032)*	0.0069(0.0041)*
Education	-0.0036(0.0042)	-0.0129(0.0152)	0.0165(0.0192)
occupation	-0.0029(0.0023)	-0.0107(0.0070)	0.0136(0.0091)
Occupation of husband	0.0001(0.0031)	0.0002(0.0114)	-0.0003(0.0145)
Income	-7.96e-07(1.73e-06)	-2.90e-06(6.17e-06)	3.69e-06(.7.88e-06)
WDDS	-0.0258(0.0109)***	-0.1067(0.0281)***	0.1325(0.0338)***
Micronutrient supplementation	0.0005(0.0132)	0.0019(0.0481)	-0.0024(0.0613)
How to take micronutrient	0.0003(0.0002)	0.0009(0.0006)*	-0.0012(0.0007)*
Antenatal follow-up	-0.0003(0.0027)	-0.0010(0.0098)	0.0013(0.0126)
Morbidity	-0.0203(0.0143)	-0.0739(0.0402)*	0.0943(0.0527)*
Waste disposal	-0.0096(0.0134)	-0.0348(0.0463)	0.0444(0.0409)
How you clean utensils	0.0019(0.0090)	0.0072(0.0319)	-0.0092(0.0242)
Hand washing practice	-0.0030(0.0053)	-0.0111(0.0190)	0.0141(0.2216)

Table 12: Ordered regression result for nutritional status by anemia.
Source: analyzed from own data (2019). **NB:** ***p<0.01, **p<5 and *p<0.1 respectively; standard error in parentheses.

Finally, the marginal effect reveals that the Morbidity status is both negatively and positively related to anemic status. The result shows when the probability of the mother being sick increases by one the probability of the mother being in moderate malnutrition decreases by 7.3%. This shows a negative relationship. Another finding was that when the probability of morbidity status increases by one the likelihood of the mother being in normal anemic status or nourished increases by 9.4%. This shows a positive relationship. This result is also in conformity to founding of [31].

Determinants of undernutrition

Malnutrition in women results in reduced productivity, increased susceptibility to infections, slow recovery from illness, and heightened risks of adverse pregnancy outcomes. Maternal diets during pregnancy need to provide energy and nutrients for the mother as well as for fetal growth. As per the objective of the study we had been studding the determinant factors for under nutrition. Variables age, parity, income, taking the supplement daily, morbidity, how to clean utensils, type of residency, and source of fuel for food preparation, how to store fresh foods, dietary diversity score, and west disposal were computed for determinants of malnutrition or undernourished. Table 13 shows the results from ordered logistic regression.

Variables	Marginal effect Severe	Marginal effect Moderate	Marginal effect Normal
Age	0.0002(0 .0003)	0.0018(0.0019)	-0.0019(0.0022)
Parity	-0.0021(0.0026)	-0.0217(0.0172)	0.0238(0.0187)
Income	-7.04e-07(5.02e-07)*	-7.18e-06(5.00e-06)	7.88e-06(4.95e-06)
Taking supplement	0.00003(0.00005)**	0.0004(0.0002)*	-0.0004(0.0002)*
Morbidity	-0.0024(0.0047)	-0.0249(0.0264)	0.0273(0.0307)
How you clean utensils	-0.0023(0.0022)**	-0.0236(0.0125)*	0.0259(0.0128)**
Type of residency	-0.0013 (0.0017)	-0.0129(0.0194)	0.0143(0.0207)
Food preparation	0.0007(0.0014)	0.0073(0.0086)	-0.0081(0.0098)
How to store fresh foods	-0.0017(0.0024)	-0.0174(0.0166)	0.0191(0.0181)
Dietary diversity score	-0.0002(0.0009)	-0.0019(0.0095)	0.0022(0.0105)
West disposal	0.0028(0.0047)	0.0293(0.0234)	-0.0322(0.0276)

Table 13: Ordered regression for determinants of undernutrition.
Source: analyzed from own data (2019).
NB: **p<5 and *p<0.1, standard error in parentheses.

The finding of the study shows that income, morbidity, and taking a supplement daily are the significant factors at different levels of significance.

The result of the study shows that income has been the determinant factor for undernutrition. The marginal effect shows that when income increases by one unit the likelihood of the women being severely malnourished decreases at a 10% significant level. And this shows income is negatively significant to undernourishment. The result is supported by research which had shown that

families which have greater incomes and resources tend to have more diverse diets as food access is determined by income and the prices of foods [39].

In another hand, not taking micronutrient supplementation daily is also a determinant factor for undernutrition. Severe undernutrition is positively related to not taking supplementation of micronutrient with a statistical significant p-value of 0.05. This implies that when a chance of not taking micronutrients daily increases by one the probability of pregnant women being in under nutrition also increases. Similarly, while the probability of not taking micronutrient daily increases by one the chance of being in moderate undernutrition also increases and has a significant p-value of 0.1. Moderate malnutrition is positively associated with taking micronutrient daily. In another way, the marginal effect shows that as the probability of taking micronutrient increases by one the probability being nourished also increases at10% significant level. Researchers found out that Low micronutrient intake has been found to be a problem even in countries undergoing a transition in terms of development. This result has also a similar finding with the finding of the study.

Finally, table 13 shows the way to clean utensils after preparing food is one of a factor that was determining undernutrition for mothers. Cleaning utensils properly has a positive significant association with undernutrition. When the chance of the utensils being clean increases, the likelihood of being severely undernourished decreases by 0.23% at 5% significant level and this tells that they are positively associated. The chance of being moderately undernourished also decreases by 0.24% at a 10% significant level when the probability of the utensil being cleaning increases. This also shows the variable is negatively associated with under nourishment. Different observation results have been shown on the independent variable that is a negative association with nourishment at 5% significant level. This implies that when the likelihood of the utensils being clean increases the probability of being nourished decreases.

4. CONCLUSION

The findings of the study indicate that the nutritional status of pregnant women especially anemia and undernutrition is middling although it was prevalent by 14.6% and 3.76%, respectively. The prevalence of anemia indicates that there could be a high proportion of the population that is at risk of maternal and fetal consequences of anemia and thus the need for further investigation. The incidences have a serious implication with regard to the micronutrient status of pregnant women because there was a lack of consistency in taking micronutrient supplementation. The malnutrition rate among pregnant women in the study area is a concern as there are risks that are associated with undernutrition in pregnancy. Women and their children risk consequences such as chronic illnesses in later years.

Dietary diversity of the pregnant women was underprivileged and low as such there is a need to scale up interventions geared towards addressing nutrition status among pregnant women. It's mainly a cereal-based diet as of the national findings revealed it's a monotonous cereal based diet. The low consumption of iron-rich foods such as eggs, flesh meats and organ meats which also have highly bioavailable iron is of concern as the foods were readily available in the community. The pregnant women are therefore at high risk of anemia which can be prevented. The high prevalence of anemia indicates that there could be a high proportion of the population that is at risk of maternal and fetal consequences of anemia and thus the need for further investigation. The dietary diversity of women needs to be improved in order to ensure dietary quality and reduce the consequences of poor dietary diversity. The low dietary intake by the pregnant women implies that future generations are threatened given that the pregnant women could be giving birth to low birth weight infants as a

result of which the worsening cycle of malnutrition shall continue to exist among the population.

The result of logistic regression analysis indicated that among the independent variables that are associated with dietary diversity include household income, meals frequency per day and hemoglobin levels which have a positive statistically significant effect. While iron-fortified diet has a negative effect on dietary diversity. The determinants of nutritional status by hemoglobin level (anemia) were analyzed by ordered logistic regression and show that the age of the pregnant women, dietary diversity, micronutrient supplementation, and morbidity status are the associated factors. The findings show that age was negatively related to moderate anemia. Alike it's positively related to normal anemic level. The other significant factor dietary diversity is negatively related to sever and moderate anemia and positively related to being in normal anemic status. Not taking supplements daily has a positive effect on moderate anemia and a negative effect on normal anemia. Lastly, morbidity status has also both positive and negative impact on moderate and on normal anemia. Whereas, income, micronutrient supplementation, and the way to clean utensils after food preparation is significant factors and show linkage with MUAC. Income is negatively related to sever undernutrition at a 10% statistical significant level [40-44].

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