

Determinants of Intermittent Preventive Treatment with Sulfadoxine-Pyrimethamine in Pregnant Women (IPTp-SP) in Mali, a household survey.

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Abstract

Background: In malaria endemic regions, Intermittent Preventive Treatment with Sulfadoxine-Pyrimethamine (IPTp-SP) is recommended for all pregnant women during prenatal consultation from the fourth to the ninth month of pregnancy, up to the time of delivery. The Government of Mali is aiming for universal coverage of IPTp-SP. However, coverage is still low, estimated to be 18% for completion of three doses (IPTp-SP3). The objective of this study was to identify the factors that influence IPTp-SP in the Health District of Sélingué, Mali.

Methods: We performed a cross-sectional survey with 30 clusters, proportional to village size with two stages of sampling. We collected data electronically with Magpi software during face-to-face interviews/surveys. The data were analyzed with SPSS version 20. We performed a descriptive analysis, and bivariate and multivariate logistic regression. An equity analysis examined the effect of distance from health care facility on completion of three or more antenatal visits (ANC3+) and three or more doses of Intermittent Preventive Treatment (IPTp-SP3+).

Results: Of the 1,021 women surveyed, 87.8% (n = 896) attended at least one ANC visit. Of these, 86.3% (n = 773) received at least 1 dose of IPTp-SP. The frequency of three or more ANC visits was 90.8%. Compliance with three or more malaria treatments was 63.7%. The determinants statistically related to ANC3+ were the early initiation of ANC (OR = 3.22 [1.22, 10.78]), the number of payments made for the malaria treatment (OR = 21.5 [2.64; 09], OR = 11.24 [2.5, 50.46]) and the presence of a Community Health Center (CHC) in the village (OR = 9.69 [1.09, 86.21]). The ability to read (OR = 1.60 [1.01, 2.55]), the early initiation of ANC (OR = 1.46 [1.06, 2.00]), knowledge of the utility of the drug (OR = 2.38 [1.24, 4.57]), and knowledge of the recommended dose of the drug (OR = 6.11 [3.98, 9.39]) were related to completion of three or more treatments (IPTp-SP3+).

Conclusion: The early initiation of ANC was a good determinant of the completeness of ANC3+ and IPTp-SP3+. Coverage was fair, but still far from universal. Alternative strategies are needed to further increase coverage.

Background

Malaria is a major public health problem. At the global level, there are approximately 3.3 billion people susceptible to malaria infection (1). In 2015, the number of malaria cases was estimated at 212 million (2). Of these cases 90% were recorded by the World Health Organization (WHO) Africa region, followed by the South-East Asia region (7%) and Eastern Mediterranean region (2%) (2). Of the 429,000 malaria deaths worldwide, 92% were recorded in Africa (1). Malaria is especially detrimental to the health and well-being of women and children (3). It can lead to maternal anemia, which increases the risk of hemorrhage during childbirth (3). In some endemic areas, malaria can directly contribute up to 25% of all maternal death (3). Malaria during pregnancy also increases the risk of miscarriage and affects fetal development, as well as preterm birth and low birth weight (4). Every year, 27.6 million pregnancies lead

to live births in malaria-endemic areas in Africa (5). It is estimated that, in the absence of prevention, 12.4 million of those would be exposed to malaria infection (5).

As part of antenatal care (ANC) services, every effort should be made to improve access to Sulfadoxine-Pyrimethamine Intermittent Preventive Treatment (IPTp-SP) everywhere in Africa where malaria endemicity level ranges from moderate to strong (6–8). The WHO recommends at least four ANC visits during pregnancy (6, 8). Starting as early as possible in the second trimester, IPTp-SP is recommended for all pregnant women at each ANC visit until delivery, and doses should be administered at least one month apart (8). Sulfadoxine-Pyrimethamine (SP) should not be administered during the first trimester of pregnancy (8). The last dose of IPTp-SP can be administered up to the time of delivery without any safety concern (6, 8). IPTp-SP should preferably be administered in the form of three SP tablets, under direct observation, which is the total required dosage of 1500 mg / 75 mg (8). SP can be administered with or without food (8). SP should not be given to women receiving prophylactic treatment with Cotrimoxazole because of a higher risk of adverse events (8). Globally, the percentage of women receiving IPTp-SP during pregnancy has increased over the years, although it remains below targets (1). IPTp-SP has been adopted by 37 countries (1). In these countries, 57% of pregnant women received at least one dose of IPTp-SP in 2013, but only 17% received three doses or more (1). In 20 countries with sufficient data, 31% of eligible pregnant women received at least 3 doses of IPTp-SP in 2015, compared to 6% in 2010 (2). A meta-analysis of 27 countries in 2011 estimated IPTp-SP compliance to be 21.5% (95% CI 19.3–23.7) across sub-Saharan Africa (9).

In Mali, the objective of the National Policy for Malaria Control, led by the National Malaria Control Program (PNLP), is to achieve universal coverage of SP through free distribution to pregnant women countrywide (10). The main goal of the 2013–2017 Strategic Plan of the PNL (7) is to ensure universal access to prevention measures for 100% of the population at risk of malaria, including the use of IPT by pregnant women (7). Hurley's secondary analysis of the 2012–2013 Demographic and Health Survey (DHS-V) data (11) shows that 56.2% and 29.9% of recently pregnant women benefited from IPTp-SP1 and IPTp-SP2+, respectively, in Mali (12). The Malaria Indicators Survey conducted in Mali in 2015 (EIPM) shows adherence of 66.4% for IPTp-SP1, 44.4% for IPTp-SP2 and 21% for IPTp-SP3+ (13). In the Sikasso Region, the adherence of IPTp-SP1 was 68.42% and that of IPTp-SP2 and IPTp-SP3+ 50.8% and 26.8%, respectively (14). In 2015 the EIPM showed an adherence of 68.7%, 44.4% and 22.2% respectively for IPTp-SP1, IPTp-SP2 and IPTp-SP3+ (13). In Sélingué, in 2016, 72% of pregnant women had received IPTp-SP1 compared to 43% for IPTp-SP2 and only 19% for IPTp-SP3 (15). Based on these data, the goals of the national malaria control program (PNLP) have not been achieved. In the Malian healthcare system, ANC provides women with the opportunity to get IPTp-SP. The frequencies were 74% for ANC1 and 41% for ANC4 and above (ANC4+) at national level. In the Sikasso region they were 79% for ANC1 (11). In Sélingué, in 2017, the frequencies of ANC1, ANC3 and ANC4 were 89%, 26% and 28% respectively (15).

Several studies have explored the determinants of the use and completeness of IPTp-SP (9, 12, 16–31). Nonattendance and/or completeness of ANC is considered a key determinant of IPTp-SP coverage (15, 16, 21, 24). A qualitative study conducted in Mali in 2013 identified the following factors influencing the

completeness of the 2 doses of IPTp-SP: late use or non-use of ANC services, perception of malaria during pregnancy, poor acceptability of SP, stock-outs of SP, and insufficient information on the policy of providing SP free of cost to pregnant women (16). In spite of this free IPTp national distribution policy, the authors reported variations in IPTp costs at various health facilities, and during prenatal visits (16). Lack of education and economic wellbeing have also been identified as factors influencing the use of IPTp-SP, with high level of education, level of economic well-being, and living in an urban area strongly associated with women taking IPTp-SP (9). In 2013, a meta-analysis was done which included 98 articles and 20 intervention studies from 1990 to 2013 (24). The results suggested that barriers to the use of IPTp-SP included lack of clarification of guidelines and policy, poor organization of services, stock-outs, costs of health services, lack of competent health workers, and the underuse of ANC by women (24). Key determinants of IPTp-SP were level of education, knowledge of malaria and IPTp-SP, socio-economic status, parity, and number of and early initiation of ANC visits (24). Despite knowledge of the factors affecting completeness of IPTp-SP, frequencies remain low. It is necessary to find an alternative strategy to improve IPTp-SP coverage. We conducted this study to identify the factors that specifically influence IPTp-SP in the Sélingué Health District in an effort to inform local efforts to improve IPTp-SP.

Methods

Site

The study was conducted in the health district of Sélingué, located 120 km southwest of Bamako. The health district of Sélingué was composed of seven subdistricts: Kangaré, Binko, Siékorolé, Tanga, Carrière, Diarani and Faraba during our study period. Currently there are nine subdistricts. The population was 91,425 in 2012, across 60 villages (32). The dam on the Sankarani River, a branch of the Niger River, has created an artificial lake of 409 km² in Sélingué, making rice cultivation, gardening, and fishing the main activities in the area (33). There were 18 community health workers (CHW) in the district; each working with several community relays (CR) and traditional birth attendants in each village (34). CHW were involved in minor medical care for children under 5 years of age and in the education and referral of pregnant women to ANC services.

Design

We conducted a cross-sectional survey with cluster sampling proportional to village population size at two levels. Thus, the number of clusters per village depended on the population size in each village. A total of thirty clusters were needed to have a representative sample. Overall, 960 households were selected for the 30 clusters (each cluster consisted of 32 households with at least one eligible woman). The minimum sample size was 981 households. To be eligible, the woman must have had a pregnancy in the two years prior to the survey, regardless of pregnancy outcome, according to the same selection process used in the EIPM and the sixth Demographic and Health Surveys (DHS-VI) (13, 14). Participants were interviewed face-to-face by interviewers and were shown the 3 SP tablets to see if they recognized them.

Data quality management and control

All data were collected on tablets by six data collectors and two supervisors (enumerators), during one month, using Magpi remote data collection software (35). Data collectors were trained by the supervisors. The tools have been pre-tested in Diago village near Bamako. Data were checked by the enumerator, uploaded to a secure cloud-based server, and later exported to an Excel spreadsheet by data manager. Data were then analyzed in SPSS software version 20 (36).

Data analysis

Our analysis focused on the following two outcomes:

1. **Completion of 3 or more antenatal consultations (ANC3+):** Women who completed at least three ANC visits were coded 1, and those who did not were coded 0. These women should have received IPTp-SP1+ (Fig. 1). We considered only women who achieved ANC3+, because with the current national policy, a woman may have obtained all three doses of IPTp-SP without completing the ANC4 +.
1. **IPTp-SP3 + intake:** Women who received at least 3 doses of IPTp-SP were coded 1, and 0 if they did not receive the 3 doses. These women were those who have completed their ANC3+ (Fig. 1).

We conducted bivariate analyses according to the flow presented in Fig. 1. Bivariate analysis for the outcome of IPTp-SP3 + intake included women who completed ANC1, IPTp-SP1 and ANC3+; and was performed using Chi square tests and simple logistic regression. We estimated odds ratios (OR) with 95% confidence intervals (95% CI) and verified the association between dependent and independent variables (age, level of education, parity, Distance from the village to CHC, possibility to read (literacy), Age of pregnancy at the first ANC, Knowledge of the usefulness of SP, Knowledge of the recommended SP dose, Knowledge of the period of starting taking SP, SP payment number, Given Insecticide Treated Nets (ITN) in ANC, Presence of CHC in the village, Rurality of the village of residence, Poverty quintile) using the Kendall tau B correlation (37). Variables that had a significant association during the bivariate analysis were selected for the multivariate (global) model. We performed multiple logistic regression and presented adjusted odds ratios (ORa) with a p value of 0.05. We assessed correlation between the independent variables with Kendall's tau B and eliminated variables that demonstrated strong correlations. For ANC3+, we added the variable "ability to read" due to its importance for understanding of medical information.

To measure equity in terms of geographic accessibility to facilities providing ANC, we used the Gini index and the concentration curve (CC). These data analysis tools are recognized as standard measures employed by health economists to estimate wealth inequity on various health indicators (38–45). We adapted these tools in our study to estimate inequities in health services utilization according to geographic accessibility. Geographic accessibility was measured using the distance index between a woman's village of residence and the CHC. This index places women's villages of residence individually on a continuous scale of relative distance. Villages have been grouped into five distance quintiles.

Distance quintiles were used to compare the influence of distance on ANC3 + and IPTp-SP3+. Principal component and factor analysis were used to determine quintiles of poverty. The original line (oblique or diagonal) shows perfect equity. The more the second line curves away from the perfect equity line, the higher the degree of inequity is. A curve below the equity line indicates a disproportionate use of services for households from villages close to health facilities. Although the concentration curve is a useful tool for the graphical representation of inequity, it does not quantify the magnitude of inequity. Hence the use of The Gini Index, which is a quantitative measure of inequity in the use of health care. It was used by Wagstaff A & van Doorslaer E in 2004 to measure the degree of inequity associated with household wealth (45). The value of the index varies between - 1 and + 1. A value of 0 indicates that the use of health services is equitably distributed among socio-economic groups (46). In this case the confidence interval around the index value includes zero. If zero is not within the confidence interval, there is a statistically significant inequity in the use of health services (46). A negative value of the concentration index implies greater use among the more remote health facilities while a positive value indicates that women in villages around health facilities have greater coverage than women far from health facilities.

Results

The analysis included 1,021 women. Table 1 shows the socio-demographic characteristics of the study sample. More than a quarter of women surveyed (26.2%) were between 20–24 years old. Many women (68.7%) had no level of education. Multiparas were the most frequent with 61.1%. Most of the women surveyed (73.4%) lived within 5 km of a CHC. Figure 1 shows the flow chart of the completeness of ANC3 + and IPTp-SP3+.

Table 1
Sociodemographic characteristics of women surveyed in 2016 Sélingué District, Mali (N = 1021)

Sociodemographic Variables	n	%
Age groups		
15–19	247	24,2
20–24	268	26,2
25–29	212	20,8
30–34	154	15,1
35–39	103	10,1
40–49	37	3,6
Level of education		
No level of education	701	68,7
Primary 1	213	20,9
Primary 2	88	8,6
At least secondary level	19	1,9
Parity		
Primipara	199	19,5
Secondi parous	197	19,3
Multiparous	625	61,2
Geographic accessibility		
Distance from the village to CHC		
0 to 5 km	749	73,4
6 to 15 km	169	16,6
> 15 km	103	10,1

Bivariate and multivariate analysis

Tables 2 and 3 present results from the bivariate and multivariate analyses for ANC3 + and IPTp-SP3+. Kendall tau B analysis revealed a negative correlation (-0.048) between the presence of CHC in the woman's village of residence and the rurality of the village of residence. There was a positive correlation (0.131) between knowledge of the recommended SP dose and knowledge of when to start taking SP, $p < 0.0001$. There was a positive correlation (0.432) between knowledge of the recommended SP dose and

the number of payments for SP, $p < 0.0001$. The knowledge of the recommended dose was correlated to two variables. We have therefore decided to remove it from the multivariate analysis presented in Table 2. We conducted a similar analysis for IPTp-SP3+. There was a positive correlation (0.121) between knowledge of the benefit of taking SP and the knowledge of the recommended dose, $p = 0.001$. There was a positive correlation (0.441) between knowledge of the recommended doses of SP and the number of payments, $p < 0.0001$. We therefore decided to remove the knowledge of the recommended dose from the multivariate analysis for IPTp-SP3+ from Table 3.

Table 2

Bivariate and multivariate analysis: Predictive variables of ANC3 + among women surveyed in 2016, Sélingué, Mali

Characteristics	n	ANC3 + n(%)	OR [CI 95%]	ORa [CI 95%]
Can read	773			
No	661	599(90,6)	-	1
Yes	112	103(92,0)	-	1,04 [0,2 ; 5,56]
Age of pregnancy at the first ANC	757			
4 months or more	444	385(86,7)	1	1
3 months or less	313	306(97,8)	6,7*** [3,02 ; 14,88]	3,62* [1,22 ; 10,78]
Knowledge of the recommended SP dose	773			
Incorrect answer	538	476(88,5)	1	-
Know the recommended dose	235	226(96,2)	3,27*** [1,6 ; 6,7]	-
Knowledge of the period of starting taking SP	773			
Incorrect answer	665	597(89,8)	1	1
4 months or less	108	105(97,2)	3,99* [1,23 ; 12,91]	5,41 [0,67 ; 43,93]
SP payment number	280			
1 time	112	84(75,0)	1	1
2 times	71	70(98,6)	23,33** [3,1 ; 175,84]	21,5** [2,64 ; 175,09]
3 times or more	97	95(97,9)	15,83*** [3,66 ; 68,47]	11,24** [2,5 ; 50,46]
Given ITN in ANC	772			
No	210	183(87,1)	1	1
Yes	562	519(92,3)	1,78* [1,07 ; 2,97]	1,51 [0,62 ; 3,7]
Presence of CHC in the village	773			
CHC planned but not operational	22	17(77,3)	1	1

*= $p < 0,05$; **= $p < 0,01$; ***= $p \leq 0,001$.

OR = Odds Ratio. ORa = Adjusted Odds Ratio.

Characteristics	n	ANC3 + n(%)	OR [CI 95%]	ORa [CI 95%]
Village with CHC	282	257(91,1)	3,02* [1,03 ; 8,89]	9,69* [1,09 ; 86,21]
No planned or operational CHC	469	428(91,3)	3,07* [1,08 ; 8,75]	7,8 [0,98 ; 62,4]
Rurality of the village of residence	773			
Rural	448	420(93,8)	1	1
Less rural	325	282(86,8)	0,44** [0,27 ; 0,72]	0,69 [0,27 ; 1,77]
*= p < 0,05; **= p < 0,01; ***= p ≤ 0,001.				
OR = Odds Ratio. ORa = Adjusted Odds Ratio.				

Table 3

Bivariate and multivariate analysis: Predictive variables of IPTp-SP3 + among women surveyed in 2016, Sélingué, Mali

Characteristics	n	IPTp-SP3 + n(%)	OR [CI 95%]	ORa [CI 95%]
Poverty quintile	697			
Q1 (poorest)	128	85(66,4)	1	1
Q2 (poorer)	140	92(65,7)	0,97 [0,58 ; 1,61]	1,5 [0,24 ; 9,25]
Q3 (mean)	142	100(70,4)	1,20 [0,72 ; 2,01]	1,23 [0,24 ; 6,15]
Q4 (wealthier)	146	79(54,1)	0,60* [0,37 ; 0,97]	0,17* [0,03 ; 0,92]
Q5 (most wealthy)	141	87(61,7)	0,82 [0,49 ; 1,34]	0,48 [0,09 ; 2,54]
Can read	701			
No	599	373(62,3)	1	1
Yes	102	74(72,5)	1,60* [1,01 ; 2,55]	10,27* [1,52 ; 69,28]
¹Age of pregnancy at the first ANC	690			
4 months or more	384	229(59,6)	1	1
3 months or less	306	209(68,3)	1,46* [1,06 ; 2,00]	1,58 [0,53 ; 4,72]
Knowledge of the usefulness of SP	700			
Incorrect answer	641	399(62,2)	1	1
Prevention of malaria	59	47(79,7)	2,38** [1,24 ; 4,57]	1,32 [0,2 ; 8,76]
¹Knowledge of the recommended SP dose	701			
Incorrect answer	475	250(52,6)	1	-
Know the recommended dose	226	197(87,2)	6,11*** [3,98 ; 9,39]	-
¹SP payment number	249			
1 time	84	16(19,0)	1	1

*= $p < 0,05$; **= $p < 0,01$; ***= $p \leq 0,001$.

OR = Odds Ratio. ORa = Adjusted Odds Ratio.

Characteristics	n	IPTp-SP3 + n(%)	OR [CI 95%]	ORa [CI 95%]
2 times	70	66(94,3)	70,13*** [22,28 ; 220,76]	139,18*** [32,94 ; 588,06]
3 times or more	95	92(96,8)	130,33*** [36,52 ; 465,18]	244,73*** [54,28 ; 1103,5]
¹ Rurality of the village of residence	701			
Rural	419	287(68,5)	1	1
Less rural	282	160(56,7)	0,60** [0,44 ; 0,82]	0,17** [0,05 ; 0,57]
*= p < 0,05; **= p < 0,01; ***= p ≤ 0,001.				
OR = Odds Ratio. ORa = Adjusted Odds Ratio.				

Equity and distance to CHC

Figures 2 and 3 present the results of the equity analysis for completeness adherence to ANC3 + and IPTp-SP3 + under the influence of distance from women's home villages to CHC. Women close to CHC were more likely to complete ANC3 + and IPTp-SP3 + than those far from the CHC, although this inequity was not statistically significant (Table 4).

Table 4
Concentration index of the realization of ANC3 + and IPTp-SP3 + in the women surveyed in 2016, Sélingué, Mali.

Concentration index (CIndex)	Variance of CIndex	Standard Error	t Statistic	95% Confidence Interval (CI)
ANC3+				
0,1641	0,0072	0,0850	1,9306	[-0,0025 ; 0,3307]
IPTp-SP3+				
0,1584	0,0096	0,0980	1,6168	[-0,0336 ; 0,3504]

Discussion

We used the same selection process of women as in the MICS and the DHS-V (11, 13). We chose ANC3 + as a dependent variable because from three ANC visits it is possible to have an adherence of IPTp-SP3+ (6–8). This choice allowed women who had missed opportunities to benefit from IPTp-SP to be excluded from the determinants analysis, as Hurley reported (12).

Frequency of ANC3 + and IPTp-SP3+

ANC is the entry point for the women included in this study to benefit from the WHO recommended intervention package (6, 8, 38) for their protection and that of their fetus as mentioned in the conclusion of Hill's 2013 study and others (12, 17, 47). Our study's frequencies of ANC1+ (87.8%) and ANC3+ (68.8%) were fairly good compared to those found in the fifth DHS of Mali in the Sikasso region (14), and those of ANC1 (78.3%) found in van Eijk's meta-analysis of 26 sub-Saharan African countries (9). Our findings are also higher than Hill's estimates of 81% of ANC1 among recently pregnant women and 63% of ANC1 among pregnant women in Segou (17). However, ANC1 frequency in our study was similar to that of the Sélingué data from the 2016 statistical yearbook (15).

We found an IPTp-SP3 + frequency of 63.7% among women who completed ANC3+, which is similar to the one that Muhumuza E. obtained in Uganda (29). This frequency was greater than 38.5% of Odjidja(48), but less than 71% of Ibrahim and al. (49) both in Ghana in 2017.

Furthermore, we found a high frequency of IPTp-SP3 + contrary to our expectation at the beginning of the study and high compared to the frequencies of the 2015 MICS of 19% in Sikasso (13), the statistical yearbook 2016 of 19.1% in Sélingué (15) and data in most other studies (9, 12, 17, 25, 26, 29, 46, 50, 51). For instance, Hill found 28.6% for IPTp-SP2 + and 47.8% for IPTp-SP1 in Segou (17).

The high frequency of IPTp-SP is related to several factors. Sélingué District is an area that has benefited from the presence of a research unit of the National Institute of Research in Public Health and the intervention of Non-Governmental Organizations (NGOs) including Borne Fonden. We can also mention the implementation of the project "Integrated control of malaria based on an environmental and community base in agro-ecosystems of West Africa" in 2012 and 2013 as an influencing factor (52). During this project, an awareness raising campaign on ANC was conducted through local radio stations (52). Additionally, the Village Malaria Committees and Farmers Field school served as a means for information, education, and action (52). Also, the presence of Community Health Workers (CHW) and Village Health Volunteers (VHV) has helped to raise awareness. Notably, in 2014, the CHW conducted 1,660 home visits involving 5,464 people (69.6% of whom were women), 1,369 discussion and sharing sessions, and 544 counseling sessions for 16,486 people (82% of whom were women) (53).

Since the implementation of the policy of 3 or more doses of SP started in Sélingué in 2014, before our survey, it is possible that the women surveyed obtained the number of doses they mentioned. Many women surveyed recognized the 3 SP tablets that the investigators were showing them. Some of them said its local name (sumaya fura kisè saaba). But this recognition was not always followed by the awareness of its usefulness. The investigators did not say the name in advance, to make sure the woman recognized them. We considered women's assertions based on the Kappa concordance test obtained by Hill J. et al. in Segou in 2014 (17). Another fact is that, after our study, the WHO guidance changes from "at least four ANC visit" to "eighth visits". This change could influence future study on the number of IPTp-SP.

Our study may have also benefited from the policy shift in IPTp-SP with the possibility of taking up to the time of delivery starting at 4 months. This could be an explanation of the observed frequency. Moreover,

our investigation, to our knowledge, is the first that covered the whole district of Sélingué, and the first to cover an entire district in Mali.

Determinants of ANC3+

The participants who reported knowledge of the usefulness of taking SP and had started taking SP earlier in their pregnancies were more likely to benefit from ANC3+ compared to those who did not know of SP's usefulness or who did not take it early in pregnancy. This theory is reinforced by the education and literacy level; women's level of education as a predictor of ANC compliance is supported by the literature (18, 22).

Distance to facility was a barrier to the completeness of ANC3+, as found in the literature (12, 54, 55). This is why women in villages with CHC were significantly more likely to achieve their ANC3+ compared to those in villages without CHC. An analysis of data from 10 West African countries in 2016 found that distance, in addition to poverty, level of education, and rurality of the village of residence, were barriers to ANC utilization as well as effectiveness (56).

Additionally, the 2016 Statistical Yearbook identified the following factors to explain low rates of ANC: the late initiation of reproductive health services, inadequate completion of monitoring forms, insufficient qualified staff in peripheral reproductive health services, insufficient active research, inadequate reception, and poor communication (15).

Surprisingly, buying SP was found to be a positive determinant of the completeness of ANC3+ in our study. However, in other studies (12, 16, 50, 54), buying SP and other charges have been identified as barriers to ANC.

Determinants of the observance of IPTp-SP3+

ANC is the entry point for a woman to benefit from IPTp-SP. In our study, the 12.2% of women who did not have any antenatal visit were less likely to receive IPTp-SP. Among those who had received ANC, 13.5% had not received SP. ANC appears as a fundamental barrier to both the use and the completeness of IPTp-SP3+. Those two factors (any ANC and any IPTp-SP during ANC) were also identified as a barrier in a study conducted by Hurley in 2016 (12). Similarly, a study by Sangaré in 2010 found that 68.7% of women eligible for IPTp-SP2 did not take any or simply had a single dose of IPTp-SP (20).

Our study found that relatively wealthy women were significantly (40%) less likely to complete IPTp-SP3+ compared to poor women as opposed to what is generally observed in the literature (27) where adherence is proportional to wealth level. Women who were educated, who knew the usefulness of SP and the correct dose of SP were significantly more likely to complete IPTp-SP3+. Similar findings were reported by Hill in Mali, Ameh and Onyeneho in Nigeria, and Kibusi in Tanzania (17, 25, 27, 57). The compliance with IPTp-SP3+ therefore appears proportional to the level of education. Hill in his systematic review and meta-analysis found that having the correct information on IPTp-SP increased the likelihood of taking the SP (24). Pell, in the same way, found that lack of knowledge was a barrier to IPTp-SP (58).

We found that starting ANC early was a good indicator of IPTp-SP3 + compliance, which reinforces findings from other studies (17, 24, 27). However, with the current recommendations (8), a woman can have 3 doses (IPTp-SP3+) even if she started her ANC at 6–7 months, taking SP every month, provided there is regular attendance at ANC visits after this late start. In this case, this indicator could, in the future, no longer serve as an adequate good indicator of compliance.

The Direct Observed Therapy (DOT) of SP, as recommended (6–8), was not widely practiced in Sélingué compared to findings of other studies (26, 59). Half of the participants in our study had practiced the DOT of SP. The other half took their SP home for self-administration, in absence of observer, contrary to the recommendations (6–8). The absence of observed treatment represents a barrier to good IPTp-SP3 + compliance as confirmed by the literature (17, 18, 24–26). Few women were aware that SP can be taken on an empty stomach. Unavailability of drinking fountain or cups by the fountain as well as asking women if they had eaten prior to coming to the health center influenced the nonobservance of DOT of IPTp-SP. That suggests the lack of competence of health workers on the guidelines for the administration of SP as identified by van Eijk (9). Similarly, Mubyazi (60) found that the lack of clean water and cups were barriers to the DOT of SP. In another study, some pregnant women brought their own water bottle to the health center to take SP, which enabled a barrier to DOT of SP (26). Other authors found the influence of availability of drinking water on the DOT of SP (18, 28), hence we reiterate recommendations for the availability of clean water and cups to improve the DOT (50). Additionally, as noncompliance with DOT of IPTp-SP guidelines has been identified in several studies (12, 16, 17, 20, 24), a need for competence building is largely suggested (19, 24, 27, 61).

Distance was also identified as a barrier to IPTp-SP3 + in our study, and was confirmed by our equity analysis. Women in CHC village sites were more likely to complete IPTp-SP3 + compared to women in villages far from the CHC. These findings are supported by those in the study by Hurley (12). However, our findings conflict with Hill's study that women in villages close to CHC were less likely to complete IPTp-SP (17).

We found that purchasing SP was a facilitator of IPTp-SP3 + completeness. This trend was confirmed by the number of payments mentioned by the participants in our study. The higher the number of payments for SP, the more likely the woman complete IPTp-SP3+, which appeared paradoxical in our context. The national guidelines suggest that SP must be delivered to pregnant women free of charge (6, 8, 62). However, paying for SP did not appear as a barrier in our study. Payment of SP was reported by women in the study carried out by Klein (16) in Koulikoro and Sikasso, Mali, which support the comments made by the participants in our study. Klein found that payment was one barrier for the IPTp-SP2 + and that even staff were confused about IPTp-SP being free of charge (16). In addition to the fact that the payment is probable, other possible explanations concerning this affirmation of payment of the SP would be : 1) the husbands or attendants were in charge of the payment of the prescription given to the women; 2) difficulties to differentiate between paid and free drugs; 3) the husbands or attendants didn't share with women the information on the policy of offering SP free of cost; 4) lack of clear explanations of free medicines by staff, or 5) free drugs are not available from the ANC agent but rather from the pharmacy.

Some of these explanations are corroborated by the studies of Hurley and Hill (12, 24). It should be noted that the guidelines recommend both predisposing the free SP in the ANC units instead of the pharmacy and, on the other hand, making the separate SP prescription (62). This is not always done in CHC. We noted a very wide confidence of SP payment number (Table 3). Future research could explore this relationship more.

Equity Analysis

Our findings suggested that distance impacts the completeness of ANC3 + and IPTp-SP3+. The appearance of our curves (Figs. 2 and 3) indicated inequities in favor of women in the villages closest to the CHCs, especially after the first quintile of distance. Women nearer were more likely to complete ANC3 + and IPTp-SP3 + than those who were distant.

Study limitations

The IPTp-SP questions did not specify exactly which dose was targeted because it was not standardized on a specific dose such as the first dose taken, or the last dose taken. The woman could answer on any dose. The IPTp-SP questions were asked only to women who said they had received ANC. Those who did not attend ANC could have interesting information, especially multiparas, hence a potential source of selection bias. The cross sectional nature of the study and the subjective responses of the women surveyed could introduce information biases not only by the women themselves but also by the interviewers because of the length of the questionnaire, the time for the interview, and some skips or connection problems in the Magpi software used for electronic data collection. Lastly, we did not evaluate the availability of SP stock in the health centers. However, few women mentioned SP stock shortage at the CHC as the reason for not getting and taking SP.

Conclusion

Despite the high frequency of IPTp-SP3 + in our study, Mali is still far from the goal of universal coverage of pregnant women. We were able to identify several critical factors in achieving this goal. The positive factors include the level of education, the early start of ANC, the level of knowledge of IPTp-SP, and the observance of DOT at the CHC. Some of the barriers include the distance to the health facility, the lack of implementation of ANC, the unavailability of water for DOT, the lack of knowledge of the national policy guidelines and, the lack of good communication between health workers and pregnant women. To overcome these barriers, we recommend the following:

- Set up a community-based distribution system to improve geographic access to treatment;
- Train health workers on the simplified technical guidelines for offering Sulfadoxine-Pyrimethamine Presumptive Intermittent Therapy;
- Reinforce the direct observed treatment of Intermittent Presumptive Sulfadoxine-Pyrimethamine.

List Of Abbreviations

ANC	Antenatal care or antenatal visits
CHC	Community Health Center
CHW	community health workers
CHW	Community Health Workers
CI	Confident Interval
CIindex	Concentration index
CR	community relays
DHS	Demographic and Health Surveys (DHS)
DOT	Direct Observed Therapy
EIPM (MICS)	Malaria Multiple Indicators Cluster Survey
IPTp-SP	Intermittent Preventive Treatment with Sulfadoxine-Pyrimethamine
ITN	Insecticide Treated Nets
NGOs	Non-Governmental Organizations
OR	Odds Ratio
ORa	Adjusted Odds Ratio
PNLP	National Malaria Control Program
SPSS	Statistical Package for the Social Sciences
VHV	Village Health Volunteers
WHO	World Health Organization

Declarations

Ethics approval and consent to participate

The study protocol was approved by both ethics committees of the Faculty of Medicine, Dentistry and Pharmacy of Mali (N°2015/112/CE/FMPOS) and John Hopkins University of Baltimore in the United States (FWA00000287). The research team members were trained in data collection techniques and questionnaires were pre-tested in a village out of the intervention area. Investigators did not collect participants' names or other personal identifiers. Informed consent was read in the local language and approval was obtained with a signature of participants. Married women aged 15 and over were considered adults with the legal power to give informed consent, as stated in Malian law.

Consent for publication

Not applicable

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

OS analysed and interpreted data and write the manuscript. MT, LWC and MB and PJW analysed and interpreted data and reviewed the manuscript. SD review the manuscript. All authors read and approved the final manuscript.

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Figures

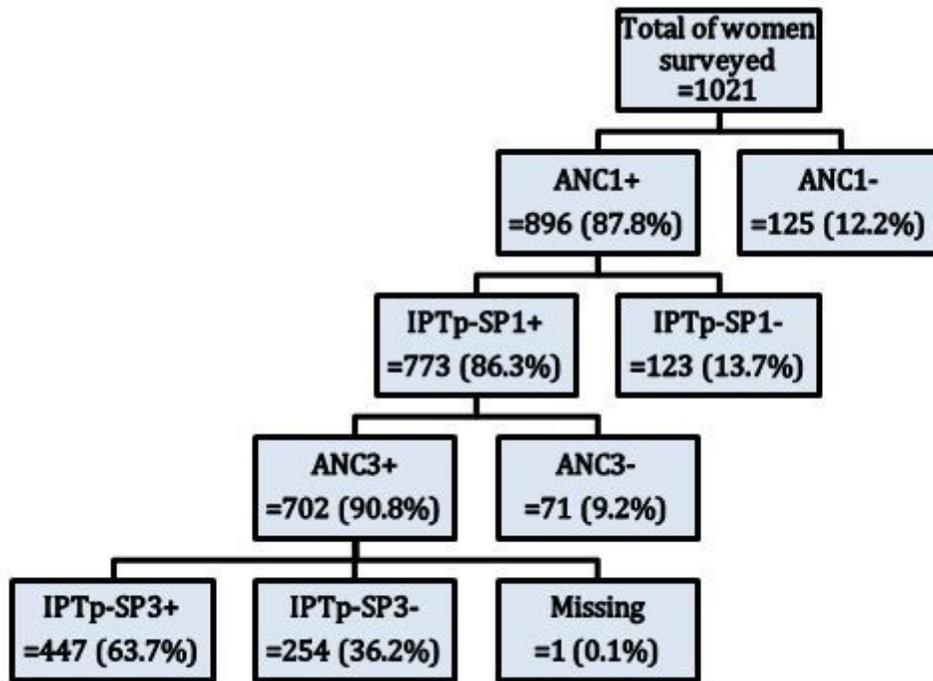


Figure 1

Flow diagram of IPTp-SP intake among women surveyed in 2016, Sélingué, Mali

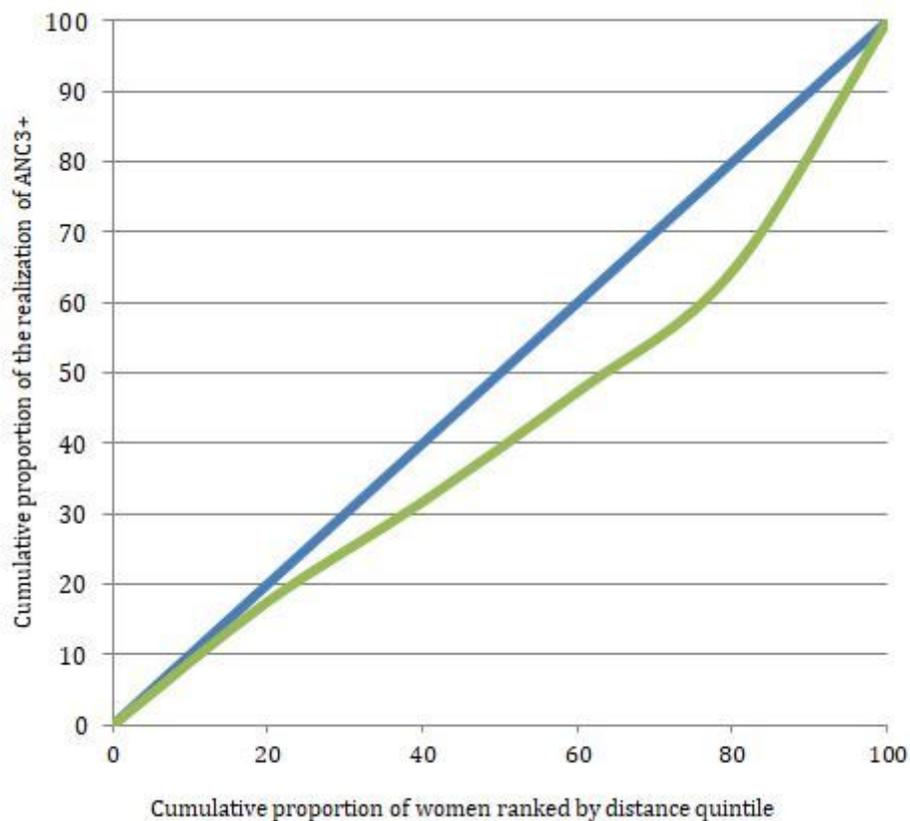


Figure 2

Curve of concentration of the realization of ANC3+ in the women surveyed in 2016, Sélingué, Mali.

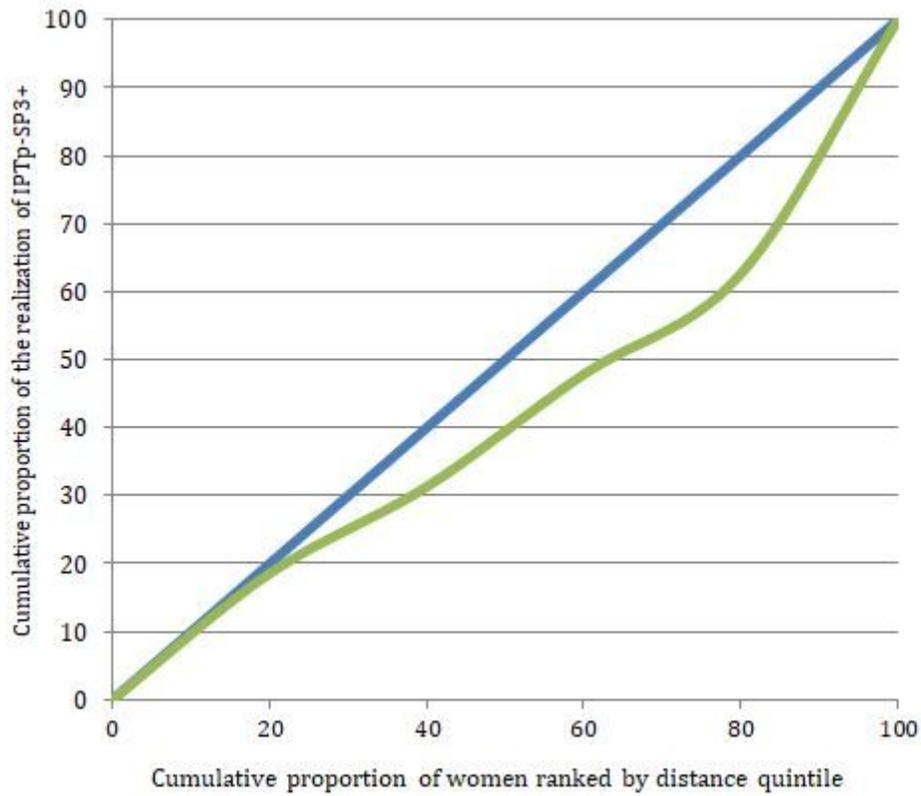


Figure 3

Curve of concentration of the realization of IPTp-SP3+ in the women surveyed in 2016, Sélingué, Mali.