Food and Nutrition Sciences, 2025, 16(4), 374-394
https://www.scirp.org/journal/fns
ISSN Online: 2157-9458
ISSN Print: 2157-944X

Prevalence and Determinants of Anaemia during Pregnancy in the Central Region of Burkina Faso: Case of the Malaria Peak and Harvesting Period

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How to cite this paper: Langam, M., Nikiema, P.A., Kassinga, V., Sondo, M., Djigma, W.F. and Simpore, J. (2025) Prevalence and Determinants of Anaemia during Pregnancy in the Central Region of Burkina Faso: Case of the Malaria Peak and Harvesting Period. *Food and Nutrition Sciences*, **16**, 374-394.
https://doi.org/10.4236/fns.2025.164021

Received: February 19, 2025
Accepted: April 11, 2025
Published: April 14, 2025

Abstract

Anaemia is a global public health problem that particularly affects pregnant women and children. Anaemia during pregnancy has harmful consequences for the health of both mother and foetus. However, little is known about the risk factors for targeted interventions. The aim of this study was to determine the prevalence and factors associated with anaemia in pregnant women in the central region of Burkina Faso at the time of the malaria peak and the period of food availability. An analytical cross-sectional study was carried out on 159 pregnant women attending for initial antenatal care between October and January 2022. Sociodemographic, obstetrical, nutritional and biological data were collected. Anaemia was defined as a haemoglobin concentration of less than 11 g/dl. The Chi-square test and bivariate analysis were used to identify factors associated with anaemia during pregnancy. The study revealed a prevalence of anaemia of around 60%. The majority of pregnant women suffered from moderate anaemia (51.06%) and mild anaemia (47.88%). The prevalence of malaria was 8.8%, with 71.43% of women being anaemic. With regard to nutritional status, 11.88% of women had a brachial circumference less than 230 mm and 52.2% had an acceptable dietary diversity score. The majority of women (91.67%) with inadequate nutritional status were anaemic. Anaemia was significantly associated with young age (OR = 3.337, 95% CI: 1.190 - 9.353, p = 0.017), low educational level (OR = 3.48, 95% CI: 1.512 - 8.025, p = 0.003). It was also associated with low consumption of vegetables/fruit rich in Vit A (OR

= 2.433, 95% IC = 1.13 - 5.21, $p = 0.02$) and other fruits (OR = 2.362, 95% IC = 1.17 - 4.76, $p = 0.015$). The prevalence of anaemia during pregnancy was high in this study. It is timely to focus on effective antenatal care and to improve nutritional counselling. Better maternal education about anaemia during antenatal consultations could reduce the prevalence of anaemia and mitigate the harmful consequences for the mother and new born.

Keywords

Gestational Anaemia, Determinants, Malaria and Harvesting Period, Ouagadougou, Burkina Faso

1. Introduction

Anaemia affects a large proportion of the population in both industrialised and developing countries, particularly vulnerable groups such as children, menstruating, lactating and pregnant women [1]. It is a widespread public health problem worldwide [2]. Anaemia contributes significantly to the global burden of diseases [3] [4] such as maternal mortality and the increase in the risk of adverse neonatal outcomes during pregnancy [5]. Globally, 30.1% of women of childbearing age were anaemic in 2019, with large geographical variations. Given the magnitude of anaemia [6], the 65th World Health Assembly (WHA) approved a global nutrition goal in May 2012. The objective was to reduce anaemia among women of childbearing age by 50% by 2025, particularly in West and Central African countries. Gestational anaemia is a major public health problem worldwide, particularly in resource-limited regions where it is estimated that one in two pregnant women is anaemic [6] [7]. Previous studies showed that iron deficiency is the most common cause. Pregnant women suffer from iron depletion [8]. A pregnant woman's iron requirements increase from 0.8 mg/day in the first trimester to 7.5 mg/day in the third trimester [9]. Adequate iron status during pregnancy implies body iron reserves of at least 1.5 mg/day during the third trimester. Also, serum ferritin concentrations above 70 g/L at the time of conception, but only 15% - 20% of women have reserves of this magnitude [10].

Anaemia is defined as a condition in which the number of healthy red blood cells does not meet the body's physiological requirements for oxygen delivery to vital organs [11]. It can lead to a reduction in work productivity, cognitive and behavioural development [11] [12]. The causes of anaemia in pregnancy are multifactorial, interdependent and context-specific. In developing countries, these include nutritional deficiencies (iron, folates, vitamins A and B12), infections (malaria, hookworms, tuberculosis and HIV) and heredity (sickle cell disease, β-thalassaemia) [13] [14]. Such factors causing anaemia during pregnancy vary according to the geographical location and socio-economic status of the community [15]. In malaria-endemic areas, *Plasmodium* sp. is a major determinant of anaemia during pregnancy with key prevention strategies including Intermittent Preventive Treatment (IPT) and the use of Long-Lasting Insecticidal Nets (LLIN) [16] [17].

In Burkina Faso, the National Survey of Iodine and Anaemia carried out in 2014 showed anaemia prevalence of 61.9% and 72.5% respectively in women of childbearing age and pregnant women [18]. The prevalence of anaemia among women of childbearing age in the Centre Region was 57.7% [18]. The WHO recommends that pregnant women should receive daily iron and folic acid supplementation as part of antenatal care (ANC) to prevent anaemia during pregnancy. Despite this national prevention programme, the burden of anaemia in pregnancy remains high, suggesting that other contributing factors may be overlooked. Although more than half of women of childbearing age are anaemic in the central region of Burkina, there are little studies that assessed the associated factors of anaemia in pregnant women.

The aim of this study was to determine the prevalence of anaemia and to identify its determinants among pregnant women attending antenatal clinics in the Central Region of Burkina Faso during the peak of malaria and the harvesting period. The results of this study will help the Government and its partners to undertake appropriate prevention strategies, and will also provide a database for researchers.

2. Methods

2.1. Study Area

This study was carried out in the Central Region of Burkina Faso. The province of Kadiogo is the only province in this region. It consists of the city of Ouagadougou divided into 12 districts, 55 sectors and six (06) rural districts [19]. Ouagadougou is the main city of the region and the political capital of Burkina Faso. The population of the region is estimated at 3,030,384, representing 14.8% of the total population of Burkina Faso [20]. It is represented by all socio-economic and cultural categories. In 2014, the prevalence of anaemia among women of childbearing age in the Central Region was 57.7% [18]. The present study took place in two hospitals of the city of Ouagadougou and the Medical Centre of the rural district of Saaba in the health district of Bogodogo. The city of Ouagadougou comprises six (06) hospitals (four national and 2 confessional/semi confessional). Two hospitals are reference structures for high complicated patient cases and one is a paediatric hospital. Out of the six (06) rural districts, The Medical Centres was the only one functional with laboratory facilities. The choice of health centres was based on the attendance rate for antenatal care, the representation of urban and peri-urban areas and the capacity of technical facilities for blood and stool tests.

2.2. Type and Study Population

This was a cross-sectional and analytical study conducted between October and December 2022. The study population consisted of pregnant women attending for their first antenatal consultation in the gynaecology and/or maternity departments of the Saint Camille Hospital of Ouagadougou (HOSCO), the Schiphra Hospital and the Saaba Medical Centre.

2.3. Study Sampling

The population size was calculated using the Schwartz formula:

Size:

$$n = \frac{t^2 * p(1-p)}{m^2}$$

t: 95% confidence level (standard value of 1.96);

p: prevalence of anaemia in central WCA (57.7%; ENIAB, 2014);

m: 5% margin of error (standard value of 0.05);

n: required sample size.

The overall size of the study population was estimated at 375 pregnant women. According to the objectives of the overall study, data collection was carried out in two phases, *i.e.* during the period of malaria peak and during the period of low malaria transmission. Therefore, the overall sample size was halved for the two periods, *i.e.*, 187 pregnant women each. This article focuses on the peak malaria period. This part of the study was based on SORE Master Degree study in 2021, which concerned 122 pregnant women through systematic enrolment at the Saint Camille Hospital of Ouagadougou (data not published).

A total of 196 pregnant women were surveyed, but at the end data from 159 women were retained for analysis. The 37 women were discarded because of missing or incomplete data.

2.4. Inclusion Criteria

The inclusion criteria were:

- pregnant women arriving at the gynaecology department and/or maternity ward for their first Ante-Natal Consultation (ANC);
- pregnant women who gave their consent to participate in the study.

2.5. Non-Inclusion Criteria

The non-inclusion criteria were:

- pregnant or non-pregnant women who came for a consultation for a reason other than the first ANC;
- women who met the inclusion criteria but did not consent to take part in the study.

2.6. Data Collection

Data collection was carried out in collaboration with health facility staff. The data was collected using the kobotoolbox system and Open Data Kit (ODK collect, V2022) on smartphones. Socio-demographic, socio-economic and dietary/nutritional data were collected. Biological data were also collected, including blood count, transferrin, serum iron and ferritin level, thick blood cell count, haemoglobin electrophoresis (Hb) and coproculture. In this study, anaemia in pregnancy was defined as Hb < 11 g/dl. Also, mild, moderate and severe anaemia was defined as Hb measurements between 10 - 10.9 g/dl, 7 - 9.9 g/dl and less than 7 g/dl, respectively [7].

A structured questionnaire was first prepared in French then translated into the local language. A 3-day training course was given for the use of the data collector. A pre-test was carried out on 10% of the total sample at the Saint Camille Hospital of Ouagadougou and any inconsistencies identified were corrected. Data collection also took place under close supervision. Appropriate categorisation and data coding were maintained to ensure quality and all data were checked by supervisors immediately after collection to ensure completeness, accuracy and clarity.

Blood and stool tests were performed by qualified laboratory personnel.

2.7. Statistical Analysis

Data were exported and processed using Excel version 2016 software and analysed using SPSS IBM version 26 software. Series of descriptive and regression analysis were performed to analyse the determinants of anaemia in pregnant women. The variables were chosen on the basis of the existing literature on the explanatory factors of anaemia in pregnancy. Bivariate analyses were used to cross-tabulate the different variables in a way to look for possible associations. The Pearson chi-square test was used for categorical variables. The significance level of the associations retained was 5%. The results are presented in the form of relative risk at 95% confidence intervals and/or the significance level (p-value).

2.8. Ethics Approval and Consent to Participate

The study has been approved by the Ethics Committee for Health Research (CERS) of the Ministry of Health and Public Hygiene of Burkina Faso with a reference number 2022-07-171/MSPH/MESRI/CERS of 06/07/2022. in addition, an informed consent form and a study information sheet were presented to the selected women to enable them to understand the purpose, procedures, risks and potential benefits of their participation and their willingness to take part in the study. No financial obligation was imposed. Written informed consent was obtained. For some women, verbal consent was obtained because of literacy barriers, in accordance with ethical guidelines. Confidentiality and privacy were respected throughout the research.

3. Results

3.1. Socio-Demographic Characteristics of the Study Population

A total of 159 pregnant women were enrolled. Table 1 shows the socio-demographic characteristics of the pregnant women. The average age of the population was 26.72 years, with extremes of 16 and 43 years. Pregnant women aged between 20 and 34 years represented the majority (79.9%). Those with secondary education represented (42.1%) compared to those with no formal education (27.7%). In terms of marital status, 96.8% of pregnant women were married with 84.9% of them being monogamous. Housewives not in paid employment represented the majority (47.2%), while 40.3% of women worked in the informal sector. Around 65% of women had their spouses working in the informal sector with low monthly income.

Table 1. Socio-demographic characteristics of pregnant women.

Characteristics	Category	Number n (%)
Heath Centre	HOSCO*	36 (22.6)
	Schiphra	23 (14.5)
	Saaba	100 (62.9)
Age	<20	13 (8.2)
	[20 - 34]	127 (79.9)
	>34	19 (11.9)
Marital status	Single	5 (3.1)
	Monogamous bride	135 (84.9)
	Polygamous bride	19 (11.9)
Education	Superior	22 (13.8)
	Secondary	67 (42.1)
	Primary	26 (16.4)
	No schooling	44 (27.7)
Occupation	Formal sector	20 (12.6)
	Informal sector	64 (40.3)
	Unemployed	75 (47.2)
Husband's occupation	Formal sector	49 (30.8)
	Informal sector	104 (65.4)
	Unemployed	6 (3.8)

*Hôpital Saint Camille de Ouagadougou.

3.2. Obstetrical Characteristics of the Study Population

Table 2 presents the obstetrical characteristics of the pregnant women. The average number of pregnancies was 3 (1 - 7). The mean number of live children was 2, with extremes ranking from 0 to 5 children. Around 46% of pregnant women had less than 2 living children when 41.3% had between 2 to 3 living children. Most women (84.6%) had an inter-gestational interval of 2 years or more. This study revealed that 5 women (3.1%) bled during pregnancy and that 12.6% had a history of anaemia.

Table 2. Pregnant women's obstetrical characteristics.

characteristics	Category	n (%)
Number pregnancies	Prim gestational	55 (34.6)
	Secondi gestational	36 (22.64)
	Multi gestational [3 - 4]	51 (32.07)
	High multi gestational (>4)	17 (10.69)
Number of living children	1	48 (46.2)
	[2 - 3]	43 (41.3)
	>3	13 (12.5)
Interginesic interval	<2 years	16 (15.4)
	≥2 years	88 (84.6)
Haemorrhage episodes current pregnancy	Yes	5 (3.1)
	No	154 (96.9)
Previous anaemia	Yes	20 (12.6)
	No	139 (87.4)

3.3. Characteristics of the Study Population According to Biological Tests

The study showed that approximately 60% of pregnant women had haemoglobin levels below 11 g/dl. Most women (64.78%) had normal Mean Corpuscular Volume (MCV) values compared to those with levels below 80 fl. The majority of pregnant women (64.2%) had normal electrophoretic status (AA) and 2.5% had β-thalassaemia. Most of them had normal serum iron level (91.2%), normal ferritin level (78%) and normal transferrin level (65.4%). In this study population, 31.4% had an elevated transferrin level. Pregnant women who have been infected with malaria accounted for 8.8%. With regard to intestinal parasites, the proportions were 15%, 0.6% and 1.9% respectively for *Entamoeba Histolytica* cysts, vegetative forms of *Entamoeba Histolytica* and *Trichomonas intestinalis* (Table 3).

Table 3. Biological characteristics of pregnant women seen in ANC*.

Variable	Category	n (%)
Haemoglobin concentration (g/dl)	Normal (≥11)	65 (40.9)
	<Normal (<11)	94 (59.1)
Electrophoretic status	AA	102 (64.2)
	AS	20 (12.6)
	AC	33 (20.8)
	B-thalassaemia	4 (2.5)
MCV** (fl)	<80.0	54 (33.96)

Continued

	[80.0 - 100.0]	**103 (64.78)**
	>100.0	2 (1.26)
Serum iron (µmol/l)	<5.83	7 (4.4)
	[5.83 - 34.5]	145 (91.2)
	>34.5	7 (4.4)
Ferritin (ng/ml)	<15.00	21 (13.2)
	[15.00 - 150.00]	124 (78.0)
	>150.00	14 (8.8)
Transferrin (g/l)	<1.6	5 (3.1)
	[1.6 - 3.2]	104 (65.4)
	>3.2	50 (31.4)
Thick blood smears	Positive	14 (8.8)
	Negative	145 (91.2)
***Entamoeba histolytica* cysts**	None (−)	135 (85)
	Present (+)	24 (15)
***Entamoeba Histolytica* vegetative form**	None (−)	158 (99.4)
	Present (+)	1 (0.6)
Trichomonas Intestinalis	None (−)	156 (98.1)
	Present (+)	3 (1.9)

*Ante-Natal consultation; **Mean corpuscular volume.

3.4. Nutritional Status of Pregnant Women

In the study population, 92.5% had a normal brachial circumference (≥ 230 mm) and those who reported dietary taboos related to their pregnancy represented 17.6%. In addition, 52.2% of the pregnant women had an acceptable dietary diversity score (consuming more than five food groups), compared to women with 47.8% of low dietary diversity score. The food consumption score was subdivided into three levels (poor, limited and acceptable). Most women's households (96.86%) had an acceptable food consumption score (**Table 4**). **Figure 1** summarises the frequency of the food consumption groups (24-hour recall). The foods consumed most frequently were starchy foods (cereals, roots and tubers) at 99.4% followed by other vegetables (92.5%) and meat, offal, fish and insects (82.4%). The foods least consumed were fruit and vegetables rich in vitamin A (24.5%), milk and dairy products (23.9%) and especially eggs (10.7%).

3.5. Prevalence of Anaemia in Pregnant Women

The prevalence of anaemia in the present study was 59.12%, with the highest prevalence being 70% observed in peri-urban area of Saaba medical centre compared to 40.68% in urban area. **Figure 2** shows the prevalence of anaemia according

Table 4. Nutritional characteristics.

characteristics	Category	n (%)
Food banned	Yes	28 (17.6)
	No	131 (82.4)
Brachial circumference	<230	12 (7.5)
	≥230	147 (92.5)
Dietary diversity score	Low	76 (47.8)
	Acceptable	83 (52.2)
Household food consumption score	Low	1 (0.6)
	Limited	4 (2.5)
	Acceptable	154 (96.86)

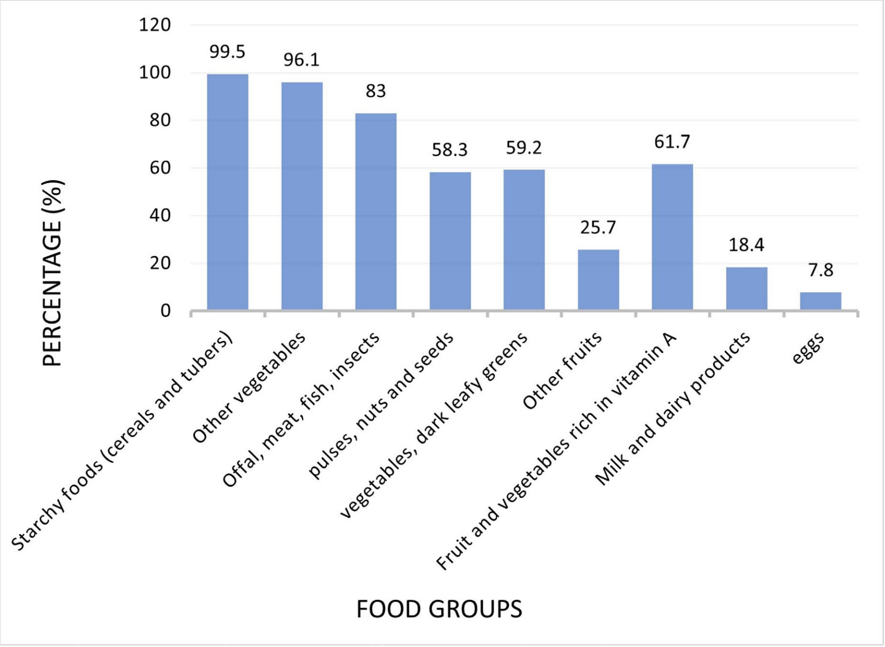

Figure 1. Food groups consumption frequency.

to its severity in pregnant women. In the study population, anaemia was predominantly mild (47.88%) or moderate (51.06%). **Figure 3** summarises the prevalence of anaemia according to the mean corpuscular volume level in pregnant women. Normocytic anaemia represented 67% in the majority of study population. Microcytic anaemia related to iron depletion, was 28.57% and 37.5% in peri-urban and urban areas respectively.

3.6. Factors Associated with Anaemia in Pregnant Women

The links between anaemia in pregnant women and the explanatory factors are shown in **Table 5**. Anaemia was more prevalent in peri-urban (70%) than in urban area (40.68%). The study showed that the living environment was a risk

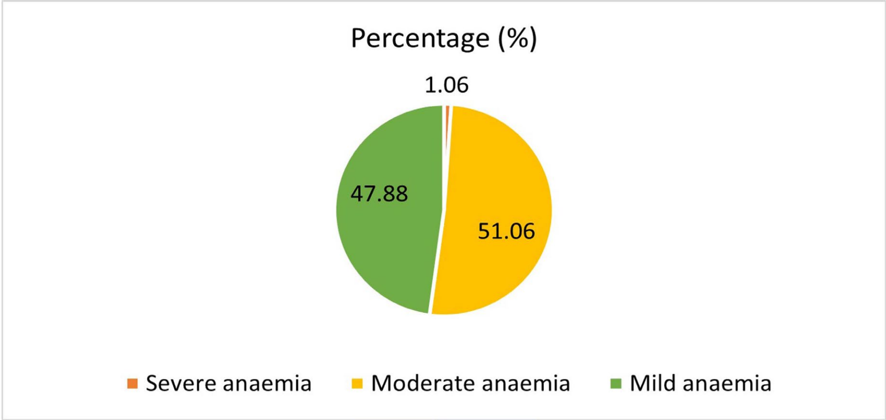

Figure 2. Prevalence of anaemia in pregnant women by haematological profile.

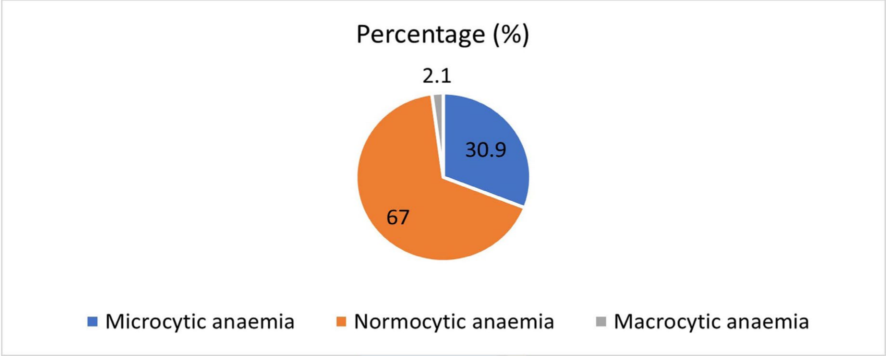

Figure 3. Prevalence of anaemia in women in relation to mean plasma volume.

factor for anaemia (OR = 3.403, 95% CI: 1.736 - 6.669, $p < 0.001$). The prevalence of anaemia was significantly higher in women aged between 20 and 34 (60.6%) than in women over 34 years old (OR = 3.337, 95% CI: 1.190 - 9.353, $p = 0.017$). Level of education was a factor significantly associated with anaemia in pregnancy in this study. Women with no education (75%) were 3.48 times more likely to be affected than those with at least secondary education (OR = 3.48, 95% CI: 1.512 - 8.025, $p = 0.003$). Women whose spouses were in the informal sector were more anaemic (65.4%) than those whose spouses were in the formal sector (42.9%). The occupation of the spouse was a factor associated with anaemia (OR = 2.519, 95% CI: 1.257 - 5.047, $p = 0.008$). Transferrin was significantly associated with anaemia, with a prevalence of 72% in pregnant women who had high transferrin levels compared to their counterparts with normal levels (OR = 2.291, 95% CI: 1.107 - 4.742, $p = 0.024$). The woman's profession, number of pregnancies, history of anaemia, serum iron level, ferritin levels, electrophoretic status and malaria infection were not significantly associated with the occurrence of anaemia during pregnancy in this study population.

3.7. Nutritional Factors Associated with Anaemia in the Study Population

Table 6 shows that most women (91.67%) with a BC < 230 mm were anaemic.

Table 5. Socio-demographic and obstetrical factors associated with anaemia.

Variable	Category	Anaemia n (%)	Not anaemia n (%)	*p*-value	OR (IC 95%)
Environment	Semi-urban	70 (70)	30 (30)	<0.001	3.403 [1.736 - 6.669]
	Urban	24 (40.68)	35 (59.32)		
Age (years)	<20	11 (84.6)	2 (15.4)	0.132*	3.571 [0.759 - 16.795]
	[20 - 34]	77 (60.6)	50 (39.4)		
	[20 - 34]	77 (60.6)	50 (39.4)	0.017	3.337[1.190 - 9.353]
	≥35	6 (31.58)	13 (68.42)		
marital Status	Monogamous	82 (60.7)	53 (39.3)	0.500	1.392 [0.531 - 3.653]
	Polygamous	10 (52.6)	9 (47.4)		
Education	No schooling	33 (75)	11 (25)	0.132	2.200 [0.782 - 6.192]
	Primary	15 (57.7)	11 (42.3)		
	No schooling	33 (75)	11 (25)	0.003	3.484 [1.512 - 8.025]
	Secondary	31 (46.3)	36 (53.7)		
	No schooling	33 (75)	11 (25)	0.558	1.400 [0.454 - 4.322]
	Superior	15 (68.2)	7 (31.8)		
Occupation	Informal sector	42 (65.6)	22 (34.4)	0.099	2.333 [0.841 - 6.476]
	formal sector	9 (45)	11 (55)		
	Informal sector	42 (65.6)	22 (34.4)	0.317	1.420 [0.353 - 1.403]
	Unemployed	43 (57.3)	32 (42.7)		
Husband's occupation	Informal sector	68 (65.4)	36 (34.6)	0.008	2.519 [1.257 - 5.047]
	formal sector	21 (42.9)	28 (57.1)		
Number pregnancies	≤2	57(62.64)	34 (37.36)	0.297	1.405 [0.741 - 2.661]
	>2	37 (54.41)	31 (45.59)		
Interginesic interval	2 years and over	54 (61.4)	34 (37.5)	0.188	2.042 [0.696 - 5.995]
	Less than 2 years	7 (43.8)	9 (56.3)		
Food banned	Yes	11 (55)	9 (45)	0.689	0.825 [0.321 - 2.119]
	No	83 (59.7)	56 (40.3)		
Serum iron (µmol/l)	<Normal	5 (71.4)	2 (28.6)	0.700*	1.815 [0.341 - 9.670]
	Normal	84 (57.9)	61 (42.1)		
Ferritin (ng/ml)	<Normal	12 (57.1)	9 (42.9)	0.827	0.901 [0.353 - 2.297]
	Normal	74 (59.7)	50 (40.3)		
Transferrin (g/l)	>Normal	36 (72)	14 (28)	0.024	2.291 [1.107 - 4.742]
	Normal	55 (52.9)	49 (47.1)		
Electrophoresis	Normal	66 (64.71)	36 (35.29)	0.055	1.899 [0.982 - 3.671]
	Falciform**	28 (49.12)	29 (50.88)		
Thick blood smears	Positive	10 (71.43)	4 (28.57)	0.327	1.815 [0.544 - 6.061]
	Negative	84 (57.93)	61 (42.07)		

*Fisher's exact test; **AS, AC and β-Thalassaemia.

These women had a risk approximately 8 times higher than women of normal nutritional status (OR = 8.482, 95% IC = 1.06 - 67.41). Subjects with a low dietary diversity score were almost twice likely to suffer from anaemia compared to those with a normal dietary diversity score (OR = 1.898, 95% IC = 0.99 - 3.61). With regard to the food groups consumed, the prevalence of anaemia was higher in women who had not consumed vegetables and fruit rich in vitamin A (62.4%) (OR = 2.433, 95% IC = 1.13 - 5.21, $p = 0.02$) than those who consumed this food group. The situation was the same for women who consumed legumes, nuts and grains (56.6%) (OR = 0.443, 95% IC = 0.22 - 0.87, $p = 0.018$) and women who had not consumed other fruits (63.9%) (OR = 2.362, 95% IC = 1.17 - 4.76, $p = 0.015$) compared to their respective counterparts. These food groups were significantly correlated with the occurrence of anaemia in pregnant women, underlining the importance of education, especially for iron and vitamin A foods.

Table 6. Dietary diversity score and nutritional factors associated with anaemia.

Variable	Category	Anaemia n (%)	Not anaemia n (%)	*p*-value	OR (IC 95%)
DDS**	Low	51 (67.11)	25 (32.89)	0.050	1.898 [0.99 - 3.61]
	Acceptable	43 (51.81)	40 (48.19)		
BC*** (mm)	<230	11 (91.67)	1 (8.33)	0.028*	8.482 [1.06 - 67.41]
	≥230	83 (93.26)	64 (6.74)		
Meat products	No	16 (61.5)	10 (38.5)	0.594	1.266 [0.53 - 3.01]
	yes	67 (55.8)	53 (44.2)		
Vegetables and fruit rich in vitamin A	No	68 (62.4)	41 (37.6)	0.020	2.433 [1.13 - 5.21]
	Yes	15 (40.5)	22 (59.5)		
Dairy products	No	67 (61.5)	42 (38.5)	0.053	2. 094 [0.98 - 4.46]
	Yes	16(43.2)	21(56.8)		
Pulses, nuts and grains	No	39 (48.1)	42 (51.9)	0.018	0.443 [0.22 - 0.87]
	Yes	47 (56.6)	36 (43.4)		
Dark green leaves	No	36 (57.1)	27 (42.9)	0.950	0.979 [0.50 - 1.89]
	Yes	84 (57.93)	61 (42.07)		
eggs	No	75 (58.1)	54 (41.9)	0.386	1.563 [0.56 - 4.31]
	Yes	8 (47.1)	9 (52.9)		
Other fruits	No	62 (63.9)	35 (36.1)	0.015	2.362 [1.17 - 4.76]
	Yes	22 (42.9)	28 (57.1)		
Other vegetables	No	10 (83.3)	2 (16.7)	0.053	4.178 [0.88 - 19.80]
	Yes	73 (54.5)	61 (45.5)		

*Fisher's exact test; **Dietary Diversity Score; ***Brachial circumference.

3.8. Comparison of Gestational Anaemia in Peri-Urban and Urban Areas

The distribution of anaemic pregnant women according to health centre locations is shown in Table 7. Peri-urban area recorded 70% cases of anaemia compared to

41% cases of anaemia in urban areas. The average age was 24.71 years, with extremes ranking from 16 to 36 years for women in peri-urban area. In contrast, anaemic pregnant women in urban area were 21 to 42 years old, with an average age of 29.25. Among the anaemic women, 46% of pregnant women in peri-urban area had a transferrin level above the normal, indicating iron depletion in these women. In urban area, however, the figure was 17%. From a total of 10 cases of malaria, 1 case was recorded in urban area. With regard to malnutrition, there were 10 cases of malnutrition in peri-urban area, compared to 1 case in urban area. Most of the women in peri-urban area did not reach secondary education.

Table 7. Distribution and characteristics of anaemic pregnant women by health centre.

Variable	Living environment	Peri-urban n (%)	Urban n (%)	*p*-value	OR (IC 95%)
	anaemic	70 (70)	24 (40.67)		
Degree of anaemia	Moderate anaemia	41(58.57)	8 (33.33)	0.033	2.828 [1.069 - 7.480]
	Mild anaemia	29 (41.42)	16 (66.66)		
Anaemia according MCV**	Microcytic	20 (28.57)	9 (37.5)	0.463	0.694 [0.261 - 1.845]
	Normocytic	48 (68.57)	15 (62.5)		
Serum iron (μmol/l)	Normal	64 (91.42)	20 (83.33)	0.594*	2.133 [0.318 - 12.950]
	<Normal	3 (4.28)	2 (8.33)		
Ferritin (ng/ml)	Normal	56 (80)	18 (75)	1.000*	1.037 [0.447 - 3.981]
	<Normal	9 (12.85)	3 (12.5)		
Transferrin (g/L)	>Normal	32 (45.71)	4 (16.66)	0.041*	3.579 [1.093 - 11.722]
	Normal	38 (54.28)	17 (70.83)		
Electrophoresis	Normal	53(75.71)	13 (54.16)	0.046	2.638 [0.999 - 6.967]
	Falciform	17 (24.28)	11 (45.83)		
Thick blood smears	Positive	9 (12.85)	1 (4.16)	0.443*	3.393 [0.407 - 28.297]
	Negative	61 (87.14)	23 (95.83)		
DDS***	Low	39 (55.71)	12 (50)	0.628	1.258 [0.497 - 3.185]
	Acceptable	31 (44.28)	12 (50)		
BC****	<230	10 (14.28)	1 (4.16)	0.279*	3.833 [0.464 - 31.652]
	≥230	60 (85.71)	23 (95.83)		
Age	≤25 years	40 (57.14)	6 (25)	0.007	4.000 [1.416 - 11.296]
	>25 years	30 (42.85)	18 (75)		
Number of pregnancies	≤2	44 (62.85)	13 (54.16)	0.452	1.432 [0.561 - 3.658]
	>2	26 (37.14)	11 (45.83)		
Education	<Secondary	43 (61.42)	5 (20.83)	0.001	6.052 [2.022 - 18.115]
	≥Secondary	27 (38.57)	19 (79.16)		
Occupation	Unemployed	33 (47.14)	10 (41.66)	0.170	0.446 [0.138 - 1.439]
	Informal sector	37 (52.85)	5 (20.83)		
Husband's occupation	Informal sector	58 (82.85)	10 (41.66)	<0.001	11.600 [3.753 - 35.856]
	Formal sector	7 (10)	14 (58.33)		

*Fisher's exact test; *Mean Corpuscular Volume; ***Dietary Diversity Score; ****Brachial circumference.

3.9. Relationship between Level of Education and Food Scores

Table 8 shows the results on education level as a major factor in the association with daily diet. Women with little or no education had a low Dietary Diversity Score (DDS) (54.5%) compared to those with secondary or higher education. With regard to the Food Consumption Score (FCS), the households of pregnant women with secondary education or higher had an acceptable score compared to those with primary education or no education at all. The dietary diversity score of the woman and the level of education were significantly associated (OR = 2.314, 95% IC = 1.220 - 4.389, $p = 0.010$). Subjects with a low dietary diversity score were almost twice as likely to suffer from anaemia as women with an acceptable score ($p = 0.050$).

Table 8. Relationship between level of education and DDS/FCS.

Variable	Category	Illiterate/primary n (%)	Secondary and over n (%)	*p*-Value	OR (IC 95%)
DDS**	Low	42 (54.5)	35 (45.5)	0.010	2.314 [1.220 - 4.389]
	Acceptable	28 (34.1)	54 (65.9)		
FCS***	Limit	4 (80.0)	1 (20.0)	0.170*	5.333 [0.582 - 48.833]
	Acceptable	66 (42.9)	88 (57.1)		

*Fisher's exact test; **Dietary Diversity Score; ***Food Consumption Score.

4. Discussion

Anaemia during pregnancy can result from both non-nutritional factors such as haemorrhage, chronic diseases and nutritional factors such as iron, vitamin and mineral deficiencies [21]. In this study, the prevalence of anaemia among pregnant women was 59.12%. This prevalence was higher than the global average reported by the WHO, which was 37% for anaemia in pregnant women aged 15 - 49 years [22]. It is close to those reported by the Demographic and Health Survey (56.6%) and by the study of Meda *et al.* (66%) in Burkina Faso [23] [24]. Other studies on anaemia during pregnancy have reported variable prevalence rates. The prevalence of anaemia in Turkey was 38.2%, while in Algeria it was 74% [25] [26]. These variations could be due to differences in the socio-demographic, nutritional factors and economic characteristics of the study populations in the countries concerned. On the other hand, public health measures and improved antenatal care services could account for these trends. Anaemia in this study was predominantly mild (47.88%) or moderate (51.06%). Only one woman had severe anaemia (1.06%). This woman was prim gravida, under 30 years of age, a housewife and had a negative malaria status. These characteristics corroborate the overall results and the associated factors obtained. This prevalence was lower than that found in Mali for the severe form (31.5%) [27]. Some authors estimate that the prevalence of anaemia and its degree of severity increases with the age of pregnancy, reaching 76.57% in the 3rd trimester [26]. This difference could be explained by the fact that in this study, the women enrolled were at their 1st antenatal consultation and were mostly in their 1st trimester of pregnancy. Pregnancy is the main factor associated with severe anaemia in women, with a risk of 3 to 4 times higher in pregnant women [28]. In this study, more than half of pregnant women (67%) suffered from normocytic anaemia and one woman in three had microcytic anaemia (30.90%). These proportions are different from those in the study by Demmouche and Moulessehoul in Algeria, who found that 54.9% of women had microcytic anaemia and that 45% had normocytic anaemia [26]. Adebo *et al.* noted that all anaemic pregnant women were microcytic and normochromic [29]. The occurrence of microcytic anaemia could be related to iron deficiency. In the case of normocytic anaemia, it could be related to the haemodilution usually observed during pregnancy [30]. Macrocytic anaemia could be the result of folate or vitamin B12 deficiency [28].

Anaemia was higher in women with no education. This finding is consistent with the results of other publications [31] [32]. The study also showed that women with no or low levels of education had a low dietary diversity score. They were 2 times more likely to have a low DDS and 5 times more likely to have a borderline FCS. This could be due to the fact that illiterate women may be economically unstable [33] and may not meet their nutritional needs (foods rich in vitamin A, iron and folic acid, etc.) during pregnancy, leading to anaemia. Two studies in the subregion reported variable results depending on the level of education [29] [34]. Therefore, the level of education can improve awareness of good nutrition during pregnancy and throughout life [35]. Thus, improved nutrition reduces vulnerability to anaemia in pregnant women. Similarly, the present study found an association between women age and anaemia during pregnancy. The rate of anaemia was higher in women aged between 20 and 34. They were 3 times more likely to suffer from anaemia than pregnant women aged over 34. This result is consistent with studies carried out in Nigeria [36], Uganda [37] and Saudi Arabia [38]. Various pieces of evidence have shown that early marriage is associated with low economic status, dropping out education and pregnancy complications (including anaemia) [39] [40]. Some studies have shown a higher risk in women with two or more children [25] [41] [42]. In this study, the results did not confirm the correlation between parity and abnormal haemoglobin concentrations. Prim gravidas and secondi gravidas were more affected. However, they are in agreement with two previous studies in Malawi and Nigeria [43] [44]. These results may be explained by the fact that multigestational women, thanks to the experience of their previous pregnancies, are more likely to adhere to good practice advices from health workers for the prevention of anaemia during pregnancy. Conversely, a study in Ethiopia showed that the risk of anaemia increased with parity [35]. This finding was similar to the results of the Jordanian study where a statistically significant increase ($p < 0.01$) was found between the overall prevalence of anaemia in multiparous women (64.0%) compared to primigravida women (49.3%) [45]. In this study, the prevalence of anaemia was higher in pregnant women with an inter-gestational interval of more than 2 years. Birth spacing was not found to be protective against anaemia. These results are in line with those of a study in Cameroon [30]. Variations could be attributed to differences in diet and differences in populations. This study found that subjects with low serum iron levels were more likely to suffer from anaemia (71.4%) than those with normal serum iron levels (57.9%). The prevalence of normosiderimic anaemia was lower than that reported in Benin (75%) in pregnant women [29]. The difference was not statistically significant. Women with a high transferrin level were 2 times more affected than those with a normal transferrin level. The difference was statistically significant (OR = 2.291, 95% CI: 1.107 - 4.742, $p = 0.024$). Pregnant women with anaemia and high transferrin levels showed iron depletion, implying iron deficiency anaemia. With regard to malaria infection, no statistically significant association with anaemia was found. This result is in agreement with those of other authors who also found no correlation between the occurrence of anaemia in pregnant women and malaria infection [29] [46]. This could be linked to the fact that the population observes protective measures against malaria through the daily and appropriate use of LLIN.

In addition, the quality of the pregnant women's diet was assessed using the dietary diversity score and no correlation was found with the occurrence of anaemia during pregnancy. However, malnourished pregnant women (91.67%) were 8 times more likely to be anaemic than pregnant women in a normal nutritional state (OR = 8.482, 95% IC = 1.06 - 67.41). In contrast, Nikiema *et al.* in Burkina Faso found no association between brachial circumference and anaemia [46]. This study found a significant association between anaemia and the consumption of vegetables/fruit rich in vitamin A, legumes and fruit. Consumption of iron-rich foods such as meat, dark green leafy vegetables and eggs showed no statistically significant difference. These results are in line with those reported in a recent study [47].

The proportion of anaemic pregnant women living in peri-urban area (70%) was high compared with those living in urban area (41%). Similar results have been reported in Ethiopia [35] [48] [49]. In their study, Samuel *et al.* reported that peri-urban residents were 2 times more likely to be affected by anaemia than urban residents. The higher prevalence of anaemia among pregnant women in peri-urban areas was probably linked to the lack of information on adequate nutrition during pregnancy and to socio-economic factors.

5. Limitations of the Study

The determination of biological examinations carried out in the three health centres with different technical platforms may lead to results of different rank. Calibrations or the diversity of methods and equipment used may influence the results. The dietary diversity of women estimated on the basis of a simple 24-hour recall may not reflect daily and seasonal variations although the questionnaire is the one recommended by the FAO [50]. Potential memory bias can occur during the survey. This study did not consider household food security and income levels. It should be noted that there are differences in the methodology used to calculate the dietary diversity score for women. In some studies, the DDS is determined on the basis of the 10 food groups using a 24h recall data set, with points only acquired when the food subcategories are consumed. In this study, a 9 food groups method was used.

6. Conclusion

This study shows that the prevalence of anaemia was high with the majority of women being mildly and moderately anaemic. This prevalence exceeds the WHO global critical threshold. In addition, several factors were associated with the occurrence of anaemia, such as low levels of education and low consumption of vegetables/fruits rich in vitamin A. To tackle this problem, efforts should focus on raising women's awareness of early prenatal consultations. This would enable iron and folic acid supplementation to be introduced in good time, provide good nutritional education for a diversified and balanced diet, and also intensify anaemia education at these prenatal consultations, which could reduce the prevalence of anaemia during pregnancy.

Availability of Data and Materials

The data are available to anyone who expresses a need by contacting me

Authors' Contributions

LM and PAN designed and carried out the study. LM, KV and SM participated in data collection, analysis and interpretation. LM wrote the manuscript. PAN and FWD made critical revisions of the article. The final manuscript was approved by PAN and JS. All authors have read and approved the final manuscript as submitted.

Acknowledgements

Thanks to the managers and staff of the Saint Camille hospital in Ouagadougou and the Schiphra hospital for their excellent cooperation in conducting the study. Thanks to the Centre Regional Health Department and the staff of the Medical Centre of Saaba for their valuable collaboration. Thanks to the interviewers for their help in collecting high-quality data. Thank you to the women and their husbands for their voluntary participation in this study.

Conflicts of Interest

No potential conflicts of interest have been reported by the authors.

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List of Abbreviations

ANC: Ante-Natal Consultation; BC: Brachial Circumference; DDS: Dietary Diversity Score; ECHR: Ethics Committee for Health Research; FAO: Food and Agriculture Organization; FCS: Food Consumption Score; HOSCO: Hôpital Saint Camille de Ouagadougou; IPT: Intermittent Preventive Treatment; LLIN: Long-Lasting Insecticidal Nets; MCV: Mean Corpuscular Volume; MMS: Multiple Micronutrient Supplementation; WCA: Women of Childbearing Age; WHA: World Health Assembly.