The Provider's Checklist to Improve Pregnant Women Coverage by Intermittent Preventive Malaria Treatment in Mali. A Pilot Implementation Study

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Research

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Abstract

Background: Intermittent Preventive Treatment of Malaria in Pregnancy (IPTp) is a comprehensive treatment protocol of antimalarial drugs administered to pregnant women to prevent Malaria, started at the fourth pregnancy month, with at least three doses of Sulfadoxine-pyrimethamine (SP), taken as directly observed treatment (DOT) every 30 days as interval until childbirth, in combination with other preventive measures.

This paper introduces feasibility and adoption concepts as implementation research outcomes (IRO), allowing, after a defined intervention, to assess the coverage improvement by intermittent preventive malaria treatment for pregnant women attending a reference District hospital in Mali. Specifically, the purpose is to evaluate the feasibility of a reminder tool (provider checklist) to enhance pregnant women's adoption of information about IPTp-SP as immediate and sustained women practices.

Methods: The implementation strategy was based on using a reminder checklist about malaria knowledge and the recommended preventive tools. Then, the checklist feasibility was assessed during routine practices with the adoption-level about pregnant women' knowledge. Quantitative data were collected through a questionnaire distributed to a non-probability purposive sampling targeting 200 pregnant women divided into two groups before and after the checklist intervention. In contrast, the qualitative data were based on in-depth face to face gynaecologists interviews.

Results: Both the implementation research outcomes (feasibility and adoption) were satisfactory. The gynaecologists agreed of the easy use of this checklist during the routine practice with a recommendation to generalise it to other health providers. After the gynaecologist visit, a significant increase of the adoption-level about the prior knowledge and preventive tools was noticed. A total of 83% of participants were not knowledgeable about malaria disease before checklist use vs 15% after. Similarly, women's coverage to SP DOT increased from 0% to 59% after introducing the checklist and the SP intake after the visit time was highly significative in the second group. The latter reached 95% of the pregnant woman with four and eight months as gestational age, who were the most respectful of all SP future visits as theoretically scheduled.

Conclusions: We recommend generalising such a checklist reminder to improve women's knowledge about malaria prevention.

Background

Malaria is a significant public health problem affecting more than 91 countries worldwide. According to the 2019 World Malaria Report, Malaria global burden is carried in 85% by Nineteen sub-Saharan Africa and India countries. The incidence rate declined globally between 2010 and 2018[1]. However, the number of malaria cases was estimated at 228 million the year before, with 405 000 associated deaths[1].
Pregnant women and children under five years old are the most affected[2, 3]. In sub-Saharan Africa, it is estimated that 25 to 30 million women are at risk of contracting *Plasmodium falciparum* during pregnancy[4]. Among the multiple prevention strategies identified, intermittent preventive treatment (IPTp) with the sulfadoxine-pyrimethamine (SP) is recommended by the World Health Organization (WHO) in stable transmission *Plasmodium falciparum* areas as an effective intervention[5]. This intermittent preventive treatment consists of administering at least three doses of SP in pregnancy from the 4th month until delivery, with at least one month between the different doses. The SP first dose is administered to pregnant women under DOT[6]. This intervention's effectiveness as preventive treatment is proved to reduce maternal malaria episodes, maternal and fetal anaemia, placental parasitemia, low birth weight, and neonatal mortality[7, 8]. In northeastern Nigeria, due to this intervention, the prevalence of malaria parasitemia has been reduced by 40%, anaemia by 41% and low birth weight by 37%[9].

Despite improved access to antimalarial interventions, only 31% of pregnant women in 20 eligible countries had received at least three SP doses during their pregnancy in 2015[10]. Moreover, it is already known that pregnant women do not receive relevant information about the appropriate timing to take preventive malaria drugs[11].

Based on the latest Malaria report in Mali published in 2016, Malaria affects the whole country and constitutes 32% of the reasons for prior medical consultation. Health facilities and community health worker (CHW) sites have recorded more than two million confirmed cases, with a quarter of severe cases. Pregnant women and children under five are the most affected by this disease[12]. In Mali and since 2003, the IPTp with SP strategy has been implemented in both public and private sectors, in order to reduce the malaria consequences during pregnancy[13]. In 2006, the Ministry of Health introduced free IPTp with SP for pregnant women[14]. However, either progress from 15–55%, between 2013 and 2018, of pregnant women received three doses of the SP during their last pregnancy, the overall targeted coverage (80%) stays far away. Moreover, the lowest coverage is observed in Bamako District[13]. The main obstacle of using IPTp-SP highlighted the essential role of health professionals in promoting this coverage[13].

There is a need for a realistic implementation strategy to enhance the IPTp-SP coverage within this vulnerable category. Some successful implementations strategies to increase the knowledge level are: firstly, growing women's attendance to antenatal consultations visits (ANC) since most women who did not receive IPTp-SP were women who did not attend ANC[15]. ANC is the official way to get free IPTp-SP. Secondly, using a provider checklist as a reminder information tool during ANC.

However, many effective interventions in some contexts are not successful in other contexts due not to the intervention failure, but the intervention was not effectively implemented. For implementation research studies, effectiveness as an outcome remains with various explanations and creates much confusion between intervention and implementation[16]. Subsequently, our hypothesis is, in health facilities areas were satisfactory ANC recruitment rate is achieved, the reminder checklist as the intervention will have feasible and adoptive outcomes.
Thus, the purpose of our implementation study is to assess the routine practice feasibility of a reminder tool (provider checklist) in enhancing the adoption of information about IPTp-SP by pregnant women attending a reference district hospital with a high recruitment rate of ANC.

**Methods**

**Design**

This is an implementation study research using explanatory mixed methods type Quan-qual. First, we conducted an implementation strategy based on a reminder checklist (Fig. 1) about malaria knowledge and the recommended preventive tools. Then, we assessed the feasibility of such a checklist in routine practices and the adoption of the information given by healthcare providers to pregnant women as immediate and sustained women practices.

We followed the standards for reporting implementation studies: StaRI Checklist (supplementary material-2)[17].

**Outcome concepts**

**Feasibility** is defined as the extent to which the checklist can be successfully used—operationalised as a self-reminder tool that the health provider check in front of the pregnant woman to give her ten mandatory information linked to Malaria during pregnancy. Once the information is explained, the corresponding box was ticked by the gynaecologist (Fig. 1).

**Adoption** is defined for the eligible pregnant woman, who understands the given preventive message around malaria risks and prevention, as her intention to take the SP doses immediately in the drug unit before living the health facility, and schedule to return, in it, every month for the same reason until childbirth. This adoption outcome could be measured from the perspective of the provider who confirmed the useful DOT for the eligible pregnant women or retrospectively from the perspective of the organisation by seeking the SP notebook (woman ID, actual and future dates of visit, pregnancy age, dates of SP intakes) and the sustained SP next visits until childbirth by phone call, as provided in the supplementary material-3.

**Context and study site**

The study was conducted at the District Hospital of Commune VI in Bamako, located on the right side of the River Niger and is the largest commune in the District of Bamako with 94 Km². This hospital recorded a high recruitment rate in ANC enrolling 130,675 pregnant women visits during 2016–2017; for a population estimated at 611,392 inhabitants and 30,570 expected pregnant women.

**Target population**

The study was conducted between February and April 2018. The inclusions criteria were women between 15 and 49 years old with a pregnancy age of four months and more determined by the result of obstetric
ultrasound, living in the same commune of the district hospital and who came to the health facility for programmed antenatal visits.

The exclusions criteria were the non-eligibility criteria that affirmed expressing an SP allergy or side effects.

Non-probability purposive sampling was applied. All pregnant women with study eligibility criteria were recruited during the study by targeting 100 pregnant women before and 100 after the checklist intervention.

Four gynaecologists (A, B, C and D); without knowing the checklist's existence, were invited to address, after the end of the health facility visit, all eligible pregnant women to the drug unit to receive appropriate medication. If the SP is recommended, the DOT SP should be taken in front of a health professional at this unit. Then, pregnant women who wanted to participate in the study met the study investigator, who did not intervene in all the process with the unique advice to follow the pathway recommended by the health professionals. In another room respecting confidentiality, each pregnant woman who took already the drugs' prescription, was officially invited to participate in this study by providing a written consent approval before starting the face to face interview with the study investigator (The first author). All of them gave phone numbers for future follow-up calls. The full description of the implementation process is included as supplementary material-5.

Once the first hundred women were enrolled, the investigator invited the same gynaecologists to introduce the checklist provider during the ANC and continue sending eligible pregnant women in the same pathway. The second group consisted of an additional one hundred women who received the provider checklist messages during the antenatal gynaecologist consultation in addition to the first group. To increase data reliability in this study, the proportions of pregnant women recruited by each gynaecologist were identical in both phases. The 200 women selected were determined based on budgetary and time constraints, considering the days of consultations of each gynaecologist participating in the district hospital of Commune VI during the period of the study.

However, for the qualitative section, the gynaecologists' in-depth interviews were important to reach data saturation on this specific topic and get the needed answers to explain the remaining questions arising from the quantitative section's initial analysis.

**Data collection plan**

Three tools were used to collect the information before and after the introduction of the implementation strategy intervention (consisting in a provider checklist to remind the gynaecologists to share key messages about IPTp-SP with pregnant women during the antenatal visit):

- 1st Tool: A quantitative questionnaire administered to all participating pregnant women before leaving the health facility to assess physicians' newest information provided by physicians at ANCs and assess women' Malaria knowledge (supplementary material-4).
• 2nd Tool: A qualitative thematic in-depth interview guide with all the participating gynaecologists at
the end of the data collection.

The thematic guide used targeted eight questions about the usefulness and the feasibility of the checklist
provider: (1) Are there any comments about its content? (2) How can it be improved? (3) Did it allow you
to remember the information to be transmitted to the pregnant woman during the ANC? (4) In your
opinion, does the checklist help to improve the knowledge of pregnant women in the context of IPTp-SP?
(5) If such a checklist is widespread in all reference health centres, what do you think they would be the
obstacles to use it? (6) Was the transmission of the checklist messages impacting on your time? (7) In
general, what do you think, the checklist is a good experience for women's adherence and adoption to the
supervised SP? (8) Who could the best category(ies) of the health professional for its use (A
gynaecologist; a general practitioner, a midwife, a nurse in charge of the pharmacy, another profile to
specify please)?

• 3rd Tool: An observational sheet was used to document the participants' SP intake in front of a
health provider inside the health facility. The investigator checked the SP's input on the drug unit's
dispensing register at the end of each study ANC day. One year later, the investigator called by the
phone all women participating in this study to mainly check the childbirth issue, the effective date
and if they took the SP in the following months before childbirth, for how many times and so-on. All
these information are available in supplementary material-3.

Data analysis

The quantitative data were entered and analysed in the IBM statistical SPSS software version 20.0.
Pregnant women's knowledge of Malaria was analysed by classifying them into three groups; combining
the knowledge of the malaria symptom and means of prevention. The current SP intake by pregnant
women under direct observation was assessed before and after introducing the checklist. Socio-
demographic characteristics were also grouped into categories. Accurate Chi-square/Fisher tests were
performed for the use of the checklist compared to the study variables. Any association with a p-value <
0.05 was considered significant.

The quantitative improvement of knowledge about Malaria in participating women and the qualitative
information about the ease use of this checklist by gynaecologists in their routine antenatal care
practices were targeted to assess the provider checklist's feasibility.

Similarly, to assess the adoption by pregnant women of IPTp-SP information, the quantitative ratio of
pregnant women who have decided by themselves to take DOT at the drug unit before living the health
facility, and the qualitative explanation for any misunderstanding of the results such as the number of
pregnant women not being well informed, even after the use of the checklist, were analysed. Moreover, the
main information about adoption was calculated by comparing the due overall SP intake times and the
real times of SP intake noticed prospectively by phone calls.
The classification of women Malaria knowledge's adoption level was considered:

- **Very good**: For a woman who responded with certainty that fever is the main Malaria symptom, and she is informed about the four protective WHO measures against Malaria (Long Lasting Impregnated Mosquito Net; Intra-home spraying; Indoor Repulsive and including the SP intake).
- **Good**: For a woman who cited fever as the main Malaria symptom, and she is informed about at least two other protective WHO measures.
- **Average**: For a woman who cited fever as the main Malaria symptom, and she is informed about only one of the other protective WHO measures.
- **Does not know**: For a woman who cited fever as the main Malaria symptom, but she does not know any of the other protective WHO measures; or for a woman who not know fever as the main Malaria symptom and knows the other protective WHO measures.

The qualitative in-depth audio-recorded interviews with the gynaecologists allowed the understanding of the overall pregnant women pathway. The interviews translated transcripts were analysed by NVivo version 11 international QRS software, and a resume of thematic analysis was developed following Bazely 2009 recommendations [18].

**Results**

**The quantitative results**

A total of 200 participants meeting the inclusion criteria were included in the study. The duration of the questionnaire administration to each participant was approximately 10 ± 0 minutes. Nine (09) pregnant women refused to participate due to family duties and were not included in the analysis (supplementary material-1).

All recruited pregnant women were between 15 and 42 years old. The average pregnancies number was four, with a maximum of twelve. The average number of ANCs visits among participating women was four with a maximum of eight ANCs. The average concentration of the sample's haemoglobin level was 11.3 ± 1.3 g/dl with a maximum of 14.7 g/dl. Out of 200 pregnant women, 11 and 15 were anaemic in both groups. The other socio-demographic of the participating pregnant women are presented in Table 1. None of the characteristics was statistically influential of the before and after checklist comparison.
Table 1
Sociodemographic and clinical characteristics of participating pregnant women

| Characteristics         | Before the checklist (n = 100) | After the checklist (n = 100) | P Value |
|------------------------|-------------------------------|-------------------------------|---------|
| **Women age**          |                               |                               |         |
| 15–25 years            | 48                            | 41                            | 0.32    |
| ≥ 26 years             | 52                            | 59                            |         |
| **Marital status**     |                               |                               |         |
| Married                | 99                            | 97                            | 0.62    |
| Single                 | 1                             | 3                             |         |
| **Literacy**           |                               |                               |         |
| Illiterate             | 30                            | 26                            | 0.53    |
| Literate               | 70                            | 74                            |         |
| **Cultural environment**|                              |                               |         |
| Bambara                | 37                            | 40                            | 0.66    |
| Peuhl & others         | 63                            | 60                            |         |
| **Number of gestures** |                               |                               |         |
| 1 to 3 gestures        | 61                            | 67                            | 0.38    |
| Four and over          | 39                            | 33                            |         |
| **Gestational age**    |                               |                               |         |
| 4 to 8 months          | 75                            | 69                            | 0.34    |
| ≥ 9 months             | 25                            | 31                            |         |

The participating pregnant women first group were divided before the checklist use spontaneously among the four gynaecologists as follows: A (35), B (30); C (20) and D (15). Then, the same ratio of repartition was respected in the second group. The study’s main result shows that independently of the gynaecologists, the use of the checklist impacts the development of Malaria's knowledge. Indeed, there is a statistically significant relationship between the physicians’ checklist use and pregnant women's correct responses about Malaria information (Table 2).
Moreover, women's knowledge was assessed according to the type of combination of malaria symptoms and preventive means, and the information given during the checklist reminder was also statistically significant (Table 3). When the checklist was used, knowledge improved from 21 to 0 as average knowledge, and from 2 to 39 as good and very good knowledge before and after the checklist, respectively.

Moreover, compared to the knowledge of the conditions of compliance needed to take the three SP doses, the correct response rate increased in the group of women benefiting from the checklist intervention.
According to Table 4, 28% women before the checklist reported being at their first SP dose vs 18% in the other group. The relationship between supervised intake of IPTp-SP and pregnant women was statistically significant between the two groups; with an overall rate of coverage of supervised IPTp-SP intake that increased from 00–59% after using the checklist for one time.

Table 4
Distribution of the immediate adoption by pregnant women of supervised intake of the three doses during their facility visit

| Number of women who adopt the supervised use of the 3 SP doses | Before the checklist n =100 | After the checklist n =100 | P-value |
|-------------------------------------------------------------|-----------------------------|-----------------------------|---------|
| Yes                                                         | 0                           | 59                          | <0.001  |
| No                                                          | 100                         | 41                          |         |

Reasons for not taking SP during pregnant women according to their degree of information n = 100 n = 41/100

| Reason                                                                 | Before the checklist | After the checklist |
|------------------------------------------------------------------------|----------------------|---------------------|
| I have not eaten yet, and I was told that I could take it at home after a meal to minimize side effects | 75                   | 27                  |
| The doctor did not explain to me that I must take it immediately here | 20                   | 5                   |
| There is no water at the facility to take the treatment                | 0                    | 1                   |
| I prefer to take it at home (with more hygiene)                       | 5                    | 7                   |
| I must take a blood sample before taking the treatment                 | 0                    | 1                   |

Of the 41% women after the checklist, who did not take the SP, only five of them did not understand the doctor message, when 27 of them, like the 75 women from the first group received contradictory information inviting them to take the SP after a meal to avoid side effects. This information raised during the qualitative analysis and one of the drug unit health worker was unfortunately identified as the source of this information.

Luckily, the other SP intake visits were confirmed done by phone calls in more than 95% in the second group compared to only 38% in the first group. Table 5 informs about the effective SP intake compared to the scheduled SP post study intakes until the childbirth days of the pregnant women recruited with a gestational age between four and eight months.
Table 5
The effective SP intake compared to the scheduled SP post study intakes until the childbirth days of the pregnant women who were recruited with a gestational age between four and eight months *

| Women who confirmed by phone the total SP intakes | Before the checklist | After the checklist | P Value |
|-------------------------------------------------|----------------------|---------------------|---------|
| Correct number like the theoretical due SP intake date | n =50* | 19                  | 66      | < 0.0001 |
| Not a correct number, fewer than the theoretical due SP intake date | 31                  | 03      |         |

(*) We excluded in this table the 9 months and above pregnant women because they had to take almost zero next SP (NB: Even by adding all participants the difference remains highly significant)

(*) 25 women do not reply to the phone call or changed the phone number

During the study, all women (200) were asked about the benefit of providers’ communication at ANC to understand health messages. Thus, 176 considered that good communication, in general, is essential, and 162 women confirmed the importance of allocating the necessary time by physicians during ANC visits to discuss malaria prevention and pregnancy, defining the needed adequate time between 10 and 20 minutes. Those responses were almost similar for women in both phases of the study.

The qualitative results

In this qualitative part of the study, the participating gynaecologists agreed that the checklist helped them remember all messages needed to be transmitted to the pregnant woman during the ANC. Also, they confirmed that they allowed more or less time to explain the information about malaria risks based on previous women knowledge and life experiences. This qualitative part helped to understand the quantitative result presented in Table 3, noticing that 77 women in the non-checklist group were not aware of malaria preventive tools compared to 61 women in the checklist group and found a non-expected explanation qualitative analysis. In the first group, all pregnant women took during their previous visits, the SP without knowing the relation between this drug and Malaria prevention. It was considered as a ‘vitamin’ pills to sustain the healthy pregnancy state. However, for the 61 pregnant women from the group getting the checklist provider explanations and giving also ‘do not know’ as response about the SP, it was mainly linked to the SP’s presentation by the gynaecologists, as spoken information without seeing the SP pills boxes. While at the study investigator meeting, he asked the women during the questionnaire if they knew the SP by showing them three different existing commercial box of this drug. That why one gynaecologist suggested adding the full pictures of the commercial name of the SP into the checklist provider. Consequently, if the study investigator asked them about the SP showing the same pillboxes, they would be responded knowing one preventive measure; and a highest statistical significant difference would appear.
Another gynaecologist suggested the introduction of the checklist by nurses and midwives during all the unit ANC visits. However, the lake of giving full explanations about Malaria prevention is due to the repetitive process of such messages. The workload creates more pressure to jump any “unnecessary waste of time” by dealing with the new visiting pregnant women.

Furthermore, the DOT was in part not respected due to some nurses’ contradictory information, who asked some pregnant women to take the SP at home after a meal to minimise or avoid side effects, in contradiction with WHO recommendations and Mali’s national guidelines for IPTp-SP. The motivation behind is based first on the health professional’s conviction about taking the SP with a good meal, decreasing side effects probabilities and avoiding more unnecessary future work if that woman return-back to the PHC. In contrast, there is a need to rethink the unit drugs architecture, to prepare an empty and suitable seating area, with permanent access to drinkable water, or cleaned water bottles with the SP doses. That helps to create a friendly atmosphere where a male or female health worker will supervise the all SP intake visiting ages and socio-culturally new woman without any shyness or embarrassment.

Discussion

In this study, the lake of information about malaria pregnancy risks is the bottleneck that limits SP’s DOT. This result is consistent with another study conducted in India, in which 80% of pregnant women did not have information about Malaria at the time of contact with health professionals[19]. The same observation was made in Benin, where half of the pregnant women had not explained how to take the SP[20].

The use of a reminder provider checklist improved; statistically, the SP supervised intake, by encouraging the provider to transmit Malaria structured information to the visiting pregnant woman. This simple one-page checklist reduced women's gap information during their only one contact during ANC. Moreover, due to the high level of doctors' trustfulness by their patients, doctors' story is more appreciative and less unforgettable. In our study, the second group was the most respectful of all SP future visits and preventive measures as theoretically scheduled for 95% of all the pregnant women recruited with a gestational age between four and eight months. The adoption of the SP intake from pregnant women was highly significant compared with the first group.

Thus, the feasibility and the adoption of this intervention were proved in the context of our study. A recent qualitative study from Mozambique highlighted the same need to foster health education and information sources against Malaria risks in pregnancy for both health professionals and pregnant women[21].

The participating women with the checklist, whatever their level of previous knowledge or education, understood that SP is also a preventive and non a curative drug, designed to protect them during pregnancy and protect their newborns like a study from India found out[19]. This checklist usefulness is consistent with Nigeria's finding confirming that women knowledge and education improvement impact the malaria control[22].
Such results, confirm that for health facilities where the ANC recruitment is highly achievable in Mali, fostering information about pregnancy risks and its prevention tools could help reach better coverage of IPTp-SP. For instance, the checklist reminder improved the immediate scope of more than half of the IPTp participants in real-life conditions contextualising this study by moving from 0–59% after its use. Simultaneously, the sustained rate jumped to 38% and 95% for the first and second groups, respectively. Our mean rate (59%) of pregnant women who enrolled in IPT-SP is slightly higher than the results of a study from Burkina Faso (55%)[23]. This coverage rate is much higher than women who received at least three or more doses in a multicentric study done in 36 African countries where the improvement goes slower 31% in 2018, compared with 22% in 2017 versus 2% in 2010[1].

Without supervision, the community agents and health workers could worsen the preventive treatment information targeting pregnant women[24, 25]. For instance, the contradictory message that asks pregnant women to take the SP drug at home after a meal to minimise side effects was also found in another study in Mali[14]. These communities should understand that Malaria has harmful consequences for the mother and her future born child and that administering DOT SP at specific times of pregnancy is one of the most effective ways in addition to other preventive measures to be protected[26]. The need for effective communication and understanding between health workers in one hand, and between health workers and their patients and communities in the other hand are essential for increasing acceptability and adoption of the IPT-SP[27].

Mali adopts WHO standards to define ANC coverage needs. Thus, Mali’s 2018–2022 National Malaria Control Strategic Plan targets the achievement of 80% of the use of IPT3 or higher. According to the new WHO recommendations, contact between the woman and the provider must be more than just one ANC visit [28]. This provider checklist as a routine ANC new tool associated to an extension by MHealth innovating technologies (reminder SMS, reminder calls) could systematically create more opportunities for giving complete information about Malaria and pregnancy, helping to achieve the desired ANC coverage quickly. However, the underreporting of SP intake by women who do not visit health facilities and take SP by themselves or take SP from other sources than the ones available at the public health facilities mitigate the accuracy of the coverage rate and need more investigation [15].

This study has some limitations. Firstly, although the physicians confirmed giving the ten information on the checklist, the study investigator did not have access to the full physician-woman speech during the ANC. Thus, it is impossible to verify if all ideas included in the checklist were explained in the same way and with the same time-length. Secondly, the evaluation of the time spent by each physician for each woman was not assessed due to the variety of ANC motivations that included, in the same visits, other discussed health questions than the malaria prevention. Finally, the study investigator was not blinded about the checklist use and was not planned to confirm the SP’s source taken previously by some participants, if it was exclusively available in the health facility or had other extra-sources.

Conclusions
The ease of using this checklist in daily activities practices increased the woman's adoption to take SP during the facility visits in front of the health worker as recommended by the national program. This provider checklist reminder tool can be updated and generalised as a prenatal consultation activity in all public health facilities in Mali and similar Malaria endemic countries. Based on this provider checklist's encouraging results, further research is suggested to assess the other outcomes—namely, acceptability, coverage, and sustainability at the organisational level.

**Abbreviations**

(ANC) Antenatal care visit ; (ANC1) First antenatal care visit ; (ANC3) Third antenatal care visits ; (ANC4) Fourth antenatal care visit ; (ANC8) Eighth antenatal care visit ; (CHW) community health worker ; (CSA) Community Health Officer ; (DOT) directly observed treatment ; (LLIN) Long-Lasting Impregnated Mosquito Net ; (WHO) World Health Organization ; (NMCP) National Malaria Control Program ; (Repul) Repulsive ; (SP) Sulfadoxine Pyrimethamine ; (HIS) Intra-home spraying ; (IPTp) Intermittent Preventive Treatment during Pregnancy ; (IPT-SP) Intermittent Preventive Treatment with sulfadoxine-pyrimethamine ; (IPT3) Third doses of IPT-SP ; (IRO) Implementation research outcomes.

**Declarations**

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- **Authors' contributions**

The study was conceptualised by ID, SF, DK and IB. ID carried out the data collection under the supervision of SF and DK. ID did data analysis under the supervision of IB. The first draft of the manuscript was written by ID and IB.

ID, SF, DK and IB contributed to the writing and to critically review the manuscript. All authors have validated this final version.

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- **Availability of data and materials**

All quantitative data analysed for this study are shared in open access within an Excel file available as supplementary material.
**Ethics approval and consent to participate**

The study protocol's approval was obtained on 17 February 2018 from the National Ethics Committee for Health and Life Sciences in Mali under the identification N° 003/MSHP-CNESS. The study administrative authorisation was provided by the Bamako District Regional Health Directorate and the District Hospital of Commune VI's Chief Medical Officer.

**Consent for publication**

Not applicable

**Competing interests**

The authors declare that they have no competing interests.

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