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Is improvement in indicators of women's empowerment associated with uptake of WHO recommended IPTp-SP levels in sub-Saharan Africa? A multilevel approach

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ABSTRACT

Objectives The global burden of malaria has reduced considerably; however, malaria in pregnancy remains a major public health problem in sub-Saharan Africa (SSA), where about 32 million pregnant women are at risk of acquiring malaria. The WHO has recommended that pregnant women in high malaria transmission locations, including SSA, have intermittent preventive treatment of malaria during pregnancy with at least three doses of sulphadoxine-pyrimethamine (IPTp-SP). Therefore, we investigated the prevalence of IPTp-SP uptake and associated individual-level, community-level and country-level predictors in SSA.

Design A cross-sectional survey was conducted using recent Demographic and Health Surveys datasets of 20 SSA countries. A total of 96 765 women were included. Optimum uptake of IPTp-SP at most recent pregnancy was the outcome variable. We fitted three-level multilevel models: individual, community and country parameters at 95% credible interval.

Results In all, 29.2% of the women had optimal IPTp-SP uptake ranging from 55.1% (in Zambia) to 6.9% (in Gambia). The study revealed a high likelihood of optimum IPTp-SP uptake among women with high knowledge (aOR=1.298, CrI 1.206 to 1.398) relative to women with low knowledge. Women in upper-middle-income countries were more than three times likely to have at least three IPTp-SP doses compared with those in low-income countries (aOR=3.268, CrI 2.392 to 4.098). We found that community (σ^2=1.999, CrI 1.088 to 2.231) and country (σ^2=1.853, CrI 1.213 to 2.831) level variations exist in optimal uptake of IPTp-SP. According to the intracluster correlation, 53.9% and 25.9% of the variation in optimum IPTp-SP uptake are correspondingly attributable to community-level and country-level factors.

Conclusions The outcome of our study suggests that low-income SSA countries should increase budgetary allocation to maternal health, particularly for IPTp-SP interventions. IPTp-SP advocacy behavioural change communication strategies must focus on women with low knowledge, rural dwellers, married women and those who do not meet the minimum of eight antenatal care visits.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ The study used large and representative sample from 20 sub-Saharan Africa countries and as such the findings and recommendations are generalisable to all women in reproductive age within the included countries.
⇒ The multilevel analysis accounted for community-level and national-level variations in optimum intermittent preventive treatment of malaria during pregnancy with at least three doses of sulphadoxine-pyrimethamine (IPTp-SP) uptake.
⇒ The study has uniquely revealed the association between optimum IPTp-SP and income status of countries.
⇒ The cross-sectional design does not allow causal inference between the independent variables and IPTp-SP uptake.
⇒ For a cross-sectional study, exposure should be measured at the same time, however that was not the case for this study as data collection periods varied across countries although the surveys fell within the same phase of the Demographic and Health Survey.

BACKGROUND

The global burden of malaria has lessened considerably in recent years; however, it remains a significant public health problem in sub-Saharan Africa (SSA), a region that accounts for over 90% of malaria morbidity and mortality.[1] It is estimated that in the SSA region, 32 million pregnant women are at risk of acquiring malaria in pregnancy (MiP) every year.[2–4] MiP is associated with increased risk of both maternal and neonatal adverse health outcomes, including maternal anaemia (which leads to increased maternal mortality), low birth weight (LBW) infants,

premature delivery, stillbirth and increased perinatal and infant mortality.[5 6]

Current strategies to combat MiP revolve around a three-pronged approach: intermittent preventive treatment of malaria during pregnancy with sulphadoxine-pyrimethamine (IPTp-SP), use of insecticides treated nets, and prompt diagnosis and effective treatment.[7] In the IPTp-SP interventional regimen, each dose contains three tablets of sulphadoxine/pyrimethamine, with each tablet containing 500 mg/25 mg SP.[7 8] In 2004, the WHO recommended a minimum of two doses of IPTp-SP during pregnancy.[9 10] In October 2012, this recommendation was updated to at least three IPTp-SP doses.[11 12] This was in response to stagnated IPTp-SP uptake and in light of new data supporting the use of three or more doses of IPTp-SP.[13]

The recommendation promotes the initiation of IPTp-SP in areas of moderate-to-high malaria transmission such as SSA. The WHO advocates that IPTp-SP should commence as early as possible in the second trimester, with at least 1 month intervals at scheduled antenatal care (ANC) visits under direct observational therapy until childbirth.[7]

Few studies have explored ≥3 IPTp-SP uptake in SSA including the Demographic and Health Surveys (DHS) Analytical Studies 39, which focused on effectiveness of IPTp delivery.[14] None of the earlier studies considered the phenomenon in light of individual-level, community-level and country-level parameters. Yaya *et al*[15] explored IPTp-SP in only eight SSA countries and concluded that ≥3 IPTp-SP uptake is low (29.5%) and significantly associated with education and household wealth. A Tanzanian-based study found a lower uptake (9%).[11] Similar findings have been reported from Malawi[2] and Ghana.[16]

Women's empowerment is reported to enhance women's utilisation of maternal healthcare[17 18] and contraception use.[19 20] It also enables women to take the necessary precautions that would guarantee their well-being and that of their newborns.[21] Women's empowerment is a multifaceted concept with varied measurement indicators. Kabeer[22] defines empowerment as 'the expansion of people's ability to make strategic life choices in a context where this ability was previously denied to them'. Malhotra *et al*[23] refer to it as women's ability to make decisions and affect consequences of significance to their families and themselves. However, a plethora of evidence supports that critical measures of women's empowerment include education/knowledge,[24 25] contribution to household decision-making,[20 26–28] labour force participation[29] and disposition towards violence.[30 31]

As a result, women's empowerment may be an enabling factor for optimum IPTp-SP uptake in SSA. However, previous studies have not examined this linkage. Therefore, the current study seeks to examine the association between indicators of women empowerment and ≥3 IPTp-SP uptake as recommended by the WHO.

METHODS

Data source

Data from the women's files of the DHS of 20 SSA countries were obtained. These 20 countries were included as their surveys were the most recent for the respective countries, possessed all the indicators that were required for the study. The surveys were conducted between 2012 and 2018 (see table 1). All the included surveys were executed with the same methodological procedure and bear the variables required for this study.

The DHS is a 5-year interval survey conducted across low-income and middle-income countries worldwide.[32] The DHS Programme works together with governments of the countries involved to execute the study. The survey collects and reports information that pertains to a number of health issues, including reproductive health, maternal and child health including IPTp and other critical health issues.

A two-stage sampling procedure was applied to recruit respondents.[33] The first phase witnessed cluster or enumeration area (EA) selection. This was done by systematic selection of households from the EAs. Extensive documentation of methodological and sampling procedure has been performed elsewhere.[32] In the present study, we included 96 765 women aged 15–49 with complete data. Table 1 details the weighted sample per country, year of each included survey and other essential information. Data were analysed using appropriate statistical methods and were presented in line with the Strengthening the Reporting of Observational Studies in Epidemiology guidelines (online supplemental file 1).

Selection of variables

Outcome variable

The outcome of interest was optimal uptake of IPTp-SP during the last pregnancy. Thus, only women with pregnancy history were included in the study. All women who indicated that they took Fansidar during their last pregnancy (not current pregnancy) were subsequently asked 'how many times did you take (SP/Fansidar) during this pregnancy?'. It is noteworthy that IPTp is only asked in DHS surveys in countries with moderate to high malaria burden in which IPTp is part of the national malaria control strategy. The WHO currently recommends at least three doses of IPTp-SP during pregnancy as a cornerstone for curbing malaria during pregnancy within all areas with moderate to high malaria transmission in Africa.[34 35] Based on this, women who reported at least three doses were considered to have optimal uptake, that is ≥3 doses (coded as 1) whereas those who had less than three (<3 doses) were considered as not having optimal uptake (coded as 0).

Individual-level factors

The principle explanatory variable was indicators of women empowerment as conceptualised by previous studies.[20 36] These comprise knowledge (measured by women's educational attainment, exposure to radio,

Table 1 Sample and income category of countries

No.	Country	Weighted sample	Weighted percentage	Income category by GNI per capita
1.	Benin (2017–2018)	4424	4.6	Lower middle
2.	Burundi (2016–2017	1891	1.9	Low
3.	Congo DR (2013–2014)	3793	3.9	Low
4.	Gabon (2012)	790	0.8	Upper middle
5.	Ghana (2014)	3457	3.6	Lower middle
6.	Gambia (2013)	4881	5.0	Low
7.	Guinea (2018)	4286	4.4	Low
8.	Kenya (2014)	2103	2.2	Lower middle
9.	Liberia (2013)	3135	3.2	Low
10.	Mali (2018)	4855	5.0	Low
11.	Malawi (2015–2016)	12115	12.5	Low
12.	Mozambique (2015)	1521	1.6	Low
13.	Nigeria (2018)	13769	14.2	Lower middle
14.	Niger (2012)	4846	5.0	Low
15.	Namibia (2013)	268	0.3	Upper middle
16.	Sierra Leone (2013)	5588	5.8	Low
17.	Togo (2013–2014)	3681	3.8	Low
18.	Tanzania (2015–2016)	4969	5.1	Lower middle
19.	Uganda (2016)	7836	8.1	Low
20.	Zambia (2018)	8556	8.8	Lower middle
	Total	96765	100.0	–

GNI, gross national income.

television and newspaper) and agreement or otherwise with reasons for domestic violence (such as neglecting children, burning food, declining sex with partner, arguing with partner and visiting others without partner's permission). The other two are decision-making capacity (comprising decision-making on respondent's healthcare, household earning, visiting family members and household purchases) and finally employment status (engaging in a paid job or otherwise). We considered other explanatory variables such as age (15–19, 20–24, 25–29, 30–34. 35–39, 40–44, 45–49 completed years), wealth quintile (poor, middle or rich), marital status (married or unmarried), gravidity (1,2 or 3), ANC visits (no visit,<8,≥8), having insecticide treated net (no/yes), and health insurance (no/yes).

Community-level factors

The community-level factors comprised residence (urban/rural) and socioeconomic disadvantage at the grassroots level. Socioeconomic disadvantage was computed using principal component analysis to consider respondents without formal education, rural residents, the unemployed and poor women. We developed an index with a standard score having a mean of zero (0) and SD of one (1), whereby higher scores denote lower socioeconomic status and vice versa. The resultant scores were segmented into tertiles to permit nonlinear effects and offer results that can easily be interpreted.

Country-level factor

At the country level, we considered income status of the included countries. We classified nations by income in accordance with the World Bank's classifications.[37] This was undertaken using gross national income (GNI) of the included countries and categorising them into low (<US$1036 GNI per capita), low-middle (US$1036–4045 GNI per capita) and upper-middle-income (US$4046–12535 GNI per capita). None of the countries fell within the high-income category (>US$12535 GNI) per capita).

Analytical procedure

We conducted descriptive and inferential analyses. The descriptive analyses involved the frequency and percentage distribution of explanatory variables by optimal IPTp-SP uptake. Further, we assessed the significant association between each of the independent variables and optimal IPTp-SP uptake with χ^2 test at 95% CI. Multivariate multilevel logistic regression analyses were conducted at the inferential level. Three-level models were specified to investigate optimum IPTp uptake, culminating in four models.

The first model (empty model) was an unconditional model devoid of explanatory variables. This model was fitted to investigate the extent of variance between country and community levels. The second model comprised individual-level factors alone. The third model featured both individual-level and community-level factors while the fourth model, being the full model, added the country-level variable. The results were presented as fixed effects and random effects. We presented the fixed effects as adjusted ORs (aORs) with their associated 95% credible intervals (Crls). Results of the random effects were presented as variance partition coefficient (VPC) and median OR (MOR).[38]

The VPC helped us estimate the magnitude of variance in the likelihood of optimal IPTp-SP uptake that is attributable to community and national-level factors. Through MOR, we were able to quantify the national and community variance in terms of ORs and estimate the chances of optimal IPTp-SP uptake induced by community and national-level factors. Categories with minimum samples formed the reference categories in the modelling. All analyses were done using Stata V.13.

Model fit and specifications

Prior to modelling, we assessed multicollinearity with the Variance Inflation Factor (VIF).[39] The results indicated that none of the explanatory variables were highly correlated (mean VIF=1.39, minimum VIF=1.01, maximum VIF=2.20). The Bayesian Deviance Information Criterion was employed to gauge the effectiveness of fit of the models. We also used Markov Chain Monte Carlo estimation in the multilevel logistic regression modelling.[40] We fixed statistical significance at 95% and modelling operations were performed with 3.05 version of MLwinN package.

Patient and public involvement

Patients or the public were not involved in the design, conduct, reporting or dissemination of the research described here.

RESULTS

Descriptive analysis results

A total of 96 765 women aged 15–49 from the DHS across the 20 countries were included in the study, and 29.2% of the women had optimal IPTp-SP uptake (ie, 3 doses or more). Findings indicate that 31.7% of women with high knowledge had at least 3 doses of IPTp-SP during their last pregnancies. About 3 out of 10 women with low domestic violence acceptance (29.9%), high decision-making capacity (30.4%) and working (29.7%) obtained a minimum of 3 IPTp-SP doses. Attainment of optimal IPTp-SP was substantial among women aged 20–24 (29.9), wealthy women (30.2%), married women (29.3%), women at first gravidity (30.4%) and those who had at least 4 ANC visits (38.0%) as shown in table 2. We realised that 30.2% of the women with insecticide treated net obtained at least 3 doses while 38.4% subscribed to health insurance received 3 or more IPTp-SP doses. Urban women who had three or more doses (30.8%) exceeded rural residents who had three or more doses of IPTp-SP (28.3%). Also, 29.5% of least disadvantaged women at the community level had optimum doses while 37.0% of 3 or more IPTp-SP uptake occurred in upper-middle income countries. The highest proportion of optimum IPTp-SP uptake occurred in Zambia (55.1%) while the least occurred in Gambia (6.9%).

Fixed effects

From model 4 in table 3, it is evident that women of high knowledge stand a greater chance of accessing the recommended IPTp-SP doses (aOR=1.298, Crl 1.206 to 1.398) relative to women with low knowledge. Single women had higher odds compared with married women (aOR=1.260, Crl 1.143 to 1.472). Women with one gravidity similarly had higher odds of achieving the recommended IPTp-SP doses compared with women who had a third gravidity (aOR=1.179, Crl 1.073 to 1.295). Women who had eight or more ANC visits were more likely to have at least three IPTp-SP doses relative to women who did not attend ANC at all (aOR=1.267, Crl 1.099 to 1.773). Compared with urban residents, rural residents had lower odds of taking three or more IPTp-SP doses (aOR=0.829, Crl 0.732 to 0.908). Women in upper-middle-income countries were more than three times more likely to have at least three IPTp-SP doses compared with those in low-income countries (aOR=3.268, Crl 2.392 to 4.098).

Random effects

Results of the random effects were presented in table 3. Model 1, which is the empty model, indicates that community (σ^2=1.999, Crl 1.088 to 2.231) and country (σ^2=1.853, Crl 1.213 to 2.831) level variation exists in the uptake three of more IPTp-SP doses in SSA. The ICC of the same model further revealed that 53.9% and 25.9% of the variation in three or more IPTp-SP uptake are attributable to community-level and country-level factors correspondingly. The MORs of model 4 also revealed that when a woman relocates from one community to another with a higher propensity of recommended IPTp-SP dosage, she is 4.01 fold more likely to attain the recommended dosage.

DISCUSSION

This study investigated women's empowerment and uptake of recommended IPTp-SP dosage in SSA. Optimum IPTp-SP in SSA was found to be generally low (29.2%) with the least prevalence in Gambia (6.9%) while the highest prevalence occurred in Zambia (55.1%). These suggest that optimum IPTp-SP in SSA is low compared with the WHO recommendation that all pregnant women in SSA should receive optimum dosage.[34 35]

The observed variation across countries may be attributable to country-specific contextual factors. For instance,

Table 2 Weighted sample and optimum uptake of intermittent preventive treatment of malaria during pregnancy (n=96 765)

Variable	<3 doses n (%)	≥3 doses n (%)	Total n (%)	X^2, P value
	68 524 (70.8)	28 241 (29.2)	96 765 (100)	
Individual-level factors				
Knowledge				191.526, p<0.001
Low	28 740 (72.6)	10 834 (27.4)	39 574 (100.0)	
Medium	19 053 (70.9)	7800 (29.1)	26 853 (100.0)	
High	20 731 (68.3)	9607 (31.7)	30 338 (100.0)	
Acceptance of wife beating				41.982, p<0.001
Low	36 862 (70.1)	15 718 (29.9)	52 580 (100.0)	
Medium	8364 (72.0)	3259 (28.0)	11 623 (100.0)	
High	23 297 (71.6)	9264 (28.4)	32 560 (100.0)	
Decision-making capacity				40.752, p<0.001
Low	8612 (71.2)	3492 (28.8)	12 103 (100.0)	
Medium	11 758 (72.6)	4427 (27.4)	16 185 (100.0)	
High	7948 (69.6)	3474 (30.4)	11 422 (100.0)	
Labour force participation				24.689, p<0.001
Not working	23 475 (71.8)	9200 (28.2)	32 675 (100.0)	
Working	45 049 (70.3)	19 041 (29.7)	64 090 (100.0)	
Age				11.833, 0.066
15–19	4978 (70.2)	2115 (29.8)	7093 (100.0)	
20–24	15 145 (70.1)	6468 (29.9)	21 613 (100.0)	
25–29	17 778 (71.1)	7214 (28.9)	24 991 (100.0)	
30–34	14 125 (71.4)	5660 (28.6)	19 786 (100.0)	
35–39	10 115 (70.8)	4176 (29.2)	14 291 (100.0)	
40–44	4742 (71.1)	1930 (28.9)	6672 (100.0)	
45–49	1641 (70.8)	677 (29.2)	2318 (100.0)	
Wealth quintile				50.727, p<0.001
Poor	27 134 (71.6)	10 747 (28.4)	37 881 (100.0)	
Middle	14 101 (71.2)	5696 (28.8)	19 797 (100.0)	
Rich	27 289 (69.8)	11 798 (30.2)	39 087 (100.0)	
Marital status				55.397, p<0.001
Married	51 063 (70.7)	21 197 (29.3)	72 260 (100.0)	
Not married	17 460 (71.3)	7043 (28.7)	24 503 (100.0)	
Gravidity				
1	26 169 (69.6)	11 441 (30.4)	37 610 (100.0)	92.654, p<0.001
2	27 150 (70.7)	11 227 (29.3)	38 377 (100.0)	
3	15 205 (73.2)	5573 (26.8)	20 778 (100.0)	
ANC visit				198.320, p<0.001
No visit	2195 (69.0)	986 (31.0)	3182 (100.0)	
<4	68 118 (81.0)	15 978 (19.0)	84 096 (100.0)	
≥4	5881 (62.0)	3606 (38.0)	9487 (100.0)	
Insecticide-treated net				
No	16 229 (69.8)	7021 (30.2)	23 249 (100.0)	8.329, p<0.05
Yes	52 295 (71.1)	21 220 (28.9)	73 515 (100.0)	
Health insurance				235.111, p<0.001

Continued

Table 2 Continued

Variable	<3 doses n (%)	≥3 doses n (%)	Total n (%)	X^2, P value
No	64 862 (71.4)	25 957 (28.6)	90 819 (100.0)	
Yes	3662 (61.6)	2284 (38.4)	5945 (100.0)	
Community-level factors				
Residence				110.330, p<0.001
Urban	22 498 (69.2)	10 038 (30.8)	32 536 (100.0)	
Rural	46 026 (71.7)	18 203 (28.3)	64 229 (100.0)	
Socioeconomic disadvantage				10.753, p<0.01
Tertile 1 (least disadvantage)	23 419 (70.5)	9810 (29.5)	33 230 (100.0)	
Tertile 2	23 176 (71.3)	9340 (28.7)	32 516 (100.0)	
Tertile 3 (most disadvantaged)	21 929 (70.7)	9090 (29.3)	31 019 (100.0)	
Country				17.103, p<0.001
Benin (2017–2018)	3266 (74.5)	1115 (25.5)	4381 (100)	
Burundi (2016–2017)	1043 (59.3)	716 (40.7)	1759 (100)	
Congo DR (2013–2014)	3006 (83.5)	595 (16.5)	3601 (100)	
Gabon (2012)	585 (64.9)	317 (35.1)	902 (100)	
Ghana (2014)	1916 (52.7)	1716 (47.3)	3632 (100)	
Gambia (2013)	4692 (93.1)	346 (6.9)	5038 (100)	
Guinea (2018)	2414 (56.1)	1893 (43.9)	4307(100)	
Kenya (2014)	1682 (72.5)	638 (27.5)	2320 (100)	
Liberia (2013)	2421 (71.9)	946 (28.1)	3367 (100)	
Mali (2018)	2884 (64.5)	1588 (35.5)	4472 (100)	
Malawi (2015–2016)	8510 (70.4)	3581 (29.6)	12 091 (100)	
Mozambique (2015)	888 (60.1)	590 (39.9)	1478 (100)	
Nigeria (2018)	10 085 (73.6)	3620 (26.4)	13 705 (100)	
Niger (2012)	4001 (85.2)	695 (14.8)	4696 (100)	
Namibia (2013)	171 (65.5)	90 (34.5)	261 (100)	
Sierra Leone (2013)	3768 (68.2)	1755 (31.8)	5523 (100)	
Togo (2013–2014)	2739 (70.4)	1151 (29.6)	3890 (100)	
Tanzania (2015–2016)	4231 (89.1)	519 (10.9)	4750 (100)	
Uganda (2016)	6175 (77.5)	1793 (22.5)	7968 (100)	
Zambia (2018)	3872 (44.9)	4752 (55.1)	8624 (100)	

ANC, antenatal care.

Zambia has instituted national guidelines for IPTp-SP since 2004.[41] At the same time, previous evidence indicate that Zambia has one of the highest optimum IPTp-SP uptake within SSA (89%).[42 43] In the case of Gambia, where the lowest optimum IPTp-SP was recorded, Anya *et al*[44] explained that most women initiate ANC in the first trimester but fail to attend ANC within the second trimester when IPTp-SP is to be initiated. These and other country-specific circumstances may account for the significant variation observed across the surveyed countries.[44]

Thus, our findings should be understood in the context of the wide range of years covered (2012–2018) and the influence survey year is likely to have on optimal IPTp-SP coverage. Generally, since the latest WHO recommendation to administer IPTp at each ANC visit spaced at least a month apart beginning in the second trimester, IPTp3 +coverage has increased significantly

Of the four empowerment indicators, only one showed significant association with optimum IPTp-SP uptake in the final model, that being knowledge level (measured by women's educational attainment, exposure to radio, television and newspaper). Women who had high knowledge were more likely to achieve the recommended IPTp-SP uptake than those who had low knowledge. Though insignificant, working women had higher odds of optimum IPTp-SP uptake relative to women who were

Table 3 Multilevel results of individual-level, community-level and country-level predictors of intermittent preventive treatment of malaria during pregnancy with sulphadoxine-pyrimethamine uptake in sub-Saharan Africa

	Model 1	Model 2		Model 3		Model 4	
	Empty model	aOR	(95% CrI)	aOR	(95% CrI)	aOR	(95% CrI)
Fixed effects							
Individual-level factors							
Knowledge	1	(1 to 1)	1	(1 to 1)	1	(1 to 1)	
Low							
Medium	1.109**	(1.025 to 1.188)	1.107**	(1.035 to 1.184)	1.108**	(1.036 to 1.186)	
High	1.296***	(1.200 to 1.402)	1.297***	(1.202 to 1.400)	1.298***	(1.206 to 1.398)	
Acceptance of wife beating							
Low	1	(1 to 1)	1	(1 to 1)	1	(1 to 1)	
Medium	0.950	(0.887 to 1.017)	0.947	(0.886 to 1.012)	0.952	(0.891 to 1.015)	
High	0.941	(0.877 to 1.008)	0.937	(0.869 to 1.010)	0.941	(0.874 to 1.012)	
Decision-making capacity							
Low	1	(1 to 1)	1	(1 to 1)	1	(1 to 1)	
Medium	0.943	(0.864 to 1.030)	0.938	(0.861 to 1.021)	0.939	(0.862 to 1.022)	
High	0.942	(0.884 to 1.005)	0.937	(0.875 to 1.003)	0.941	(0.882 to 1.002)	
Labour force participation							
Not working	1	(1 to 1)	1	(1 to 1)	1	(1 to 1)	
Working	1.122*	(1.005 to 1.252)	1.139*	(1.015 to 1.278)	1.114	(0.990 to 1.254)	
Age							
15–19	0.894	(0.712 to 1.123)	0.919	(0.725 to 1.165)	0.889	(0.725 to 1.089)	
20–24	1.050	(0.878 to 1.255)	1.082	(0.892 to 1.313)	1.046	(0.886 to 1.234)	
25–29	1.009	(0.849 to 1.200)	1.039	(0.867 to 1.245)	1.006	(0.859 to 1.178)	
30–34	1.042	(0.879 to 1.234)	1.071	(0.896 to 1.280)	1.037	(0.887 to 1.213)	
35–39	1.067	(0.901 to 1.263)	1.097	(0.913 to 1.319)	1.063	(0.907 to 1.244)	
40–44	1.108	(0.927 to 1.327)	1.137	(0.937 to 1.380)	1.103	(0.932 to 1.306)	
45–49	1	(1 to 1)	1	(1 to 1)	1	(1 to 1)	
Wealth quintile							
Poor	1	(1 to 1)	1	(1 to 1)	1	(1 to 1)	
Middle	0.931	(0.858 to 1.029)	0.931	(0.853 to 1.021)	0.911	(0.882 to 1.034)	
Rich	0.941	(0.858 to 1.057)	0.933	(0.843 to 1.015)	0.915	(0.841 to 1.077)	
Marital status							
Married	1	(1 to 1)	1	(1 to 1)	1	(1 to 1)	
Not married	1.095	(0.812 to 1.254)	1.322	(0.893 to 1.801)	1.081	(0.739 to 2.06)	
Gravidity							
1	1.191***	(1.082 to 1.311)	1.180***	(1.070 to 1.300)	1.179***	(1.073 to 1.295)	
2	1.060	(0.983 to 1.144)	1.050	(0.971 to 1.135)	1.050	(0.974 to 1.131)	
3	1	(1 to 1)	1	(1 to 1)	1	(1 to 1)	
ANC visit							
No visit	1	(1 to 1)	1	(1 to 1)	1	(1 to 1)	
<4	0.927	(0.918 to 1.051)	0.950	(0.802 to 1.125)	0.918	(0.800 to 1.052)	
≥4	1.288***	(1.101 to 1.491)	1.313**	(1.101 to 1.564)	1.267**	(1.099 to 1.773)	
Have insecticide treated net							
No	1	(1 to 1)	1	(1 to 1)	1	(1 to 1)	
Yes	1.059	(0.990 to 1.132)	1.065	(0.995 to 1.141)	1.071	(0.999 to 1.127)	
Health insurance							

Continued

Table 3 Continued

	Model 1	Model 2		Model 3		Model 4	
	Empty model	aOR	(95% CrI)	aOR	(95% CrI)	aOR	(95% CrI)
No		1.032	(0.921 to 1.155)	1.036	(0.916 to 1.173)	1.018	(0.932 to 1.135)
Yes		1	(1 to 1)	1	(1 to 1)	1	(1 to 1)
Community-level factors							
Residence							
Urban				1	(1 to 1)	1	(1 to 1)
Rural				0.783**	(0.610 to 0.862)	0.829**	(0.732 to 0.908)
Socioeconomic disadvantage							
Tertile 1 (least disadvantage)				1.024	(0.936 to 1.120)	1.027	(0.940 to 1.123)
Tertile 2				0.990	(0.907 to 1.080)	0.992	(0.913 to 1.077)
Tertile 3 (most disadvantaged)				1	(1 to 1)	1	(1 to 1)
Country-level factor							
Income level							
Low (<US$1036)						1	(1 to 1)
Lower middle (US$1036–4045)						1.723***	(1.386 to 2.353)
Upper middle income (US$4046–12 535)						3.268***	(2.392 to 4.098)
Random effect							
Country level							
Variance (SE)	1.853 (1.213,2.83)	1.994	(1.200 to 3.311)	1.970	(1.211 to 3.206)	2.167	(1.221 to 3.844)
ICC, %	25.9 (21.7,33.)	27.0	(18.6 to 37.4)	26.7	(18.7 to 36.5)	28.6	(18.9 to 40.8)
MOR	3.66 (2.86,4.9)	3.85	(2.84 to 5.67)	3.81	(2.86 to 5.52)	4.07	(2.87 to 6.49)
Explained variation	Ref	18.0	(15.22 to 21.51)	19.42	(14.88 to 23.00)	20.01	(15.92 to 25.01)
Community level							
Variance (SE)	1.999 (1.088 to 2.23)	2.098	(1.952 to 2.256)	2.119	(1.958 to 2.293)	2.118	(1.960 to 2.288)
ICC, %	53.9 (41.1 to 60.)	55.4	(48.9 to 62.8)	55.4	(49.0 to 62.5)	56.5	(49.1 to 65.1)
MOR	3.85 (2.70 to 4.1)	3.98	(3.79 to 4.19)	4.01	(3.80 to 4.24)	4.01	(3.80 to 4.23)
Explained variation	Ref	24.51	(19.41 to 31.11)	23.16	(17.21 to 28.44)	22.99	(19.21 to 28.66)
Model fit statistics							
DIC	104 168	11 522		10 982		11 211	
Sample							
Country	20	20	20	20	20	20	20
Community	10 478	10 478	10 478	10 478	10 478	10 478	10 478
Individual	96 765	96 765	96 765	96 765	96 765	96 765	96 765

Exponentiated coefficients; 95% CIs in brackets *p <0.05, **p <0.01, ***p <0.001.
ANC, antenatal care; DIC, deviation information criterion; ICC, intracluster correlation; MOR, median OR.

not working. However, women with high acceptance of domestic violence and low decision-making capacity had lower odds of optimum IPTp-SP uptake.

Women's empowerment is multidimensional, operating through diverse pathways with varied indicators.[19 20 45] The finding that women with high knowledge have a higher chance of optimum IPTp-SP emphasises the importance of widening women's knowledge base. Women with the right knowledge are likely to be active in household decision-making, influence decisions in their favour and take the right precautions to guarantee their holistic well-being.[46 47] SSA governments and their partner

organisations need to advance women's knowledge base and enhance their labour force participation prospects in order to assuage and ultimately end MiP. The findings on women's empowerment (knowledge) and achievement of three or more IPTp-SP doses go a long way to explain why MiP appears common in SSA compared with other regions of the world.

It is well established that formal education is a dominant avenue for knowledge acquisition[48] and has a positive impact on health.[49] In the case of SSA, however, females generally lag behind on the education ladder.[50–52] As a result, IPTp-SP campaigns must target women with less formal education. Of essence, education via various mass media outlets, especially radio, can be utilised due to its wide coverage and acceptance in SSA.[53–55] Women's empowerment is therefore essential to uptake, and due to its multidimensionality, varied context-specific approaches may be required between and within the respective countries. For instance, while knowledge enhancement alone may be enough for one country, in other countries, widening employment avenues, labour force participation, together with enhanced decision-making prospects may be required to achieve a markable improvement in uptake of IPTp SP. Priority should also be given to the nuances within and across communities to develop targeted interventions that can yield the desired outcome.

Single women were noted to have higher odds of optimum IPTp-SP uptake. A single woman is likely to be independent in her life choices and decisions. Being independent in decision-making is a notable pathway to empowerment and supports the movement that empowered women are likely to use health service optimally and make choices that would enhance their well-being.[36 46] A number of communities in SSA are patriarchal and some married/in-union women in such communities may require permission to access IPTp-SP and healthcare in general.[56–58] Subsequently, these women may have lower chances of achieving the recommended dosage than those who are single.

Women with one birth achieved the recommended IPTp-SP during the last pregnancy compared with those with three births. Women who have one birth may be relatively young with little birthing experience and may consequently adhere to health workers' advice with ease. However, those with multiple births may be tempted to rely on their own experiences. Additionally, those with single births are likely to be desperate for healthy newborns compared with women who already have about three children.[59] This could motivate women with one birth to enrich their knowledge about protective measures, including how to protect themselves and their fetus from possible adverse pregnancy or birth consequences. They would eventually adhere to all the precautions, drug regimen and antimalaria options, including achieving the recommended IPTp-SP dosage, as suggested by a study from Cameroon.[60]

Women who had eight or more ANC visits were associated with a higher likelihood of three or more IPTp-SP doses relative to those who did not attend ANC during their last pregnancies. ANC presents an opportunity for health professionals to educate pregnant women on a wide range of required precautions for a positive pregnancy outcome.[61 62] As such, ongoing MiP interventions that do not advocate ANC need to be reviewed to incorporate the essence of ANC for all pregnant women. This would increase the chances that a pregnant woman will hear about and receive the recommended IPTp-SP dosage.

Women in rural locations had lower odds of achieving the recommended IPTp-SP dosage. A common trait across SSA is that health facilities and health personnel are concentrated in urban locations at the detriment of rural areas.[63–65] Besides, there is also limited health facility access (distance, cost of transport, cost of lost labour, limited ANC clinic hours, etc) in rural settings coupled with limited supplies including IPTp-SP.[66] These disparity in healthcare access and IPTp-SP may account for our finding. Improving educational standards in rural locations, incentivising health professionals financially and providing highly subsidised accommodation facilities can motivate health professionals to accept postings in rural locations.[67] Health professionals are likely to accept postings and work in rural settings if they are convinced their children can access schools that are comparable to those in urban locations.[68]

Women in upper-middle income countries were more than three times likely to have the recommended IPTp-SP dosage compared with those in low-income countries. This plausibly indicates that IPTp-SP is likely prominent when a country has a robust economy. However, this does not imply that low-income countries cannot overcome malaria in pregnancy with IPTp-SP. Instead, there is the need for the low-income countries in SSA to prioritise and increase investments in MiP interventions to secure the well-being of pregnant women and their newborns.

Strengths and limitations

This study presents multicountry evidence of IPTp-SP uptake nested within community and national level factors. The surveys represent each of the included countries, and thereby findings, conclusions and recommendations can be generalised to all reproductive aged women in the countries studied. The study has some limitations however. The cross-sectional design does not allow causal inference between the independent variables and IPTp-SP uptake. For a cross-sectional study, exposure should be measured at the same time, however that was not the case for this study as data collection periods varied across countries. However, surveys for all of the countries fall within the same phase/version of the DHS and followed the same methodological procedures, which makes them comparable. Several studies have followed the same approach.[69–73] There is also the possibility of recall and social desirability bias in reporting the number of times IPTp-SP was taken. The study did not account for the level of malaria risk within the specific countries or

communities. However, the findings reflect true optimum IPTp-SP uptake in the included countries.

CONCLUSION

In all, 29.2% of the women studied had optimal IPTp-SP uptake ranging from 55.1% (in Zambia) to 6.9% (in Gambia). The study has revealed which category of women to target to increase IPTp-SP uptake across SSA countries. It has further indicated the importance of acknowledging community and country-level factors in IPTp-SP uptake. The study's outcome suggests that SSA countries in the low-income category should increase budgetary allocation to maternal health, particularly IPTp-SP interventions. IPTp-SP advocacy behavioural change communication strategies must focus on women with low knowledge, rural dwellers, those who do not meet the minimum of eight ANC visits and married women. In essence, SSA countries may have to incentivise women who attend ANC in order for health professionals to have greater opportunity to administer IPTp-SP. These incentives can be non-monetary (eg, respectful and person-centred care) or gifts.

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