Dietary Iron Consumption Estimates Among Women Of Reproductive Age In Kersa, Eastern Ethiopia: Cross-Sectional Study

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Abstract

Dietary iron inadequacy is a public health concern in developing countries. Women of reproductive age (WRA) are the most at risk for this micronutrient deficiency due to biological, socio-cultural, and dietary factors. This analysis aimed to assess estimated dietary intakes of iron (including heme and non-heme) and estimate bioavailability of dietary iron intake in Ethiopian women of reproductive age in Kersa district, Eastern Ethiopia.

A total of 1140 randomly selected women from households in Kersa participated in this study. We used a non-quantitative food frequency questionnaire to assess total dietary iron consumption in WRA. Adjusted prevalence ratios (APRs) and 95% confidence intervals (CIs) were computed using modified Poisson regression to evaluate factors for inadequate dietary iron intake.

The median usual iron consumption was 24.7 mg/d and 41.8 % of WRA were at risk for iron inadequacy. The following factors were associated with a greater likelihood for the risk of iron inadequacy: seasonal (APR 1.56; 95% CI 1.36-1.80) and part-time (APR 1.75; 95% CI 1.45-2.12) agricultural employment, market food source (APR 1.30; 95% CI 1.14-1.49), old age (APR 1.29; 95% CI 1.05-1.60) and low women's dietary diversity (APR 2.34; 95% CI 1.88-2.91).

Two-fifths of women had an inadequate dietary iron intake. Improving dietary diversity and food security, fortifying staple foods that have low iron bioavailability, and increasing animal-based foods and fruit consumption with meals would help to decrease the burden of iron dietary inadequacy and deficiency in WRA.

Introduction

The human body needs iron (*Fe*), which is a trace mineral that is essential for the synthesis of *Heme*, a constituent of hemoglobin - an oxygen carrier in the body, iron-containing enzymes, and for neural development in the fetus and during childhood [1, 2]. Dietary iron intake is composed of both heme (from meat, poultry, and fish) and non-heme iron (from cereals, legumes, fruits, and vegetables). Bioavailability is high for heme compared to non-heme iron. It is estimated that a quarter of heme-iron and one-tenth of non-heme iron is bioavailable from the diet [3, 4]. Iron is actively absorbed in the gut and transported by transferrin to the bone marrow for producing blood products and is reversibly stored as ferritin [5, 6]. The body's balance of iron depends upon its reserve, loss, and absorption (bioavailability and intake).

Iron deficiency occurs when the diet cannot supply enough iron to cover the body's physiological requirements. This can occur due to dietary intake is quantitatively inadequate, reduced absorption, or increased demands for iron for example among women of reproductive age (WRA) during pregnancy or due to menstruation [7, 8]. Iron deficiency is the most frequently encountered micronutrient malnutrition in the world [9]. Although the global prevalence of iron deficiency in non-pregnant women has decreased from 33–29% in the past decade [10], it is still a significant public health concern as it affects up to 500-600 million people, the majority in low- and middle-income countries (LMICs) [11, 12]. Inadequate iron intake can cause iron deficiency anemia (IDA), and IDA prevalence is high in WRA (because of loss in menstruation) in

developing countries [13, 14]. It also leads to reduced work capacity, loss of appetite, weakened immunity and puts pregnancies at risk contributing to 20% of all perinatal and maternal deaths [15, 16]. IDA can also disrupt the metabolic process and affect behavioral and cognitive function, with severe consequences for children [5, 17].

The mean dietary iron intake among WRA reported in Kenya, Nigeria, and South Africa ranged from 3.8 to 97.8 mg/d and around 34–100% of the WRA had inadequate intakes [13]. Studies suggest that only 8–12% of the WRA in Ethiopia have inadequate *Fe* intake, however, most of the staples consumed in Ethiopia including iron-rich foods such as teff have low bioavailability of iron [13, 18]. Additionally, the prevalence of maternal and child anemia in Ethiopia at 23% and 56% is among the highest globally [19]. Therefore, understanding the role of dietary intake in iron status among Ethiopians is of critical importance.

Several factors contribute to inadequate intake of dietary iron in Ethiopia. As dietary intake in Ethiopia is mostly plant-based with limited diversity and consumption of animal source foods, the presence of anti-nutritional factors has made the bioavailability of iron significantly low [18]. Additionally, poverty, illiteracy and limited knowledge of nutrition, and poor lifestyle choices are also contributing factors [5, 20]. Studies in other LMICs have also shown that high cost and limited access to micronutrient-rich foods, low acceptability of fortified foods, fasting, and sub-optimal dietary practices influence dietary iron intake in WRA [21].

Little is known about the dietary iron intake of Ethiopian women and the factors influencing it. Past research is outdated, and there are considerable discrepancies between regions. This study aims to estimate the usual dietary iron consumption and its components in Ethiopian WRA in the Kersa district in eastern Ethiopia. These findings will help to estimate the risk of inadequate iron intake among WRA in the area, and the factors associated with estimated dietary iron inadequacy. The findings help health officials to collaborate with stakeholders in improving the food security and fortification policy of locally available foods in Ethiopia.

Methods And Methods

Study design and settings

This study took place in the Kersa Health Demographic Surveillance system (Kersa HDSS) field research site, in Oromia region of eastern Ethiopia. Kersa HDSS includes 24 kebeles (the lowest administrative unit in Ethiopia), out of the 38 kebeles in the district [22]. Of the HDSS Kebeles, 21 are rural. The 2016 national census reported that the population of Kersa district was 170,816, of which 50% were women and 6.7% were urban dwellers [23].

We conducted a cross-sectional survey among households in Kersa HDSS from August 1 to September 30, 2019 [22]. The total sample size for the study was 1,200 women. Study participants were selected using a random selection method from a sampling frame derived from the Kersa HDSS database. Households with at least one married WRA (15-49 years old) or women head of the households were included in the sampling

frame. If more than one WRA lived in the household and was present at the interview, one woman was randomly selected using a number generator. We excluded pregnant women from the study.

Data collection tool

The participants responded to the questionnaire; which had five sections, including information on socio-demographic characteristics, health information, food choices, and cooking practices, food security, food expenditures, homestead food production, and dietary intake. Data were collected via interviewer-administered tablet-based questionnaires, using an Open Data Kit (ODK) platform.

Sociodemographic and anthropometric assessment

Household wealth index was calculated from principal component analysis including 10 items describing the household asset ownership, crowding, housing roof or floor quality, and water and sanitation facilities. The wealth index was used to group women using tertiles (the poor, middle, and rich) [24]. Women's employment status was classified according to the Ethiopian Demographic and Health survey defined categories [23]. Women who were classified as entirely employed had a skilled and stable job and had been working at least for 7 days before the survey. Hard labor or agricultural employment was categorized as partial and seasonal based on monthly employment and experience before the survey.

Height and weight of WRA were measured to the nearest centimeter (cm) and kilograms (kg) using a stadiometer and standard weighing scale [25]. We calculated body mass index (BMI) as weight in kilograms divided by height in meters squared. Based on BMI, individuals were classified using standard cutoffs as underweight ($<18.5 \text{ kg/m}^2$), normal weight ($18.5\text{--}24.9 \text{ kg/m}^2$), or overweight/obese ($\geq 25 \text{ kg/m}^2$). Overweight was classified as BMI $25\text{--}29.9 \text{ kg/m}^2$, and obesity BMI $\geq 30 \text{ kg/m}^2$ [26].

Dietary assessment:

Participants' dietary intake was assessed using a 69-item non-quantitative, food frequency questionnaire (FFQ), locally adapted from a semi-quantitative FFQ version validated for use among urban Tanzanian adults [27]. The FFQ included locally available foods and varieties and an option to specify other foods. The participants were asked the number of days they consumed each food out of the past seven days. The number of food items consumed per week was divided by seven to derive daily consumption. If a participant reported consuming a particular food with respective once twice, thrice and every day, a week, the frequency of consumption recorded would be 0.14, 0.29, 0.43, and 1. Portion sizes and frequencies of intake were not collected. The mean portion sizes for each food item were computed from previous population-based study protocol [19, 28]. The Ethiopian Food Composition table and other studies were used to capture iron composition data of reported foods [29–31].

Diet diversity was assessed using the minimum dietary diversity for women (MDD-W) indicator [32]. We grouped foods consumed by women (based on the FFQ) into ten non-overlapping food groups according to Food Agriculture Organization (FAO) guidance [33, 34]. The 10 food groups are 1) starchy staples, 2) pulses 3) nuts and seeds 4) dairy products 5) flesh foods 6) eggs 7) dark green leafy vegetables 8) vitamin-a rich fruits and vegetables 9) other vegetables, and 10) other fruits [34]. Foods made from grains cereals roots

and tubers are grouped into starchy staples. Poultry and all meat products were categorized as flesh foods and all milk products as dairy [33]. If a participant reported daily consuming at least one of the food items in a particular food group, it is scored one and if a participant didn't consume any of the food items, it is scored zero. The scores are then summed into a dietary diversity score (DDS-W, range 0-10). We categorized women as meeting minimum dietary diversity (MDD) if they consumed at least five food groups ($DDS \geq 5$) out of the 10 groups, as a proxy for micronutrient adequacy [33, 35, 36].

The usual iron intake of participants was estimated by multiplying the mean portion size and iron composition for each reported food item with its converted daily consumption. Heme and non-heme iron intake were estimated based on assumptions that 40% of animal food sources had heme iron and 60% of animal, and all plant source foods and dairy contained non-heme iron [37]. We estimated iron bioavailability after food intake assuming that 25% of all heme-iron and 10% non-heme would be bioavailable on average after consuming a cooked meal or ripe food [37]. We calculated the usual iron, heme and, non-heme iron intake in milligrams per day.

We calculated the risk of inadequate dietary iron intake based on consumption less than the age- and sex-specific Estimated Average Requirement (EAR) for iron for WRA. We assumed a low bioavailability of iron absorption (5%). A cut-off of < 22.4 mg/d was used to define inadequate intake of dietary iron [38].

Data analysis

Data were analyzed using STATA 16. We characterized sociodemographic characteristics of the study population using means, and standard deviations (SDs) and medians, and interquartile ranges for variables that were not normally distributed for continuous variables; and, counts and percentages for categorical variables. Data points with more than 50% missing data and with usual amounts (outliers) were removed from the analysis. Wilcoxon rank-sum test was used to evaluate significant differences in medians for the outcome measures. We describe dietary iron intake by specific food type and women's characteristics. We evaluated for multi-collinearity among the independent variables using the covariance matrix.

Modified Poisson regression models were used to evaluate associations between the independent variables and risk of dietary Fe inadequacy (0 = no risk of Fe dietary inadequacy, 1 = risk of Fe inadequacy) based on EAR-derived cut-offs for WRA. Covariates were selected based on significance in univariate analysis at $p < 0.2$. Crude Prevalence Ratios (CPR) and Adjusted Prevalence Ratio (CPR) and 95% CI were calculated. The statistical association level was $p < 0.05$ to identify independent variables associated with the risk of dietary iron inadequacy.

Results

The study included 1,123 WRA from the community. Forty-seven households refused to participate in the study, making a response rate of 96%. We excluded 52 missing observations and 25 outlier observations from the analysis.

The median age of participants was 30 years (Inter Quantile Range (IQR) 26; 30) and half of the participants had never attended school. Most participants (96%) were Muslims and played a spouse and head role of

the household. Even though a majority of WRA (67.1%) worked full time, more than half of the households were in the poor wealth index category. The median weight and height for WRA were 51 kg (IQR 47.8; 56.0) and 157 cm (IQR 154.5; 161.1), respectively. Most study participants (90.7%) had under-five children in their household with a median age of 36 months (IQR 23; 48). The median number of previous pregnancies reported was four (IQR 3; 6). Many women (76.0%) reported using household products as a primary source of food and travels more than half a kilometer (0.7 km) for reaching a food source. The median dietary diversity score was 4.0 (IQR 3.0; 5.0) and 34.6% of women met minimum dietary diversity (Table 1).

Table 1

Sociodemographic, reproductive characteristics, and food source, and diversity study participants women of reproductive age, Kersa, Eastern Ethiopia (N=1123)

Variables	N	Values
Woman's age (years)	1123	
16- 25		267 (23.8)
26- 35		633 (56.4)
≥ 36		223 (19.8)
Highest Education	1123	
Never attended school		609 (54.2)
Did not finished first grade		99 (8.8)
Completed 10 grade and more		415 (37.0)
Partner Highest Education	1123	
Never attended school		571 (50.8)
Did not finished first grade		84 (7.5)
Completed 10 grade and more		468 (41.7)
Religion	1123	
Muslim		1079 (96.1)
Orthodox		33 (2.9)
Other ^b		11 (1.0)
Employment type	1123	
Full-time		753 (67.1)
Part-time		102 (9.1)
seasonal		268 (23.8)
Occupational status of women	1123	
Farmer		925 (82.4)
Trade		44 (3.9)
Professional/technical		61 (5.4)
Other ^d		93 (8.3)
Role in the household	1123	
Head of the HH		141 (12.5)

Variables	N	Values
Spouse	1123	971 (86.5)
Another ^c		11 (1.0)
Wealth index		
Poor		639 (56.9)
Middle	1123	255 (22.7)
Rich		229 (20.4)
Weight ^a (kg)	1123	51.0 (47.8; 56.0)
Height ^a (cm)	1123	157.0 (154.5; 161.1)
Body mass index		
Underweight	1123	188 (16.7)
Normal		868 (77.3)
Overweight		67 (6.0)
Family size [#]	1123	5.9 ± (3.0)
Has an under 5 children	1123	1018 (90.6)
Age of Under 5 children ^{a*}	1018	36.0 (23.0; 48.0)
Number of previous pregnancies [#]	1123	4.45 ± (2.4)
Source of household food	1123	
Household production	1123	853 (76.0)
Street Vendor and local market		270 (24.0)
Food source distance from Household ^{#e}	284	0.7 ±(1.4)
Women's DDS ^{a f}	1123	4.0 (3; 5)
Minimum dietary diversity	1123	
Optimum		389 (34.6)
Estimated daily iron intake (mg/d) ^a	1123	24.7 (17.7; 33.2)
Estimated daily non-heme iron consumption (mg/d) ^a	1123	24.7 (17.7; 33.1)
Estimated daily heme-iron consumption (mg/d) ^a	1123	0.0 (0.0; 0.0)

Variables	N	Values
Estimated heme-iron consumption after consuming animal products (mg/d) ^{a g}	114	0.3 (0.1; 0.6)
Estimated relative bioavailable Iron ^a	1123	2.5 (1.8; 3.3)
Low usual Iron intake	1123	381 (33.9)
Values are mean $\pm$ SD, median [IQR], or frequency (percent).		
^a = Median (25th ; 75th percentile)		
[#] = Mean $\pm$ (SD)		
^b = Protestant, Jehovah-witness		
^c = sister, daughter, aunt		
^d = un skilled and manual labor, clerical		
^e = 284 observations		
^f = total score = 10		
[*] = age in Months		
^g = 114 observations		

Usual iron, non-heme, heme, and bioavailable iron intake

The median dietary iron intake estimated in this study was 24.7 mg/day: 95% CI (23.9– 25.5). The mean heme and non-heme iron intakes respectively were 0.05 (95% CI 0.04-0.06) and 24.7 mg/d (95% CI 23.9-25.5). Around 2.5 mg/d (95% CI 2.4-2.6) of iron is estimated to be bioavailable after consumption. Total *Fe* consumption distribution was positively skewed. 41.8% of women of reproductive age were at risk of iron inadequacy based on a cut-off for *Fe* inadequacy of EAR. Heme-*Fe* contributes less than one percent of the total iron intake. The median daily iron intake for women who met minimum dietary diversity (5+ food groups) and those with low dietary diversity was 32.7 (95% CI 31.1 – 34.3) and 21.6 (95% CI 20.8- 22.4) mg/d, respectively Figure 1-3

Food frequency distribution and total iron consumption

Table 2 shows the amounts of total and bioavailable dietary *Fe* consumption was lower in women whose ages were 36 or above than the other groups. The median intake of all types of iron was higher in women meeting criteria for minimum dietary diversity, as well as in women in the overweight category and among those in the highest SES. The mean dietary intake of all types of iron was higher in a household that

depended on a household food source. Participants who reported concurrent intake of flesh foods and fruits daily had the highest amount of dietary iron intake across all groups.

Table 2
Stratified dietary Iron, heme, non-heme, and bioavailable iron of women of reproductive age in Kersa,
Eastern Ethiopia, 2019

Variable	N (%)	Iron (mg/d) *	P-value ^b	Non-hem Iron (mg/d)	P-value ^b	Bioavailable Iron (mg/d)	P-value
Age (in Years)							
16- 25	267 (23.8)	24.6 (17.4;33.5)		24.6 (17.4;33.1)		2.5 (1.7;3.4)	
26- 35	633 (56.4)	25.3 (18.6;34.9)	0.01**	25.3 (18.5;34.4)	0.01**	2.5 (1.9;3.5)	0.01**
≥ 36	223 (19.9)	22.0 (15.7;28.6)		22.0 (15.7;28.5)		2.2 (1.6;2.9)	
Employment type							
Full-time	753 (67.1)	26.3 (19.3;34.9)		26.3 (19.3;34.9)		2.6 (1.9;3.5)	
Part-time	102 (9.1)	20.4 (15.4;30.0)	0.000**	20.4 (15.4;29.9)	0.000**	2.0 (1.5;3.0)	0.000**
Seasonal	268 (23.9)	20.6 (16.6;28.1)		20.6 (16.5;28.1)		2.1 (1.7;2.8)	
BMI							
Underweight	188 (16.7)	23.0 (17.1;30.1)		23.0 (17.1;30.1)		2.3 (1.7;3.0)	
Average	868 (77.3)	24.9 (17.9;33.1)	0.05	24.9 (17.9;33.1)	0.04**	2.5 (1.8;3.3)	0.06
Overweight	67 (6.0)	27.5 (17.5;49.8)		27.5 (17.5;49.4)		2.7 (1.7;5.0)	
Wealth Index							
Poor	639 (56.9)	22.2 (16.6;27.8)		22.2 (16.6;27.8)		2.2 (1.7;2.8)	
Middle	255 (22.7)	29.2 (20.9;41.9)	0.000**	29.2 (20.9;41.9)	0.000**	2.9 (2.1;4.2)	0.000**
Rich	229 (20.4)	30.6 (20.1;47.6)		30.6 (20.0;47.6)		3.1 (2.0;4.8)	
Dietary Diversity							

^a =114 observations consumed flesh foods ^b = Wilcoxon rank-sum test *median (IQR) ** significance at 0.05 level

Variable	N (%)	Iron (mg/d) *	P-value ^b	Non-hem Iron (mg/d)	P-value ^b	Bioavailable Iron (mg/d)	P-value
Optimum (5+ food groups)	389 (34.6)	32.7 (23.9;49.4)	0.000**	32.4 (23.7;49.0)	0.000**	3.3 (2.4;5.0)	0.000**
Low	734(65.4)	21.6 (15.7;27.7)		21.6 (15.7;27.7)		2.2 (1.6;2.8)	
Food source							
Household	853 (76.0)	24.9 (18.7;32.5)	0.02**	24.9 (18.6;32.5)	0.02**	2.5 (1.9;3.3)	0.04**
Market	270 (24.0)	22.6 (15.7;39.1)		22.6 (15.7;38.9)		2.3 (1.6;3.9)	
Concurrent Consumption of flesh and fruit							
Yes	39 (3.5)	45.5 (31.1;57.7)	0.000**	45.3 (30.8;57.3)	0.000**	4.6 (3.2;5.8)	0.000**
^a =114 observations consumed flesh foods ^b = Wilcoxon rank-sum test *median (IQR) ** significance at 0.05 level							

Table 3 shows the consumption patterns of the study women and the contribution of food groups consumed to Fe intake. The median intake of iron for women who reported eating beans and peas, and dairy products was 5.8 mg/d and 4.8 mg/d, respectively. Almost all participants reported consumption of starchy staples (99.6%) and other vegetables (98.1%) in the previous 7 days; the 2 food groups providing 16.5 and 1.1 mg/d iron (median), respectively. Of the usual *Fe* consumed; starchy staples contributed 66.8% (16.5/24.7) of the intake. Nuts and seeds, and flesh foods were the least consumed food groups and eggs, and other fruits contributed the least amount of *Fe*. Many of the participants (66.5%) reported an intake of dairy products at least once a week. Participants who reported at least a daily intake of starchy staples had the highest estimated bioavailable iron after consumption.

Table 3
Food frequency with median usual Iron intake of women of reproductive age in Kersa, Eastern Ethiopia

Food group	Rank/ contribution	Consumed	Iron (mg/d) *	Bioavailable Fe*
1) All starchy staples	1 /66.8%	1119 (99.6)	16.5 (11.7;23.2)	1.6 (1.2;2.3)
Consumed everyday		756 (67.3)	18.3 (12.8;24.1)	1.8 (1.3;2.4)
Consumed ≤6 days in 7 days		363 (32.3)	12.7 (8.8;18.6)	1.3 (0.9;1.9)
2) Beans and Peas	2 /23.5%	454 (40.4)	5.8 (2.3;12.6)	0.6 (0.2;1.3)
Consumed everyday		16 (1.4)	20.3 (8.0;29.5)	2.0 (0.8;2.9)
Consumed ≤6 days		438 (39.0)	5.7 (2.3;12.6)	0.6 (0.2;1.3)
3) Nuts and Seeds	6 /3.2%	69 (6.1)	0.8 (0.7;1.0)	0.0 (0.0;0.0)
Consumed everyday		0.0 (0.0)	0 (0; 0)	0.0 (0.0;0.0)
Consumed ≤6 days		69 (6.1)	0.8 (0.7;1.0)	0.0 (0.0;0.0)
4) All Dairy	3 /19.4%	747 (66.5)	4.8 (3.2;5.6)	0.5 (0.3;0.6)
Consumed everyday		289 (25.7)	5.6 (5.6;5.6)	0.6 (0.6;0.6)
Consumed ≤6 days		458 (40.8)	3.2 (2.4; 4.8)	0.3 (0.2;0.5)
5) Flesh Foods	8 /2.8%	114 (10.2)	0.7 (0.4; 1.4)	0.4 (0.4;0.7)
Consumed everyday		4 (0.4)	2.5 (2.5; 4.3)	0.4 (0.4;0.7)
Consumed ≤6 days		110 (9.8)	0.7 (0.4; 1.4)	0.1 (0.1;0.2)
6) Eggs	9 /0.4%	128 (11.4)	0.1 (0.1; 0.3)	0.0 (0.0; 0.0)
Consumed everyday		2 (0.2)	0.5 (0.5; 0.5)	0.0 (0.0; 0.0)
Consumed ≤6 days		126 (11.2)	0.1 (0.1; 0.3)	0.0 (0.0; 0.0)
7) Vitamin A-rich dark green leafy vegetables	4 /7.7%	514 (45.8)	1.9 (1.2; 3.1)	0.2 (0.1;0.3)
Consumed everyday		09 (0.8)	4.3 (4.3; 4.3)	0.4 (0.4;0.4)
Consumed ≤6 days		505 (45.0)	1.9 (1.2; 3.1)	0.2 (0.1;0.3)
8) Other vitamin A-rich vegetables and fruits	7 /3.2%	344 (30.6)	0.8 (0.3; 1.0)/	0.07/0.07

* Median/ Inter-Quantile Range (25th ;75th percentile) of daily Iron of those consumed

Food group	Rank/ contribution	Consumed	Iron (mg/d) *	Bioavailable Fe*
Consumed everyday		3 (0.3)	1.8 (0.9; 1.8)	0.2 (0.1;0.2)
Consumed ≤6 day		341 (30.4)	0.8 (0.3; 1.0)	0.1 (0.0;0.1)
9) Other vegetables	5 /4.4%	1102 (98.1)	1.1 (1.1; 1.2)	0.1 (0.1; 0.1)
Consumed everyday		877 (78.1)	1.10 (1.1; 1.2)	0.1 (0.1;0.1)
Consumed ≤6 days		225 (20.0)	0.9 (0.8; 1.0)	0.1 (0.1; 0.1)
10) Other fruits	10 /0.4%	142 (12.6)	0.1 (0.1; 0.3)	0.0 (0.0; 0.0)
Consumed everyday		21 (1.9)	1.5 (1.5; 1.5)	0.2 (0.2;0.2)
Consumed ≤6 days		121 (10.8)	0.1 (0.1; 0.2)	0.0 (0.0; 0.0)
* Median/ Inter-Quantile Range (25th ;75th percentile) of daily Iron of those consumed				

Factors associated with dietary iron inadequate consumption.

Table 4 shows factors associated with inadequate dietary Fe intake using the EAR cut-off Women's age was positively associated with the risk of dietary iron inadequacy. Participants whose aged 36 and higher were 29% more likely (APR 1.29, 95% CI 1.05-1.60) to have iron inadequacy compared to women aged 15 to 25. Seasonal and part-time agricultural employment, having street food sources, and low dietary diversity was associated with increased risk of dietary iron inadequacy. Women who had seasonal agricultural employment were 56% more likely (APR 1.56, 95% CI 1.36-1.80 to have dietary iron inadequacy compared to those employed full-time. Compared to wealthier households, women in the lowest wealth tertile were 1.2 (APR 1.2 95%CI 0.9-1.4) times as likely to have iron inadequacy. This relationship was statistically insignificant. Women with low dietary diversity intake were almost two and half times as likely (APR 2.4 CI 1.9-2.9) to have inadequate dietary iron compared to women with optimum dietary diversity (consuming 5 or more food groups daily). We found similar findings when categorized iron tertiles of iron intake as shown in Table 5.

Table 4
Factors Associated with risk of dietary iron inadequacy of women of reproductive age in Kersa, Eastern Ethiopia, 2019

	Risk of iron inadequacy N (%)	CPR	95% CI	APR	95% CI	P-value
Age						
16- 25	108 (40.4)	ref				
26- 35	245 (38.7)	0.96	0.80- 1.14	1.05	0.88- 1.25	0.6
≥ 36	117 (52.7)	1.30	1.07- 1.57	1.29	1.05- 1.60	0.02**
Employment type						
Full-time	260 (34.5)	ref		ref		
Part-time	57 (55.9)	1.62	1.33- 1.97	1.75	1.45- 2.12	0.000**
Seasonal	153 (57.1)	1.65	1.43- 1.91	1.56	1.36- 1.80	0.000**
BMI						
Underweight	89 (47.3)	1.15	0.98- 1.37	1.10	0.9-1.3	0.20
Average	355 (40.9)	ref		ref		
Overweigh	26 (38.8)	0.95	0.69- 1.29	1.01	0.76- 1.33	0.95
Wealth Index						
Poor	322 (50.4)	1.56	1.27- 1.91	1.17	0.97- 1.42	0.08
Middle	74 (29.0)	0.90	0.69- 1.17	0.84	0.65- 1.08	0.18
Rich	74 (32.3)	ref				
Number of previous pregnancies ^a	4.6(2.4)	1.03	1.00- 1.01	0.99	0.96- 1.02	0.72
Dietary Diversity						
^a = mean (SD)						
CPR = Crude Prevalence Ratio						
APR = Adjusted Prevalence Ratio						
** = significant at p = 0.05						

	Risk of iron inadequacy N (%)	CPR	95% CI	APR	95% CI	P-value
Optimum	80 (20.6)	ref		ref		
Low	390 (53.1)	2.58	2.10- 3.18	2.34	1.88- 2.91	0.000**
Food source						
Household	338 (39.6)	ref		ref		
Market	132 (48.9)	1.23	1.06- 1.43	1.30	1.14- 1.49	0.000**
^a = mean (SD)						
CPR = Crude Prevalence Ratio						
APR = Adjusted Prevalence Ratio						
** = significant at p = 0.05						

Table 5
Factors Associated with low usual iron consumption of women of reproductive age in Kersa, Eastern Ethiopia, 2019

	Low usual Iron intake N (%)	CPR	95% CI	P-value	APR	95% CI	P-value
Age							
16- 25	88 (32.96)	0.81	0.64-1.02	0.07	0.86	0.67-1.10	0.2
25- 35	202 (31.91)	0.78	0.64-0.95	0.01	0.89	0.74-1.07	0.2
≥ 36	91 (40.8)	ref			ref		
Employment type							
Full-time	206 (27.36)	ref			ref		
Part-time	50 (49.02)	1.79	1.42-2.25	0.000	1.99	1.59-2.49	0.000**
Seasonal	125 (46.64)	1.70	1.43-2.03	0.000	1.60	1.35-1.89	0.000**
BMI							
Underweight	72 (38.30)	1.15	0.94-1.42	0.17	1.10	0.91-1.33	0.34
Average	288 (33.18)	ref			ref		
Overweight and obese	21 (31.34)	0.94	0.65-1.36	0.76	1.01	0.73-1.39	0.95
Wealth Index							
Poor	266 (41.63)	1.67	1.31-2.13	0.000	1.19	0.95-1.50	0.12
Middle	58 (22.75)	0.91	0.66-1.26	0.58	0.87	0.64-1.18	0.27
Rich	57 (24.89)	ref					
Number of previous pregnancies ^a	4.73(2.48)	1.04	1.01-1.08	0.01	1.01	0.98-1.05	0.51
Dietary Diversity							
^a = mean (SD)							
CPR = Crude Prevalence Ratio							
APR = Adjusted Prevalence Ratio							
** = significant at p = 0.05							

	Low usual Iron intake N (%)	CPR	95% CI	P-value	APR	95% CI	P-value
Optimum	53 (13.62)	ref			ref		
Low	328 (44.69)	3.28	2.52-4.27	0.000	2.96	2.25-3.91	0.000**
Food source							
Household	271 (31.77)	ref			ref		
Market	110 (40.74)	1.28	1.07-1.53	0.005	1.36	1.16-1.59	0.000**
^a = mean (SD)							
CPR = Crude Prevalence Ratio							
APR = Adjusted Prevalence Ratio							
** = significant at p = 0.05							

Discussion

This study assessed the usual iron, hem, non-heme, and bioavailable iron intake among women of reproductive age in Kersa, Eastern Ethiopia. The median usual iron consumption was 24.7 mg/d and 41.8 % of WRA were at risk for iron inadequacy. The following factors were associated with a greater likelihood for the risk of iron inadequacy: seasonal and part-time agricultural employment, market food source, and low women's dietary diversity. Older women in the study were more likely to have inadequate dietary iron intake.

The mean dietary total iron intake in this study was lower than a study that was done in an urban resident of Gonder, which reported a mean iron dietary of 97.81 mg/d [39]. The size of dietary iron inadequacy was also high compared to the national report that listed 14% and others that reported iron inadequacy in women of reproductive age group [40, 41]. This difference could be due to the disparity of malnutrition in the regions and cities of Ethiopia. The district, like most rural areas, is dependent solely on rainfall and traditional agricultural means of food productions [42]. Moreover, the study's accuracy in the estimation of the total dietary iron intake might be limited due to not measuring biochemical markers of iron amount and storage and the use of a non-quantitative FFQ which can distinguish between high and low consumers of nutrients, but is not ideal for measuring absolute intake.

Diets for study participants were plant-based and poor as expected. Most participants consumed starchy staples and all types of vegetables, and the least food groups consumed were fish, eggs, flesh foods, and fruits. Non-heme iron-made up most of the dietary intake.

The dietary iron inadequacy found in this study was high compared to the recommended cut-off point in a population [38]. The finding is not surprising Ethiopia has high levels of poverty, food insecurity, and malnutrition [43]. Malnutrition and hunger are also common in this rural district being a major cause of

death in children under five [22]. Many households are also dependent on handouts from Ethiopia's Productive Safety Net Program (PSNP) due to chronic malnutrition [44].

Some Sub-Saharan African countries have implemented fortification of cereal and other food products with iron to meet their high dietary needs [45]. There are limited iron-fortified foods or enriched food products yet available in Ethiopia, and food insecurity has made the matter even worse [40]. Fortifying wheat and cereals, availing inexpensive nutrient-rich food alternatives, and eliminating hunger have significantly improved nutrition and the health status of WRA. The World Health Organization (WHO) currently recommends iron supplementation for women of reproductive age and children [46], fortification of foods, and food and nutrition education as a strategy in combating iron deficiency [47]. The application and effectiveness of these strategies in developing countries are affected by economic, socio-cultural, and infrastructural challenges. Therefore, dietary approaches are a top priority in addressing IDA.

Low iron intake among women of reproductive age impacts the women's life and future pregnancy and birth outcomes. Several studies have shown that a woman with low iron intake is at risk for antepartum and postpartum hemorrhage, which is the number one cause of maternal morbidity and mortality [7]. In addition, women with low iron stores and consumption are more likely to have poor birth outcomes including preterm birth, stillbirth, and low birth weight babies (ref). Babies that were born from anemic women tended to show poor physical growth performance, predisposition to infection, and retarded brain development, which affects eventual schooling and social development [48]. Therefore, it would be an important addressing problem.

Furthermore, older women had a higher risk of dietary iron inadequacy in this study. Because the need for higher dietary iron intake for old women increases due to larger families and have more children, they are the most at risk for iron deficiency and insufficiency [21]. On the contrary, other studies had shown traditional social and cultural inequities, younger women are also more likely to impose dietary restrictions that would decrease the consumption level and inadequacy of iron [49]. This difference could arise from other unmeasured confounders and the potential introduction of recall bias in the study.

Women that had lower dietary diversity were also found to be at higher risk of dietary iron inadequacy. This could be explained by poor individuals are more likely to consume foods that are less diverse and healthy [50]. Furthermore, the mean dietary total iron in our sample with higher dietary diversity had roughly twice the amount of recommended dietary iron and was statistically different across the subtypes of *Fe* [38]. Having a lower dietary diversity tends to decrease the consumption level of a balanced and healthy diet, leading to nutrient inadequacy and deficiency. This is in line with different studies that describe a strong relationship between individual dietary diversity score and micronutrient inadequacy [34, 51, 52]. Research has shown that women meeting minimum dietary diversity for the FAO MDDW are more like to meet their RDAs/EARs for iron, vitamin A and other micronutrients [53]. It is also worth noting that women's dietary diversity varies in the seasonal availability of foods, which was not considered in this study.

In addition, Others have also shown poor individuals had a higher restrain on financial freedom in the household that would limit securing and choosing nutrient-rich food for the family. This not only predisposes families to hunger but also other poor health outcomes [54]. are more likely to consume foods

that are less diverse and healthy [50]. Furthermore, the mean dietary total iron in our sample with higher dietary diversity had roughly twice the amount of recommended dietary iron and was statistically different across the subtypes of *Fe* [38].

Conclusion

This study sheds light on a burden of dietary iron inadequacy in women of reproductive age in Kersa, Eastern Oromia using the FFQ questionnaire. Even though Teff-based foods and staples have high iron with low bioavailability [41], their fortification with iron and diversification with other foods would improve bioavailability and adequacy of iron in women of the reproductive age group. The authors recommend further study of FFQ with iron biomarkers for accurate identification of iron deficiency and insufficiency. National nutrition-based surveillance system should be strengthened, as well as further collaboration with stakeholders to improve and modernize agricultural systems to meet the global sustainable goals. Ethiopia's commitment to the fortification of iron, diversification of our diet, and frequent use of animal source food and fruits may help in decreasing the burden of iron insufficiency and increase its bioavailability and absorption. Improving and identifying dietary iron intake alone is not the most efficient in identifying anemia, other socio-cultural inequities, women empowerment, other causes of non-nutritional anemia, and nutrition knowledge were not addressed in this paper.

Abbreviations

DDS; dietary diversity score; **EAR**: Estimated Average Requirement **FFQ**; food frequency questionnaire; **MDD**; minimum dietary diversity, **PSA**; principal component analysis, **SSA**; Sub-Saharan Africa, **WRA**; women of reproductive age,

Declarations

Ethics approval and consent to participate

This study was ethically approved by the Institution Health Research Ethical Review Board of the College of Health and Medical Sciences with reference number **SHE/S1M/14.4/708/19**. The study procedures were also undertaken per the Helenski Declaration. At the time of visit to the household, written informed, voluntary consent was secured from respondents

Consent for publication

Not Applicable

Availability of data and materials

The datasets used and analyzed during this study are available from the corresponding author on reasonable request

Competing Interest

The authors declare no conflicts of interest.

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Authors' contributions

NS, AA, KTR, YD, and WWF designed a concept note. NS, AA, KTR, and YD developed a proposal. NS, AA, KTR, and YD worked on data generation and fieldwork. NS, YYA, EC, and IM performed statistical analysis. NS, YYA, EC, IM, and WWF developed the manuscript. All authors reviewed, edited, and approved manuscript the final manuscript.

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References

1. von Koerber K, Bader N, Leitzmann C: **Wholesome Nutrition: an example for a sustainable diet.** *Proceedings of the Nutrition Society* 2017, **76**:34-41.
2. Abbaspour N, Hurrell R, Kelishadi R. Review on iron and its importance for human health. *J Res Med Sci.* 2014;19:164–74.
3. French MR, Barr SI, Levy-Milne R. Folate intakes and awareness of folate to prevent neural tube defects: a survey of women living in Vancouver, Canada. *J Am Diet Assoc.* 2003;103:181–5.
4. Matsuzaki M, Haruna M, Ota E, Sasaki S, Nagai Y, Murashima S. Dietary folate intake, use of folate supplements, lifestyle factors, and serum folate levels among pregnant women in Tokyo, Japan. *J Obstet Gynaecol Res.* 2008;34:971–9.
5. Van Cauwenbergh R, Hendrix P, Robberecht H, Deelstra H. Daily dietary iron intake in Belgium using duplicate portion sampling. *Zeitschrift for Lebensmitteluntersuchung -Forschung A.* 1997;205:401–6.
6. Roughead ZK, Zito CA, Hunt JR. Initial uptake and absorption of nonheme iron and absorption of heme iron in humans are unaffected by the addition of calcium as cheese to a meal with high iron bioavailability. *Am J Clin Nutr.* 2002;76:419–25.
7. Guillaume M, Riquet S, Zakarian C, Comte F. Iron, folic acid, and vitamin D supplementation during pregnancy: patient compliance. *Sante Publique.* 2020;32:161–70.
8. Ferguson EL, Watson L, Berger J, Chea M, Chittchang U, Fahmida U, Khov K, Kounnavong S, Le BM, Rojroongwasinkul N, et al. Realistic Food-Based Approaches Alone May Not Ensure Dietary Adequacy for Women and Young Children in South-East Asia. *Matern Child Health J.* 2019;23:55–66.
9. Thane CW, Bates CJ, Prentice A. Risk factors for low iron intake and poor iron status in a national sample of British young people aged 4-18 years. *Public Health Nutr.* 2003;6:485–96.

10. Stevens GA, Finucane MM, De-Regil LM, Paciorek CJ, Flaxman SR, Branca F, Peña-Rosas JP, Bhutta ZA, Ezzati M. Global, regional, and national trends in haemoglobin concentration and prevalence of total and severe anaemia in children and pregnant and non-pregnant women for 1995-2011: a systematic analysis of population-representative data. *Lancet Glob Health*. 2013;1:e16–25.
11. Abeywickrama HM, Koyama Y, Uchiyama M, Shimizu U, Iwasa Y, Yamada E, Ohashi K, Mitobe Y. **Micronutrient Status in Sri Lanka: A Review.** *Nutrients* 2018, 10.
12. Kassebaum NJ. The Global Burden of Anemia. *Hematol Oncol Clin North Am*. 2016;30:247–308.
13. Harika R, Faber M, Samuel F, Kimiywe J, Mulugeta A, Eilander A: **Micronutrient Status and Dietary Intake of Iron, Vitamin A, Iodine, Folate and Zinc in Women of Reproductive Age and Pregnant Women in Ethiopia, Kenya, Nigeria and South Africa: A Systematic Review of Data from 2005 to 2015.** *Nutrients* 2017, 9.
14. Amoroso L: **The Second International Conference on Nutrition: Implications for Hidden Hunger.** *World Rev Nutr Diet* 2016, 115:142-152.
15. Young MF, Oaks B, Tandon S, Martorell R, Dewey K, Wendt A. **Maternal Hemoglobin Concentrations Across Pregnancy and Maternal and Child Health: A Systematic Review and Meta-analysis (P11-033-19).** *Current Developments in Nutrition* 2019, 3.
16. Rahman MM, Abe SK, Rahman MS, Kanda M, Narita S, Bilano V, Ota E, Gilmour S, Shibuya K. Maternal anemia and risk of adverse birth and health outcomes in low- and middle-income countries: systematic review and meta-analysis. *Am J Clin Nutr*. 2016;103:495–504.
17. Assami M, Hercberg S, Assami S, Galan P, Assami A, Potier de Courcy G. Assessment of the nutritional status of Algerian women in the reproductive age living in an urban, rural and semi-rural area. *Ann Nutr Metab*. 1987;31:237–44.
18. Asayehu TT, Lachat C, Henauw S, Gebreyesus SH. Dietary behaviour, food and nutrient intake of women do not change during pregnancy in Southern Ethiopia. *Matern Child Nutr*. 2017;13:e12343.
19. Tadesse AW, Hemler EC, Andersen C, Passarelli S, Worku A, Sudfeld CR, Berhane Y, Fawzi WW. Anemia prevalence and etiology among women, men, and children in Ethiopia: a study protocol for a national population-based survey. *BMC Public Health*. 2019;19:1369.
20. Enawgaw B, Birhanie M, Terefe B, Asrie F. Prevalence of anemia and iron deficiency among pregnant women attending antenatal care service at University of Gondar Hospital, Northwest Ethiopia. *Clinical Laboratory*. 2019;65:479–84.
21. Gupta S, Pingali P, Pinstруп-Andersen P. Women's empowerment and nutrition status: The case of iron deficiency in India. *Food Policy*. 2019;88:101763.
22. Assefa N, Oljira L, Baraki N, Demena M, Zelalem D, Ashenafi W, Dedefo M. HDSS Profile: The Kersa Health and Demographic Surveillance System. *Int J Epidemiol*. 2016;45:94–101.
23. Central Statistical Agency (CSA), ICF. **Ethiopia Demographic and Health Survey.** Addis Ababa, Ethiopia and Rockville. Maryland: CSA and ICF; 2016.
24. Rutstein SO, Johnson K. **The DHS wealth index.** In: DHS Comparative Reports No 6. Maryland: ORC Macro; Calverton; 2004.

25. Bilukha O, Leidman E. Concordance between the estimates of wasting measured by weight-for-height and by mid-upper arm circumference for classification of severity of nutrition crisis: analysis of population-representative surveys from humanitarian settings. *BMC Nutrition*. 2018;4:24–4.
26. WHO (World Health Organization). **Body Mass Index - BMI**. 2019.
27. Zack RM, Irema K, Kazonda P, Leyna GH, Liu E, Gilbert S, Lukmanji Z, Spiegelman D, Fawzi W, Njelekela M, et al. Validity of an FFQ to measure nutrient and food intakes in Tanzania. *Public Health Nutr*. 2018;21:2211–20.
28. Ethiopian Public Health Institute. **Ethiopian national food consumption survey**. Addis Ababa, Ethiopia 2013.
29. Agren G, Gibson RS. *Food composition table for use in Ethiopia*. Addis Ababa 1969.
30. Ethiopia Health and Nutrition Research Unit/Food Agriculture Organization of the United Nations. *Food Composition Table for Use in Ethiopia*. Addis Ababa: EHNRU/FAO; 1998.
31. Abebe Y, Bogale A, Hambidge KM, Stoecker BJ, Bailey K, Gibson RS. Phytate, zinc, iron and calcium content of selected raw and prepared foods consumed in rural Sidama, Southern Ethiopia, and implications for bioavailability. *J Food Compos Anal*. 2007;20:161–8.
32. Wiesmann D, Arimond M, Loechi C: **Dietary diversity as a measure of the micronutrient adequacy of women's diets: Results from rural Mozambique site**. In *Washington (DC): Food and Nutrition Technical Assistance II Project, FHI 360* 2009.
33. FAO. **A resource guide to method selection and application in low resource settings**. pp. 152. Rome 2018:152.
34. FAO, FHI 360. Minimum dietary diversity for women: a guide for measurement. Vol. 82. Rome: FAO; 2016.
35. Women's Dietary Diversity Project Study Group. **Development of a Dichotomous Indicator for Population-Level Assessment of Dietary Diversity in Women of Reproductive Age**. *Curr Dev Nutr* 2017, 1.
36. Verger EO, Ballard TJ, Dop MC, Martin-Prevel Y. Systematic review of use and interpretation of dietary diversity indicators in nutrition-sensitive agriculture literature. *Global Food Security*. 2019;20:156–69.
37. Vandevijvere S, Michels N, Verstraete S, Ferrari M, Leclercq C, Cuenca-Garcia M, Grammatikaki E, Manios Y, Gottrand F, Valtuena J, et al. Intake and dietary sources of haem and non-haem iron among European adolescents and their association with iron status and different lifestyle and socio-economic factors. *Eur J Clin Nutr*. 2013;67:765–72.
38. Allen LH, Carriquiry AL, Murphy SP. Perspective: Proposed Harmonized Nutrient Reference Values for Populations. *Adv Nutr*. 2020;11:469–83.
39. Amare B, Moges B, Moges F, Fantahun B, Admassu M, Mulu A, Kassu A. Nutritional status and dietary intake of urban residents in Gondar, Northwest Ethiopia. *BMC Public Health*. 2012;12:752.
40. Mekonnen DA, Talsma EF, Trijsburg L, Linderhof V, Achterbosch T, Nijhuis A, Ruben R, Brouwer ID. Can household dietary diversity inform about nutrient adequacy? Lessons from a food systems analysis in Ethiopia. *Food Security*. 2020;12:1367–83.

41. Ethiopian Public Health Institute (EPHI). Ethiopian national micronutrient survey report. Ethiopia: Addis Ababa; 2016.
42. Aweke K, Tsehai A, Masresha T, Andinet A, Berhanu W. **Challenges and opportunities in CBN adaptation to pastoral areas in Ethiopia: Report Prepared by Ethiopian Health and Nutrition Research Institute, Food Science and Nutrition Research Directorate In collaboration with FMOH and WB.** (EPHI ed. Ethiopia2014.
43. United Nations Economic Commission for Africa., African Union Commission: **The cost of hunger in Africa: social and economic impact of child undernutrition.** In *the 5th joint annual meetings of the AU conference of ministers of economy and finance* (UN ed. Addis Ababa2012.
44. Bahru BA, Jebena MG, Birner R, Zeller M. Impact of Ethiopia's productive safety net program on household food security and child nutrition: A marginal structural modeling approach. *SSM Popul Health.* 2020;12:100660.
45. Belfort MB, Rifas-Shiman SL, Rich-Edwards JW, Kleinman KP, Oken E, Gillman MW. Maternal iron intake and iron status during pregnancy and child blood pressure at age 3 years. *Int J Epidemiol.* 2008;37:301–8.
46. McGuire S. WHO Guideline: Vitamin A supplementation in pregnant women. Geneva: WHO, 2011; WHO Guideline: Vitamin A supplementation in postpartum women. Geneva: WHO, 2011. *Adv Nutr.* 2012;3:215–6.
47. World Health Organization (WHO), Food and Agriculture Organization (FAO). Vitamin and mineral requirements in human nutrition. 2 ed. Geneva: WHO; 2004.
48. Motadi SA, Matsea Z, Mogane PH, Masidwali P, Makwarela M, Mushaphi L. Assessment of Nutritional Status and Dietary Intake of Pregnant Women in Rural Area of Vhembe District, Limpopo Province. *Ecol Food Nutr.* 2020;59:229–42.
49. Barchitta M, Maugeri A, Magnano San Lio R, Favara G, La Mastra C, La Rosa MC, Agodi A. **Dietary Folate Intake and Folic Acid Supplements among Pregnant Women from Southern Italy: Evidence from the "Mamma & Bambino" Cohort.** *Int J Environ Res Public Health* 2020, 17.
50. Jemal K, Awol M. Minimum Dietary Diversity Score and Associated Factors among Pregnant Women at Alamata General Hospital, Raya Azebo Zone, Tigray Region, Ethiopia. *J Nutr Metab.* 2019;2019:8314359.
51. Ayensu J, Annan R, Lutterodt H, Edusei A, Peng LS. Prevalence of anaemia and low intake of dietary nutrients in pregnant women living in rural and urban areas in the Ashanti region of Ghana. *PLoS One.* 2020;15:e0226026.
52. Ahmed AE, Salih OA. Assessment of the Minimum Dietary Diversity of Reproductive Women in Saudi Arabia. *Pakistan Journal of Nutrition.* 2019;18:615–22.
53. Daniels MC, Adair LS, Popkin BM, Truong YK. Dietary diversity scores can be improved through the use of portion requirements: an analysis in young Filipino children. *Eur J Clin Nutr.* 2009;63:199–208.
54. Sato APS, Fujimori E, Szarfarc SC, Borges ALV, Tsunehiro MA. Food Consumption and Iron Intake of Pregnant and Reproductive Aged Women. *Revista Latino-Americana de Enfermagem.* 2010;18:247–54.

Figures

Figure 1

This is Figure 1 Total Daily Dietary Iron consumption among women of reproductive age, Kersa, Eastern Ethiopia, 2019

Figure 2

This is Figure 2 Total Dietary Iron Consumption Distribution by Dietary Diversity of among women of reproductive age, Kersa, Eastern Ethiopia, 2019

Figure 3

This is Figure 3 Daily Hem and non-Hem Iron Consumption among women of of reproductive age, Kersa, Eastern Ethiopia, 2019