



Dietary Habits Associated with Anemia in Pregnant Women Attending Antenatal Care Services

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ABSTRACT

Anemia is a major cause of morbidity and mortality of pregnant women and increases the risks of fetal and neonatal morbidity and mortality. Approximately 50% of all anemia is estimated to be caused by low dietary intake of iron, poor absorption of dietary iron, or blood loss. The objective of the present study was to determine the prevalence of and assess the dietary habits associated with anemia in pregnant women receiving antenatal care (ANC) in Unguja Island, Tanzania. A cross-sectional study was conducted to select 338 pregnant women at Kivunge, Mwembeladu, and Mnazimmoja hospitals from March to June 2018. Hemoglobin concentration was measured using a HemoCue photometer on capillary blood. Sociodemographic data and dietary habits were collected using a structured questionnaire. Multivariate logistic regression analysis was carried out to determine the predictors of anemia in pregnant women. The overall prevalence of anemia was 80.8%. Of these 68.64% had mild anemia, 11.24% had moderate anemia, and 0.89% had severe anemia. Anemia was significantly associated with inadequate dietary diversity [adjusted OR (AOR): 1.16; 95% CI: 0.57, 2.36; $P < 0.05$], drinking tea or coffee with a meal (AOR: 0.06; 95% CI: 0.03, 0.13; $P < 0.001$), consuming <3 meals/d (AOR: 2.92; 95% CI: 1.60, 5.84; $P < 0.001$), higher education level (AOR: 3.4; 95% CI: 1.6, 7.2; $P < 0.0001$), birth interval <2 y (AOR: 3.6; 95% CI: 1.1, 11.9; $P < 0.05$), and multigravida status (AOR: 1.2; 95% CI: 0.3, 4.4; $P < 0.0001$). The prevalence of anemia in this study demonstrates a severe public health problem among pregnant women. Inadequate dietary diversity coupled with inadequate daily meal intake and consumption of tea or coffee were the dietary habits predicting anemia in pregnant women. Other predictors of anemia were higher education level, multigravida status, and birth interval <2 y. Nutrition policy interventions are needed to complement ANC services by providing important information on healthy eating habits during pregnancy. *Curr Dev Nutr* 2021;5:nzaa178.

Keywords: dietary practices, maternal anemia, dietary factors, dietary diversity, eating patterns

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Manuscript received June 30, 2020. Initial review completed October 8, 2020. Revision accepted December 7, 2020. Published online December 11, 2020.

The authors reported no funding received for this study.

Author disclosures: The authors report no conflicts of interest.

Supplemental Appendix 1 is available from the "Supplementary data" link in the online posting of the article and from the same link in the online table of contents at <https://academic.oup.com/cdn/>.

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Abbreviations used: ANC, antenatal care; AOR, adjusted odds ratio; WDDS, women's dietary diversity score.

Introduction

Anemia is a condition in which the number of RBCs (and consequently their oxygen-carrying capacity) is insufficient to meet the body's physiological needs (1). The body's physiological needs vary with a person's age, gender, altitude, smoking behavior, and different stages of pregnancy (1). Anemia is a global health problem affecting both developed and developing countries, and has an overwhelming impact on pregnant women (2, 3). Anemia during pregnancy is associated with adverse outcomes including increased maternal and perinatal morbidity and mortality. It is also associated with preterm birth and low birth weight, impaired cognitive development in children, and reduced adult work productivity (4, 5).

The Global Burden of Diseases, Injuries, and Risk Factors Study for 1990–2015, estimated that across the globe, 2.36 billion people were anemic (6). The most current estimates for 2016 indicate that worldwide 33% of women of reproductive age were anemic (7), and the prevalence was highest at 35% in Asia and Africa (8). The WHO report of 2008 on the prevalence of anemia indicated that 57.1% of pregnant women in Africa were anemic (9). Tanzania shares the burden of the problems associated with anemia. According to the 2015–16 Tanzania Demographic and Health Surveys (TDHS) report, 60% of Tanzanian women in Zanzibar were anemic (10). Nutritionally related iron deficiency is the main cause of anemia throughout the world (11). It occurs at all stages of the life cycle but is common in young children and women of reproductive age, particularly during pregnancy

(12). Women commonly become anemic during pregnancy because the requirement for iron and other vitamins increases due to the physiological burden of pregnancy (13). The inability to meet the demand for these nutrients is a result of either dietary deficiency or infection, which gives rise to anemia (13).

Good dietary habits during pregnancy play a significant role in determining the long-term nutritional status of both the mother and the unborn baby. Studies have shown that dietary inadequacy due to dietary habits and patterns is higher during pregnancy than at any other stage of the life cycle (14–16). Researchers have found that many women in developing countries restrict their food intake during pregnancy, for fear of having a large-for-gestational-age baby, which they think can predispose them to birth complications (17), as well as for cultural reasons (18). Poor dietary habits during pregnancy can result in low intake of essential nutrients like protein, vitamin C, vitamin A, and iron (14). Absence of these nutrients in the diet can result in anemia, which can contribute to increased rates of stillbirths, premature birth, low birth weight, and maternal and prenatal death (17). Poor dietary habits and patterns include consuming excess tea, coffee, or cocoa during meal times, reducing the number of meals per day (<3 meals), and lack of dietary diversity (14). A study of nutritional habits in pregnant women revealed that the average nutrient intake was deficient in some important nutrients, resulting in anemia (19), and that the prevalence of anemia was higher in pregnant women with a meal frequency of ≤ 2 times/d (20).

In Tanzania, efforts to reduce the burden of anemia during pregnancy have been varied. They include preventive strategies to increase iron supplementation, food fortification, and nutritional education. Deworming, antimalarial prophylaxis, and free insecticide-treated bed nets are routine components of antenatal care (ANC) in Tanzania (10). Despite the above interventions to reduce the burden of anemia, still the prevalence of anemia in pregnant women is high (10). Limited studies have been conducted in Unguja Island to assess dietary practices of women during pregnancy. Understanding different dietary habits of women during pregnancy is important in designing interventions to address the problem. Therefore, the aim of this study was to assess dietary habits associated with anemia in pregnant women attending ANC in Unguja Island, Tanzania.

Methods

Study design, area, and population

An analytical cross-sectional study involving pregnant women attending ANC services in 3 hospitals of Kivunge, Mwembeladu, and Mnazimmoja in Unguja Island, Zanzibar, was carried out during March to June 2018. ANC is the routine care of pregnant women provided between conception and the onset of labor (21). Unguja was selected due to its high prevalence of anemia in pregnancy and limited information on dietary habits associated with anemia during pregnancy. The total population of Unguja was 896,721 persons according to the 2012 national census, mostly concentrated in the Zanzibar urban region, with 463,137 being women (22). The typical diet consists of cassava, bread, and rice mixed with occasionally available vegetables and fish. Due to its high cost and poor availability, meat is consumed irregularly (23).

Kivunge and Mwembeladu hospitals are secondary-level healthcare facilities whereas Mnazimmoja hospital is a tertiary-level healthcare facility. The 3 hospitals are the only government institutions that provide ANC services, to ~9288 pregnant women annually. The average monthly attendance for ANC services in each of these hospitals was ~258 women (24), with 342 attendees at Mwembeladu hospital, 229 at Kivunge hospital, and 202 at Mnazimmoja hospital. During ANC visits the standard assessment and follow-up care is provided based on gestational age. The care provided includes assessment of maternal and fetal well-being such as screening for anemia and provision of preventive measures and assessment of blood pressure to screen for pregnancy-induced hypertension. The care providers also screen for multiple pregnancy and malpresentation and assist clients to develop a birth preparedness and emergency plan in the event of complications. Pregnant women in Unguja Island who attended ANC in Kivunge, Mwembeladu, and Mnazimmoja Hospitals were the target population of this study.

The study was approved by the University of Dodoma Institutional Research Review Committee. Permission to collect data was obtained from Zanzibar Ministry for Health and Social Welfare and Hospital directors of Kivunge, Mwembeladu, and Mnazimmoja hospitals. Free and informed consent, written or verbal, was obtained from each individual participant at the start of the study. Participants were told that their names would not be written anywhere to ensure confidentiality.

Sample size and sampling technique

Sample size was estimated using the Leslie Kish formula based on the following assumptions: 95% CI, 27.8% estimated anemia prevalence, findings from a previous study in Tanzania (25), and a 5% margin of error; the sample was further increased by 10% to account for nonresponse or recording error (26). Therefore, the estimated total sample size was 338 respondents. The total sample size (338) was proportionally allocated to the 3 hospitals based on monthly attendance (24). Consequently 151 participants were selected from Mwembeladu hospital, 99 from Kivunge hospital, and 88 from Mnazimmoja hospital. A systematic random sampling technique was used to select pregnant women in each hospital. The sampling interval was calculated by dividing the total number of pregnant women attending ANC for a period of 1 mo in a particular hospital to the respective allocated sample size. For example, at Kivunge hospital the total number of pregnant women attending ANC for a period of 1 mo was 202, divided by current allocated sample size of 99, which gave the sampling interval of 2 (2). The lottery method was employed to assign the first participant at random on each day of data collection. All pregnant women who attended on 1 d were assigned a number on a piece of paper and these numbers were mixed together in a box; then the researcher picked 1 paper randomly to get the first participant. For instance, on the first day of data collection at Kivunge hospital the randomly selected starting point was number 4. The interview started from the fourth pregnant woman, and then the sampling interval of 2 was added to select the next participant. The same technique was used daily in all hospitals until the required sample was achieved. Participants who resided in Unguja Island for <6 mo and who came for ANC during the time of data collection were included in the study. Pregnant women who were seriously ill during the time of data collection were excluded from the study.

Data collection technique and procedure

A structured, interviewer-administered questionnaire containing open and closed questions was used to collect data. The questionnaire was adapted from previous work (27) based on the objective of this study, literature review, and relevant local factors related to the research question. The questionnaire was divided into 3 parts (**Supplemental appendix 1**). The first part captured information on household social demographic variables. The second part assessed the dietary habits, and the third part assessed the dietary diversity using a 24-h food recall questionnaire adapted from the FAO (28). Prior to data collection, the questionnaire was pretested with 34 pregnant women at Makunduchi District Hospital, which has similar characteristics to the 3 hospitals selected for the study. The questionnaire was modified accordingly and translated into Swahili (Tanzania's national language) before being used in the study. It was administered by 2 research assistants who were Swahili-speaking midwifery nurses with diploma level of education and were trained by the principal investigator for 2 d before the start of data collection. The interviews were conducted in Swahili. Secondary data were collected by a documental review of Reproductive and Child Health Card Number 4, which is the ANC card used in this setting.

In assessing the 24-h dietary recall, respondents were asked to mention all the foods (meals and snacks) eaten the previous day during the day and night. The food items mentioned were recorded in the spaces provided at the top of the questionnaire. Using this information, it was determined whether they ate from the following 9 food groups: 1) starchy staples; 2) dark-green vegetables; 3) other fruit and vegetables; 4) organ meats; 5) meat and fish; 6) eggs; 7) legumes, nuts, and seeds; 8) milk and milk products; and 9) oil and fats (28). Hemoglobin concentration was measured for each participant using the portable HemoCue B-Hb photometer. One drop of capillary blood via finger prick was obtained to test hemoglobin concentration. Testing was performed by a laboratory technician.

Measurement of variables

Women's dietary diversity scores.

After the respondent recalled all the foods and beverages consumed, the foods were underlined with the corresponding foods in the list under the appropriate food group. Number "1" was assigned in the column next to the food group if ≥ 1 food in this group had been underlined, and "0" was assigned in the righthand column of the questionnaire when it was certain that no foods in that group were eaten. Women's dietary diversity scores (WDDSs) were calculated by summing the number of food groups consumed by the individual respondent over the 24-h recall period (28). Total scores ranged from 0 to 9. The mean score was calculated based on the number of food groups to indicate adequate or inadequate dietary diversity (28). Therefore, a score from 0 to 4 was categorized as inadequate dietary diversity, whereas a score >4 was categorized as adequate dietary diversity. The WDDS is an indicator variable for whether a woman has eaten from ≥ 5 food groups out of 9 designated food groups within the last 24 h and is a measure of adequacy of micronutrients.

Anemia.

Anemia was defined as a hemoglobin concentration <11.0 g/dL (29). The reference values of hemoglobin were categorized accord-

ing to the WHO criteria as: normal (hemoglobin ≥ 11 g/dL), mild (hemoglobin = 10.0–10.9 g/dL), moderate (hemoglobin = 7.0–9.9 g/dL), and severe (hemoglobin <7.0 g/dL) (29). Therefore, mild, moderate, and severe concentrations (<11 g/dL) of hemoglobin were defined as anemia.

Data analysis

The Statistical Package for Social Science (SPSS) version 21 (IBM) was used for both data entry and analysis. Descriptive statistics were used to analyze demographic characteristic and presented by using frequency, percentage, and tables. Bivariate and multivariate analyses were employed to predict dietary habits associated with anemia. Variables that were significant in bivariate analysis with a χ^2 test were entered into a multivariate logistic regression model to find the independent determinants of anemia. The variables (parity, gravidity, and birth interval) that could confound the outcome variable were controlled in the model during analysis. The strength of association was estimated in terms of OR, *P* value, and its 95% CI; a *P* value <0.05 was considered statistically significant.

Results

Demographic characteristics of the study respondents

A total of 338 pregnant women participated in the study. The mean age of respondents was 28 y. The minimum and maximum ages were 18 y and 45 y, respectively. Most respondents were 20–30 y of age (45.6%), from an urban area (84.6%), were married (98.1%), and were not employed outside the home (85.2%). Most women listed domestic work as their main activity within their own homes and did not earn any salary. With regard to education level, most (51.4%) of the respondents had secondary school education, and less than half (44.4%) of the respondents had higher education level. About 41.1% of respondents had child spacing interval of <2 y. Most of the respondents were living on $<US\$1/d$ (89.1%) (Table 1).

Prevalence of anemia in pregnant women

The overall prevalence of anemia was 80.8%. With respect to its severity, 68.64% of the pregnant women were mildly anemic (hemoglobin = 10.0–10.9 g/dL), 11.24% had moderate anemia (hemoglobin = 7.0–9.9 g/dL), and 0.89% were severely anemic.

Dietary habits of pregnant women and food craving

A majority (70.4%, $n = 234$) of the pregnant women reported drinking tea or coffee during pregnancy, with 81.4% consuming them during meal times. More than half (54.7%, $n = 185$) of the pregnant women had <3 meals/d. The vast majority (90.8%, $n = 307$) of the pregnant women did not avoid foods during the current pregnancy. However, 41.1% ($n = 139$) craved nonfood substances including soil (33.8%, $n = 47$), stone (44.6%, $n = 62$), and charcoal (21.6%, $n = 30$) (Table 2).

Foods consumed by pregnant women based on 24-h recall

A majority of the pregnant women (95.9%, $n = 324$) ate food from starchy staples such as rice, bread, and porridge (Table 3). A majority of the respondents (81.4%) had eaten dark-green leafy vegetables such as

TABLE 1 Sociodemographic characteristics of participants

Variable	n	%
Age, y		
<20	77	22.8
20–30	154	45.6
>30	107	31.7
Residence		
Urban	286	84.6
Rural	52	15.4
Marital status		
Married	332	98.2
Unmarried	6	1.8
Occupation status		
Employed	50	14.8
Unemployed	288	85.2
Child spacing interval		
No child	90	26.6
<2 y	139	41.1
≥2 y	109	32.2
Education level		
No education	14	4.1
Primary school	45	13.3
Secondary school	174	51.5
Higher education	105	31.1
Individual income per day, US\$		
<1	301	89.1
≥1	37	10.9

amaranth, cassava leaves, spinach, and Chinese cabbage within the past 24 h ($n = 275$). Likewise, most women reported eating fruits and vegetables (72.5%, $n = 245$) and animal meat protein (79.6%, $n = 269$) in the past 24 h. One-third (33.4%, $n = 113$) of respondents reported that they had consumed organ meat; 24.3% ($n = 82$) had consumed eggs; 41.1% ($n = 139$) had consumed legumes, nuts, and seeds; 31.4% ($n = 106$) had consumed milk and milk products; and 33.1% ($n = 112$) reported consumption of oils and fats. Based on this 24-h diet recall, more than half (62.1%, $n = 210$) of the pregnant women had adequate dietary diversity scores.

The association between anemia and selected characteristics of pregnant women

Bivariate and multivariate logistic regression analysis was performed to establish the association between respondents' selected characteristics and anemia. It was found that a birth interval of <2 y, higher education level, and multigravida status were associated with anemia. After adjusting for the confounding variables (parity, gravidity, and birth interval) the same variables (birth interval <2 y, higher education level, and multigravida status) remained significantly associated with anemia. The odds of being anemic were 3 times greater when pregnant women had a birth interval of <2 y [adjusted odds ratio (AOR): 3.6; 95% CI: 1.1, 11.9; $P < 0.05$]. Pregnant women who had higher education level (college and university) were 3 times more likely to be anemic compared with their counterparts having no higher education (AOR: 3.4; 95% CI: 1.6, 7.2; $P < 0.001$). Multigravidas were more likely to be anemic than primigravidas (AOR: 1.2; 95% CI: 0.3, 4.4; $P < 0.001$) (Table 4).

TABLE 2 Dietary habits of pregnant women and food craving

Food habit	n	%
Consuming tea or coffee		
Yes	238	70.4
No	100	29.6
Time tea or coffee taken		
During meals	275	81.4
<2 h before/after meals	55	16.3
≥2 h before/after meals	8	2.4
Meals per day		
<3	185	54.7
≥3	153	45.3
Avoiding food during pregnancy		
Yes	31	9.2
No	307	90.8
Foods avoided during the current pregnancy		
Meat	25	7.4
Beans	6	1.8
None	307	90.8
Reasons for avoiding the foods		
Vomiting	18	58.1
Diarrhea	13	41.9
Craving for nonfood substances		
Yes	139	41.1
No	199	58.9
Type of craving		
Soil	47	33.8
Stones	62	44.6
Charcoal	30	21.6

Association between dietary habits of pregnant women and anemia

To establish the association between the dietary habits of pregnant women and anemia, the variables of interest were subjected to bivariate and multivariate logistic regression analysis. After adjusting (for food avoided, craving for nonfood substances) for OR the variables that remained associated with anemia were drinking tea or coffee with meals, consuming <3 meals/d, and an inadequate dietary diversity score (Table 5). Pregnant women who had inadequate dietary diversity scores were more likely to be anemic compared with those who had adequate dietary diversity scores (AOR: 1.16; 95% CI: 0.57, 2.36; $P < 0.05$). Pregnant women who were not drinking tea or coffee with meals were less likely to be anemic than those who consumed tea or coffee with meals (AOR: 0.06; 95% CI: 0.03, 0.13; $P < 0.001$), and those who ate <3 meals/d were more likely to be anemic compared with those who ate ≥3 times/d (AOR: 2.92; 95% CI: 1.60, 5.84; $P < 0.0001$) (Table 5).

Discussion

According to the WHO classification, the prevalence of anemia in pregnant women in this study area denotes a severe public health problem (29, 30). A similar prevalence (81.8%) was reported in a study by Bansal et al. (31). The prevalence of anemia in this study is higher than the national anemia prevalence in pregnant women (48% in Mainland and 60% in Zanzibar) (10), and higher than a study conducted in northern Tanzania, which found a prevalence of 47.4% (32).

TABLE 3 Foods consumed by pregnant women based on 24-h recall before the survey day

Food groups	n	%
Starchy staples		
Yes	324	95.9
No	14	4.1
Dark-green leafy vegetables		
Yes	275	81.4
No	63	18.6
Other fruits and vegetables		
Yes	245	72.5
No	93	27.5
Organ meat		
Yes	113	33.4
No	225	66.6
Meat and fish		
Yes	269	79.6
No	69	20.4
Eggs		
Yes	82	24.3
No	256	75.7
Legumes, nuts, and seeds		
Yes	139	41.1
No	199	58.9
Milk and milk products		
Yes	106	31.4
No	232	68.6
Oils and fats		
Yes	112	33.1
No	226	66.9
Women's dietary diversity score		
Adequate	210	62.1
Inadequate	128	37.9

The differences in the prevalence of anemia might be due to socioeconomic variations and differences in dietary habits across regions within the same country. For instance, the majority of people in Zanzibar are clustered around the poverty line and could easily fall back into poverty (33). This is supported by the finding of this study that 89.1% of respondents were living on <US\$1/d. Based on the international poverty line of US\$1.90/person/d this indicates that these communities live below the international poverty line. Poverty is a marker for likely food insecurity and can prevent pregnant women from consuming adequate, good-quality, and nutritious food, which predisposes them to the risk of developing anemia. However, in this study nearly 80% of pregnant women reportedly had eaten protein-dense foods such as fish or meat in the past 24 h, which might not truly reflect their usual diet. A more typical diet of local people in Unguja consists of mainly cassava, bread, and rice mixed with seasonally available vegetables and fish. Meat is eaten only occasionally due to its high cost and poor availability (34).

Another possible explanation for the observed prevalence of anemia in this study could be that the high consumption of tea and coffee at meal times by pregnant women could reduce the bioavailability of iron from foods they ate. It has been shown that drinking tea with a meal can decrease iron absorption by $\geq 50\%$ (35), and that can increase the chances of iron deficiency (35, 36). However, other studies stress that tea reduces iron absorption but does not influence iron status in people with adequate iron stores (36, 37). Studies conducted elsewhere have re-

ported the association between drinking tea or coffee at meal times and anemia in pregnancy (37, 38). The prevalence of anemia in this study is not in line with the studies conducted in Ethiopia, Ghana, and Morocco, which showed lower prevalences of anemia (32.8%, 50.8%, and 57.6%, respectively) (39–41).

The variation in prevalence of anemia among these studies could be due to difference in methods used to measure hemoglobin concentration: capillary blood samples have a higher average hemoglobin concentration than venous blood samples, which can result in overestimation of hemoglobin concentration (42). Socioeconomic factors, differences in preventive health practices, and cultural dietary habits in pregnant women can also explain the variation in the prevalence of anemia. However, this study did not assess the socioeconomic factors and preventive health practices factors.

Although craving of nonfood substances in pregnant women was not associated with anemia in this study, the proportion of women who reported this food habit was high compared with a study done in Kenya, which found only 19.8% of pregnant women reported such nonfood cravings (27). The finding of this study is consistent with a study conducted in the Kilimanjaro Region in Tanzania (32) and in Ghana (40), in which 38% and 41.6% of pregnant women, respectively, had pica practices. None of these studies found an association between food craving habit and prevalence of anemia. It is important that pregnant women are educated on the dangers of eating nonfood substances such as stones, soil, and charcoal, which can predispose them to intestinal worms and other infections that can contribute in development of anemia or other unwanted outcomes.

Surprisingly, this study revealed a negative association between level of education and anemia, whereby women with higher levels of education were more likely to be anemic than women with little or no education. This finding was unexpected but could imply that higher education is not a marker for income because most women in this study were living on <US\$1 daily. Income is a marker for food security, which can enable women to purchase nutritious food and prevent anemia. However, without nutritional knowledge it is challenging to purchase nutritious food, but this knowledge can be acquired even in the family, from older family members, antenatal clinics, and social networks and not necessarily in school (43). Another possible explanation for this finding could be that those with higher education are likely to be employed, and hence spend much of their time performing their job, leaving them with insufficient time to prepare quality food and eat adequate meals each day; instead they depend on foods sold at their workplace, which are mostly junk foods with minimal diversity. The finding of this study is similar to studies in India and Indonesia that found that anemia was more prevalent in women with secondary-level education than in women with primary-level education or who were illiterate (31, 44). However, further studies are needed to explore the relation between the level of education, nutritional knowledge, and its adherence in pregnant women.

A short interval between pregnancies in multigravidas was associated with anemia. This could be explained in terms of physiological changes that occur during pregnancy. Hormonal changes during pregnancy lead to increased plasma volume, which causes a reduction in hemoglobin concentration. If this situation happens frequently as the number of pregnancy increases, it can lead to anemia (45). The finding of this study is similar to other studies conducted in African countries

TABLE 4 Bivariate and multivariate logistic regression analysis of selected characteristics of pregnant women associated with anemia¹

Variable	Anemia		COR ² (95% CI)	AOR ² (95% CI)
	Yes, n (%)	No, n (%)		
Age, y				
<20	59 (76.6)	18 (23.4)	1	1
20–30	129 (83.8)	25 (16.2)	1.2 (0.6, 2.4)	0.9 (0.4, 1.8)
>30	85 (79.4)	22 (20.6)	0.8 (0.4, 1.4)	0.8 (0.5, 1.5)
Residence				
Urban	229 (80.1)	57 (19.9)	1	1
Rural	44 (84.6)	8 (15.4)	1.4 (0.6, 3.1)	1.1 (0.5, 2.2)
Marital status				
Married	269 (81.0)	63 (19.0)	1	
Unmarried	4 (66.7)	2 (33.3)	0.5 (0.1, 2.6)	0.4 (0.1, 2.5)
Occupation status				
Employed	41 (82.0)	9 (18.0)	1	1
Unemployed	232 (80.6)	56 (19.4)	0.9 (0.4, 2.0)	1.1 (0.5, 2.2)
Individual income per day, US\$				
<1	240 (79.7)	61 (20.3)	1	1
≥1	33 (89.2)	4 (10.8)	2.1 (0.7, 6.1)	1.8 (0.6, 5.0)
Birth interval				
No child	75 (83.3)	15 (19.7)	1	1
<2 y	123 (88.5)	16 (11.5)	2.3 (1.1, 4.5)***	3.6 (1.1, 11.9)*
≥2 y	75 (68.8)	34 (31.2)	0.7 (0.3, 1.4)	1.4 (0.4, 5.2)
Education level				
No education	14 (100)	0 (0)	1	1
Primary school	39 (86.7)	6 (13.3)	0.6 (0.2, 5.2)	0.3 (0.1, 2.3)
Secondary school	126 (72.4)	48 (27.6)	1.3 (0.5, 3.8)	1.3 (0.4, 3.9)
Higher education	94 (89.5)	11 (10.5)	3.3 (1.6, 6.6)***	3.4 (1.6, 7.2)***
Gravidity				
Primigravida	94 (34.4)	37 (56.9)	1	
Multigravida	179 (65.9)	28 (43.1)	2.5 (1.5, 4.4)***	1.2 (0.3, 4.4)***
Parity				
Primiparous	137 (78.3)	38 (21.7)	1	1
Multiparous	136 (83.4)	27 (16.6)	1.4 (0.8, 2.4)	1.3 (0.8, 2.3)

1*,**,***Statistically significant association: * $P < 0.05$, ** $P < 0.001$, *** $P < 0.0001$. AOR, adjusted odds ratio; COR, crude odds ratio.

²1 = reference.

that found that women with short interpregnancy intervals were more likely to be anemic than their counterparts (24, 46, 47).

The finding that women with inadequate dietary diversity scores were more likely to have anemia supports the importance of pregnant women having access to a variety of foods during pregnancy. This helps to promote optimal nutrition during pregnancy for both the pregnant woman and her fetus. Women with inadequate dietary diversity often struggle to consume the necessary nutrients during pregnancy to support growth and development of fetus (48). Therefore, strategies to improve dietary diversity can increase nutrient adequacy, which can lead to a decrease in the prevalence of anemia during pregnancy. In other settings, dietary diversity scores have also been shown to reflect a pregnant woman's risk of anemia (49, 50). Therefore, public health interventions that target strategies to improve dietary diversity in pregnant women can be significantly impactful to reduce anemia and associated comorbidities.

Women who ate <3 meals/d were more likely to be anemic. This finding could imply that increasing daily meal frequency increases nutrient adequacy as nutrient demand increases during pregnancy. This finding is consistent with previous studies conducted in Southern Sudan and Kenya, which found that pregnant women who consumed ≥3

meals/d had reduced risk of anemia during pregnancy (20, 35). However, this finding could simply imply that eating <3 meals/d was a marker for food insecurity, which itself increases the likelihood of anemia. Food insecurity certainly increases the risk of anemia in many settings, and low economic status within the household hampers a pregnant woman's ability to purchase adequate, quality food (51). This can affect dietary diversity practices, leading to nutrient inadequacy and consequently anemia in pregnancy and associated risks. Therefore, household economics and nutrition-related problems need to be explored extensively to determine the contributing effects of eating habits on maternal anemia.

A major strength of this study is that it provides key baseline information about the prevalence of anemia in pregnant women in this setting based on point-of-care testing among study participants. The study also has some limitations. In the process of assessing the dietary diversity of study participants, only a single 24-h dietary recall was carried out. This might not reflect the typical dietary pattern of individual participants. Another limitation is that the study design was cross-sectional and there are issues of recall bias, whereby respondents could be more likely to provide answers that they believe the researcher will consider appropriate; this can lead to either

TABLE 5 Bivariate and multivariate logistic regression analysis of dietary habits associated with anemia in pregnant women ($n = 338$)¹

Variables	Anemia		COR ² (95% CI)	AOR ² (95% CI)
	Yes, n (%)	No, n (%)		
Drinking tea or coffee with meal				
Yes	223 (93.7)	15 (6.3)	1	1
No	50 (50.0)	50 (50.0)	0.07 (0.04, 0.13)***	0.06 (0.03, 0.13)**
Numbers of meals per day				
≥ 3	107 (69.9)	46 (30.1)	1	1
< 3	166 (89.7)	19 (10.3)	2.57 (1.47, 5.28)***	2.92 (1.60, 5.84)***
Avoiding food during pregnancy				
Yes	26 (83.9)	5 (16.1)	1	1
No	247 (80.5)	60 (19.5)	1.26 (0.47, 3.43)	0.90 (0.31, 2.92)
Craving for nonfood substances				
Yes	117 (84.2)	22 (15.8)	1	1
No	156 (78.4)	43 (21.6)	1.47 (0.83, 2.58)	1.25 (0.64, 2.27)
WDDS				
Adequate	97 (75.8)	31 (24.2)	1	1
Inadequate	176 (83.8)	34 (16.2)	1.65 (1.00, 2.90)*	1.16 (0.57, 2.36)*

¹*,**,***Statistically significant association: * $P < 0.05$, ** $P < 0.001$, *** $P < 0.0001$. AOR, adjusted odds ratio; COR, crude odds ratio; WDDS, women's dietary diversity score.

²1 = reference.

overestimation or underestimation of their intakes during recall. This could have influenced the results of dietary diversity of the participants in this study when compared with the prevalence of anemia. Also, because the study participants were drawn from tertiary and secondary healthcare facilities, which act as referral centers for women with pregnancy and birth complications from other satellite facilities, several factors might limit generalization of the study findings. Probably the prevalence of anemia would have been lower if the study had been conducted in the general population. The study did not assess other health conditions such as malaria, hookworm infestations, HIV status, adherence to preventive measures such as iron supplementation, malaria prophylaxis, deworming, and the use of insecticide-treated bed nets, which might have contributed to anemia in study participants. Food security was not assessed nor was socioeconomic status. More discussion on food security might be warranted given the potential connection to consuming < 3 meals/d. Despite the above-mentioned shortcomings, this study provides important information on the prevalence of anemia and dietary habits associated with anemia in pregnant women in Zanzibar.

In conclusion, the prevalence of anemia (80.8%) in pregnant women attending ANC in government health institutions of Kivinge, Mwembeladu, and Mnazimmoja in Unguja Island is a severe public health problem, and is higher than the national prevalence. Dietary habits such as consumption of tea or coffee during meal times, eating < 3 meals/d, and inadequate dietary diversity were associated with anemia in the pregnant women. Other predictors of anemia were higher education level, multigravida status, and birth interval < 2 y. Key protective strategies should be strengthened in ANC services to reduce the burden of anemia in pregnant women. Nutritional counseling and education interventions should aim to create awareness about consumption of iron-rich foods and avoidance of tea and coffee at meal times. Creative community antenatal educational strategies that promote extra meals and dietary diversity during pregnancy are recommended. Community-based studies are needed to better understand why the prevalence of anemia

in pregnancy remains high despite the availability of preventive health services.

Acknowledgments

The authors' responsibilities were as follows—MMA, NSG, and AFN: designed the research; MMA: conducted the research; NSG, MJM: analyzed data; MMA, NSG, and AFN: wrote the paper; MJM: had primary responsibility for final content of the manuscript; and all authors: read and approved the final manuscript.

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