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Anemia Prevalence and Associated Factors among Pregnant Women in Mbujimayi, a Highly Malaria-Endemic Region from the Democratic Republic of Congo

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Abstract

Background Anemia during pregnancy is a major public health problem, particularly in malaria-endemic regions such as the Democratic Republic of Congo (DRC). This study aimed to estimate the prevalence of maternal anemia and identify associated factors among pregnant women delivering in Mbujimayi, a city in central DRC. **Methods** A cross-sectional study carried out from August 15, 2023 to March 14, 2024 in four maternity units. Data combined individual interviews with medical record searches and biological laboratory analyses. Hemoglobin levels were determined on arrival at the maternity hospital, using a HemoCue® automatic hematology analyzer. Capillary blood was tested for plasmodial infections using thick drop and thin smear microscopy, as well as a rapid diagnostic test targeting the Plasmodium falciparum HRP2 antigen. Uni- and multivariate statistical logistic regression models were used to assess factors associated with anemia. **Results** A total of 199 parturients were recruited, with an average age of 28.3 ± 6.4 years, mainly secondary education (72.4%) and a domestic occupation (51.3%). The prevalence of maternal anemia was 21.1% [CI 95% 15.8 - 27.6] and that of malaria was

18.1% [CI 95% 13.1; 24.3]; P. falciparum was the most prevalent species (85.7% [95% CI 42.0; 99.2]), followed by P. malariae (14.3% [95% CI 0.75; 57.9]). The median hemoglobin level was statistically different according to malaria status: 11.2 g/dL (8.5 - 14 g/dL) versus 11.9 g/dL (8.1 - 14.2 g/dL) with p = 0.0028. Illiteracy and history of malaria during pregnancy were found to be significant factors, multiplying the risk of anemia by 2.5 for the former (aOR = 2.5 [95% CI 1.1; 5.9]; p = 0.035) and by 4 for the latter (aOR = 4.3 [95% CI 1.9; 9.9]; p < 0.001). Preterm delivery was significantly associated with anemia (adjusted OR = 3.7 [95% CI 1.4; 9.1]; p = 0.006). **Conclusion** Anemia is common among pregnant women in Mbujimayi, so education of young girls must be encouraged, and preventive and curative treatment of malaria must be stepped up.

Keywords

Anemia, Pregnant Women, Factors, Malaria, Endemic Region

1. Introduction

Anemia is a public health problem, predominantly affecting children and women of childbearing age. Defined by the World Health Organization (WHO) as a hemoglobin level below 11 g/dL, the Centers for Disease Control and Prevention (CDC) defines it as a hemoglobin level below 11 g/dL in the first and third trimesters, and below 10.5 g/dL in the second trimester of pregnancy [1] [2]. The global prevalence of anemia is 42% in pregnant women, and it is responsible for 20% of maternal deaths worldwide [3] [4]. Its consequences also include an increased risk of neonatal mortality, preterm delivery and low birth weight [4].

In developed countries, 23% of pregnant women are anemic, with iron deficiency remaining the most common cause. Pregnant women are particularly vulnerable due to the substantial increase in iron requirements during pregnancy to support the increase in red blood cell mass and plasma volume, as well as fetal-placental growth. Thus, the American College of Obstetricians and Gynecologists (ACOG) recommends screening for anemia in all pregnant women and advocates iron supplementation and prenatal vitamins [2].

African countries where malaria is endemic are the most affected by maternal anemia, with up to 57% of pregnant women in some regions [2] [5]-[7]. In the Democratic Republic of Congo (DRC), where malaria is hyper-endemic, the prevalence of maternal anemia can still be very high, reaching 76% in Kisangani, according to a study by Likilo *et al.* [8]. Among the main associated factors are parity, antenatal clinics (ANC), level of education and iron-folate supplementation [2] [6] [7]. Although the causes of maternal anemia are multiple, including nutritional deficiencies (vitamin B12, folic acid and iron deficiencies), chronic pathologies and intestinal parasitosis, malaria occupies a central position in endemic countries [2].

In areas with stable malaria transmission, maternal anemia and placental malaria are major complications of malaria infection in pregnant women [9] [10]. Plasmodium falciparum, the main species involved in malaria infections in Africa, can accumulate in the placenta and cause anemia, even in the absence of parasites in the maternal peripheral blood. Every year, around 400,000 cases of severe maternal anemia are attributed to malaria in sub-Saharan Africa, with maternal mortality of almost 10,000 cases per year [11] [12]. A study conducted in Republic of Congo by Massamba revealed that microscopic and submicroscopic malaria were twice as frequent in anemic parturients [13].

In view of these risks, the WHO recommends several strategies to prevent malaria during pregnancy, including the use of long-acting insecticide-treated mosquito nets (LLINs), intermittent preventive treatment with sulfadoxine-pyrimethamine (IPTg-SP) and effective management of malaria and anemia, especially through iron and folic acid supplementation [14]. However, coverage of these interventions remains insufficient in the DRC, particularly in Kasaï-Oriental province, where coverage of three-dose IPT-SP was only 16% according to the 2023-2024 Demographic and Health Survey. And yet, this province is an area with a tropical epidemiological facies with malaria transmission with long seasonal increases and is one of the regions with the highest burden of malaria-related morbidity in the country [15].

In addition, the emergence and expansion of P. falciparum resistance to antimalarial drugs and mosquito resistance to insecticides threaten the effectiveness of the strategies advocated [16] [17]. Recent studies have thus reported contrasting results on the effectiveness of IPT-SP, imposing the need for ongoing evaluation of control strategies across the country. Labama *et al.* found an association between malaria and maternal anemia at delivery, but no significant reduction in risk with IPT-SP in Kisangani [18]. Similarly, Kayiba *et al.* found that IPT-SP was not associated with a reduction in maternal malaria, although it did demonstrate a protective effect against maternal anemia and preterm delivery in Kinshasa [19]. Against this backdrop, we undertook this study to estimate the prevalence of maternal anemia and identify associated factors in parturients in Mbujimayi, a highly malaria-endemic area in central DRC. A better understanding of these determinants will enable us to adapt prevention strategies and improve care for pregnant women exposed to this risk.

2. Methods

2.1. Setting, Type and Period of Study

The study was carried out in Mbujimayi, capital of Kasaï-Oriental province in central DRC, in 4 health zones within the maternity wards of four hospitals, namely Bonzola, Christ-Roi, Sudmeco and La Grâce Divine. These sites had been selected because of their high attendance rates (an average of 40 deliveries per month), according to the National Health Information System (NHIS) report for 2022. The study was cross-sectional and analytical in nature, and took place over

a seven-month period from August 15, 2023 to March 14, 2024. This duration includes site preparation, investigator training, data collection and analysis of biological samples.

2.2. Study Population and Minimum Sample Size

The study targeted all parturients presenting successively for delivery at the selected maternity hospitals during the study period. They were invited to participate in the survey, on the basis of defined selection criteria. The minimum sample size was calculated using the Schwartz formula, based on a 13.6% prevalence of placental malaria as a carrier of anemia, observed in Kwilu province [20]. Assuming a precision of 5%, the minimum number required was 180 parturients. A 10% increase was applied to account for non-response, bringing the final number to 199. All parturients admitted to the targeted maternity units were eligible for the study, regardless of gestational age, provided they had given informed consent. However, those for whom the essential study data were inaccessible, for whatever reason (e.g. advanced labor on admission, insufficient blood sample due to technical shortcomings or incomplete clinical assessment), were excluded from the analysis.

2.3. Data Collection

Data collection was carried out by a multidisciplinary team of 12 midwives or birthing nurses (three per targeted maternity hospital), two laboratory technicians, four medical student finalists in charge of logistics, a supervising physician and a principal investigator. The investigators were recruited from among staff working in the target health facilities. These investigators were already qualified to carry out activities relating to delivery room management, and had undergone prior training in the management of malaria during pregnancy. Together with the laboratory technicians and student finalists, they underwent additional brief training to master the study protocol, particularly with regard to the collection equipment for individual use on each participant, an informed consent form, a survey questionnaire and biological sampling tools, labelled a priori with a distinct identification number (ID) for each parturient. They were also instructed on the procedures for collecting biological samples and the timeframe for their analysis by the laboratory technician. The survey questionnaires were tested and adjusted beforehand, in a real field situation, by the trained interviewers and under the direct supervision of the principal investigator.

Thus, on admission to the maternity unit, parturient were informed of the study objectives and invited to participate. After verification of eligibility criteria, they signed the informed consent form before undergoing a clinical examination. Data were then collected using a collection sheet, combining several methods: interviews, analysis of medical records, clinical and obstetrical examination, and biological analyses. Firstly, interviews were conducted using a structured questionnaire, translated into Tshiluba (the local language), and administered to parturi-

ents to gather socio-demographic, clinical and obstetrical information. This information was then supplemented by analysis of individual medical records, including prenatal consultation records. Finally, two milliliters of maternal venous blood were collected on EDTA for various biological analyses, including a rapid diagnostic test (RDT), microscopic examination of a thick drop and a thin blood smear, and hemoglobin determination.

At the same time, all data was entered daily and compiled on electronic sheets designed with the KoboToolbox application (https://kf.kobotoolbox.org/), installed on cell phones. Ongoing supervision was set up to identify and correct any data entry errors or inconsistencies. Finally, at the end of the survey, the database was exported in Excel format (Microsoft Office 2010, USA), checked, corrected and consolidated into a single, definitive database.

2.4. Laboratory Analysis

Duly labelled EDTA blood tubes were sent daily, within 4 hours of collection, to the analysis laboratory at Valentin Disashi Hospital for screening for maternal anemia, as well as testing for Plasmodium spp. by RDT and thick drop by two experienced laboratory technicians. As soon as the tube was received, drops of blood were pipetted and deposited successively on the RDT device, on a slide for thick drop and thin smear, and on a microcuvette for haemoglobin measurement.

The SD Bioline© RDT (Standard Diagnostics Bioline©, South Korea) used is an immunochromatographic test that detects the histidine-rich protein 2 (HRP-2) of P. falciparum. Following the manufacturer's instructions, a drop of blood (50 µL) was placed in the reaction well of the test device, then dilution buffer was added. The sample migrated along the test strip and the results were interpreted after 15 minutes. The appearance of a band in the "control zone" validated the test, while an additional band in the "test zone" indicated a positive result for P. falciparum. A HemoCue® Hb 301 automatic hematology analyzer (HemoCue® AB, Ängelholm, Sweden 2020) was used to measure hemoglobin levels. The principle of this measurement is based on spectrophotometric determination (at 570 nm and 880 nm) of the absorbance of turbidity resulting from the transformation of hemoglobin into azidemethhemoglobin after lysis of red blood cells. To do this, a microcuvette loaded with a drop of blood was inserted into the device; the system analyzed the sample photometrically, then displayed the results almost instantaneously on the screen, indicating the hemoglobin concentration in g/dL. This method provides fast, accurate results for monitoring hemoglobin levels in the blood.

Infection with the various plasmodial species was detected by microscopy on a thin smear and a thick drop. For the thick drop, slides were immersed in a solution of Giemsa for 10 to 15 minutes, then carefully rinsed and air-dried. The thin smears, spread out and fixed in methanol, were also stained with Giemsa for further analysis. Microscopic examination of the thick drop began with low magnification, followed by high magnification, enabling Plasmodiums to be identified on the ba-

sis of their characteristic shapes (rings, trophozoites, gametocytes) within the red blood cells. Examination of the thin smears enabled Plasmodium species to be identified on the basis of their distinctive morphologies.

2.5. Operational Definitions

The following operational definitions were used in this study:

- Malaria infection in parturients was defined by a composite indicator, including infections detected by a rapid diagnostic test (RDT) targeting the P. falciparum HRP2 antigen or by microscopic examination of a thick drop of blood.
- Maternal anemia was defined as hemoglobin (Hb) < 11 g/dL for pregnancies of 28 weeks' amenorrhea (WA) or more, and hemoglobin < 10.5 g/dL for second-trimester pregnancies.
- Preterm delivery (PD) was defined as a delivery between 28 and 37 weeks' amenorrhea.
- Primiparity was defined as the first parturition, secondiparity as the second parturition, and multiparity as three or more parturitions.

2.6. Statistical Data Analysis

Statistical analyses were carried out using R software version 4.4.1. Categorical variables were summarized in the form of frequencies and percentages. Calculations of the mean with standard deviations and the median with extremes were performed for quantitative variables. To measure the strength of association between variables, we calculated odds ratios (OR) and their 95% confidence intervals (CI). Hemoglobin levels were compared between two groups (malaria present/absent) using the Wilcoxon test. Distributions were tested for normality using the Shapiro-Wilk test. Logistic regression models were used to identify the various factors associated with maternal anemia. The final model was selected using Akaike's information criterion (AIC) with a "forward" and "backward" approach. A p-value < 0.05 was considered statistically significant.

2.7. Ethical Considerations

This study had been approved by the National Health Ethics Committee, under number 558/CNES/BN/PMMF/2024. Free and informed consent was obtained and an identifier was assigned to all participants. The study was conducted in compliance with the ethical principles set out in the Declaration of Helsinki and in accordance with good clinical and laboratory practice.

3. Results

3.1. Socio-Demographic Characteristics and Clinical Status of Participants

At admission, 246 parturients were eligible during the study period. However, only 199 were retained due to data availability. Table 1 and Table 2 present the

socio-demographic and clinical characteristics of the parturients included in the study. The results show that the majority of parturients were aged between 20 and 34 years (74.4%), with an average age of 28.3 ± 6.4 years. Most had attained secondary education (72.4%), while 18.6% were illiterate. More than half of parturients (51.3%) were housewives. Obstetrically, the majority of women went into labor with a gestational age of between 37 and 41 weeks' amenorrhea (84.4%), while 13.6% delivered prematurely (<37 WA). Over half the parturients were multiparous (59.8%).

A review of medical records revealed that 68.8% of women had attended at least three antenatal clinics (ANC), while 12.6% had had no medical check-ups at all during their pregnancy. Three quarters (75.9%) reported fever during pregnancy. With regard to the use of malaria prevention measures, 64.9% of women reported having a long-acting insecticide-treated net (LLIN). However, only 28.1% used it systematically (7 days/7), while 35.2% said they never used it. When it came to intermittent preventive treatment (IPT) with Sulfadoxine-Pyrimethamine (SP), around 62.8% of women claimed to have received no dose at all, while only 9% had received the recommended three doses.

3.2. Prevalence of Anemia and Malaria at Delivery

Overall, Plasmodium spp. were detected by RDT in 29 out of 199 participants and by thick drop in 7 out of 199, giving an estimated malaria prevalence of 18.1% [95% CI 13.1; 24.3] at the time of delivery (**Figure 1(A)** and **Figure 1(B)**). Two species of Plasmodium spp. were identified at thin smear among infected participants, notably P. falciparum as the most prevalent species (85.7% [95% CI 42.0; 99.2]) followed by P. malariae (14.3% [95% CI 0.75; 57.9]) (**Figure 1(C)**). Overall, 74.6% of women had been diagnosed with malaria during pregnancy (**Figure 1(D)**). The median hemoglobin level at delivery was statistically different according to malaria status: 11.2 g/dL (8.3 - 13.9 g/dL) in parturients with malaria versus 11.9 g/dL (8.1 - 14.1 g/dL) in parturients without malaria, with p = 0. 0028 (**Figure 1(E)**) and the median overall hemoglobin level was 11.8 g/dL, with extremes ranging from 8.1 g/dL to 14.1 g/dL. This allowed us to estimate the prevalence of maternal anemia at 21.1% [95% CI 15.8; 27.6] (**Figure 1(A)**).

3.3. Factors Associated with Maternal Anemia

Table 3 on the Multivariate logistic regression modeling showed that maternal anemia was independently influenced by several factors, including the parturient's level of education and medical history. Thus, illiteracy and diagnosis of malaria during pregnancy proved to be significant factors multiplying the risk of anemia by 2.5 for the former (aOR = 2.5 [95% CI 1.1; 5.9]; p = 0.035) and by 4 for the latter (aOR = 4.3 [95% CI 1.9; 9.9]; p < 0.001) in the women concerned. Furthermore, preterm delivery (<37 weeks' amenorrhea) was found to be a consequence significantly associated with anemia (adjusted OR = 3.7 [95% CI 1.4; 9.1]; p =

0.006). In contrast, prevention of malaria during pregnancy showed no statistically significant association with anemia ($p > 0.05$).

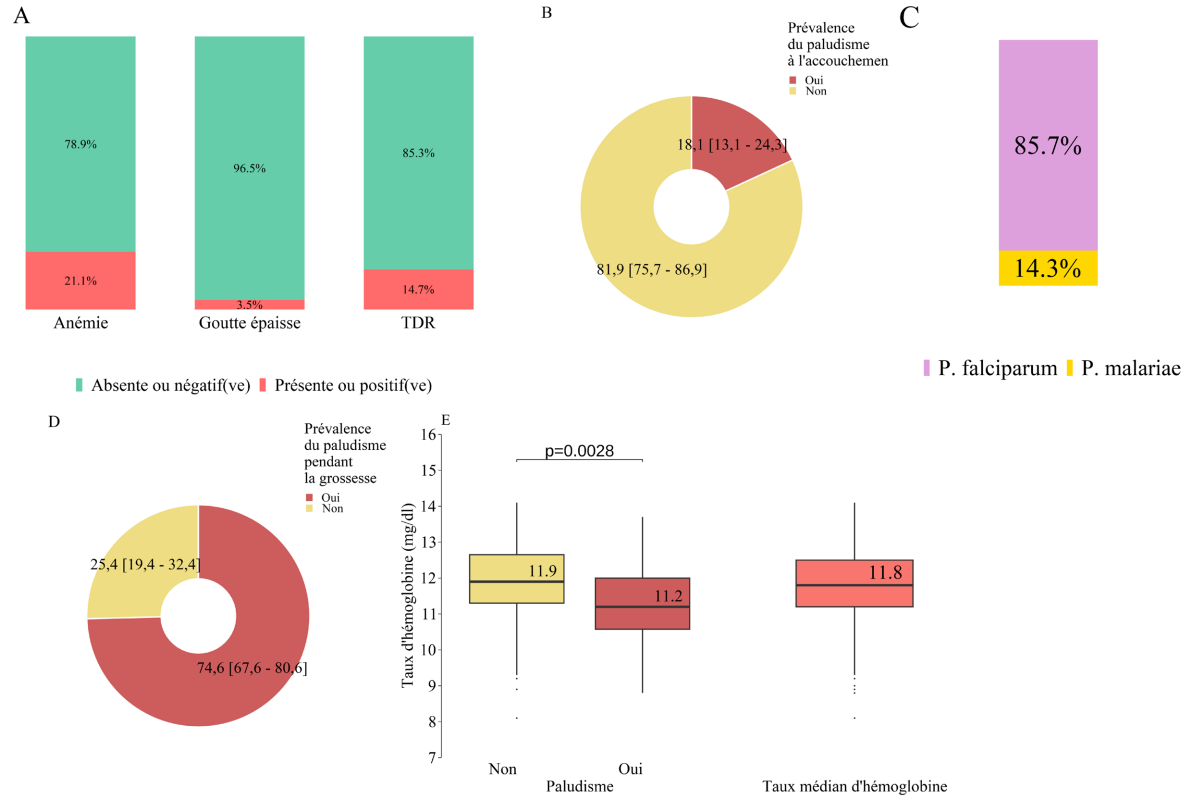

Figure 1. Prevalence of maternal anemia and malaria.

Table 1. Socio-demographic characteristics of parturients at inclusion.

Characteristics	n	%
Age (years)		
< 20	11	5.5
20 - 34	148	74.4
≥ 35	40	20.1
Mo Average ± Standard deviation	28.3 ± 6.4	
Level of education		
Illiterate	37	18.6
Primary	18	9.1
Secondary	144	72.4
Profession		
Household	102	51.3
Self-employed	66	33.2
Salaried	31	15.6

Table 2. Clinical (Anamnestic) characteristics of parturients at inclusion.

Chracteristics	n	%
Gestational age (WA)		
<37	27	13.6
37 - 41	172	86.4
Parity		
Primiparous	43	21.6
Secondiparous	37	18.6
Multiparous	119	59.8
Median (Min - Max)	3 (1 - 12)	
Number of ANC follow-up visits		
None	25	12.6
1 - 2 ANC visits	37	18.6
3 or more ANC visits	137	68.8
Median (Min - Max)	3 (0 - 10)	
Fever during pregnancy		
No	48	24.1
Yes	151	75.9
Using LLIN		
No	70	35.1
Yes	129	64.9
Frequency of LLIN use (in a week)		
Never	70	35.2
Rarely (less than 7 days/month)	12	6.0
Often (less than 7 days/week)	61	30.7
Always (7 days/7)	56	28.1
IPT to MS		
No	125	62.8
Yes	74	37.2
Number of SP doses		
0	125	62.8
1 - 2	56	28.1
≥ 3	18	9

Table 3. Logistic regression models identifying factors associated with maternal anemia in the study population.

Characteristics	Hb < 11 g/dl	Hb≥ 11 g/dl	OR goal [CI 95%]	p	OR adjusted [CI 95%]	P
	n (%)	n (%)				
Age (years)						
<20	4 (9.5)	17 (10.8)	0.9 [0.2; 2.5]	0.807		
≥20	38 (90.5)	140 (89.2)				
Education level						
Illiterate	13 (31.0)	24 (15.3)	**2.5 [1.1; 5.4]**	**0.023**	**2.5 [1.1; 5.9]**	**0.035**
Educated	29 (69.0)	133 (84.7)				

Continued

Gestational age (WA)						
<37	12 (28.6)	15 (9.6)	**3.8 [1.6; 8.9]**	**0.002**	**3.7 [1.4; 9.1]**	**0.006**
37 - 41	30 (71.4)	142 (90.4)				
Parity						
Primiparous	7 (16.7)	36 (22.9)	0.7 [0.3; 1.6]	0.383		
Secondiparous and multiparous	35 (83.3)	121 (77.1)				
ANC follow-up						
≤1	6 (14.3)	28 (17.8)	0.7 [0.3; 1.9]	0.588		
≥2	36 (85.7)	129 (82.2)				
Fever during pregnancy						
Yes	37 (88.1)	114 (72.6)	2.8 [1.1; 8.5]	0.044		
No	5 (11.9)	43 (27.4)				
Malaria during pregnancy						
Positive	33 (78.6)	105 (73.4)	**1.3 [0.6; 3.1]**	**0.502**	**4.3 [1.9; 9.9]**	**<0.001**
Negative	9 (21.4)	38 (26.6)				
Malaria at delivery						
Positive	15 (35.7)	21 (13.4)	3.6 [1.6; 7.9]	0.001		
Negative	27 (64.3)	136 (86.6)				
IPT/SP						
Less than 2 doses	29 (69.0)	114 (72.6)	0.8 [0.4; 1.8]	0.648		
2 doses or more	13 (31.0)	43 (27.4)				
LLIN/pregnancy						
Less than 7 days/week	30 (71.4)	113 (72.0)	1.0 [0.5; 2.1]	0.944		
7days/7(always on LLIN)	12 (28.6)	44 (28.0)				
Occupation						
Housewife	20 (52.4)	82 (52.2)	0.8 [0.4; 1.7]	0.596		
Working	22 (47.6)	75 (47.8)				

4. Discussion

The aim of this study was to determine the prevalence of maternal anemia and identify associated factors in pregnant women in a malaria-endemic area.

4.1. Prevalence of Maternal Anemia and Malaria

This study enabled us to estimate the prevalence of maternal anemia and malaria at delivery in parturients admitted to the above-mentioned maternity hospitals. The prevalence of maternal anemia was 21.1% [95% CI 15.8; 27.6] and that of maternal malaria was 18.1% [95% CI 13.1; 24.3], with Plasmodium falciparum the most prevalent species at 85.7%. These results confirm that maternal anemia and

malaria remain a major, persistent public health problem among pregnant women living in areas with stable malaria transmission [9] [10]. At least these prevalences are lower than those reported by other studies, such as Doumbo in Mali with a rate of 44.5% anemia and 52% malaria; the prevalence of anemia was 33% in the Vindhya series in India, it varied between 11 and 63% in the Bihoun series, depending on the degree of placental malaria infestation, and Oumaro reported a maternal malaria prevalence of 36.5% [21]-[24]. The prevalence of anemia was very high, at 76% in the Likilo *et al.* series in Kisangani [8]. In contrast, other studies have reported low prevalences of maternal malaria: Bamba with 4.7% in Burkina Faso; 7.2% in the Massamba series in the Republic of Congo; and Mudji who reported 9.7% malaria with 63% maternal anemia in Vanga, Kwilu [13] [20] [25]. Our results are superior to those of Kayiba *et al.* in Kinshasa, who reported a prevalence of 10.8% malaria and 14.9% maternal anemia [19]. These observed differences can be attributed to several factors, including geographical, environmental and nutritional variations or disparities, the study methodologies used, but also the effectiveness of malaria prevention and control programs in other settings, notably the distribution of insecticide-treated mosquito nets, intermittent preventive treatment with Sulfadoxine-pyrimethamine and iron and folic acid supplementation during pregnancy [7] [8] [14] [20] [22] [25]. Plasmodium falciparum remains the most common species in areas of stable transmission, especially in pregnant women, due to its affinity with placental tissue [26] [27].

4.2. Characteristics and Clinical History of the Study Population

The majority of participants were aged between 20 and 34 (74.4%), with an average age of 28. Women with secondary education were the most represented (72.4%), and most were multiparous (59.8%). Our results are similar to those of Biaou, who reported an average age of 27 years, with the majority being pauciparous (multiparous) [21] [28], but differ from those of Oumaro in Niger with regard to educational level, with a high proportion of illiterate women (67.5%) [24]. Bamba reported an average age of 26 years, with the majority being uneducated (41.5%) [25]. In contrast, in Doumbo's series, adolescents were the most represented with 28% [21]. The similarity of average age in most studies is explained by the fact that these are women of childbearing age, and the differences are explained by early marriage in some remote areas with a lack of education for girls; our study was carried out in the city, where girls' studies are becoming increasingly encouraged. Over 68% of women had undergone at least 3 ANCs, a rate of 72% of 4 or more ANCs was reported in the Biaou series [23], while in the Oumaro study, only 26% had undergone 3 ANCs [24].

Nearly 65% used LLINs, the same trend was observed in the Doumbo study (62%) [21], the regular use of insecticide-treated nets is the main large-scale preventive measure against malaria, particularly in regions where the endemic is high, this rate of use is superposable on ANC attendance (68%) because it is during these sessions that LLINs are distributed, although their use is often abused in

most cases [20].

The IPTg-SP coverage rate was 37.2%, but only 9% of participants had received at least 3 doses of SP. This IPT coverage rate is significantly lower than those reported by other studies: 64, 8% and 22% for 3 doses; 80% and 13% for 3 doses; 31-34% for 3 doses and Mudji who reported 80% coverage with an average number of doses at 2.5 [13] [20] [24] [28]. The 2023-2024 Demographic and Health Survey reported a 3-dose SP coverage rate of 16% for the whole province of Kasaï-Oriental. According to the same survey, ours is higher than that of Tanganyika province (7.8%) [15]. Differences in national malaria control program (NMCP) policies may explain these disparities. For example, some peripheral health zones are well supported compared with those in the city center, but overall IPT coverage remains very low in our area. More than three quarters (75.9%) of parturients mentioned a history of fever during pregnancy; several studies report that fever is the most common sign of malaria in endemic areas, and also contributes to maternal anemia [19] [23] [24].

4.3. Factors Associated with Maternal Anemia in Malaria-Endemic Areas

Lack of education (illiteracy) and history malaria during pregnancy were factors associated with maternal anemia, and preterm delivery was a direct consequence, underlining the impact of anemia on perinatal health. Pregnancy makes women vulnerable to malaria infection, exposing them to anemia and death; Plasmodium falciparum can localize in the placenta and contribute to maternal anemia even in the absence of parasites in peripheral maternal blood [11]. Malaria in pregnant women is characterized by maternal anemia, and preterm delivery is one of the consequences [19] [25] [28].

IPT is not only an effective but also, and above all, an inexpensive means of preventing malaria-related maternal anemia. Numerous studies have shown the benefit of IPT and LLIN in the prevention of placental malaria and its effects on maternal anemia and birth weight [19]-[21] [24] [25] [28]. On the other hand, we did not note any impact of IPT-SP on maternal anemia in this study. Our results concur with those of Labama in Kisangani [18], but contrast with those of Kayiba, who noted a beneficial effect of IPT-SP on maternal anemia and preterm delivery in Kinshasa, although the prevalence of maternal malaria was not reduced by this prevention; This could be explained by the emergence of Plasmodium falciparum resistance to sulfadoxine-pyrimethamine [19] [29]. It should be noted, however, that we reported a very low IPT coverage rate to assess the benefit, and also, the notion of iron-folate supplementation was not taken into account in this study due to a lack of reliable data. Nevertheless, these results suggest a reassessment of these measures in settings endemic to Plasmodium falciparum, which is clearly becoming increasingly resistant to antimalarial drugs.

5. Conclusion

The results of our study show that anemia is a major problem among pregnant

women in Mbujimayi, significantly influenced by the low level of education, and that malaria is the major source of anemia in an environment endemic to Plasmodium spp. Maternal anemia thus adds to perinatal morbidity through the prematurity associated with it. On the other hand, the emergence of resistance to SP and other antimalarial drugs, which has yet to be demonstrated in our environment but has already been documented in other parts of the country, would threaten the hopes placed in this preventive method

6. Recommendations

In the light of these results, we recommend:

- That the government strengthen the universal health coverage program, revitalize the national malaria control program (NMCP), especially in malaria-endemic regions such as Kasai-Oriental province, and provide ongoing training for healthcare providers in the monitoring of pregnant women;
- That healthcare providers educate pregnant women about good habits for preventing malaria and anemia, and provide high-quality care;
- That women of childbearing age consult healthcare facilities at the first sign of pregnancy for proper monitoring and adhere to various malaria prevention measures, including the judicious use of LLINs, IPT, and iron and folic acid supplements.

Conflicts of Interest

The authors declare no conflict of interest in relation to this article.

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