Evaluation of the adhesion of pregnant women to intermittent presumptive treatment with Sulfadoxine-Pyrimethamine in a rural area of Gabon.

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Research Article

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Abstract

**Background:** Gestational malaria remains one of the most complex forms of malaria. To fight it, several African countries adopted intermittent presumptive treatment with Sulfadoxine-Pyrimethamine (IPT-SP) and the use of preventive measures such as insecticide-treated bed nets (ITNs), indoor residual sprays (IRS) and popular education on good practices to fight against malaria. In Gabon, a country of central Africa, no study has investigated the use of IPT-SP in rural areas since its implementation. The aim of this study was to investigate the adhesion level of pregnant women to IPT-SP, coverage of ITNs and IRS, and knowledge on the good practices about malaria in a rural area of Gabon.

Using a questionnaire, we led a retrospective study including pregnant women from January 5th 2016 to January 31st 2018 and a cross-sectional survey including women seen for antenatal care and all febrile patients in consultation from February 2nd to May 31st 2018. Malaria was diagnosed using rapid diagnostic tests. Statistical analyses were done.

**Results:** We included 607 pregnant women before their delivery. Women between 20 and 25 years old were the most prevalent (37.26%, n=229). Among them, 74.53% were unemployed and 47.21% living in the villages surrounding the rural town of Fougamou. The rate of adhesion to IPT-SP was 94.37% (n=573). Among them, 47.8% (n=274) had received 3 doses of IPT. Among the pregnant women included during the cross-sectional survey, only 8.7% (n=14) were infected with *Plasmodium*. Bed nets were used by 80.12% (n=129) of women.

**Conclusion:** Data showed a near complete adhesion of IPT-SP in the rural area of Fougamou. Clinical trials are needed to investigate the efficacy of IPT-SP and antimalarial drug markers.

Introduction

In 2016, the global count of malaria reached 212 million cases and 429 000 deaths among which more than half were recorded in sub-Saharan Africa [1]. Pregnant women are among the most vulnerable individuals to malaria, with children under five years old and non-immunized travelers [2].

During pregnancy, women must tolerate the fetus, which carries 50% of the father’s genetic material [3], they are therefore prone to immune suppression. This situation increases the risk of susceptibility to infectious pathogens, such as *Plasmodium falciparum* [4–6]. Gestational malaria is often externalized by hyperthermia, which is related to parasitemia. Susceptibility to malaria decreases with the number of pregnancies [7], suggesting the acquisition of a specific immunity directed against this pathology [8–10]. Anemia is common during pregnancy [11, 12], it affects primiparae more than multiparae. Cerebral malaria is not frequent among pregnant women in areas of high transmission, both in multiparae and primiparae.

One of the pathophysiological factors of gestational malaria is placental sequestration of parasitized red blood cells [13]. Numerous studies have shown that this preferably occurs through the cytoadherence of
parasitized red blood cells on placental syncytiotrophoblasts via Chondroitin Sulfate A [14]. Thus, the placenta behaves like a niche concentrating parasitized red blood cells, called CSA cytoadherence phenotypes [15, 16]. The consequences of gestational malaria are therefore increased morbidity and mortality in pregnant women [17]. For fetuses, placental infection leads to spontaneous abortions, in utero growth delays, and children born with low weight [18–21].

To prevent placental malaria, WHO recommends the use of intermittent presumptive treatment with Sulfadoxine-Pyrimethamine (IPT-SP), in addition to the use of insecticide-treated bed nets (ITNs). However, in 2014, among the 28 million pregnant women registered, 15 million pregnant women had not received IPT-SP [22]. Moreover, among the pregnant women who had received IPT-SP, 50% had received one dose, 35% two doses and only 15% had received at least three doses.

In Africa, the Sulfadoxine-Pyrimethamine (SP) therapeutic combination was adopted in most countries. However, these two molecules are subject to *P. falciparum* resistance. Pyrimethamine resistance is the result of mutations in codons 16, 51, 59, 108, 164 of the *P. falciparum* Dihydrofolate Reductase (*PfDHFR*) gene [23–25], while mutations in codons 436, 437, 540, 580 and 613 of the *P. falciparum* Dihydropteroate synthase (*PfDHPS*) gene generate resistance to sulfadoxine [26].

In Gabon, IPT based on SP in pregnant women was adopted in 2003. As a result, the prevalence of *P. falciparum* infection declined among pregnant women both in urban and rural areas [27].

The aim of this study was to determine the level of adhesion of pregnant women to IPT-SP in the rural area of Fougamou, Gabon.

**Methods**

**Area and study population**

The study was conducted in a Gabonese semi-urban town named Fougamou located in the Ngounié province, in the western central part of Gabon. Fougamou is the chief town of the Tsamba-Magotsi department, as such, its hospital receives patients from villages throughout the department.

The study population was composed of pregnant women who received antenatal care at the maternity of the Fougamou medical center. The women met the following criteria: they had been seen in consultation at the maternity ward and had been entered in the consultation registers. Women who did not fill the criteria were excluded from the study.

**Study Design And Sampling Collection**

We conducted a prospective study from February to May 2018 at the maternity of the Fougamou medical center. Retrospective data from 2018 to January 2018 from maternity registries were also included in this study. Blood samples from the pregnant women were collected in ethylene diamine tetra acetic acid (EDTA) tubes during the prenatal consultation after the pregnant women gave their informed consent.
Questionnaire Interview And Ethical Consideration

An interview based on a questionnaire was given to all the participants. The questionnaire included questions on socio-demographic data (age, education and family income/month), medical history and clinical data (the number of IPT-SP doses taken). Data on their use of IPT-SP, their use of ITNs, indoor residual sprays (IRS) and their knowledge, attitudes and practices regarding malaria were collected.

This study was approved by the Gabonese national committee of ethics and registered under PROT 0020/2015/SG/CNE; it was performed in accordance with the principles of Committee. To ensure their voluntary participation, an informed consent form was signed by all the participants.

Malaria Diagnosis

The Optimal-IT® rapid diagnostic test was used. The sensibility and specificity of the tests were 94 and 97 % [28]. Previous work in Gabon showed that this test is a good tool to diagnose malaria [29]. Parasite load was determined on blood smears using the Lambarene method [30]. All blood smears were read by two independent technicians and quality control was done for 10 % of slides by a third reader. Fever and P. falciparum infection (1000 parasites per µl of blood) were considered as malaria.

Statistical analysis

Statistical analysis was performed with the use of Stat view 5.0 1992–1998 (SAS Institute, Cary, USA). A chi-square test was used to compare quantitative variables among groups.

The average values of the qualitative variables were compared by the Student’s t-test. Quantitative variables were compared by the chi-square test and when the numbers were lower than 5, Fisher's exact test was used. The threshold of significance was established for \( \alpha = 5\% \).

Results

Study population

During the study period, 607 pregnant women were received in prenatal consultation in the medical center of Fougamou. The general characteristics of the women are described in Table 1. Unemployed pregnant women were the most numerous (60.9%), then came high school students and employed pregnant women (\( p < 0.001 \)). The proportion of women aged between 20–25 years (37.7%) was significantly higher than the proportion of women of the other age groups (\( p < 0.001 \)). The proportion of women aged between 20–25 years was similar to the proportion of women aged between 26–30 years (19.9%) and 31–35 years (16.0%) (\( p > 0.05 \)). Hematological values were normal. The interval between the prenatal consultations was of 1 month.
The level of adherence was analyzed from 427 women who gave birth in the Fougamou medical center. Ninety-four percent (94.4%; n = 403) of women included in the study had taken at least one dose of IPT-SP and 3.3% (n = 14) had not taken the treatment. This information was unavailable for 10 women. There was a significant difference between women who took the treatment and women who did not take IPT-SP (p < 0.05). The prevalence of women who took 1 dose (16.1%; n = 65) of IPTp-SP was significantly lower than the prevalence of women who took 2 doses (29.5%; n = 119) and 3 doses (47.9%; n = 193) of IPT-SP.

### Table 1: Socio demographical and biological characteristics of included pregnant women.

<table>
<thead>
<tr>
<th>General parameters</th>
<th>Pregnant women included</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age ± SD (month)</td>
<td>309.5 ± 80.4</td>
</tr>
<tr>
<td>Hemoglobin (g/dl)</td>
<td>9.7 ± 2.1</td>
</tr>
<tr>
<td>*WBC (x 10^3/μl)</td>
<td>6.2 ± 2.6</td>
</tr>
<tr>
<td>**RBC(x 10^6/μl)</td>
<td>4.1 ± 0.8</td>
</tr>
<tr>
<td>Platelet (x 10^3/μl)</td>
<td>159.7 ± 60.1</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Age groups (years) ; % (n)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>14-19</td>
<td>16.1% (98)</td>
</tr>
<tr>
<td>20-25</td>
<td>37.7% (229)</td>
</tr>
<tr>
<td>26-30</td>
<td>19.9% (121)</td>
</tr>
<tr>
<td>31-35</td>
<td>16.0% (97)</td>
</tr>
<tr>
<td>36-40</td>
<td>6.6% (40)</td>
</tr>
<tr>
<td>&gt;40</td>
<td>3.6% (22)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Profession (N= 604)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Student high school</td>
<td>25.2% (152)</td>
</tr>
<tr>
<td>Employed</td>
<td>13.9% (84)</td>
</tr>
<tr>
<td>unemployed</td>
<td>60.9% (368)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parity (N=603) ; % (n)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>large multipara***</td>
<td>6.8 (41)</td>
</tr>
<tr>
<td>Multipara</td>
<td>48.6% (293)</td>
</tr>
<tr>
<td>Nullipara (Primigravidae)</td>
<td>24.9% (150)</td>
</tr>
<tr>
<td>Primipara</td>
<td>19.7% (119)</td>
</tr>
</tbody>
</table>

*White blood cell, ** Red blood cell, *** More than 4 deliveries.

### Level Of Adherence To IPT-SP Treatment

The level of adherence was analyzed from 427 women who gave birth in the Fougamou medical center. Ninety-four percent (94.4%; n = 403) of women included in the study had taken at least one dose of IPT-SP and 3.3% (n = 14) had not taken the treatment. This information was unavailable for 10 women. There was a significant difference between women who took the treatment and women who did not take IPT-SP (p < 0.05). The prevalence of women who took 1 dose (16.1%; n = 65) of IPTp-SP was significantly lower than the prevalence of women who took 2 doses (29.5%; n = 119) and 3 doses (47.9%; n = 193) of IPT-SP.
The prevalence of women who took 2 doses of IPT-SP was significantly lower than the prevalence of women who took 3 doses (p < 0.001). Two women (2.1%; n = 2/96) had received IPT-SP between the first and 15th week of amenorrhea (WA). In addition, the majority of women who had not received a dose of IPT-SP were those with one to 25 WA.

**Plasmodium characterization**

The overall prevalence of *Plasmodium* infection was 11.7% upon blood smear examination (n = 67/508). The mean values of parasitemia were calculated based on the 67 pregnant women with positive thick films. Mean parasitemia was low at 1052 (33–19,880) p/IL of blood. We found that 100% of infections were due to *P. falciparum*. Table 2 shows that *Plasmodium*-infected women were less old than uninfected women (p < 0.05). Figure 1 shows that the proportion of *Plasmodium*-infected women aged between 14–19 years (22.8%) was significantly higher than the proportion of *Plasmodium*-infected women aged between 20–25 years (11.0%), 26–30 years (8.8%), 31–35 years (7.6%) and 36–40 years (7.9%) (p < 0.05). The Kruskal–Wallis test showed a significant difference in mean parasitemia according to age groups (p = 0.02). The mean values of red blood cell were significantly lower in infected women than uninfected women (p < 0.01) whereas white blood cells were higher in infected women than uninfected women (p = 0.0007).

**Influence of IPT-SP treatment on plasmodial infection.**

In this study, 29.9 % (n = 20/67) of women having received at least one dose of IPTp-SP were infected by *P. falciparum* with a mean parasitemia of 229 (33-19880) p/µL. Among the *Plasmodium*-infected women (Fig. 2), the prevalence of women who took 3 doses of IPTp-SP (5.0%; n = 1/20) was not significantly different than the prevalence of *Plasmodium*-infected women who took 1 dose (50.0%; n = 10/91) and 2 doses (45.0%; n = 9/20) of IPT-SP (p > 0.05).

**Influence Of Parity On Plasmodial Infection**

In this study, multipara women (48.6%) were more represented than other women (grand multiparae, nulliparae and primiparae) (P < 0.001) (Table 1). *Plasmodium*-infected nulliparae (primigravidae) (38.8%; n = 26/67) were more represented than *Plasmodium*-infected multiparae (34.2%; n = 23/67) and the other *Plasmodium*-infected women [primiparae (22.4%; n = 15/67) and grand multiparae (4.5%; n = 3/67) (P < 0.05)].

*Plasmodium*-infected multiparae (35.0%; n = 7/20) and *Plasmodium*-infected nulliparae (primigravidea) (30.0%; n = 6/20) having received at least one dose of IPT-SP were more represented than *Plasmodium*-infected primiparae (25.0%; n = 5/20) and *Plasmodium*-infected grand multiparae (10.0%; n = 2/20), but without statistical significance (p > 0.05).

**Preventive Measures**
We analyzed the patients’ use of preventive measures (Table 2). The overall coverage of bed nets was 68.2% (n = 413/606). The proportion of insecticide house spray use was 44.7% (n = 268/600) and the proportion of pregnant women showing essential information on malaria was 74.3% (n = 437/588). Univariate and multivariate analysis showed no association between the use of preventive measures and malaria infection (p > 0.05). The use of preventive measures had no preventive effect in pregnant women without and with malaria.

Table 2: Socio demographical and biological characteristics of uninfected versus infected pregnant women.

<table>
<thead>
<tr>
<th></th>
<th>Uninfected versus infected pregnant women</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Uninfected</td>
<td>Infected</td>
</tr>
<tr>
<td>Mean age ± SD (month)</td>
<td>312.7 ± 79.6</td>
<td>284.1 ± 80.5</td>
</tr>
<tr>
<td>Hematological parameters</td>
<td></td>
<td>n = 64</td>
</tr>
<tr>
<td>Hemoglobin (g/dl)</td>
<td>9.8 ± 2.0</td>
<td>9.1 ± 2.5</td>
</tr>
<tr>
<td>*WBC (x 10^9/μl)</td>
<td>6.2 ± 2.4</td>
<td>6.6 ± 3.5</td>
</tr>
<tr>
<td>**RBC (x 10^6/μl)</td>
<td>4.1 ± 0.8</td>
<td>3.8 ± 0.9</td>
</tr>
<tr>
<td>Platelet (x 10^9/μl)</td>
<td>161.3 ± 60.7</td>
<td>147.4 ± 54.3</td>
</tr>
</tbody>
</table>

| Prevention measures           |                                          |               |
| Bed net                       | 67.5 (342)                               | 68.7 (46)     | 0.84  |
| Insecticides                  | 42.9 (216)                               | 44.8 (30)     | 0.78  |
| Received an IEK on malaria*** | 77.1 (380)                               | 73.4 (47)     | 0.52  |

*White blood cell, ** Red blood cell; ***IEK: Information, education and knowlegment on malaria.

Discussion

Gestational malaria remains a major public health problem since it leads to severe risks for the mother, the fetus or the newborn child. This study investigated the epidemiology of malaria in Gabon and estimated the level of adherence to IPT-SP in pregnant women. We noted an average of about 200 deliveries per year, which represents between four and five deliveries per week and is representative of the low demography of Fougamou.
The mean age of the pregnant women in our study was about 25.8 ± 6.7 years. This result is consistent with previous data from rural areas in Burkina Faso, in Benin and in the capital of Gabon, Libreville, and its surroundings, in 2011 [31–33]. In Gabon, this data highlights the fact that there does not seem to be a significant difference in the distribution of age of the pregnancy between urban and rural areas.

In this work, we noticed that nearly half of the women included in the study lived in villages. The rural context of Fougamou is confirmed by the socio-demographical factors (a majority of women were unemployed).

However, the analysis of the hematological parameters revealed a good general health state, suggesting an efficient medical follow-up of these women.

The excellent level of adhesion to IPT-SP consolidates this hypothesis. Previous data from Gabon showed that the level of adherence to IPT-SP was very high, resulting in a minimization of the consequences of malaria associated with pregnancy [34]. In other African countries such as Kenya or Burkina Faso, similar results were reported [35–37]. The level of adherence to IPT-SP in our study was 94.4%. This proportion is higher than the value previously reported in Libreville and in Burkina Faso [31, 37]. This result in Fougamou fits the goal set by OMS, which aimed to have 80% of women receive at least 2-doses of IPTp-SP during pregnancy.

Although the national directive indicates that pregnant women have to receive at least 3 doses of IPT-SP, in this study, we found that women received a maximum of 3 doses, which is an erroneous reading of the national directive. In this study, the proportion of women having received IPT-SP during the first quarter of pregnancy is similar to that observed in Libreville where 5.9 % of the women had received IPT-SP in the first quarter. After delivery, half the women had received 3 doses of IPT-SP.

Data showed that the majority of women without IPT-SP were between one and 25 weeks of amenorrhea, which could suggest a late start in their antenatal care. This observation is revealing of the rural context of Fougamou. The time between consultations confirms the high attendance of women to prenatal visits in Fougamou, which ranged from one to nine visits.

The low prevalence of plasmodial infection observed in our study could be a consequence of the adherence of women to IPT-SP. Moreover, nulliparae (primigravidae), without IPT or under IPT, remain the most exposed to malaria. Similar results were observed in Burkina Faso, in Benin, in Malawi and in Gabon [31, 33, 38–41]. This could be explained by the fact that multigravidae develop, over subsequent pregnancies, a protective immunity against placental malaria infection. These women develop antibodies which are able to specifically inhibit the cytoadhesion on Chondroitin Sulfate A [42–44]. The more women age and have parity, the more they are protected from malaria.

The overall malaria rate in women having benefited from IPT-SP obtained in our study is similar to the rates of malaria infections reported in Burkina Faso, in Mali, in Kenya and in Malawi [39, 41, 45–47]. However, lower rates than ours were reported in Burkina Faso in 2013 (4.7 %) and in Benin (4,1 %) [33, 37].
The low prevalence of plasmodial infection observed in this study could also be a consequence of adhesion to other recommended malaria prevention measures. Indeed, an overall coverage rate in bed nets of about 70% was observed. This very high coverage rate could have reduced the development of plasmodial infection. Several studies reported the association of IPT-SP and the use of bed nets to protect women against plasmodial infection during their pregnancy [48, 49]. However, this rate contrasts the women's knowledge on malaria because during the questionnaire only 74.3% of the women answered the three questions which define the level of knowledge on malaria correctly (What is malaria? How can you avoid it? How does it manifest itself?). These data suggest that women follow IPT without a clear understanding of its role and might indicate that the impact of public health messages is erroneous.

The positive impact of IPT-SP in pregnant woman is confirmed in this study by the fact that all the pregnant women infected by \textit{P. falciparum} were asymptomatic and that the average parasitemia was low. This is consistent with previous data indicating that in areas of stable transmission, plasmodial infection in pregnant women is often asymptomatic [50].

**Conclusion**

This study shows that almost all women giving birth in the Fougamou medical center receive at least one dose of IPT-SP during their pregnancy. About 80% of them were 14 to 30 years old with a peak between 20 and 25 years. We also confirm the efficiency of IPT-SP in association with preventive measures against malaria. It would be necessary to pursue these malaria control strategies in pregnant woman by looking at the impact of IPT-SP on the genetics of the parasite.

**Abbreviations**

\textbf{FGM}: Fougamou; \textbf{IPT}: Intermittent preventive treatment; \textbf{SP}: Sulfadoxine-pyrimethamine; \textbf{WHO}: World Health Organization; \textbf{WA}: Week of amenorrhea.

**Declarations**

**Ethics approval and consent to participate**: This study was approved by the Gabonese national Committee of ethics and registered under PROT 0020/2015/SG/CNE; it was performed in accordance with the principles of Committee. To ensure their voluntary participation, an informed consent form was signed by all the participants.

**Consent for publication**: All authors read the last file of this paper and agree the submission for publication

**Availability of data and materials**: The authors declare that the data will be made available after the article's acceptance and publication
Competing interests: The authors have no conflicts of interest to declare. Funding sources had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; and preparation, review, or approval of the manuscript

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Authors' contributions: FMB: conducted the study and participated in writing the paper; SMN and IPM: participated in the study and in writing the paper; PBM: coordinated the study and the writing of the paper; DTMA: participated in the study and in the data collection; JBLD: conceived and conducted the study and wrote the paper. All authors read and approved the final manuscript.

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Authors' information (optional): MMF: PhD student, IPM: PhD; MNS: PhD, PBM: PhD physician; DTMA: Master; JBLD: PhD, associate professor.

References


