## Prevalence and factors associated with anemia, among pregnant women at the Franceville University Hospital Center, South East Gabon.

Thiéry NDONG MBA<sup>1</sup>,<sup>2\*</sup>Arnaud Brice PAMBO-PAMBO<sup>3</sup>, Hilaire KENGUELE MOUNDOUNGA<sup>1</sup>, Assane NDIAYE<sup>1</sup>, , Marlyne Jeffride PEKOU-TOUNG<sup>1</sup>, Simon MAPASU<sup>4</sup>.

- 1. Laboratory of Molecular and Cellular Biology, University of Sciences and Technology of Masuku, BP 943, Franceville, Gabon.
- Research Laboratory in Biochemistry, University of Sciences and Technology of Masuku, BP 943, Franceville, Gabon.
- Laboratory of Animal Physiology, University of Sciences and Technology of Masuku, BP 943, Franceville, Gabon.
- 4. Amissa Bongo University Hospital Center (ABUHC), BP 943, Franceville, Gabon.

## ABSTRACT

Anemia, a frequent complication of pregnancy, is a major public health issue. This prospective study assessed the prevalence of and factors associated with anemia among 354 pregnant women followed at the Amissa Bongo University Hospital Center in Franceville, Gabon.

Materials and Methods: Sociodemographic, obstetrical and clinical data were collected, and anemia was defined as a hemoglobin (Hb) level < 11 g/dL among the pregnant women of the study. The results were analyzed using bivariate and multivariate logistic regression. With a 95% confidence interval, the results were considered significant at a p-value  $\leq 0.05$ .

**Results:** A total of 354 pregnant women were enrolled in this study. The results show an overall prevalence of anemia of 27.68% (95% CI: [0.21- 0.3]). Bivariate and multivariate analyses revealed that pregnant women with a low level of education (primary) (adjusted Odds Ratio = 1.32; 95% CI [0.01 -0.72] p=0.028\*), unemployed (adjusted Odds Ratio = 3.1; 95% CI [4.98 - 60.3] p=0.003\*), residing in rural areas (adjusted Odds Ratio = 56.9; 95% CI [1.07 -89.1] p=0.023\*), and presenting with one or more clinical signs (pallor, fatigue, shortness of breath, palpitations) (adjusted Odds Ratio = 7.46; 95% CI [2.97 -18.76] p=0.001\*) had a significantly higher risk of anemia in this study.

**Conclusion:** These results suggest that anemia in pregnant women is a multifactorial problem linked to socioeconomic factors and the presence of symptoms.

Keywords: Prevalence, Anemia; Pregnant women; CHUAB; Franceville; Gabon.

## **I.INTRODUCTION**

Anemia is a pathological condition characterized by a decrease in the number of red blood cells or hemoglobin [1]. This situation leads to a decrease in oxygen levels in the body's tissues, reducing their metabolic capacity [2]. Depending on the type and severity of the diagnosis, the most common symptoms of anemia are shortness of breath, weakness, irregular heartbeat, pallor, hypotension, chest pain, or heart failure [1]. Causal factors for anemia include iron deficiency, micronutrient deficiencies (folate and vitamin B-12), rare genetic disorders, or serious infections during pregnancy, such as malaria [3]. Acute anemia can also occur as a result of blood loss or sudden hemorrhage, requiring a blood transfusion to replenish blood volume [4]. Anemia can develop in people from all walks of life, but it disproportionately affects women and children worldwide, as it is most often a disorder due to micronutrient deficiency [5]. In women of childbearing age, the development of anemia during pregnancy poses a risk to both the mother and the unborn child, and it is one of the most common complications of pregnancy worldwide [6]. Currently, the World Health Organization (WHO) estimates that more than 40% of pregnant women worldwide are anemic at some point during their pregnancy [7]. In a large WHO survey of several countries, it was found that women with severe anemia were twice as likely to die during or after childbirth [8]. Through global nutrition targets, the risks associated with maternal anemia are considered a global public health problem for both mother and newborn, leading the WHO to encourage a 50% reduction in anemia rates among women of childbearing age by 2025 [9].

In sub-Saharan Africa, where the majority of countries have limited resources, anemia represents a significant mortality risk and is associated with a high hospital occupancy rate [10]. Much of the African research on anemia has focused on children, yet there is a wide disparity in the prevalence and severity of anemia depending on a country's demographic level and the resulting nutritional deficits [11]. In Gabon, a country located in Central Africa, despite the implementation of maternal and child health programs by the government, challenges persist, particularly in rural areas. Access to care is still difficult for women living in remote areas or with limited resources. This could result in a worrying prevalence of anemia among pregnant women. Previous research on anemia in Gabon has been conducted but has been limited to small geographical studies on various micronutrient-related disorders or in blood donors [12]. Consequently, there is no study on the prevalence of maternal anemia among pregnant women attending consultations in the area of this study. It is in this context that the latter aims to assess the frequency of anemia and to identify associated factors among pregnant women followed at the Amissa Bongo University Hospital Center of Franceville (CHUAB) South East, Gabon, in order to better target prevention and treatment interventions.

## **II. MATERIALS AND METHODS**

**II.1. Study Location and Period** 

The study was conducted from February to September 2024 at the medical analysis laboratory of the Amissa Bongo University Hospital Center in Franceville, Gabon.

#### **II.2. Study Type and Population**

This is a prospective and cross-sectional study targeting all pregnant women who gave their consent during their prenatal consultations at the Amissa Bongo University Hospital Center in Franceville during the study period.

#### **II.3. Inclusion and Exclusion Criteria**

#### **II.3.1. Inclusion Criteria**

The study sample consisted of pregnant women followed at the University Hospital of Franceville, residing in the Haut-Ogooué province, and who agreed to participate in the research after being informed of the objectives and procedures. To ensure the reliability of the results, only women who had reached at least 12 weeks of gestation were included.

#### **II.3.2.** Exclusion Criteria

To ensure the reliability of the results, the study excluded pregnant women with special characteristics likely to influence hemoglobin levels. These include multiple pregnancies, severe chronic diseases, recent history of blood transfusion, participation in other similar studies, as well as premature interruptions of follow-up.

#### **II.4. Sample Size Determination**

Taking into account a previous study that highlighted a prevalence of anemia of 71.2% among pregnant women in Gabon [13], the sample size required for this study was calculated based on the single proportion formula, in a 95% confidence interval.

 $n = (Z\alpha / 2)^2 (P (1-P)^2) / (d)^2) [14]$ 

n representing the sample size,  $Z\alpha/2 = 1.96$  for a significance level of 5%, and a maximum margin of error of 5%.

 $n = (1.96)^2 \ge 0.712(1-0.712)/(0.05)^2 = 2.79104 \ (0.288)/0.0025 = 322.$ 

The initial sample size was adjusted by adding a non-response rate of 10%, and the final total sample size was 354 participants.

#### **II.5. Data Collection Tools and Procedures**

A rigorous methodology was implemented for data collection.

#### II.5.1. Questionnaire

A questionnaire, adapted to the local context and translated into the local language, was used to collect detailed information on the participants (sociodemographic characteristics, reproductive and obstetric characteristics, medical history, nutritional habits, and knowledge related to anemia).

#### **II.5.2.** Laboratory Diagnosis

#### II.5.2.1. Sampling

Each participant underwent a peripheral venous blood sample in an EDTA (ethylene diamine tetra-acetic acid) tube to prevent clotting, according to a standardized procedure.

#### II.5.2.2. Diagnosis of Anemia

After collection, the blood tube containing the patient's information (identification number and sex) was gently homogenized to ensure proper mixing with the anticoagulant. The analysis was performed using a blood count automaton (URIT 2900 Plus), powered on ("Power On"). Then, the automaton probe was inserted into the tube to aspirate a precise amount of blood. The analysis was launched by pressing the "OK" button.

#### **II.5.3.** Operational Definitions

- Minimum: This is the smallest value of a molecule observed in the subjects studied.
- Maximum: This is the largest value of a molecule observed in the subjects studied.
- Geometric mean: This is the transformed mean of the mean of the values of a molecule obtained in the subjects studied.
- Standard values or American usual values (Pentra 400 normal): These are the values for each molecule provided by the manufacturer.
- A reference value, a term preferable to "usual value" or "normal value", is an average result, observed, for a given element, in a reference population, whose individuals are

healthy. It can vary depending on geographical origin, sex, and age. It is expressed in units, in the international system, in the form of a range with a lower and upper limit, determined by statistical analysis.

• Anemic pregnant women: Anemia was assessed at a hemoglobin (Hb) level < 11 g/dL of blood in women [15].

#### **II.6. Measured Variables**

During this study, variables such as sociodemographic characteristics (age, education level, place of residence, marital status, professional status, monthly income, access to drinking water, hygiene conditions), obstetric characteristics (number of pregnancies; gestational age, interpregnancy spacing, obstetric history, prenatal follow-up, mode of delivery), clinical aspects (clinical signs of anemia, history of chronic diseases, medication intake during pregnancy, food allergy, alcohol or tobacco consumption, diet) and the result of the anemia diagnosis were evaluated.

#### **II.9. Ethical Considerations**

Before starting this study, the research protocol was submitted and approved by the ethics committee of the Regional Health Directorate of the Southeast in Franceville (letter n° 0345/PHO/SG/DRSSE/SGP/D). This ensured the protection of the rights of the participants and the ethical compliance of the study. Aware of the vulnerability of pregnant women and the potential influence of their condition on their decisions, a point of honor was made to inform them clearly and completely about all aspects of the study such as the objectives and procedures (samples, questionnaires, etc.), the potential benefits and risks (discomfort, anxiety, etc.), the duration of participation, data confidentiality, the right to withdraw at any time without justification. We ensured their understanding and their free and informed consent, formalized in writing. The data collected were anonymized and treated confidentially thanks to a coding system. Access to the data was restricted to authorized researchers and stored securely. All measures were taken to minimize risks (pain, stress, etc.). Participants were informed of the potential benefits of the study, both for themselves (screening and management of anemia) and for public health. Participation in the study did not in any way hinder access to care. In case of diagnosis of anemia, appropriate care was offered.

#### **II.10. Data Quality Assurance**

To ensure data quality, a rigorous protocol was put in place. The investigators received extensive training and the questionnaire was subjected to a rigorous pre-test. Quality control measures were implemented throughout the collection, thus guaranteeing the reliability and validity of the data collected.

#### **II.11. Statistical Analysis and Data Interpretation**

Before analyzing the data, it was entered into an Excel spreadsheet to be cleaned (i.e. correct errors and missing data). Then, the data were transferred to R software version 3.6.1, for statistical analysis. In a confidence interval estimated at 95%, each factor was first examined individually, to see if it was linked to anemia. Then, the factors that appeared to have a link (P-value  $\leq 0.05$ ) were selected for multivariate analysis. Here, the selected factors were analyzed together to determine their actual influence on anemia in the pregnant women of the study, taking into account their interactions. Only factors with a strong link to anemia (P-value  $\leq 0.05$ ) were retained. The reliability of the results was ensured by a multicollinearity test, to verify that the factors studied were not too similar, which could distort the results.

### **III. RESULTS**

#### III.1. Prevalence of Anemia among the Study's Pregnant Women (N=354)

In total, 354 pregnant women attending prenatal consultations at the Amissa Bongo University Hospital Center of Franceville, from February to September 2024, were included in this study. Of these, 98 tested positive for anemia, indicating an overall prevalence of 27.68% (95% CI: [0.23- 0.32]), compared to 72.32% or 256 who tested negative.

## III.2. Analysis of the Prevalence of Anemia According to the Sociodemographic Characteristics of Pregnant Women (N=354)

A bivariate analysis of the prevalence of anemia, according to the sociodemographic characteristics of the pregnant women in the study, showed that those who were not married (Odds Ratio = 5.54; 95% CI [3.28 - 9.5], p $\leq 0.001^*$ ), had a primary education level (Odds Ratio = 2.17; 95% CI [1.32 - 3.6] p= $0.002^*$ ), were unemployed (Odds Ratio = 10.22; 95% CI [4.7 - 23.77] p $\leq 0.001^*$ ), were students (Odds Ratio = 2.26; 95% CI [1.16 - 4.35] p= $0.011^*$ ), lived in rural areas (Odds Ratio = 10.21; 95% CI [5.81 - 18.3]  $\leq 0.001^*$ ), and did not have access to drinking water (Odds Ratio = 6.38; 95% CI [2.35 - 19.2]  $\leq 0.001^*$ ), were significantly associated with the prevalence of anemia in the present study (Table 1).

Table 1: Bivariate analysis of the prevalence of anemia, according to the sociodemographic
characteristics of the pregnant women in the study, (n=354).

Variables	Total number of	Prevalence of anemia		Bivariate analysis	
	pregnant women N (%)	Positive N (%)	Negative N (%)	Crude OR 95% CI	p-value
Age groups (years) A	Age of at time of p	oregnancy.		1	
<u>≤ 25</u>	73 (20.62)	21 (28.77)	52 (71.23)	Reference	-
26 - 35	173(48.87)	44 (25.43)	129 (74.57)	0.80 [0.49 – 1.31]	0.41
36 - 45	108 (30.51)	33 (30.56)	75 (69.44)	1.22 [0.2 - 2.1]	0.44
Marital status		1			1
Married	227(64.12)	34(14.98)	193(85.02	Reference	-
Other	127 (35.88)	64 (50.39)	63(40.61)	5.54 [3.28 -9.5]	≤0.001*
Niveau d'éducation	(Niveau d'études	atteint)			
High school and above	211 (59.61)	45(21.33)	166 (78.67)	Reference	-
Primary	143 (40.39)	53(37.1)	90 (62.9)	2.17 [1.32-3.6]	0.002*

Employment status						
Housewife.	227(64.12)	32 (14.1)	195(85,9)	Reference	-	
Unemployed	42 (11.86)	31(78.81)	11(21.19)	10.22 [4.7- 23.77]	≤0.001*	
Employed	34 (9.60)	13 (38.24)	21 (61.76)	1.71 [0.75- 3.76]	0.16	
Student	51(14.42)	22 (43.14)	29 (56.86)	2,26 [1.16- 4.35]	0.011*	
Residence						
Urban	234(66.10)	28 (11.97)	206 (88.03)	Reference	-	
Rural	120 (33.9)	70 (58.33)	50 (41.67)	10.21 [5.81 – 18.3 ]	<b>≤0.001</b> *	
Monthly income: Hou	sehold income					
High	72 (20.34)	27 (37.5)	45 (62.5)	Reference	-	
Medium	72 (20.34)	16 (22.22)	56 (77.78)	0.7 [0.35-1.32]	0.30	
Low	210 (59.32)	55 (26.19)	155 (73.81)	0.83 [0.51- 1.38]	0.47	
Access to drinking water: Availability of a source of drinking water						
Yes	332 (83.79)	83 (25)	249 (75)	Reference		
No	22(16.21)	15 (68.18)	7 (31.82)	6.38 [2.35- 19.2]	≤0.001*	

OR= Odds Ratio; CI= Confidence Interval; \* = Significant Test, Other= Single, Cohabiting.

# III.3. Prevalence of anemia according to obstetrical characteristics of pregnant women in the study (N=354)

Pregnant women with 0-1 prior pregnancies (Odds Ratio = 2.69; 95% CI [1.55 - 4.66] p=0.000), in their first trimester of pregnancy (Odds Ratio = 2.04; 95% CI [1.17 - 3.53] p=0.008\*), with a history of obstetric complications (Odds Ratio = 2.80; 95% CI [1.06 - 7.42] p=0.025\*), and who did not adhere to the recommended medical visit schedule (Odds Ratio = 6.18; 95% CI [3.24 - 12.42] p $\leq$ 0.001\*), had a significantly higher risk of anemia in the present study (Table 2).

**Table 2:** Bivariate analysis of the prevalence of anemia, according to the obstetric characteristics of the pregnant women in the study (n=354).

VariablesPrevalence of anemiaBivariate analysis	
---	--

Total	Positive	Negatifve	Crude OR	p-value		
number of	N (%)	N (%)	95% CI			
pregnant						
women in						
study N (%)	<b>.</b>					
eies (1 otal number)	per of pregnar	1C1es)	2 (0	0.000*		
84 (23.73)	37 (44.05)	47(55.95)	2.69 [1.55-4.66]	0.000^		
165 (46.61)	53(32.12)	112(67.88)	Reference	-		
105(29.66)	8 (7.62)	97(92.38)	0.15 [0.06-0.32]	≤0.001		
84 (23.73)	33(39.29)	51(60.71)	2.04 [1.17 -3.53]	0.008*		
110 (31.08)	27(24.55)	83(75.45)	0.79 [0.45- 1.36]	0.44		
160 (45.19)	38 (18.13)	122(81.87)	Reference	-		
cing (years)						
286 (80.79)	87 (30.42)	199 (69.58)	Reference	-		
68 (19.21)	11(16.18)	57 (83.82)	0.5 [0.2- 0.9]	0.023		
History of misc	arriage, ectop	ic pregnancy, o	obstetrical complication	ations		
22 (6.21)	11 (50)	11(50)	2.80 [1.06- 7.42]	0.025*		
332 (93.79)	87(26.2)	245(73.8)	Reference	-		
Prenatal follow-up: Adherence to visit schedule.						
298 (84.18)	63(21.14)	235 (78.86)	Reference	-		
56 (15.82)	35 (62.5)	21(37.5)	6.18 [3.24 - 12.42]	≤0.001*		
Mode of delivery						
329 (92.94)	89 (27.05)	240 (72.95)	Reference	-		
25 (7.06)	9 (36)	16 (64)	1.51 [0.57- 3.8]	0.36		
	Total           number of           pregnant           women in           study N (%)           ies (Total number of           84 (23.73)           165 (46.61)           105(29.66)           84 (23.73)           110 (31.08)           160 (45.19)           cing (years)           286 (80.79)           68 (19.21)           History of misca           22 (6.21)           332 (93.79)           Adherence to vi           298 (84.18)           56 (15.82)           329 (92.94)           25 (7.06)	Total number of pregnant women in study N (%)Positive N (%)ies (Total number of pregnant 84 (23.73) $37 (44.05)$ 165 (46.61) $53(32.12)$ 105(29.66)8 (7.62)84 (23.73) $33(39.29)$ 110 (31.08) $27(24.55)$ 160 (45.19)38 (18.13)cing (years) $286 (80.79)$ 286 (80.79) $87 (30.42)$ 68 (19.21)11(16.18)History of miscarriage, ectop22 (6.21)11 (50)332 (93.79) $87(26.2)$ Adherence to visit schedule.298 (84.18) $63(21.14)$ 56 (15.82) $35 (62.5)$ 329 (92.94) $89 (27.05)$ 25 (7.06) $9 (36)$	Total number of pregnant women in study N (%)Positive N (%)Negatifve N (%)ies (Total number of pregnancies) $84 (23.73)$ $37 (44.05)$ $47(55.95)$ $165 (46.61)$ $53(32.12)$ $112(67.88)$ $105(29.66)$ $8 (7.62)$ $97(92.38)$ $84 (23.73)$ $33(39.29)$ $51(60.71)$ $110 (31.08)$ $27(24.55)$ $83(75.45)$ $160 (45.19)$ $38 (18.13)$ $122(81.87)$ cing (years) $286 (80.79)$ $87 (30.42)$ $199 (69.58)$ $68 (19.21)$ $11(16.18)$ $57 (83.82)$ History of miscarriage, ectopic pregnancy, of 	Total number of pregnant women in study N (%)Positive N (%)Negatifve N (%)Crude OR 95% CI84 (23.73) $37 (44.05)$ $47(55.95)$ $2.69$ [1.55-4.66]165 (46.61) $53(32.12)$ $112(67.88)$ Reference105(29.66) $8 (7.62)$ $97(92.38)$ $0.15$ [0.06-0.32]84 (23.73) $33(39.29)$ $51(60.71)$ $2.04$ [1.17 - 3.53]110 (31.08) $27(24.55)$ $83(75.45)$ $0.79$ [0.45- 1.36]160 (45.19) $38 (18.13)$ $122(81.87)$ Referencecing (years) $2266 (80.79)$ $87 (30.42)$ $199 (69.58)$ Reference286 (80.79) $87 (30.42)$ $199 (69.58)$ Reference68 (19.21) $11(16.18)$ $57 (83.82)$ $0.5$ [0.2- 0.9]History of miscarriage, ectopic pregnancy, obstetrical complication22 (6.21) $11 (50)$ $11(50)$ $2.80$ [1.06- 7.42]332 (93.79) $87(26.2)$ $245(73.8)$ Reference298 (84.18) $63(21.14)$ $235 (78.86)$ Reference56 (15.82) $35 (62.5)$ $21(37.5)$ $6.18$ [3.24 - 12.42]329 (92.94) $89 (27.05)$ $240 (72.95)$ Reference25 (7.06) $9 (36)$ $16 (64)$ $1.51$ [0.57- 3.8]		

OR= Odds Ratio; CI= Confidence Interval; \* = Significant Test-

# III.4. Prevalence of anemia according to clinical features observed among pregnant women in the study (N=354)

Pregnant women presenting with one or more clinical signs (pallor, tiredness, shortness of breath, palpitations) (Odds Ratio = 17.95; 95% CI [8 - 44.5] p $\leq 0.001^*$ ), and consuming alcohol

or smoking (Odds Ratio = 2.75; 95% CI [1.47 - 5.13]  $p \le 0.001^*$ ), were significantly associated with anemia in the present study (Table 3).

**Table 3:** Bivariate analysis of the prevalence of anemia, according to clinical featured observed among pregnant women in the study, (n=354).

Variables	Total	Prevalence of anemia		Bivariate analysis		
	pregnant women in study N (%)	Positive N (%)	Negative N (%)	Crude OR 95% CI	p-value	
Clinical signs of anen	nia: Pallor, tired	lness, shortnes	ss of breath, pa	lpitations		
Yes	48 (13.56)	39 (81.25)	9 (18.75)	17.95 [8 – 44.5]	<b>≤0.001</b> *	
No	306 (86.44)	59 (19.28)	247(80.72)	Reference	-	
History of chronic di anemia.	seases (diabetes	, hypertension	, infectious dis	seases, etc.), hist	ory of	
Yes	16 (4.52)	2 (12.5)	14(87.5)	0.36 [0.04 -1.62]	0.25	
No	338 (95.48)	96 (28.40)	242(71.6)	Reference	-	
Taking medication d	uring pregnand	ey.				
Yes	39 (11.02)	9 (23.08)	30 (76.92)	0.76 [0.31-1.73]	0.57	
No	315 (88.98)	89 (28.25)	232 (71.75)	Reference	-	
Food or drug allergie	28					
Yes	45 (12.71)	16 (35.55)	39 (64.45)	1.14 [0.56-2.21]	0.74	
No	309 (87.29)	82 (26.54)	227 (73.46)	Reference	-	
Lifestyle: Smoking, alcohol consumption						
Yes	58 (16.38)	27 (46.55)	31 (53.45)	2.75 [1.47-5.13]	0.000*	
No	296 (83.62)	71 (23.99)	225 (76.01)	Reference	-	

OR= Odds Ratio; CI= Confidence Interval; \* = Significant Test-

## III.5. Multivariate analysis of anemia prevalence according to variables significant in bivariate analysis among pregnant women in the study (N=354).

The study, deepened by multivariate analysis using logistic regression, revealed that, pregnant women with primary education level (Adjusted Odds Ratio = 1.32; 95% CI [0.01 -0.72] p=0.028\*), unemployed (Adjusted Odds Ratio = 3.1; 95% CI [4.98 - 60.3] p=0.003\*), residing

in rural area (Adjusted Odds Ratio =56.9; 95% CI [1.07 -89.1] p= $0.023^*$ ), and presenting one or more clinical signs (pallor, fatigue, shortness of breath, palpitations) (Odds Ratio = 7.46; 95% CI [2.97 -18.76] p= $0.001^*$ ), were statistically associated with anemia in the present study (Table 4).

Table 4 : Multivariate analysis of the prevalence of anemia according to the significant	nt
variables in bivariate analysis in the pregnant women of the study (N= 354).	

Variables	Total	Prevalence of anemia		Multivariate analysis	
	number of pregnant women N (%)	Positive N (%)	Negative N (%)	OR Brut IC 95%	p-value
Marital status		I.	1	1	,
Married	227(64,12)	34(14.98)	193 (85.02)	1	-
Others	127 (35,88)	64 (50,39)	63(40,61)	-	-
Education level (Gra	ade attained)		1	1	1
High school and	211 (59,61)	45(21.33)	166	1	-
above			(78.67)		
Primary	143 (40,39)	53(37.1)	90 (62.9)	1,32 [0,01- 0,72]	0,028*
Employment status					
Housewife	227(64,12)	32 (14.1)	195(85,9)	1	-
Unemployed	42 (11,86)	31(78,81)	11(21,19)	3,1 [4,98- 60,3]	0,003*
Employed	34 (9,60)	13 (38,24)	21 (61,76)	-	-
Student	51(14,42)	22 (43,14)	29 (56,86)	1,27 [0,92-1,7]	0,35
Residence	I	1	1		
Urban	234(66,10)	28 (11,97)	206 (88,03)	1	-
Rural	120 (33,9)	70 (58.33)	50 (41.67)	56,9 [1,07 ; 89,6]	0,023*
Access to drinking w	ater: Availabilit	ty of a source	of drinking w	ater	1
Oui	332 (83,79)	83 (25)	249 (75)	1	
Non	22(16,21)	15 (68,18)	7 (31,82)	8,8 [0,12;121,3]	0,51

Number of pregnane	<b>cies</b> (Total numbe	er of pregnanc	cies.)		
0 - 1	84 (23,73)	37 (44.05)	47(55.95)	-	-
2 - 3	165 (46,61)	53(32,12)	112(67,88)	1	-
≥ 4	105(29,66)	8 (7,62)	97(92,38)	-	-
Gestational age					
1st trimester	84 (23,73)	33(39,29)	51(60,71)	1.17 [0.55; 2.32]	0,8
2nd trimester	110 (31,08)	27(24,55)	83(75,45)	-	-
3rd trimester	160 (45,19)	38 (18.13)	122 (81.87)	1	-
Inter-pregnancy spa	icing (years)	1		1	1
Greater than 2	286 (80,79)	87 (30.42)	199 (69.58)	1	-
Less than 2	68 (19,21)	11(16,18)	57 (83,82)	-	-
Prenatal follow-up:	Adherence to vis	it schedule		,	
Yes	298 (84,18)	63(21.14)	235 (78.86)	1	-
No	56 (15,82)	35 (62,5)	21(37,5)	-	-
Clinical signs of ane	mia: Pallor, tired	lness, shortnes	ss of breath, pa	alpitations	
Yes	48 (13,56)	39 (81,25)	9 (18,75)	7,46 [2,97-18,76]	0,001*
No	306 (86,44)	59 (19.28)	247 (80.72)	1	
Lifestyle: Smoking, a	alcohol consumpt	tion			
Yes	58 (16,38)	27 (46,55)	31 (53,45)	-	-
No	296 (83,62)	71 (23.99)	225 (76.01)	1	-

OR= Odds Ratio; CI= Confidence Interval; \* = Significant Test, Other= Single, Cohabiting

## **IV. DISCUSSION**

Highly prevalent among pregnant women in developing countries such as Gabon, and causing a significant burden of morbidity and mortality, anemia is a condition that occurs when the body does not have enough hemoglobin. To design, plan, and evaluate appropriate intervention strategies against this life complication, it was crucial to understand its epidemiology, transmission, distribution, and extent, as well as the associated risk factors in pregnant women [16]. Therefore, this study aimed to assess the prevalence and factors associated with anemia in 354 pregnant women followed at the Amissa Bongo University Hospital Center in Franceville, Gabon.

Contrary to a study conducted in Malaysia, which found that the prevalence of anemia among women was 34.1% [17], this study indicated an overall prevalence of anemia of 27.68% (95% CI: [0.21-0.3]). Lower than the results obtained in some studies conducted in Ethiopia (32.8%), Turkey (41.6%), and India (100%) [18], the prevalence of this study was higher than those obtained in Iran (16.8%), Uganda (22.1%), and Great Britain (24.4%) [19]. This variability in results could be explained, on the one hand, by the difference in participant sampling, the difference in periods, regions, and the characteristics of the participants used in each study. On the other hand, the management of pregnant women from the third month onwards and the free prenatal care provided by the Gabonese government during this delicate period of pregnancy could justify this slight improvement. A univariate analysis of the distribution of the prevalence of anemia cases according to the variables of the present study indicated that anemia was statistically associated with: Unmarried pregnant women, Having a primary education level, Being unemployed, Being a student, Residing in a rural area, Not having access to safe drinking water, Having a number of pregnancies between 0 - 1, Being in the first trimester of pregnancy, Not following the recommended medical visit schedule, Presenting with one or more clinical signs (Pallor, fatigue, shortness of breath, palpitations), and Consuming alcohol, or smoking. However, further analysis using logistic regression showed that pregnant women with a primary education level were more likely to suffer from anemia. This result, although contrary to that of a study that showed that less educated women had a lower probability of being anemic than educated women [20], corroborates those obtained from previous studies, which revealed that pregnant women with a low level of education had a higher prevalence of anemia than those with a higher level of education [21]. Knowing that education is an essential factor for human development, the result obtained in this study would suggest a lack of knowledge about the importance of good nutrition and the need for iron-rich foods among most of the pregnant women in this study [22]. Also, unemployed pregnant women were strongly associated with anemia in this study. This result is consistent with other studies that have shown that in a context of poverty, women with low or no monthly family income had a high probability of being anemic than those who did [9]. This could be due to the fact that the absence or low monthly family income can affect the pregnant woman's ability to purchase food, which affects her food security. Consequently, pregnant women with low incomes cannot feed themselves properly and are therefore at risk of anemia. In addition, pregnant women in this study living in rural areas were more at risk of suffering from anemia than those living in urban areas. This result is consistent with a study conducted in Malaysia, which indicated that the prevalence of anemia during pregnancy was generally higher in rural areas [23]. This can be explained by the fact that in urban areas there is better access to information and education [24], leading to better health awareness and a healthier diet and lifestyle. This may also be related to the wealth of urban communities [25] and the disadvantages faced by pregnant women in ensuring full access to health and nutrition services in rural and most marginalized areas. Finally, this study indicated that pregnant women with one or more clinical signs (pallor, fatigue, shortness of breath, palpitations) had a significantly higher risk of anemia. This result is consistent with that of a study that mentioned that the most common symptoms of anemia are most often shortness of breath, weakness [26]. This result can be justified because anemia is characterized by a lack of healthy red blood cells to carry oxygen in the body, this means less oxygenated red blood circulating in the body, which makes the skin paler [27]. Then, the body's cells need oxygen to produce energy. A lack of oxygen leads to general fatigue [28]. In addition, to compensate for the lack of oxygen, the human body increases the respiratory rate, which can cause shortness of breath, even at rest [29]. Finally, to circulate the less oxygen-rich blood, the heart has to pump harder, which can lead to palpitations or a feeling of rapid and irregular heartbeat [30].

#### Highlights of this study:

The study addresses an important public health problem, anemia in pregnant women, which can have serious consequences for both mother and child. With 354 participants, the study has a sufficient sample size to obtain statistically significant results. Multivariate logistic regression was used to control for confounding factors and identify factors independently associated with anemia. The study highlights important risk factors, such as low level of education, unemployment, residence in a rural area and the presence of clinical signs. These findings can help target prevention and management interventions, and have direct implications for clinical practice and public

#### **Study Limitations**

This study on anemia in pregnant women appears to be robust, but like any research, it has some limitations that need to be raised. First, the study was conducted on 354 pregnant women followed in a single hospital center (Amissa Bongo University Hospital Center). The results may not be representative of all pregnant women in Franceville or Gabon, particularly those living in more isolated rural areas or with limited access to health care. Second, the study did not take into account certain factors that may influence anemia, such as nutritional status (iron, vitamin B12, folate deficiencies). Despite these limitations, this study provides important information on the prevalence and factors associated with anemia in pregnant women in Gabon. It highlights the importance of considering socio-economic factors in the prevention and management of anemia.

## CONCLUSION

The study conducted at the Amissa Bongo University Hospital Center in Franceville highlighted a significant prevalence of anemia among pregnant women (27.68%). It demonstrated that this condition was influenced by socio-economic factors, including low education level, unemployment, and rural residence. In addition, the presence of clinical signs such as pallor, fatigue, shortness of breath, and palpitations were important indicators of increased risk of anemia. These findings underscore the need for a multi-pronged approach to address anemia in pregnant women. Interventions targeting socioeconomic determinants, combined with early detection and appropriate management of symptoms, are essential to improve the health of pregnant women and their children.

#### Acknowledgements

The authors express their sincere gratitude to all the pregnant women who participated in this study at the Amissa Bongo University Hospital Center in Franceville. Their collaboration was essential to the completion of this work. We also thank the medical and administrative staff of Amissa Bongo University Hospital Center in Franceville (ABUHF), for their support and assistance throughout the study. Finally, we would like to thank the anonymous reviewers for their constructive comments which helped improve the quality of this manuscript.

#### Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

#### **Author's contributions**

This study was conceived by TNM. HKM. TNM, and AN collaborated on the design, analysis, and writing of the data and methods sections. The initial draft of the manuscript was prepared by ABPP, TNM, and MJPT. TNM, HKM, and SM critically reviewed and revised the manuscript for intellectual content. All authors contributed to the article and approved the final submitted version.

#### **Conflict of interest**

The authors declare that there is no conflict of interest.

#### REFERENCES

- 1- Turner J, Parsi M, Badireddy M. Anemia. [Updated August 2023 8]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 Jan.-. Available from: <u>https://www.ncbi.nlm.nih.gov/books/NBK499994/</u>.
- 2- Bhutta BS, Alghoula F, Berim I. Hypoxia. [Updated August 2022, 9]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 Jan.-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK482316/.
- Wegmüller R, Bentil H, Wirth JP, Petry N, Tanumihardjo SA, Allen L, Williams TN, Selenje L, Mahama A, Amoaful E, Steiner-Asiedu M, Adu-Afarwuah S, Rohner F. Anemia, micronutrient deficiencies, malaria, hemoglobinopathies and malnutrition in young children and non-pregnant women in Ghana: results of a national survey. PLoS Un. Jan. 30, 2020; 15(1) :E0228258. DOI : 10.1371/journal.pone.0228258. PMID : 31999737 ; PMCID : PMC6991996
- 4. Killeen RB, Tambe A. Acute anemia. [Updated August 17, 2023]. In: StatPearls [Internet]. Treasure Island (Florida) : StatPearls Publishing ; 2024 janv.-. Disponible à partir de : https://www.ncbi.nlm.nih.gov/books/NBK537232
- Coad J, Pedley K. Iron deficiency and iron deficiency anemia in women. Scand J Clin Lab Invest Suppl. 2014;244:82-9; Discussion 89. doi : 10.3109/00365513.2014.936694. PMID : 25083899
- Suryanarayana R, Chandrappa M, Santhuram AN, Prathima S, Sheela SR. Prospective study on the prevalence of anemia in pregnant women and its outcomes: a community-based study. J Famille Med Prim Care. 2017 October-December; 6(4):739-743. DOI : 10.4103/jfmpc.jfmpc 33 17. PMID : 29564255; PMCID : PMC5848390.
- 7. Davidson EM, Scoullar MJL, Peach E, Morgan CJ, Melepia P, Opi DH, et al., Quantify differences in anemia attributable to iron deficiency during pregnancy and postpartum.

2023 Juil 18;4(7):101097. doi : 10.1016/j.xcrm.2023.101097. EPUB 2023 Juil 5. PMID : 37413986; PMCID : PMC10394161.

- Ngimbudzi EB, Massawe SN, Sunguya BFThe burden of anemia during pregnancy among women attending antenatal clinics in Mkuranga district, Tanzania. Public Health Front. 2021 Déc 2;9:724562. doi : 10.3389/fpubh.2021.724562. PMID : 34926366; PMCID : PMC8674738
- Balcha WF, Eteffa T, Tesfu AA, Alemayehu BA, Chekole FA, Ayenew AA, et al., Factors associated with anemia in pregnant women who received prenatal care: a cross-sectional study conducted in a healthcare facility. Ann Med Surg (Lond). 11 avr. 2023; 85(5):1712-1721. doi: 10.1097/MS9.00000000000000608. PMID : 37228917; PMCID : PMC10205215.
- Tesema GA, Worku MG, Tessema ZT, Teshale AB, Alem AZ, Yeshaw Y, Alamneh TS, Liyew AM. Prevalence and determinants of anemia severity levels in children aged 6-59 months in sub-Saharan Africa: a multilevel ordinal logistic regression analysis. PLoS One. 2021 avril 23;16(4):e0249978. doi: 10.1371/journal.pone.0249978. PMID : 33891603; PMCID : PMC8064743.
- 11. Seifu, B. L. et Tesema, G. A. (2022). Individual and community factors associated with anemia in children aged 6-23 months in sub-Saharan Africa: data from 32 sub-Saharan African countries. *Archives de la santé publique*, 80(1), 1-12
- Parkouda S, Saidou M, Bisseye C. Microfilariae Prevalence and its Association with Anemia Among First-time Blood Donors in Lambaréné, Gabon. Balkan Med J. 2024 Mar 1;41(2):139-143. doi: 10.4274/balkanmedj.galenos.2023.2023-9-86. Epub 2024 Jan 23. PMID: 38259115; PMCID: PMC10913112
- Ovono Abessolo, Jean-Pierre Ngou-Mve Ngou, Jacques Bang Ntamack, Alexandrine Sylvie Nsi, Jean-François Meye, Edouard Ngou-Milama, Micronutrient status of Gabonese women during pregnancy diagnosis, Revue Francophone des Laboratoires, Volume 2011, Issue 436, 2011, Pages 67-71, ISSN 1773-035X.
- Mba, T., Obiang, C., Kenguele, H., Pambo-Pambo, A., Mba, I., Sah, U., . . . Mickala, P. (2023). Prevalence of pulmonary tuberculosis and associated factors in patients admitted to the Amissa Bongo University Hospital in Franceville, Gabon. journal of Biosciences and Medicines, 11, 160-173. doi:10.4236/jbm.2023.117014
- 15. Waye BG, Gurara AM, Awoke KSPrevalence of anemia and associated factor among pregnant women receiving antenatal care in arba minch public health facilities, Southern Ethiopia. World 2020 ; 5:76 à 83.
- 16. Abd Rahman R, Idris IB, Isa ZM, Rahman RA, Mahdy ZA. Prevalence and risk factors for iron deficiency anemia in pregnant women in Malaysia: a systematic review. Front Nutr. 15 avril 2022; 9:847693. doi:10.3389/fnut.2022.847693. PMID:35495961; PMCID: PMC9051477.
- 17. Alreshidi MA, Haridi HK. Prevalence of anemia and associated risk factors among pregnant women in an urban community in northern Saudi Arabia. J Prev Med Hyg. 15

septembre 2021; 62(3):E653 et E663. DOI : 10.15167/2421-4248/JPMh2021.62.3.1880. PMID : 34909493 ; PMCID : PMC8639134.

- Vemulapalli B, Rao KK. Prevalence of anemia among pregnant women of rural community in Vizianagram, North coastal Andhra Pradesh, India. Asian Journal of Medical Science. 2014;5(2):21–25.
- 19. Mardania Mahnaz, Rezapourb Sadegh, Ahmadipourb Shokoufeh, Mohsenzadehb Azam AH, Khalkhali Rad AH, Roostac Sajjad, Ebrahimzadeh Farzad. Prevalence of anemia and its risk factors among pregnant women in Khorramabad (Iran) 2010-2014. J Matern Fetal Neonatal Med. 2016;26:1–4
- 20. Novivanti B, Harry C, Simanjuntak ES, Hutasoit P, Silitonga HA, Julianto E. The relationship between socioeconomic levels and anemia events in pregnant women at Glugur Darat health center. *J Mater Santé de l'enfant*. (2019) 4:48–56. DOI : 10.26911/thejmch.2019.04.06.05
- Abizari, A. R., Buxton, C., Kwara, L., Mensah-Homiah, J., Armar-Klemesu, M., & Brouwer, I. D. (2014). School feeding contributes to micronutrient adequacy of Ghanaian schoolchildren. *British Journal of Nutrition*, *112*(6), 1019-1033.
- 22. Ługowska K, Kolanowski W. Nutritional behavior of pregnant women in Poland. Int J Environ Res Public Health. (2019) 16:43–57. DOI : 10.3390/ijerph16224357
- 23. Usoh N, Ismail TAT, Daud A. Anemia in pregnant teenagers in northwest Malaysia: what are the factors? *Int J Collab Res Internal Med Public Health*. (2015) 7 : 196.
- 24. Tesfaye TS, Tessema F, Jarso H. Prevalence of anemia and associated factors in "apparently healthy" urban and rural residents in Ethiopia: a comparative cross-sectional study.. J Blood Med. (2020) 11 : 89–96. 10.2147/JBM.S239988
- 25. Soofi S, Khan GN, Sadiq K, Ariff S, Habib A, Kureishy S, et alPrevalence and possible factors associated with anemia and vitamin B12 and folate deficiency among women of reproductive age in Pakistan: analysis of national-level secondary survey data.. BMJ Open. (2017) 7 :e018007. 10.1136/bmjopen-2017-018007
- 26. Tettegah E, Hormenu T, Ebu-Enyan NI. Risk factors associated with anaemia among pregnant women in the Adaklu District, Ghana. Front Glob Womens Health. 2024 Feb 15;4:1140867. doi: 10.3389/fgwh.2023.1140867. PMID: 38425653; PMCID: PMC10902161
- 27. Dean L. Blood types and red cell antigens [Internet]. Bethesda (MD): National Center for Biotechnology Information (USA); 2005.. Chapter 1, Blood and the cells it contains.t. Available at:: <u>https://www.ncbi.nlm.nih.gov/books/NBK2263/</u>
- Rhodes CE, Denault D, Varacallo M. Physiology, oxygen transport. [Updated November 14, 2022]. In: StatPearls [Internet]. Treasure Island (FL) : StatPearls Publishing ; 2024 janv.-. Disponible sur : <u>https://www.ncbi.nlm.nih.gov/books/NBK538336/</u>
- 29. Brinkman JE, Toro F, Sharma S. Physiology, respiratory drive. [Updated June 5, 2023]. In
  : StatPearls [Internet]. Treasure Island (FL) : StatPearls Publishing ; 2024 janv.-.
  . Disponible sur : https://www.ncbi.nlm.nih.gov/books/NBK482414/

30. Rabadia, J. P., Thite, V. S., Desai, B. K., Bera, R. G., & Patel, S. (2024). Cardiovascular System, Its Functions and Disorders. In *Cardioprotective Plants* (pp. 1-34