ADDIS ABABA UNIVERSITY

COLLEGE OF HEALTH SCIENCES

SCHOOL OF PUBLIC HEALTH

Residential Disparities in Iron Utilization during Pregnancy in Ethiopia

BY

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APPROVAL SHEET

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I, the undersigned, agree to accept all responsibilities for the scientific and ethical conduct of this research project and declare that this thesis is my original work in partial fulfillment of the requirement for the Master of Public Health in Epidemiology and Biostatistics

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This thesis work has been submitted with our approval as university advisor.

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APRROVAL BY EXAMINATION BOARD

This thesis by Hanim Tesfaye is accepted in its present form by the board of examiners as satisfying thesis requirements for the Degree of Master of Public Health in Epidemiology and Biostatistics

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Abbreviations and Acronyms

AAU	Addis Ababa University
ANC	Antenatal Care
AIC	Akaike's Information Criterion
AOR	Adjusted Odd Ratio
BIC	Bayesian Information Criterion
CI	Confidence Interval
CBHI	Community Based Health Insurance
EDHS	Ethiopian Demographic and Health Survey
EFDA	Ethiopian food and drug administration
ENHES	Ethiopian National Health Equity Survey
ICC	Intra-Class Correlation
IDA	Iron Deficiency Anemia
IFA	Iron and Folic Acid Supplementation
MENA	Middle East and North Africa
MDG	Millennium Development Goals
RCH	Reproductive and Child Health
SNNPR	Southern Nations Nationalities and People's Region
SSA	Sub-Saharan Africa
STATA	Statistics and Data
SPSS	Statistical Package for the Social Sciences
UN	United Nations
WHA	World Health Assembly
WHO	World Health Organization

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ABSTRACT

Background: Low levels of hemoglobin are the major cause of symptoms related to low circulation of oxygen throughout the body. Taking iron supplements during the time of pregnancy helps pregnant women accumulate the additional blood they need. In Ethiopia very few pregnant women take iron supplement for more than 90 days. Therefore, this research aims to identify factors that affect iron utilization during pregnancy and explains between rural-urban differences in Iron Utilization during pregnancy

Method: The 2022 Ethiopian National Health Equity Survey (ENHES) dataset was used and secondary analysis was performed. A sample of 5,316 of mothers who gave birth five years prior to the study were those that were included in the analysis process. Multi-level logistic regression analysis was done by STATA version 16.0 and blinder Oaxaca decomposition were applied.

Results: This study revealed that 37.2% of the women took IFA below the recommended period during pregnancy. Rural – urban differences in the utilization of IFAS women was showed as 9%. In addition, women in the Afar region had the lowest usage of iron. Married women [AOR = 1.40, 95% CI: (1.04, 1.88)], women with higher wealth status [AOR= 1.95, 95% CI:(1.45, 2.62)], women enrolled in community-based health insurance [AOR = 1.50, 95% CI:(1.30, 1.74)], and women who had more than four antenatal (ANC) visits [AOR = 1.62, 95% CI: (1.42, 1.83)] showed a higher odd to use iron supplementation. Conversely, women with larger family sizes (more than 6 members) [AOR = 0.65, 95% CI (0.54, 0.80)] and women who reside more than 5 kilometers away from a healthcare facility [AOR = 0.87, 95% CI:(0.05, 0.15)] were less inclined to take iron supplements during pregnancy.

Conclusion: The findings show that some of the factors that increase iron utilization are high wealth, using community-based health insurance program, being married and attending antenatal care. On the other hand, mothers who have large family sizes and live more than 5km far from health centers are less probable to take iron supplements. Promoting women's education and maternal health services like ANC visits and participating in community-based health insurance (CBHI); specifically in growing regions and rural parts.

Keywords: Inequality**,** Iron utilization, Multilevel, Decomposition, Ethiopia

1. INTRODUCTION

1.1. Background

Women's body goes through significant changes when they become pregnant; the amount of blood in women's body increases by about 20-30 percent, which increases the supply of iron and vitamins that the body needs to make hemoglobin. Low levels of hemoglobin are the major cause of symptoms related to anemia as a result of reduced circulation of oxygen throughout the body(1). Anemia during the time of pregnancy is defined as having less than 11g/dl hemoglobin concentration(2). The feeding habit and nutritional status of a mother highly influences the health, growth and wellbeing of her fetus(3).

According to the results of the meta-analysis in 2022, the global prevalence of anemia in pregnant women is 36.8%; the highest prevalence of anemia is mild in the third trimester of pregnancy with the prevalence of 48.8%, while the highest prevalence of anemia in pregnant women was in Africa; with the prevalence of 41.7%(4). Among pregnant women in Ethiopia Only 0.4% take iron supplement for more than 90 days(5).

In sub–Saharan Africa the use of iron supplements related to pregnancy is very low (28.7%); this is due to different factors such as antenatal care (ANC) visits, the levels of education, the wealth status of families(6). To reduce the low consumptions of iron among pregnant mothers are constantly being done but the use of this supplements still remen low. From a study done in 22 Sub-Saharan Africa (SSA) countries the result states that only 28.7% of pregnant mothers utilized to at this supplements for at least a period of 90 days(6) .

The incidence of anemia in less developed countries is high accounting for over 50%. The highest region with incidence of anemia is SSA regions and there seems to be no decrease in anemia through time as compared to other regions with better decrease rates of anemia(7). Severe health consequences like preterm labor, anemia, death of a mother and her child, bleeding after delivery and low birth of a new born are related with the insufficient supplements of iron and low consumption during pregnancy(7).

The majority of studies suggest that achievements in school, visit to health facility at pregnancy time, and decision-making power are highly associated factor to taking iron tablets. The usage prevalence in iron tablets is different in SSA nations , the greatest consumption is in Zambia

(83.8%) and the lowest in Burundi(3.8%)(6). The insufficient use of IFA tablets by pregnant mothers highly affects the effectiveness in reducing maternal anemia and its complications(6) .

The most vulnerable groups at risk for anemia are women who are pregnant. The World Health Organization (WHO) highly suggests the taking of 400mg of folic acid and 30-6- mg of iron per day which should begin as early as possible during pregnancy. In the efforts to manage and prevent anemia the maternal adherence is highly necessary. The World Health Assembly (WHA) has established a total of 6 objectives on nutrition in 2014 and as part of a comprehensive implementation plan for nutrition for expecting mothers, new born babies and young children(8).

But by the year 2025 the second global nutritional objective aims to decrease the anemia among pregnant woman by 50%. This is because of high impacts that anemia causes on women such as years lost due to disability and impairment in the ability to do physical work and performance (8). The age of a mother, a previous history of anemia, maternal level of education, the wealth index of a family, understanding of anemia, receiving nutritional guidance from healthcare professional and support of husband were found to be associated factors in the use of iron tablets in different studies(3, 6, 9, 10).

Compared to the Ethiopian Demographic and Health Survey it found a high difference in the percentage between urban and rural populations in their use of iron supplementation (61 % Vs. 39%) (11). However there is still not enough literature that explains why pregnant women in Ethiopia who attend ANC still have low adherence to iron supplementation(3). The reasons behind the low utilization of pregnant women who attend ANC in Ethiopia is not yet sufficiently addressed in other literatures available(3).

This research uses the dataset from the Ethiopian National Health Equity cross-sectional survey that is conducted in 2022 to examine the residential differences and the factors that highly influence the pregnant mother's adherence to Iron supplementation.

1.2. Statement of the problem

Taking iron supplements during the time of pregnancy helps pregnant women accumulate the additional blood they need. It is necessary for the production of hemoglobin, which is an

essential protein found in erythrocytes(12). During pregnancy, iron is also needed for the development of the fetus and placenta and to expand maternal erythrocyte mass(12). It is highly advised to intake adequate iron through meals high in iron or supplements because low iron consumption during pregnancy period might lead to iron deficiency anemia (7). Because of Iron deficiency over two billion people suffer with anemia in all over the world. Some of the effects anemia brings are bad mental development, low ability to fight disease, limited ability to work, and low weight of new born. Those vulnerable groups that are most affected by this are women who are pregnant and small children(13)

Deficiency of Iron is the major cause of anemia during the period of pregnancy. According to the WHO the Middle East and North Africa (MENA) area is home to the highest percentage of pregnant women with iron deficiency anemia. One of the major reasons of anemia is a mother's poor adherence to a constant iron supplementation program, this is evidence by different researches from Southeast Asia Latin America and some African nations(14)

In Ethiopia it is found that 26. 3% of pregnant mothers are affected by anemia (15). One of the major ways to avoid and manage iron deficient anemia is taking iron supplements constantly. Woman with ages 25 and older were less likely to use iron supplements in comparison to women that are younger(less than 25 years old)(16). Woman who did not previously experience negative side effects from using iron tablets were almost three times more likely to using the iron tablets than then those women who previously experienced side effects(17).

Even though all pregnant mothers in Ethiopia receive iron Supplements as part of their major antenatal care treatments the countries. Iron supplement coverage still remains very low and falls short of the WHO guidelines(13).

Therefore, the research questions “What are the key factors that determine the use of Iron supplementation among pregnant women in Ethiopia and “what are the key indicators that explain the difference in the utilization of Iron among pregnant women in urban and rural areas of Ethiopia

1.3. Rationale of the study

Studies that's were done previously on iron utilization use create contradicting results. However, these studies imply that a woman's medical status, Iron supplement availability and health service-related factors highly impact the use of iron supplements. The majority reports high levels of 51.4 to 72% (4-6), which may account for the persistence of iron deficiency anemia (IDA). Some reveal adherence as high as 44%(17). This study aims to close these gaps by utilizing data obtained from ENHES to determine the variables that highly contribute to the residential differences in the use of iron supplements among women in Ethiopia (ENHES, 2022).

1.4. Significance of the study

As a result of inadequate consumption of iron tablets during pregnancy, anemia remains the most widespread nutritional problem among pregnant women in Ethiopia and this has several consequences for both reproductive and productive activities. Among mothers who have anemia the incidence of premature delivery and the risk of maternal and newborn mortality are much higher.

- ✓ The study primarily benefits mothers and newborns by contributing to the development of strategy aimed at reducing iron deficiency anemia throughout pregnancy. To sustain and enhance the effectiveness of nutritional problem solving the approach must be reviewed on a regular basis.
- ✓ The government and healthcare organizations that will help with enhancing and organizing iron deficiency anemia counseling practices and interventions in our nation and the area at large are the secondary beneficiaries.
- ✓ At last, this study will be useful to future academics and policymakers as they develop an intervention to counteract anemia outcomes during pregnancy and enhance vitamin supplementation for vulnerable populations in the study region.

2. LITERATURE REVIEW

Many pregnant women have low iron reserves as a reason to this they face this most common nutritional issues worldwide (18). This section presents a review of the literatures on the factors associated with iron-utilization of women during pregnancy. This section also presents the factors that determine the use of Iron supplementation among pregnant women and explain the difference in the utilization of Iron among pregnant women in urban and rural area studies conducted in various countries including in Ethiopia.

2.1. Individual level factors on iron utilization during pregnancy

Factors that affect an individual's iron status during pregnancy include dietary iron consumption, the amount of iron storage in the body and Iron supplement utilization(19). Pregnant and non-pregnant women's diets differ in that the emphasis is on food quality rather than quantity, with a diet low in fat and carbs and high in protein, calcium, iron, and vitamins (20).

The positive increase in women's utilization of iron supplement was highly affected by age group of the woman and secondary and above secondary educational status of their husband (21). The study conducted in Norway and Indonesia, age has Positively and significantly associated factors with iron status(22, 23).

In different research found that women who had formal education were more likely to use iron supplements than non-educated women (24, 25). The respondents' highest educational level was correlated with the use of iron supplements; the variable that had a negative correlation with the outcome variable was literacy(25).

Pregnant mothers who fulfilled the WHO minimum ANC attendance requirement which is four times or more visits are highly likely to take iron supplementations and mothers who were well aware of the community conversation program also were also very likely to utilize Iron supplementation(26). Animosity at the time of the research and having received a minimum of four ANC visits were shown to be strongly correlated with adherence to iron/folic acid supplementation in Dire-Dawa, Eastern Ethiopia. Pregnant women who had at least four ANC

visits were three times more likely to adhere to IFAS than those who had two to three visits, and mothers who currently have anemia were twice as much to take this supplements compared to those who don't have anemia (27). Taking from a study done in Bangladesh , the number of visit to ANC and the adherence to IFA supplements had a linear relationship that is affected by the time of the first ANC visit (28). Women who had four or more prenatal care visits (ANC) improved their adherence levels by 15.1%, almost twice as much as those who had fewer than four ANC visits 6.7% according to related research. The proportion of women who visited their first prenatal care provider within four months also showed an increase in adherence levels by 15.8%, which is twice as high as the percentage of women who had their first ANC visit after four months8.6% (21).

A study carried out in India found a strong correlation between religion and IFA intake; among women of Hindu and other religious backgrounds, the likelihood of eating at least 90 IFA supplements was nearly double that of Muslim women(29); the likelihood of iron supplement intake was lower among Muslim than Christians(24).

There is a strong relationship between participant's work status and their commitment to taking iron supplements. The findings imply that, in comparison to pregnant women who were employed, unemployed women could be more flexible in keeping their clinic visits, which could result in greater rates of iron supplement uptake(19).

2.2. Household-related factors on iron utilization during pregnancy

The nutritious quality of food is the primary determinant of the dietary differences between pregnant and non-pregnant women not the quantity and amount of food. It is recommended to eat foods low in fat and carbohydrates and rich in protein, calcium, iron, and vitamins. pregnant women who had 1-2 total children ever born; 1.18 times more likely to receive iron supplements during pregnancy than pregnant women with over 3 children ever born(23). Mothers who have children that are ten or more are less likely to receive iron supplements during pregnancy(26). And the chance of taking at least 90 IFA tablets increased considerably with income index; the

wealthiest women take more tablets, presumably as a result of having access to more reasonably priced healthcare and higher educational opportunities(29).

Furthermore, a strong positive correlation was found between the respondents' wealth index and their use of iron supplements, suggesting that pregnant women with middle-class and upper-class wealth assessments were more likely than their counterparts to adhere to their iron supplementation regimens. Higher wealth assessments may indicate that the respondents believe they can purchase and use alternative treatments in place of iron supplements, while lower wealth assessments may indicate that the respondents do not believe so(19). Other research have shown that with higher wealth index and have the ability to eat three or more times per day were more likely to adhere to IFAS compared to those women that have low wealth index(10).

2.3. Community level factors on iron utilization during pregnancy

Unfortunately, there is insufficient evidence about geographic distributions, and hotspot areas of high and low iron supplementation coverage in the research context have yet to be found. While, geographical analysis studies would provide information regarding hotspot areas for prioritizing, resource allocation, and prediction of healthcare utilization trends(30). About 30.9% of the overall change in the adherence level to iron supplement use during pregnancy was due to the difference in women's sociodemographic-related variables(21). Pregnant women living in developing regions the odds iron and folic acid supplementation decreased by 43% than those living in developed regions(30). According to other research, pregnant women in urban and rural areas adhered to iron supplementation at rates of 17.7% and 11.2%, respectively(31). According to this finding, urban women were more likely to take their iron supplements than rural women.

Another study states that the women’s location had a highly significant impact on their uptake of IFAS. Living in rural regions is found to have a negative effect in the utilization of IFAS. This can be elaborated by the fact that women that live in urban areas benefit from constant access to information such as the advantages of micronutrients and the reasons to use the in their time of pregnancy(19). One good explanation for the negative prediction of iron supplement uptake

among pregnant women living in rural regions is the presence of differences in access to maternal health care between urban and rural residents(19).

The distance it takes to get to a health facility from home is highly correlated to the adherence to IFAS (26). In similar research pregnant mothers who live close to a health care center were found to be more likely to follow IFAS on constant basis that mothers living far from health care centers (32, 33).

2.4 Application of multilevel and decomposition analyses for residential differences in iron utilization of women

Multilevel and decomposition analyses have been applied in Ethiopia to explain the regional differences and found that with regional increases of 61.7% in rural areas and 19.9% in urban areas, leading to a current national supplementation rate of 65.4%(34). In the other study also multilevel analyses was employed to identify the contributions of regional differences to average predictions(13).

Logit-based decomposition analysis technique was also used for the analysis of factors contributing to the disparity in immunization coverage to identify the sources of disparity between urban and rural areas (35). The research conducted in Ethiopia with identifying factors contributed to the disparity across the residence shows that there was a statistically significant difference in full immunization coverage between children in urban and rural areas; full immunization coverage or complete immunization status was found to be 28% higher among children in urban areas than in rural areas(35). Similarly using Multilevel and decomposition analyses at the household level, the household wealth status and type of sanitation facilities were found to be the key factors in explaining rural-urban inequality in child mortality in line with the previous studies(36, 37).

Since the NHES data had a hierarchical nature. Hence, women from the same cluster are more similar as compared with women who were from different clusters. Such kind of hierarchy of data might have a dependency nature. Therefore, this study was analyzed the urban–rural differential in the association between iron utilization among pregnant women in Ethiopia.

3. CONCEPTUAL FRAME WORK

This conceptual framework shows the linkage between pregnant women of iron utilization and related factors which were developed from different literature reviews. The utilization of iron supplements during pregnancy has been influenced by antenatal visits, wealth index, education, residence, parity, and working status (38). Thus, this study has been to investigate the differences in residential inequalities of iron utilization and associated factors among pregnant women in Ethiopia using NHES 2022 survey data.

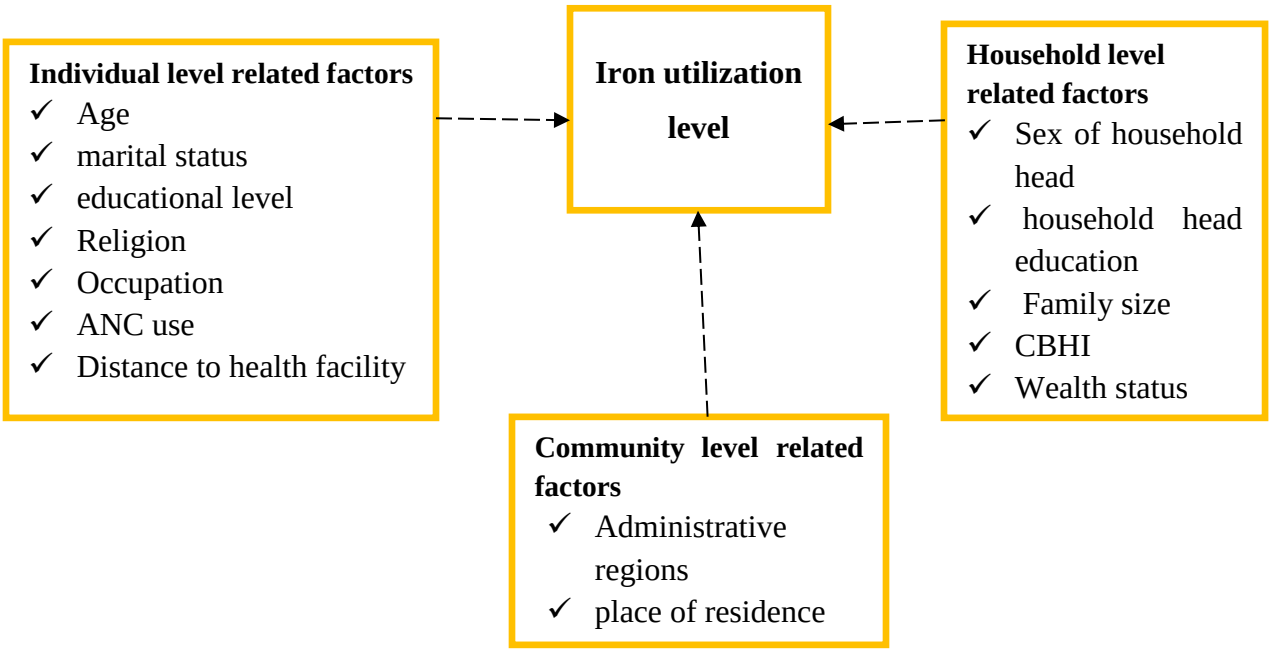

Figure 1. Linkage between pregnant women of iron utilization and related factors, NHES 2022

4. OBJECTIVES

4.1. General Objective

To examine the key factors that explains between rural-urban differences in Iron Utilization during pregnancy in Ethiopia using NHES 2022 data.

4.2. Specific objectives

- ✓ To identify factors associated with iron utilization among antenatal care attending women.
- ✓ To examine the key factors that explain rural-urban differences in iron utilization in Ethiopia

5. MATERIALS AND METHODS

5.1. Study Area and Period

This study was conducted in Ethiopia by using the ENHES dataset. Ethiopia is the second most populated country in Africa and ranks 12th globally with 102,850,793 people living there and in 2020 Ethiopia had annual growth rate of 2.6%. Ethiopia is home to more than 80 diverse ethnic groups and has over 80 different languages. In the year 2016 the life expectancy of Ethiopia was 65.3 years (67.3 and 63.7 years, for men and women respectively)

The survey was done in two city administrations (Addis Ababa and Dire Dawa) and 9 regional states of Ethiopia: Afar, Amhara, Oromia, Somali, Benishangul-Gumuz, Southern Nations Nationalities and Peoples (SNNP), Sidama, Gambela, and Harari. Data for this study was based on the NHES data set which obtained from the Ethiopian National Health Equity cross-sectional survey conducted from February 2022 to September 30, 2022**.**

5.2. Study Design

The study was national-based cross-sectional study utilizing the 2022 NHES dataset.

5.3. Study Population

The survey interviewed 8,077women of reproductive age (age 15–49). Of the 8077 employed women, 8060 were successfully interviewed, obtaining a response rate. A weighted 4,641 pregnant women who had received IFA supplements and who were asked how many days they consumed IFA tablets/ syrup during their last pregnancy that occurred five years prior to the national survey were included. The survey was designed to represent national, urban–rural, and regional estimates of health and demographic outcomes.

5.2. Sampling procedures

A two-staged, stratified cluster sampling design was used to choose the ENHES sample for 2022. Using independent selection in each sample stratum and a probability proportional to EA size, 387 EAs 153 in urban areas and 234 in rural regions were selected for the first step. The freshly constructed household listing was used to choose a set of 22 homes per cluster, with an equal possibility of systematic selection in second stage. Every chosen EAs had its households thoroughly listed.

5.3. Data collection procedures

We used the 2022 ENHES data set. The basic characteristics of the respondents, determinants of individual, household and community level related variables were extracted from the 2022 ENHES data set. Subsequently a total of women in the age group 15–49 years who were usual residents or who slept in the selected households the night before the survey were eligible and interviewed for the survey. Among those women interviewed, the respondents were identified for data analysis.

5.4. Study variables

Dependent variable: the outcome variable was iron/folate supplementation utilization during pregnancy, split into pregnant women who had taken the combined iron with folic acid tablets (women who took iron tablets/syrups during their most recent pregnancy for 90 days or more) coded as '1' and pregnant women who did not adhere to IFAS (women took iron tablets/syrups during their most recent pregnancy for less than 90 days) coded as '0'(13).

Independent variables: The independent variables for this study are, variables on individual level like age of women, marital status of women, education level, working status of women, and ANC use; variables related to household like, education level of household head, working status of household head, family size of the house, wealth index of the house, and variables on community-level consist of administrative regions and place of residence (urban vs. rural).

For this study we have has a conventional knowledge about the data quality. Throughout the data collection period the supervisors guided the data collectors and the data was constantly checked by the field supervisors and principal investigator.

5.5. Operational definitions

- ✓ **Iron Utilization:** Women who use iron tablets during their pregnancy which occurred five years prior to the survey were questioned about the number of days they took IFAS. In this study the women were classified as those who took iron tablets for ≥ 90 days as those that adhered iron supplementation while the rest were considered as non- adherent(13).

- ✓ **Residential disparity:** It is the physical division of population groups according to residence(urban-rural) and administrative regions.
- ✓ **Decomposition analysis:** is a statistical method that is used to identify the variables that contribute to the observed variation in a dichotomous result, it decomposes the variation into its constituent parts.

5.6. Data management and analysis

The software STATA V.16 was used to provide descriptive and summary statistics and further statistical models such as multi-level regression models. A correlation matrix was utilized to assess the presence of multicollinearity (39). By considering the hierarchical nature of the 2022 ENHES dataset into account we used multilevel (i.e., three level: Community, household, and individual level) analysis methods to get unbiased estimates of standard errors. Bivariate analysis was performed to taste the availability of association between dependent and each independent variable. Variables with a significant level (p-value) <0.2 in bivariate analysis were selected and included in the multivariable multilevel logistic regression model for more analysis. The clustering of the units of analysis is taken into explicit considerations in multilevel modeling. In addition to that a unified approach that has impact on individual, family and community approach to impacts at the individual, family, and community levels can be obtained by multilevel modelin g (11). Wealth index was created by using the EDHS method; it is based on a range of amenities and assets. It is classified in to five quintiles which are the poorest (the group with the lowest wealth index), poorer (the second quintile), middle (the middle quintile), richer (the fourth quintile) and richest (the group with the highest wealth index).

5.6.1. Multilevel mixed logistic regression

Multilevel analysis techniques were applied to the hierarchical nature of the 2022 ENHES dataset (i.e., three level: community, household and individual level). This was done to have an unbiased estimate of standards errors and to enable the modeling of between – level interactions by treating every effect at the appropriate level. An explicit multilevel modeling takes into

consideration the units of analysis's clustering. Additionally, the multilevel modeling offers a cohesive approach to impacts at the home, community, and individual levels (11).

5.6.2. Decomposition analysis

We also used decomposition analysis to quantify the contribution of observed and unobserved heterogeneity at the individual, household, and community levels.

In this study, the researcher was considering a dichotomous outcome variable $y_{ijk} \sim \text{Bernoulli}(\pi_{ijk})$ then the logit link function is:

$$\eta_{ijk} = \beta_0 + \beta_1 x_{ik} + \beta_2 x_{PSU(k)} + +\varepsilon^2_{(k)}$$

Where$\eta_{ik} = \ln(\frac{\pi_{ik}}{1-\pi_{ik}})$, π_{ijk} denotes the probability that the i^{th} subject in the 2^{nd} level cluster and iron utilization of pregnant women during pregnancy$\pi_{ik} = P(Y_{ik} = 1)$, x_{ik} denotes the vector of the subject level variables, $x_{psu(k)}$denotes the vector of the second level variables.

In addition, β_1 denotes the vector of regression parameters for the subject level variables, β_2 denotes the vector of regression parameters for second level variables; $\varepsilon^2_{(k)}$ denotes the random effect for cluster in the k^{th} level cluster.

We assume that $\varepsilon^{(2)}_{(k)} \sim N(0, \delta^2_{PSU})$ are independent.

In order to quantify the contributions of observed and unobserved heterogeneity at the individual household and Community label at the composition analysis was performed. The decomposition analysis helps us in the understanding of variance estimates weather regressors are random or fixed, which is based on multiplying regression coefficients using repressors. Hence, to explain the urban ruler inequalities in Iron utilization during pregnancy, we applied the Blinder- Oaxaca decomposition technique for a non- liner variable. This technique allows us for quantifying the gap between the advantaged and the disadvantaged groups (34).

6. ETHICAL CONSIDERATIONS

The scientific Ethical Review Office provided ethical clearance for the initial conduct of the 2022 Ethiopian National Health Equity cross-sectional survey. Permission to utilize the ENHES dataset was obtained from EPHI. Additionally, the Addis Ababa University School of Public Health granted us ethical approval.

Furthermore, the dataset does not contain any identifiable information that links to the actual survey participants.

7. RESULTS

7.2. Individual characteristics of pregnant mother

From the total study subjects 1,128 (21.2 %) were in the age range of 25-34. Considering the marriage status of this women the majority of the study participants that account for 95.13 % were married. A large number of the study subjects 2,148 (40.4 %) were orthodox in religion and 1,720 (32.4%) were Muslims. Regarding their level of educational status 1,772 (33.3%) mothers had never received any type of education, and 1.928 (36.3%) of the mothers were those who had attended primary level education.

Table 1: Individual characteristics of pregnant mothers

Variable	Category	Frequency	Percent (%)
Age	15-24	1128	21.2
	25-34	2971	55.9
	35-49	1217	22.9
Marital status	Married	5,057	95.13
	Unmarried	259	4.87
Religion	Orthodox	2,148	40.4
	Protestant	1,431	26.9
	Muslim	1,720	32.4
	Catholic	15	0.3
Educational status	No education	1,772	33.33
	Primary	1,928	36.27
	Secondary	936	17.61
	More than secondary	680	12.79
Women occupation	Employed	916	17.2
	Unemployed	4,400	82.8
ANC visits	<4 ANC visits	2,569	48.3
	≥4 ANC visits	2,747	51.7
.distance to health faci. (km)	<=5km	3,018	56.8
	>5km	2,298	43.2

Around 4,400(82.8%) of the women were not employed, they were limited to household activities. 28.7% of women were employed in various institutions. From the study subjects 2,569 (48.3%) had fewer than 4 ANC visits. Distance from home to a health facility was stated as a huge difficulty (5km & above) from 56.8% of the women (Table 1).

7.3. Result of household related characteristics of pregnant mothers

The majority (82.7%) of respondent women were from unemployed-headed households, and 23.5% of households had 3 or fewer members. The majority (34.8%) of women were from primary educated-headed households. Table 2 also depicts that 15.8% of women were grouped with the lowest wealth status and 25.3% of women were also grouped with the highest wealth index. Almost a quarter of women (34.2%) were enrolled in community-based health insurance.

Table 2: Household related characteristics of women

Variable	Category	Frequency	Percent (%)
Household head employment	Unemployed	4397	82.7
	Employed	919	17.3
Household head educational status	Not educated	1527	28.7
	Primary	1849	34.8
	Secondary	992	18.7
	Higher	948	17.8
Family size	1-3	1248	23.5
	4-6	3080	57.9
	>6	988	18.6
Wealth index	Lowest	839	15.8
	Second	982	18.5
	Middle	922	17.3
	Fourth	1226	23.1
	Highest	1347	25.3
CBHI	Yes	1818	34.2%
	No	3498	65.8%

7.4. Result of community level variable characteristics of women

52.3% of these study participant were living in in rural areas, whereas 47.7 % of the study participants lived in urban areas.

Table 3: **community level characteristics of pregnant women**

Variable	Category	Frequency	Percent (%)
Residence	Urban	2536	47.7
	Rural	2780	52.3

7.5. Bivariate binary logistic regression analysis

Table 4 provides us with an overview of the bivariate binary logistic regression model findings for the individual level variables. Marital status, educational level, employment status and distance to a health care facility were shown to be highly correlated with the adherence of iron supplements among mothers during their time of pregnancy

Table 4: Bivariate logistic regression analysis for individual level variables

Variable	Category	Iron utilization		COR	p-value	CI
		Yes (%)	No (%)			
Age	15-24 (ref)	404(36)	724(64)			
	25-34	1157(39)	1814(61)	1.14	0.066	(0.99, 1.32)
	35-49	419(34)	798(66)	0.94	0.482	(0.794, 1.115
Marital status	Unmarried (ref)	14(42)	19(58)			
	Married	1966(37)	3317(63)	1.32	0.042	(1.01, 1.73)
Educational status	No education (ref.)	14(42)	19(58)			
	Attend primary	4(33)	8(67)	1.23	0.003	(1.07, 1.41)
	secondary	1899(38)	3158(62)	1.71	0.000	(1.452, 2.01)
	Higher & above	63(29)	151(71)	2.23	0.000	(1.86, 2.67)
Women	Unemployed	13231(34)	2380(66)			

occupation						(1.30, 1.732)
	Employed	749(44)	956(56)	1.50	0.000	
Number of ANC visits	<4 ANC visits(ref.)	758(30)	1811(70)			(1.73, 2.144)
	≥4 ANC visits	1222(44)	1525(56)	1.914	0.000	
Distance from health facility (Km)	<=5km(ref.)	1197(40)	1821(60)			(0.702, 0.88)
	>5km	783(30)	1515(70)	.786	0.000	

Table 5 summarizes the results of the bivariate binary logistic regression model at the household and community level. There is a high significance correlation between the amount of iron supplements utilized by mothers during pregnancy due to factors such as family size, CBHI use, educational level of household head, occupational status and household wealth index.

Residence and is highly correlated to utilization of iron supplements during pregnancy. The community level factors are administrative regions and place of residence (urban vs. rural)

Table 5: **Bivariate logistic regression at household and community level related variables**

Variable	Category	Iron Utilization		COR	p-value	CI
		Yes(%)	No(%)			
Household head educational status	No education (ref.)	467(31)	1060(69)			
	Attend primary	642(35)	1207(65	1.207	0.011	(1.044, 1.395)
	Secondary	428(43)	564(57)	1.722	0.000	1.459, 2.03)
	Higher & above	443(47)	505(53)	1.991	0.000	1.684, 2.354)
Household occupation	Unemployed	1231(34)	3280(66)			
	Employed	749(44)	956(56)	1.515	0.000	(1.35, 1.704)
Family size	1-3 (ref.)	546(44)	702(56)			
	4-6	1127(37)	1953(63)	0.742	0.000	(0.649, 0.848)
	6& above	307(31)	681(69)	0.580	0.000	(0.487, 0.690)
Wealth index	Poorest (ref.)	260(31)	579(69)			
	Poor	306(31)	676(69)	1.008	0.937	(.826, 1.23)
	Middle	288(31)	634(69)	1.012	0.911	(0.827, 1.238)
	Rich	442(36)	784(64)	1.255	0.017	(1.041, 1.513)
	Richest	684(51)	663(49)	2.297	0.000	(1.917, 2.754)

CBHI	No(ref)	1245(36)	2253(64)			
	Yes	735(40)	1083(60)	1.230	0.001	(1.093, 1.38)
Residents	Urban (ref.)	1072(42)	1464(58)			
	Rural	908(33)	1872(67)		0.000	(0.613, 0.766)

7.6. Multivariable multilevel logistic regression analysis

A multivariable multilevel logistic regression analysis was applied to estimate the effects of individual, household, and community-level determinants of IFA consumption for the recommended period of time among pregnant women in this study, where pregnant women are nested within regions and between urban and rural areas. This made it possible to account for the geographical impact. Several methods were used to select the suitable independent variables based on bivariate analysis for the final model. For the multivariable multilevel logistic regression analysis model, factors at the individual, household, and community levels with a p-value less than 0.2 were accordingly taken into consideration as potential predictor variables.

Table 6. Shows the results from the multilevel regression analysis and it is necessary to recognize that each variable at individual level and household level is nested within this community. According to that only variables with $P < 0.2$ (3) from the bivariate analysis are presented and used to create four multilevel models For both of the household and community level .For the overall analysis a random intercept model was applied The applicability of multilevel models for our analysis was first justified by fitting the null model also known as model 0 or a model with no explanatory variable , this revealed a statistically significant differences among the utilization of iron by pregnant women across individual and household levels by their place of residence.

Furthermore, the result of the model effect 0 showed a statistically significant differences in the utilization of IFAS between pregnant women in household clusters by residence (table 6). The ICC in the null model shows that the different clusters by urban –rural differences take up for 13.5% of the IFAS utilization variability the estimated variance (unobserved heterogeneity) of the random intercepts for the null model was 0.514 with a CI (0.024,1.71) at regional level.

Second, by adding the community level variables to the null model, Model I was fitted. In model I the utilization of IFAS during pregnancy were noted based on residency, location and region and significant differences were observed. In this study, women that reside in rural regions had a 13% lower chance of adhering to IFAS than woman in urban regions. Pregnant mothers from urban regions have about 50% high adherence to IFAS than pregnant mothers living in emerging regions (table 6)

Third, by adding household level variables to model I, Model II was fitted. The use of iron-folate supplements during pregnancy was shown to be less common among pregnant women with larger families than in those with smaller ones. Pregnant women from wealthier homes were found to consume IFAS at a greater rate than pregnant women from poorer households. Compared to pregnant women who are unrolled to CBHI, IFAS consumption was 47% more common among those who were enrolled in CBHI.

Table 6: Binary mixed effects multilevel regression model (N=5,316), ENHES, 2022

	Model 0	**Model I**	**Model II**	**Model III**
Attributes	AOR(CI)	AOR(CI)	AOR(CI)	AOR(CI)
Cons.	0.54**(.36, .816)	.148**(.102, .214)	.115**(.073, .180)	.087**(.051, .148)
Community- level				
Residence: urban (ref.)				
Rural		.871* (.761, .995)	0.78 (.534, 1.163)	.896 (0.61 1.32)
Household level: head				
No education(ref.)				
Primary			0.82 (0.70 0.96)	0.88 (0.72 1.07)
secondary			1.11 (0.91 1.36)	1.04 (0.81 1.34)
Higher			1.19 (0.95 1.50)	0.92 (0.68 1.25)
unemployed (ref.)				
Employed			.969(.816, 1.151)	.921(.76, 1.117)
Family-size (1-3 ref.)				
4-6			0.74**(.644, .860)	0.73** (0.63 0.85)
>6			0.64**(.532, .787)	0.65** (0.54 0.80)
Wealth-poorest(ref.)				
Second			1.11 (0.90 1.36)	1.11 (0.90 1.37)
Middle			1.04 (0.84 1.29)	1.01 (0.81 1.26)
Fourth			1.29* (1.00 1.65)	1.22 (0.95 1.56)

Highest			2.28** (1.71 3.04)	1.95** (1.45 2.62)
CBHI(No-ref)				
Yes			1.47**(1.276, 1.705)	1.50**(1.30, 1.74)
Individual level: women				
No education(ref.)				
Primary				0.85 (0.70 1.03)
Secondary				1.09 (0.85 1.40)
Higher				1.38 (0.99 1.91)
Women-unemployed(ref.)				1.143(.926, 1.411)
Employed				
Marriage: unmarried (Ref.)				
Married				1.40**(1.04, 1.88)
ANC visit: <4(ref.)				
≥4 ANC visits				1.62**(1.42, 1.83)
Distance: <5Km(ref.)				
≥5km				0.87**(.051, .148)
Random effect				
Region: Var (δ^2)	.514(0.024, 1.71)	5.49e-33	1.20e-33	1.61e-34
ICC	0.135	1.67e-33	3.65e-34	4.89e-35
AIC	6589.1	6549.32	6449.09	6371.68
BIC	6602.3	6634.84	6606.97	6575.61

Note: *P< 0.01, ** P<0.05

Finally, a complete model (Model III) was fitted to analyze the impact of location on pregnant mother's adherence to IFAS. This model included all explanatory factors that are suggested including individual level predictors.

In comparison to mothers who were married, unmarried mothers had a 40% greater likelihood of using IFAS for the suggested duration. Compared to mothers who did not attend ANC follow up Mothers who did attend a minimum of four ANC follow up as suggested by the WHO had about five times more probability to take IFAS. Mothers living in more than 5km far from a health care center had 13% lowered chances of using the IFAS than mothers who lived near (Table 6).

When comparing pregnant women who are married to unmarried, those unmarried women had a 40% high probability of using IFAS (AOR = 1.40, 95%CI: 1.04, 1.88). The best fitted model was known by comparing all four models by using the Akaikes Information Criterion (AIC) and

Bayesian Information Criterion (BIC). The model that had the lowest AIC and BIC value was known to be the best fitted model. Therefore, the full model was the best fitted model for this study (Table 6).

7.7. Decomposition analysis

The multilevel analysis produced strong evidence of a statistically significant difference among woman's level of iron utilization between rural and urban settings in Ethiopia. Lower levels of IFAS use are seen among women residing in rural regions. We used the Blinder-Oaxaca decomposition analysis based on the place residence for this purpose. Table-7 presents the decomposition of the rural-urban inequalities in women's iron utilization grouped by place of residence. the average use of iron by pregnant women was 33% for those living in rural areas and 42% for those living in urban areas. The rural – urban differences in the utilization of IFAS among pregnant women was showed as 9%. To conclude, the disparity of utilization to IFAS among women is 77.8 % (0.07/0.09) of this was due to predictors (endowment). In the urban rural decomposition analysis family size 11.1% and ANC visit 33.3% (0.03/0.609) contributed to explaining the urban-rural gap in women's iron utilization.

Table 7: Blinder Oaxaca decomposition of urban-rural in women iron utilization, ENHES, 2022(n=5,316)

Iron utilization	Coef.	StD. Err	z	P>z	[95%]CI	
Overall						
Urban	0.42	0.01	42.69	0.00	[0.40	0.44]
Rural	0.33	0.01	36.91	0.00	[0.31	0.35]
difference	0.09	0.01	6.66	0.00	[0.06	0.11]
endowments	0.07	0.02	3.67	0.00	[0.03	0.10]
coefficients	-0.07	0.02	-2.93	0.00	[-0.12	-0.02]
Interaction	0.09	0.03	3.34	0.00	[0.04	0.14]
Endowment						
Women age	0.00	0.00	0.24	0.81	[0.00	0.00]
Marital status	0.00	0.00	-1.47	0.14	[-0.01	0.00]
Women employment	-0.01	0.01	-0.40	0.69	[-0.03	0.02]
Women education	0.00	0.00	-0.81	0.42	[0.00	0.00]
Family size	0.01	0.00	3.48	0.00	[0.01	0.02]
Wealth	0.02	0.02	1.23	0.22	[-0.01	0.06]
HH-education	0.00	0.01	0.15	0.88	[-0.02	0.02]
HH-employment	0.03	0.02	1.63	0.10	[-0.01	0.06]
CBHI	-0.01	0.00	-3.39	0.00	[-0.02	-0.01]
ANC visit	0.03	0.00	7.38	0.00	[0.02	0.04]
Coefficient						
Women age	0.03	0.05	0.73	0.47	[-0.06	0.12]
Marital status	0.00	0.00	0.92	0.36	[0.00	0.00]
Women employment	0.00	0.00	1.03	0.30	[0.00	0.01]
Women education	-0.02	0.13	-0.11	0.91	[-0.27	0.24]
Family size	0.02	0.02	0.89	0.37	[-0.03	0.07]
Wealth	0.14	0.03	4.29	0.00	[0.08	0.21]
HH-education	0.03	0.01	2.38	0.02	[0.01	0.06]
HH-employment	-0.01	0.01	-2.11	0.04	[-0.02	0.00]
CBHI	-0.11	0.05	-2.40	0.02	[-0.20	-0.02]
ANC visit	-0.05	0.01	-4.37	0.00	[-0.08	-0.03]
_cons	-0.11	0.15	-0.73	0.47	[-0.41	0.19]
Interaction						
Women age	0.00	0.00	0.57	0.57	[0.00	0.00]
Marital status	0.00	0.00	0.94	0.35	[0.00	0.01]

Women employment	0.01	0.01	1.03	0.30	[-0.01	0.04]
Women education	0.00	0.00	-0.11	0.91	[0.00	0.00]
Family size	0.00	0.01	-0.89	0.38	[-0.01	0.01]
Wealth	0.12	0.03	4.29	0.00	[0.07	0.17]
HH-education	0.04	0.02	2.37	0.02	[0.01	0.07]
HH-employment	-0.04	0.02	-2.12	0.03	[-0.08	0.00]
CBHI	-0.02	0.01	-2.38	0.02	[-0.03	0.00]
ANC visit	-0.02	0.01	-4.14	0.00	[-0.03	-0.01]

8. DISCUSSIONS

This research found that 37.2% of pregnant mothers did not get any IFA tablets in the time of their pregnancy. In this research result, pregnant women in urban and rural areas adhered to iron supplementation were 42.0% and 33.0%, respectively. In the urban rural decomposition analysis family size 11.1% and ANC visit 33.3% (0.03/0.609) contributed to explaining the urban-rural gap in women's iron utilization. In this finding, it was higher than other studies conducted in different areas of Ethiopia (26, 27, 40). The difference between the current and previous study findings may be explained by the difference in study areas, living conditions and socio-cultural differences. The discrepancies in research locations, living situations and sociocultural variations may account for the differences in current and previous studies. In the multilevel model distance to health facility, household wealth index, CBHI enrollment, family size, region, ANC follow up and marital status were statistically significant in relation to utilization of IFAS among pregnant women in Ethiopia.

The findings of our study showed that married women were 40% more likely to adhere to IFAS than unmarried women. A research study based on EDHS that was done in Ethiopia adds credibility to this data(13). The explanation is probably due to the fact that married women have their husbands constant support and they may stick to certain habits better than unmarried women. Based on this study married women with high wealth index has a 2.28 times higher chance of adhering to IFAS.

This result aligns with a research done in Ethiopia(41), Pakistan(42) and 22 SSA nations(6). One explanation for this could be that women that live in families with low wealth index may not have access to maternal health care services(43). This is associated to financial limitations for transportation and other amenities.

When we compare pregnant mothers who has fewer than four ANC visits, those pregnant mothers that had more than four ANC visits were highly inclined to the utilization of IFAS. This result is supported by researches done in Ethiopia by using the EDHS data in 2011 and 2016 respectively (40, 41). This finding also aligns with a research done in 22 SSA nations(6) and research done in Tigray (44). A possible explanation for this association could be that pregnant women who received ANC follow ups were highly likely to receive information on the advantages of adhering to IFAS. The medical professionals also warn mothers on the consequences of not taking the IFAS by stating effects such as abnormalities in the pregnancy and postpartum anemia. Compared to women who had to travel a longer distance (>5 km) to reach a health facility, those who travel less than 5 km were more likely to IFAS. A substantial relationship between iron supplementation and distance to healthcare facilities is shown. This maybe as a result of women who have easy access to health care facility being more likely to use ANC follow ups and other healthcare services (41).

Mothers with families with more than six members were less likely to adhere to IFAS. This result is in alignment with research from Ethiopia using EDHS data, which showed that women with bigger families had a lower likelihood of taking IFAS during pregnancy(26). This may be because these mothers in particular have greater domestic responsibilities, such as taking care of several family members, including children, which may lead to lower attendance at ANC.

Pregnant women who were enrolled in CBHI program had a higher probability of adhering to IFAS. Women who were enrolled at CBHI program have a good perception on the advantages of taking iron supplements (26).

When we come to the community-level factors; ANC visits contributed to clarifying the difference in women's iron consumption between urban and rural areas on an individual

basis(13). This might be due to differences in access to public health services provided in rural and urban areas of Ethiopia including ANC service and health education services.

According to earlier studies , the main variables influencing the urban-rural disparity in women's iron consumption at the household level were determined to be family size and household financial status(45). Since pregnant mothers with lower socioeconomic position in rural areas are unable to afford the same amount or quality of food pregnant mothers with better socioeconomic status. Comparatively, households with lower incomes buy less nutritious foods.

9. STRENGTHS AND LIMITATIONS

The factors influencing pregnant women's adherence to iron supplements have been extensively researched and documented in the literature review and provided a solid foundation for this study. This research was differing from others with assessing the factors associated with the differences in iron tablet utilization of women during pregnancy between urban and rural areas. This study represents an important initial step in investigating the determinants of iron tablet utilization during pregnancy in Ethiopia by using decomposition analysis. Notable strengths of the study include considering the clustering effect by place of residence and utilizing a large sample size for analysis.

However, despite its strengths, the study has several limitations that need to be acknowledged. One major limitation is the exclusion of the Tigray region from the analysis, which may impact the generalizability of the findings to the entire country. Additionally, the reliance on self-reported data for information on iron tablet utilization status may introduce recall bias and social desirability bias.

10. CONCLUSION AND RECOMMENDATION

10.1. Conclusions

The utilization of IFAS during the time of pregnancy has a significant relationship with individual, household and community-level characteristics. This research found that 37.2% of pregnant mothers did not get any IFA tablets in the time of their pregnancy. In this research result, pregnant women in urban and rural areas adhered to iron supplementation were 42.0% and 33.0%, respectively. Those individual- factors that are highly significant are: women's education, ANC – follow up, CBHI and distance to health facility.

Factors that are highly significant from household and community-level factors are wealth index, residence and region. This has been found to have a statistically significant correlation with iron-folic acid intake among pregnant women in Ethiopia.

10.2. Recommendation

The government should take great actions in improving women's education access and expand availability to maternal health care services like ANC services. And targeted initiatives towards growing regions are required.

The Ministry of Health should give top priority to enhance the standards of healthcare facilities in rural regions. Promoting women's education and maternal health services like ANC visits and participating in community-based health insurance (CBHI); specifically in growing regions and rural parts.

The Ethiopian food and drug administration (EFDA) should maintain a regular and sufficient supply of IFAS to increase the adherence among pregnant women in distant locations to health facility.

When it comes to providing pregnant women with advice and counseling on the advantages of adapting to IFAS health professionals and authorities play a huge role. Future research could benefit from incorporating observational and pill count methods to provide more objective measures of iron tablet utilization during pregnancy.

11. REFERENCES

1. Paul P, Maiti D, Adhikary TJIJoRiP, Sciences P. Iron deficiency anemia-An updated overview. 2021;6(4):28-33.
2. Breymann C, editor Iron deficiency anemia in pregnancy. Seminars in hematology; 2015: Elsevier.
3. Asmamaw DB, Debebe Negash W, Bitew DA, Belachew TBJFiN. Poor adherence to iron-folic acid supplementation and associated factors among pregnant women who had at least four antenatal care in Ethiopia. A community-based cross-sectional study. 2022;9:1023046.
4. Karami M, Chaleshgar M, Salari N, Akbari H, Mohammadi MJM, journal ch. Global prevalence of anemia in pregnant women: a comprehensive systematic review and meta-analysis. 2022;26(7):1473-87.
5. Beressa G, Lencha B, Bosha T, Egata GJSR. Utilization and compliance with iron supplementation and predictors among pregnant women in Southeast Ethiopia. 2022;12(1):16253.
6. Ba DM, Ssentongo P, Kjerulff KH, Na M, Liu G, Gao X, et al. Adherence to iron supplementation in 22 sub-Saharan African countries and associated factors among pregnant women: a large population-based study. 2019;3(12):nzz120.
7. Abu-Ouf NM, Jan MMJSmj. The impact of maternal iron deficiency and iron deficiency anemia on child's health. 2015;36(2):146.
8. Targets WGNJGWHO. Stunting policy brief. 2014:1-2.
9. Felipe-Dimog EB, Yu C-H, Ho C-H, Liang F-WJN. Factors influencing the compliance of pregnant women with iron and folic acid supplementation in the Philippines: 2017 Philippine demographic and health survey analysis. 2021;13(9):3060.
10. Lyoba WB, Mwakatoga JD, Festo C, Mrema J, Elisaria EJIJoRM. Adherence to iron-folic acid supplementation and associated factors among pregnant women in Kasulu communities in north-western Tanzania. 2020;2020.
11. Tegodan E, Tura G, Kebede AJPp, adherence. Adherence to iron and folic acid supplements and associated factors among pregnant mothers attending anc at gulele sub-city government health centers in addis ababa, ethiopia. 2021:1397-405.
12. Siu AL, Medicine UPSTFJAoI. Screening for iron deficiency anemia and iron supplementation in pregnant women to improve maternal health and birth outcomes: US Preventive Services Task Force recommendation statement. 2015;163(7):529-36.
13. Mulugeta SSJBo. Geographical disparities and determinants of adherence to iron folate supplementation among pregnant women in Ethiopia: spatial and multilevel analysis of the Ethiopian Mini Demographic and Health Survey of 2019. 2022;12(9):e061900.
14. Taye B, Abeje G, Mekonen AJPAMJ. Factors associated with compliance of prenatal iron folate supplementation among women in Mecha district, Western Amhara: a cross-sectional study. 2015;20(1).
15. Geta TG, Gebremedhin S, Omigbodun AOJPo. Prevalence and predictors of anemia among pregnant women in Ethiopia: Systematic review and meta-analysis. 2022;17(7):e0267005.

16. Fouelifack FY, Sama JD, Sone CEJPAMJ. Assessment of adherence to iron supplementation among pregnant women in the Yaounde gynaeco-obstetric and paediatric hospital. 2019;34(1).
17. Gebremariam AD, Tiruneh SA, Abate BA, Engidaw MT, Asnakew DTJPo. Adherence to iron with folic acid supplementation and its associated factors among pregnant women attending antenatal care follow up at Debre Tabor General Hospital, Ethiopia, 2017. 2019;14(1):e0210086.
18. Cappellini MD, Musallam KM, Taher ATJJoim. Iron deficiency anaemia revisited. 2020;287(2):153-70.
19. Moshi FV, Millanzi WC, Mwampagatwa IJFiPH. Factors associated with uptake of iron supplement during pregnancy among women of reproductive age in Tanzania: an analysis of data from the 2015 to 2016 Tanzania Demographic and Health Survey and Malaria Indicators Survey. 2021;9:604058.
20. Naicker T, Mkhize PZ, Onyangunga O, Moodley JJSAFP. Adherence to iron prophylactic therapy during pregnancy in an urban regional hospital in South Africa. 2019;61(5):1-6.
21. Delie AM, Gezie LD, Gebeyehu AA, Tarekegn GE, Muche AAJFiN. Trend of adherence to iron supplementation during pregnancy among Ethiopian women based on Ethiopian demographic and health surveys: A Multivariable decomposition analysis. 2022;9:955819.
22. Caspersen IH, Iglesias-Vázquez L, Abel MH, Brantsæter AL, Arija V, Erlund I, et al. Iron status in mid-pregnancy and associations with interpregnancy interval, hormonal contraceptives, dietary factors and supplement use. 2021;126(8):1270-80.
23. Efendi F, Israfil I, Ramadhan K, McKenna L, Alem AZ, Malini HJEJoGM. Factors associated with receiving iron supplements during pregnancy among women in Indonesia. 2023;20(5).
24. Zegeye B, Adjei NK, Olorunsaiye CZ, Ahinkorah BO, Ameyaw EK, Seidu A-A, et al. Pregnant women's decision-making capacity and adherence to iron supplementation in sub-Saharan Africa: a multi-country analysis of 25 countries. 2021;21:1-10.
25. Demie TG, Gessese GT, Woldeamanuel BT, Biratu TD, Handebo SJFS, Nutrition. Adherence to iron supplement intake during pregnancy and associated factors in Ethiopia: Further analysis of a national population-based study. 2023;11(9):5460-71.
26. Haile D, Tabar L, Lakew YJBp, childbirth. Differences in spatial distributions of iron supplementation use among pregnant women and associated factors in Ethiopia: evidence from the 2011 national population based survey. 2017;17:1-8.
27. Solomon Y, Sema A, Menberu TJEJoM. Adherence and associated factors to iron and folic acid supplementation among pregnant women attending antenatal care in public hospitals of Dire Dawa, Eastern Ethiopia. 2021;5.
28. Billah SM, Raynes-Greenow C, Ali NB, Karim F, Lotus SU, Azad R, et al. Iron and folic acid supplementation in pregnancy: findings from the baseline assessment of a maternal nutrition service programme in Bangladesh. 2022;14(15):3114.
29. Chourasia A, Pandey CM, Awasthi AJCE, Health G. Factors influencing the consumption of iron and folic acid supplementations in high focus states of India. 2017;5(4):180-4.

30. Tamirat KS, Kebede FB, Gonete TZ, Tessema GA, Tessema ZTJBp, childbirth. Geographical variations and determinants of iron and folic acid supplementation during pregnancy in Ethiopia: analysis of 2019 mini demographic and health survey. 2022;22(1):127.
31. Geremew MA, Tefera Z, Gashaw W, Ayalew S, Habtie EJJoM, Health R. Rural-Urban Differential of Iron Supplementation Compliance during Pregnancy among Reproductive aged Women in Ethiopia. 2023;11(2).
32. Niang K, Faye A, Tine JAD, Diongue FB, Ndiaye B, Ndiaye MB, et al. Determinants of iron consumption among pregnant women in southern Senegal. 2016;7(1):41-50.
33. Mahundi P, Pillay K, Wiles NJAJoN, Midwifery. Barriers to Optimal Iron Supplementation by Pregnant Women Attending the Mutare City Clinic, Manicaland, Zimbabwe. 2021;23(1):17 pages- pages.
34. Shahzad R, Zakar R, Shahzad H, Zakar NM, Tariq F, Ahmed R, et al. Regional variations in the trend of iron supplementation during pregnancy and its multi-level predictors: Evidence from Pakistan Demographic and Health Surveys. 2024.
35. Negussie S, Chalachew G, Nigatu R, Terefe D. Residential inequalities in child mortality in Ethiopia: Multilevel and decomposition analyses. International Journal of Population Studies. 2021;7(2):47-59.
36. Touré S, Weeks J, Lopez-Carr D, Stow DJDR. Evaluating links between dynamic urban landscapes and under-five child mortality in Accra, Ghana. 2020;42:589-614.
37. Dendup T, Zhao Y, Putra IGNEJJoHR. Rural-urban differentials in the determinants of under-five mortality in Bhutan. 2020;35(3):226-39.
38. . !!! INVALID CITATION !!!
39. Senaviratna N, A Cooray T. Diagnosing multicollinearity of logistic regression model. Asian Journal of Probability and Statistics. 2019;5(2):1-9.
40. Tadesse AW, Aychiluhm SB, Mare KUJH. Individual and community-level determinants of Iron-Folic Acid Intake for the recommended period among pregnant women in Ethiopia: A multilevel analysis. 2021;7(7).
41. Agegnehu CD, Tesema GA, Teshale AB, Alem AZ, Yeshaw Y, Kebede SA, et al. Spatial distribution and associated factors of iron supplementation use among pregnant women in Ethiopia; Ethiopian Demographic and health survey 2016 data: spatial and multilevel logistic regression analysis. 2020.
42. Nisar YB, Dibley MJ, Mir AMJBp, childbirth. Factors associated with non-use of antenatal iron and folic acid supplements among Pakistani women: a cross sectional household survey. 2014;14:1-12.
43. Wendt A, Stephenson R, Young M, Webb-Girard A, Hogue C, Ramakrishnan U, et al. Individual and facility-level determinants of iron and folic acid receipt and adequate consumption among pregnant women in rural Bihar, India. 2015;10(3):e0120404.
44. Gebre A, Mulugeta A, Etana BJIJNFS. Assessment of factors associated with adherence to iron-folic acid supplementation among urban and rural pregnant women in North Western Zone of Tigray, Ethiopia: comparative Study. 2015;4(2):161.

45. Abate TW, Getahun B, Birhan MM, Aknaw GM, Belay SA, Demeke D, et al. The urban–rural differential in the association between household wealth index and anemia among women in reproductive age in Ethiopia, 2016. 2021;21:1-8.

11. ANNEX

11.1. Questionnaire:

No	QUESTIONS	Coding categories
1.	Household head employment	1. Government employee 2. Private employee 3. Non-government Employee 4. Merchant/Trader 5. Farmer 6. Homemaker/housewife 7. Student 8. Laborer 9. unemployed 10. Other(specify)
2	Household head educational status	11. No education at all 12. Attend primary (1-8 grade) 13. secondary (9-12 grade) 14. Technical/Vocational 15. Higher education
3	Household head marital status	1. Single 2. Co-habitation 3. Married 4. Divorced 5. Widowed/Separated
4	Age of woman	_____ Age in completed years
5	Woman's educational status	16. No education at all 17. Attend primary (1-8 grade) 18. secondary (9-12 grade) 19. Technical/Vocational 20. Higher education
6	Residence	1. Urban 2. Rural
7	Region	_____
8	Marital status	1. Single 2. Co-habitation 3. Married 4. Divorced

		5. Widowed/Separated
9	Religion	1. Orthodox 2. Protestant 3. Muslim 4. Catholic 5. Other (specify)
10	Occupation	1. Government employee 2. Private employee 3. Non-government Employee 4. Merchant/Trader 5. Farmer 6. Homemaker/housewife 7. Student 8. Laborer 9. unemployed 10. Other(specify)_____
11	Income	1. Rich 2. Middle 3. Poor
12	How many children have you ever given birth?	_____
13	Are you pregnant now?	1. Yes 2. No
14	Did you see anyone for antenatal care for this pregnancy?	1. Yes 2. No
15	Where did you receive antenatal care for this pregnancy? Anywhere else?	1. Home 2. Public Sector
16	How long does it take you (round trip on foot) to travel to the nearest primary health care unit?	_____ km
17	How many months pregnant were you when you first received antenatal care for this pregnancy?	1. Months_____ 2. Don't know
18	How many times did you receive antenatal care during this pregnancy?	1. Number of times_____ 2. Don't know
19	During this pregnancy, were you given or did you buy any iron tablets? SHOW TABLETS.	1. Yes 2. No 3. Don't know
20	During the whole pregnancy, for how many days did you take the tablets?	1. Days_____ 2. Don't know

Annex 10.2: Data use permission

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ቁጥር Ref. No. ሠሀ3/04
ቀን Date ሕዳር 17 2016 ዓ

ለሃኒም ተስፋዬ
አዲስ አበባ

ጉዳዩ ፦ የNational Health Equity ጥናት መረጃ እንድትጠቀም ስለመፍቀድ

የኢንስቲትዩታችን ሰራተኛ የሆነችው ሃኒም ተስፋዬ ከ National Health Equity ጥናት ላይ በ Objective: - to examine the key factors that explains both between and within rural-urban inequities in iron utilization during pregnancy in Ethiopia. በሚል የተሰበሰበውን መረጃ በመጠቀም ጥናታዊ ፅሁፉን ለመስራት በ ቀን 17/03/2016 በማማልከቻ ጠይቃለች፡፡ በዚሁ መሰረት የ National Health Equity ጥናት መረጃውን ተጠቅማ ጥናታዊ ፅሁፉን እንድትሰራ እና እንድታሳትም የፈቀድን መሆኑን እንገልፃለን፡፡

ከሰላምታ ጋር

ቴዎድሮስ ጌታቸው (ዶ/ር)
ዐርጭቀ ጤናና ሰነ ተዋልዶ ጤና
ምርምር ዳይሬክቶሬት ዳይሬክተር

ግልባጭ

- ለም/ዋ/ዳይሬክተር ፅ/ቤት

Annex 10.3: Ethical clearance

ADDIS ABABA UNIVERSITY
College of Health Sciences
School of Public Health
Ethical Clearance Form

Version January, 2024

Date: /31/01/2024/
Ref. No. SPH/296/2024

Project number /001/

Date of approval (D/M/Y) /19/01/2024	
Project Title: Residential Inequalities in Iron Utilization during Pregnancy in Ethiopia: Multilevel and Decomposition Analysis Approach.	
Name of PI Hanim Tesfaye	Phone Number
Institution	School of Public Health
Department	
Decision of Research and Ethics Committee:	✓ Approved ☐ Approved with Recommendation ☐ Resubmission ☐ Disapproved
Valid until	January, 2024 - June, 2024

Dean, School of Public Health
Signature
Date /31/01/2024/

A.A.U School of Public Health Dean's Office

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