Community-based strategies to increase coverage of intermittent preventive treatment of malaria in pregnancy with sulfadoxine–pyrimethamine in sub-Saharan Africa: a systematic review, meta-analysis, meta-ethnography, and economic assessment

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Summary

Background Community-based approaches might increase uptake of intermittent preventive treatment of malaria in pregnancy with sulfadoxine-pyrimethamine (IPTp-SP). We assessed the effects of community-based approaches on IPTp-SP and antenatal care coverage, and barriers and facilitators to implementation in sub-Saharan Africa.

Methods We did a systematic review, meta-analysis, meta-ethnography, and economic assessment. We searched the WHO International Clinical Trials Registry Platform, PubMed, the Malaria in Pregnancy Library database, Medline, Global Health and Global Health Archives, and the Cochrane Library for trials, mixed-methods, qualitative, and cost-effectiveness studies of community health worker promotion of antenatal care, IPTp-SP delivery, or both, with no language restrictions, published before March 21, 2024. Information on interventions, number of IPTp-SP doses, antenatal care visits, and barriers and facilitators were extracted. We did a meta-analysis (random effects) comparing effects on two or more or three or more IPTp-SP doses and one or more or four or more antenatal care visits. We followed Noblit and Hare's method of meta-ethnography to synthesise qualitative findings, using reciprocal translation and line-of-argument synthesis. We developed a theory for increased community IPTp-SP uptake. We also summarised cost and cost-effectiveness studies. This study is registered with PROSPERO, CRD42022364114.

Findings Of 4753 records screened, we included 23 (0·5%) reporting on 15 studies. Community health worker involvement was associated with an increase in two or more IPTp-SP doses (pooled risk ratio 1·48, [95% CI 1·24–1·75]; 12 sub-studies; I^2 94·7%) and three or more IPTp-SP doses (1·73 [1·19–2·50]; ten sub-studies, I^2 97·5%), with no decrease in four or more antenatal care visits (1·17 [1·00–1·36]; 13 sub-studies; I^2 90·3%). Cluster-randomised controlled trials showed a lower increase in coverage of three or more IPTp-SP doses (1·08 [1·00–1·16]; I^2 0·0%; six studies) compared with before-and-after studies (2·86 [1·29–6·33]; I^2 98·9%; four studies; subgroup analysis p=0·019). Barriers to community health worker delivery of IPTp-SP included women's fear of side-effects, lack of knowledge, lack of trust in community health workers, and sociocultural factors. Community sensitisation, engagement of husbands, pre-established community health worker networks, and trained and supported community health workers facilitated IPTp-SP delivery by community health workers. Incremental cost-effectiveness ratios ranged from $1·1 to $543 per disability-adjusted life-year averted.

Interpretation Community-based approaches increased IPTp-SP coverage and might have a positive effect on the number of antenatal care visits in addition to being cost-effective, although we found high heterogeneity among studies. Community sensitisation and engagement in addition to established, trained, and supported community health workers can facilitate acceptability, delivery, and uptake of IPTp-SP delivered by community health workers.

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For the French translation of the abstract see Online for appendix 1

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Introduction

WHO recommend intermittent preventive treatment for preventing malaria in pregnancy with sulfadoxine–pyrimethamine (IPTp-SP) in areas of moderate-to-high malaria transmission, to be administered monthly after 13 weeks of gestation through scheduled antenatal care visits.[1] IPTp-SP decreases the incidence of low birthweight, neonatal mortality, and maternal severe anaemia.[2] Yet, 30 years after its recommendation, IPTp-SP coverage remains low relative to the frequency of antenatal care visits.[3] To close this gap and address underlying inequities, WHO have recommended that countries explore the use of other delivery methods, including community-based approaches, to promote or

Research in context

Evidence before study

We searched the Cochrane Library, EBSCOhost including Medline, Global Health and Global Health Archives, the International Clinical Trial Registry Platform, the Malaria in Pregnancy Library, and PubMed for studies on the use of community health workers to increase the uptake of intermittent preventive treatment of malaria with sulfadoxine–pyrimethamine (IPTp-SP) using the search terms "(pregnant women OR provider* OR ANC service* OR community health worker*) AND (intermittent preventive treatment*) AND (delivery OR administration OR distribution OR uptake*)". The initial search included studies published between April 1, 2012, and Sept 19, 2022, and was updated on March 20, 2024, without language restrictions.

We found one systematic review and meta-analysis of factors affecting the delivery, access, and use of interventions to prevent malaria in pregnancy in sub-Saharan Africa by Hill and colleagues, which included publications until April, 2012. This study found community-based approaches to be effective at increasing the IPTp uptake; however, results on the effect on antenatal visits were mixed.

Added value of this study

Our review provides a comprehensive assessment of the effects of community health worker involvement in the promotion, community-based delivery, or both, of IPTp-SP on the number of sulfadoxine–pyrimethamine doses and antenatal visits and summarises and integrates existing knowledge from qualitative research and costing studies. This analysis included 15 studies, of which 11 were quantitative. Overall, we found that community health worker involvement was likely to increase the number of IPTp-SP doses without decreasing the number of antenatal visits and was found to be cost-effective. For the provision of IPTp-SP by community health workers in addition to antenatal clinics, we identified factors that prevented or contributed to the uptake of IPTp-SP, and developed a theory that highlights the importance of community involvement to address sociocultural barriers and of the linkage between community health workers and the health system.

Implications of all the available evidence

This systematic review, meta-analysis, meta-ethnography, and cost-effectiveness analysis covering all aspects of community health worker involvement to improve IPTp coverage, provides evidence on the effectiveness and health systems and community perspectives of the strategy. Findings can be used by public health officials and policy makers to inform potential integration of community-based strategies with antenatal care channels to increase IPTp-SP coverage. The developed theory of community delivery of IPTp-SP leading to increased uptake can provide a useful tool to support the planning and design of such strategies. Where possible, implementation of community delivery of IPTp-SP should include inbuilt process evaluation to identify which components of the strategy work best, where, how, and why.

deliver IPTp-SP while recognising that antenatal care remains an important platform for delivering IPTp-SP alongside other essential antenatal care.[4] Community health workers (CHWs) already carry out diverse health interventions in communities, including malaria preventive and curative services,[5] and WHO have provided guidelines for their optimal use.[6]

A previous systematic review[7] of factors affecting the delivery and uptake of IPTp-SP found few studies that assessed community-based promotion or delivery strategies. Initial studies[8,9] noted that although use of CHWs increased IPTp-SP coverage, an unintended consequence was a decrease in the number of antenatal care visits among women receiving IPTp-SP from CHWs (c-IPTp-SP).[8,9] This finding was concerning because of the missed benefits of accessing other essential antenatal care services, such as identification of high-risk pregnancies, iron and folate supplementation, and treatment of infections. The few studies that explored the feasibility and efficacy of c-IPTp reported that the strategy is feasible from the CHW perspective, acceptable to pregnant women, and improves pregnancy outcomes.[8,10–13]

See Online for appendix 2

In WHO's 2022 consultation meeting report, the members recommended that c-IPTp might improve IPTp-SP coverage and also promote early antenatal care attendance and retention.[4] With new studies now available, we assessed the effectiveness of community-based approaches for increasing IPTp-SP uptake, the barriers and facilitators to implementation, and cost-effectiveness of these approaches in sub-Saharan Africa.

Methods

Search strategy and selection criteria

Using search terms developed on the basis of the Population, Intervention, Condition, Control, Outcomes, Timing, Setting (PICOTS) framework,[14] we searched the WHO International Clinical Trials Registry Platform, PubMed, the Malaria in Pregnancy Library database, Medline, Global Health and Global Health Archives, and the Cochrane Library for original articles, abstracts, reports, and protocols published from April 1, 2012, until Sept 19, 2022 with no language restrictions. A similar review[7] was conducted in 2012 and studies from that review were included. Search terms were pretested beforehand to ensure they captured relevant records. The search was updated on March 20, 2024, (appendix 2 p 1). Records were uploaded into EndNote to identify and remove duplicates. Two reviewers (KKo and AMVE) reviewed the abstracts independently and disagreements were resolved after

discussion, or by a third reviewer (JH). For those abstracts retained, KKo and AMVE reviewed the full texts independently and compared results. Original research studies done in sub-Saharan Africa with information on interventions using CHWs (used here as a generic term for a range of cadres) to promote antenatal care or deliver IPTp-SP to improve IPTp-SP coverage were eligible. We included original studies with information on factors affecting c-IPTp-SP, including user-satisfaction surveys and qualitative research nested within clinical trials or implementation studies, in the meta-ethnography, and costs and cost-effectiveness studies of c-IPTp-SP in the economic assessment. We excluded studies with no information on the delivery method of IPTp-SP and studies including only women with HIV. Reference lists were assessed for additional records. Lists of records excluded and reasons for exclusion are provided in appendix 2 (pp 26–32).

Data extraction

Two reviewers (KKo and AMVE) independently extracted data from quantitative studies using a pre-piloted electronic data extraction form, and KKo and JH independently extracted data from qualitative and mixed-methods studies using a Microsoft Excel spreadsheet. Quality assessment was performed by two reviewers (KKo and AMVE) using the Risk of Bias In Non-randomized Studies of Intervention (ROBINS-I)[15] tool for non-randomised cohort studies and the Cochrane risk-of-bias tool (RoB 2) for randomised trials.[16] KKo and JH assessed qualitative studies using the Clinical Appraisal Skills Programme's Qualitative checklist[17] and mixed-methods studies using the Mixed Methods Appraisal.[18] Disagreements were resolved through discussion or consultation with the third reviewer (AMVE or JH).

Data extracted from quantitative studies included the study period and location; design (randomised controlled trial, before-and-after [in which a post-intervention survey is compared with a baseline survey], or quasi-experimental parallel); study population; number and demographics of participants; maternal characteristics (age and gravidity); proportions of women receiving one or more, two or more, three or more, or four or more doses of IPTp-SP; timing of receipt of first and second dose of IPTp-SP (months of gestation); antenatal care visits (≥1, ≥2, ≥3, or ≥4 visits); and interventions' effect measures. Additionally, details on the interventions were recorded (context, setting, intervention strategy, and actors). We extracted qualitative data on the barriers and facilitators of IPTp-SP delivery by CHWs by the primary (participants' accounts) and secondary themes (author's interpretation of primary themes) identified by the authors of the eligible studies. The themes were further categorised into data source: pregnant women, CHWs, and health facility providers. Perception and satisfaction data were extracted from one quantitative study using an interviewer-administered questionnaire. Cost and cost-effectiveness information were extracted when available and assessed by two reviewers (KKo and EW) using the CHEERS checklist.[19]

Data analysis

We analysed quantitative and qualitative findings separately. Not all quantitative studies provided adjusted risk ratios (RRs) or odds ratios. All eligible studies provided unadjusted (raw) coverage data for antenatal care visits and IPTp-SP. Two studies provided intra-cluster correlation coefficients (ICCs), ranging from 0·02 to 0·2.[11,20] Using ICCs of 0·02, 0·06, 0·09, and 0·2, and estimating the number of participants per cluster (appendix p 2), we calculated design effects for each study that did not provide adjusted RRs or odds ratios using the formula described by Higgins and colleagues.[21] For studies with RRs adjusted for clusters (and other covariates), we used the reported effect estimates. When adjusted odds ratios were available, these were transformed into RRs using the method described by Zhang and colleagues.[22] We calculated the pooled RR (pRR) for the outcomes of IPTp-SP doses and antenatal care visits and tabulated them using these different design effects to assess the range of potential results. Because these results were overall similar, we presented the meta-analysis (random effects) and forest plots using an ICC of 0·06.[20] We did subgroup analysis by study design, intervention strategy, baseline IPTp-SP and antenatal care coverage, and location of first dose of IPTp-SP (antenatal care *vs* community), with the p value estimated using meta-regression. We had insufficient data to assess effect by age or gravidity. Analyses were done using Stata (version 17). Heterogeneity was quantified using the I^2 statistic.[23] To examine the presence of small-study effects due to potential publication and other biases, we used funnel plots with effect size (risk ratio [RR] of ≥3 doses of IPTp-SP and ≥4 antenatal care visits) as a function of study size (the standard error of the log RR), and Egger's test[24] as a statistical test for funnel plot asymmetry. We did a sensitivity analysis using the quality assessment in subgroup analysis (low-to-moderate *vs* high-quality studies) and when excluding one large implementation trial with an outsized effect (appendix 2 pp 2–3).[25]

We used the meta-ethnography approach by Noblit and Hare[26] adopted by Munro and colleagues[27] to analyse the qualitative studies. Primary and secondary themes created by the authors of the primary studies that related to barriers and facilitators of c-IPTp were used to create higher-order thematic categories through translational synthesis. The higher-order themes were then compared and matched across studies to ensure they conveyed comparable themes and concepts. Finally, we synthesised the translation synthesis results through a line of argument to create a theory of how the higher-order themes interacted to impede or promote the acceptability and uptake of c-IPTp.

As a final synthesis, we used the qualitative findings to explain the results of the meta-analysis on the effect of community-based approaches on IPTp-SP and antenatal care uptake. Additional subgroup analyses of the effect of key themes (free antenatal care service, pre-existing CHW network, CHW incentives, CHW training, and CHW selection) on the number of IPTp-SP doses and antenatal care visits were explored, but the data were insufficient.

A narrative synthesis of the cost and cost-effectiveness analyses was undertaken because of the scarcity of available studies and the diversity in the measures reported.

The protocol was registered with PROSPERO, CRD42022364114.

Role of the funding source

The funder of the study had no role in the study design, data collection, data analysis, data interpretation, or writing of the report.

Results

We identified 4753 records. After review of full-text articles, we included 23 (0·5%) records covering 15 studies, of which 11 (73%) were quantitative studies, two qualitative (13%), and two mixed methods (13%). We included 12 studies in the meta-analysis, five in the meta-ethnography, and three in the cost synthesis (figure 1), with overlap of some studies (table 1).

The 12 studies included in the meta-analysis were five cluster-randomised controlled trials,[11,20,28–32] four non-randomised controlled trials,[8,9,13,33,34] two non-randomised before-and-after studies,[35,37] and one large-scale implementation trial.[25] Five studies assessed only two or more doses of IPTp as the outcome, which was policy at the time of the study (table 1).[8,9,13,33,34,37] One study[25] did not assess antenatal care visits. Studies used different intervention strategies (appendix pp 4–7) and consisted of CHW promotion of antenatal care visits either in addition to c-IPTp (nine studies)[8,9,13,33,34,37] or without (two studies,[28–31] one with CHWs conducting rapid diagnostic tests[30,31]) and one study providing home-based antenatal care by CHWs without IPTp-SP delivery).[20] Four (33%) of the 12 studies were graded good, three were moderate, and five were low quality (appendix pp 8–9). Two studies were done in more than one country, resulting in 17 sub-studies for analysis when split by countries.[28,29,35,36]

All 12 studies provided data on the effects of CHW involvement on uptake of IPTp-SP doses. CHW involvement was associated with an increase in one or more IPTp doses (pRR 1·05 [95% CI 1·01 to 1·09]; eight sub-studies; I^2 94·0%), two or more IPTp doses (1·48 [1·24 to 1·75]; 12 sub-studies; I^2 94·7%), and three or more IPTp doses (1·73 [1·19 to 2·50]; ten sub-studies; I^2 97·5%; figure 2). Three studies provided difference-in-differences estimates for three or more IPTp doses with a pooled estimate of 0·23 (–0·04 to 0·50; six sub-studies; I^2 96·5%; appendix p 10).

By intervention strategy, c-IPTp was associated with an increase in two or more IPTp doses and three or more IPTp doses (appendix 2 pp 11–12). One study using antenatal care promotion by CHWs showed a beneficial effect on two or more IPTp doses in women in first or second pregnancies.[30,31] We found no significant difference between the effect of c-IPTp and antenatal care promotion on the uptake of two or more IPTp doses (p=0·071) or three or more IPTp doses (p=0·16; appendix 2 pp 11–12).

In five of the c-IPTp sub-studies, the first dose was provided at antenatal care whereas the remaining seven studies allowed the first dose to be given by CHWs.[8,9,13,25,34–36] This difference affected the findings for two or more IPTp doses (pRR for first IPTp-SP dose given by CHWs 2·12 [95% CI 1·62–2·76] and pRR for first IPTp-SP dose in antenatal care 1·09 [0·98–1·20]) but not for three or more IPTp doses (appendix 2 pp 11–12). Studies using a before-and-after design showed higher increases in coverage of three or more IPTp doses than did cluster-randomised controlled trials (p=0·0193; appendix 2 p 13).

Subgroup analysis by study quality showed more modest effects in good quality studies compared with moderate studies for three or more IPTp doses (p=0·019; appendix 2 p 13). The difference was less striking for two or more IPTp doses (p=0·50; appendix 2 p 12). Results of a sensitivity analysis, with the removal of the large implementation trial[25] and a leave-one-out forest plot in which each study is removed one by one are given in appendix 2 (pp 15–16).

We included 11 studies that reported on the effects of CHW involvement on the number of antenatal care visits.[8,9,11,13,20,28–37] CHW involvement in antenatal care promotion and IPTp-SP delivery showed increases in three or more antenatal care visits (pRR 1·13 [95% CI 1·06–1·20]; five sub-studies; I^2 0·0%), and four or more antenatal care visits (1·17 [1·00–1·36]; 13 sub-studies; I^2 90·3%), and little difference for one or more or two or more antenatal care visits (figure 3). Two studies provided difference-in-difference estimates for four or more antenatal care visits, with a pooled estimate of 0·18 (0·03–0·33; I^2 0·0%; appendix 2 p 17). CHW involvement was not associated with an early antenatal care start (appendix 2 p 18).

The pRR for four or more antenatal care visits was 1·26 (95% CI 1·02–1·56) in two studies using antenatal care promotion and community intermittent screening and treatment, 1·25 (1·08–1·43) in the study using home-based antenatal care visits by CHWs, 1·61 (0·85–3·04) in a study that used antenatal care promotion only, and 1·14 (0·95–1·56) in studies using c-IPTp (p=0·90 for subgroup analysis; appendix 2 p 19). Increases in four or more antenatal care visits were seen in cluster randomised trials and quasi-experimental studies but

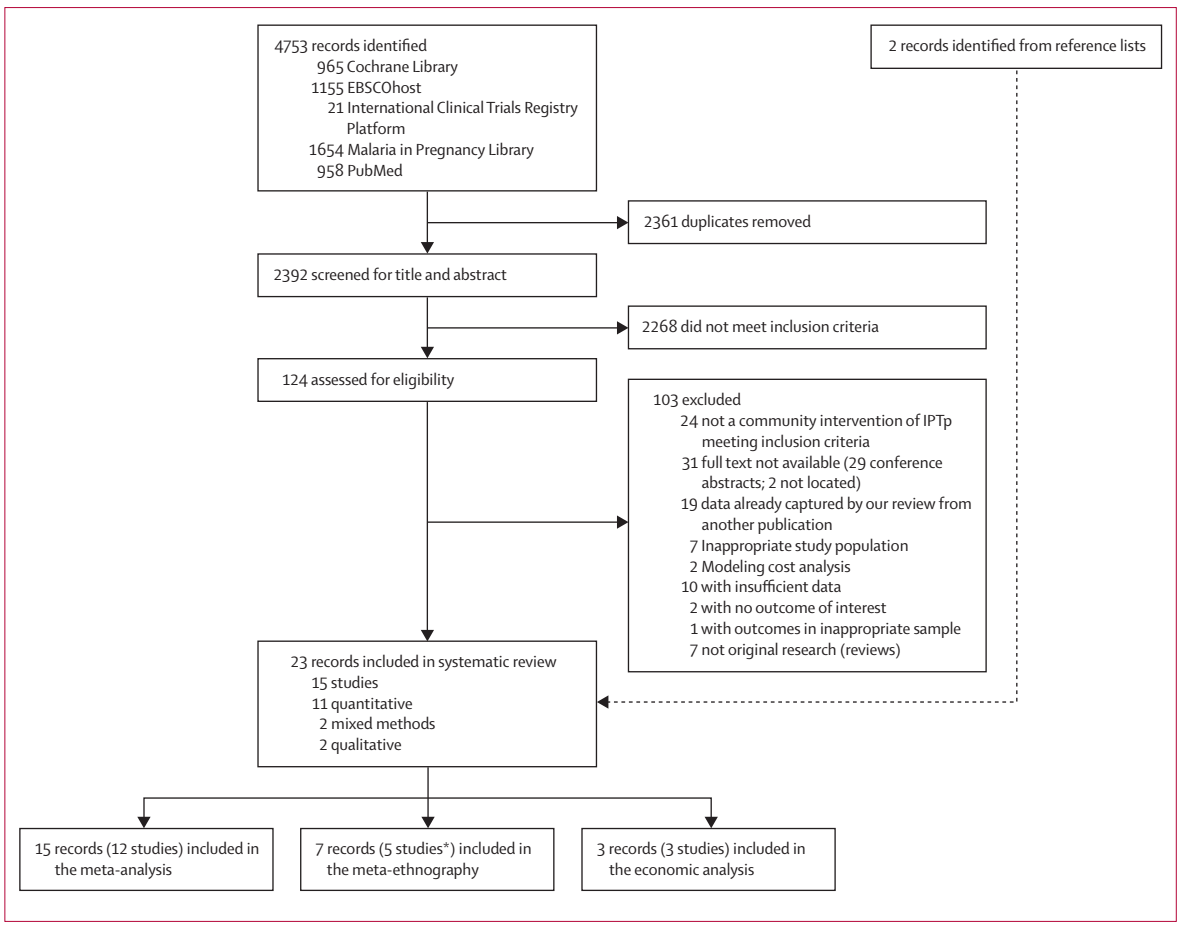

Figure 1: **Study selection**
*The total number of studies across the three analysis groups are not additive as some studies used more than one method, and a study could have multiple records. Some of the studies included in the meta-ethnography and economic analysis overlapped with those included in the meta-analysis; two studies were included in both the meta-analysis and the qualitative synthesis, three studies were included in both the meta-analysis and cost synthesis, and one study was included in all three analyses.

not in before-and-after studies (appendix 2 p 19). The increase in four or more antenatal care visits in c-IPTp studies in which the first IPTp-SP dose was required at antenatal care was not different from that of studies in which the first IPTp-SP could be given by CHWs (appendix 2 p 19). A leave-one-out forest plot showing the effect of each study on four or more antenatal care visits is presented in appendix 2 (p 21).

Five studies using quantitative, qualitative, and mixed methods designs were included in the meta-ethnography. One was a multi-country study in DR Congo, Madagascar, Mozambique, and Nigeria, and the other four were single-country studies.[10,13,33,38–41] Three studies were before-and-after intervention design,[10,38–41] and two studies were endline assessments.[13,33] These studies assessed perceptions, experiences, and satisfaction with c-IPTp among CHWs and health facility workers, and four of them included pregnant or postpartum women.[13,33,38–41] Of the four qualitative and mixed methods studies, one was good quality and three were moderate (appendix 2 p 23).

We identified six overarching themes on barriers to c-IPTp (appendix 2 p 24).

First, lack of trust in CHWs' capacity to administer IPTp-SP was common across studies. CHWs felt that their role was not well understood by pregnant women, that they lacked their trust, and were not able to meet their needs.[10] In the pre-implementation assessment of a multi-country study, pregnant women believed that CHWs would not be adequately trained to address potential complications from IPTp-SP, whereas health-facility providers were concerned that CHWs would be unable to correctly identify gestational age. However, these concerns abated during implementation after CHWs were trained to assess eligibility using women's self-report of fetal movements.[40] Low literacy among CHWs was also cited as a barrier.[10,40] In a multisite study, CHWs in Nigeria selected from outside the community they served were mistaken for informal drug vendors, whereas CHWs in Mozambique who had provided community health services in the past were trusted.[40]

	Country	Study period	Study design	Comparison	Main outcome used for review	Primary outcome	Outcome assessment	Effect measure reported	Age; gravidity*	Sample size, n
Quantitative studies (n=11)										
Msyamboza (2009)[44]	Malawi	2002–04	Quasi-experimental, non-randomised study: 14 interventions and 12 control villages	c-IPTp plus antenatal care promotion *vs* antenatal care promotion and IPTp-SP in antenatal care only	≥2 IPTp-SP doses and ≥2 antenatal care visits	≥2 c-IPTp-SP doses	At birth, between groups, and repeated cross-sectional surveys	..	No information on age; first pregnancy in 484/1752 (27·6%) women	1752
Gies (2009)[45]	Burkina Faso	2003–06	Cluster-randomised controlled trial: 12 health centres, 3 groups (IPTp-SP plus promotion, IPTp-SP without promotion, and weekly chloroquine without no promotion	Antenatal care promotion by CHWs *vs* no promotion	≥2 IPTp-SP doses and ≥3 antenatal care visits	Peripheral and placental parasitaemia, anaemia, and birthweight	At birth, between groups	Odds ratio	Mean age 19·7 years (range 14–41) first or second pregnancy in 2766/2766 (100%) women	2766
Ndyomugyenyi (2009)[46]	Uganda	2007–08	Quasi-experimental, non-randomised study: 40 intervention and 39 control villages, and community's perception of c-IPTp-SP	c-IPTp-SP *vs* IPTp-SP in antenatal care only	≥2 IPTp-SP doses, ≥4 antenatal care visits, and barriers and facilitators of IPTp-SP	Antenatal care attendance IPTp-SP uptake	Repeated cross-sectional surveys in women ≤3 and ≤1 months postpartum	..	Mean age 26·5–27·2 (range 15–47); mean gravidity 3·3–4·1 (range 1–10)	1552
Okeibunor (2011)[47]	Nigeria	2007–10	Quasi-experimental, non-randomised study: 3 intervention and 3 control local government areas	c-IPTp-SP *vs* IPTp-SP in antenatal care only	≥2 IPTp-SP doses and ≥1 antenatal care visits	Insecticide-treated net use, 2 IPTp-SP doses, and antenatal care attendance	Repeated cross-sectional surveys in women ≤6 months postpartum	..	Mean age 25·1–26 1 (SD 5·96–6·24); no gravidity information	2652
Wangalwa (2012)[48]	Kenya	2008–10	Quasi-experimental, before-and-after study: 7 supervision units (around 418 villages)	c-IPTp-SP *vs* IPTp-SP in antenatal care only	≥2 IPTp-SP doses and ≥4 antenatal care visits	≥4 antenatal care visits, proportion of assisted births, proportion receiving postnatal care within 2 days of birth, ≥2 IPTp doses, proportion of women tested and counselled for HIV	Repeated cross-sectional surveys in women 0–23 months postpartum	..	Mean age 25·2 (SD 5·6); no gravidity information	266
COSMIC Consortium (2018)[49]	Benin, Burkina Faso, and the Gambia	2013–16	Cluster-randomised controlled trial	Antenatal care promotion and IST by CHWs *vs* no CHW involvement	≥2 IPTp-SP doses, ≥2 antenatal care visits, and ≥4 antenatal care visits	Placental malaria	At birth, between groups	Odds ratio	Median age 25–26 years (IQR 20-30); first pregnancy in 974/4731 (20·6%) women	4731
Orobaton (2016)[50]	Nigeria	2014–15	Non-randomised, scale-up implementation trial: 3 intervention and 1 control local government areas	c-IPTp-SP and community health information *vs* IPTp-SP in antenatal care only	≥2 IPTp-SP doses and ≥3 IPTp-SP doses	IPTp-SP coverage, child head circumference, stillbirth, and cost of delivering 3 IPTp-SP doses	Antenatal care routine data at endline using IPTp-SP eligibility estimates	..	Not available†	31493
Gutman (2020)[51]	Burkina Faso	2017–18	Cluster-randomised controlled trial: 12 health centres and 2 groups	c-IPTp-SP *vs* IPTp-SP in antenatal care only	≥3 IPTp-SP doses and ≥4 antenatal care visits	3 IPTp-SP doses	Repeated cross-sectional surveys in women ≤9 months postpartum	Difference in difference	Median age 26–27 years (range 18-47); first pregnancy in 175/731 (24%) women	734

(Table 1 continues on next page)

	Country	Study period	Study design	Comparison	Main outcome used for review	Primary outcome	Outcome assessment	Effect measure reported	Age; gravidity*	Sample size, n
(Continued from previous page)										
Rubenstein (2022)[52]	Malawi	2018–20	Cluster-randomised controlled trial: 62 health centres and 2 groups	c-IPTp-SP *vs* IPTp-SP in antenatal care only	≥3 IPTp-SP doses and ≥4 antenatal care visits	Antenatal care attendance, IPTp-SP uptake, timing of antenatal care initiation	Repeated cross-sectional surveys in women ≤12 months postpartum	Difference in difference	Median age 24 years (range 16–45); first pregnancy in 369/1056 (34·9%) women	1057
Gonzalez (2023)[53,54]	DR Congo, Madagascar, Mozambique, and Nigeria	2018–21	Quasi-experimental, non-randomised trial: 12 regions and 458 health facility areas, with staggered implementation	c-IPTp-SP *vs* IPTp-SP in antenatal care only	≥3 IPTp-SP doses, ≥4 antenatal care visits, and ICER of IPTp-SP	≥3 IPTp-SP doses, cost of c-IPTp-SP, DALYs associated with clinical malaria, neonatal mortality, anaemia at birth, low birthweight, and ICER	Repeated cross-sectional surveys in women ≤6 months postpartum	Difference in difference	Mean age 25–27·8 years (SD 5·7–7·2); first pregnancy in 484/1752 (27·6%) women	18215
Kayentao (2023)[55]	Mali	2016–20	Cluster-randomised controlled trial: 137 clusters (160 villages and hamlets) and 2 groups	Door-to-door antenatal care services and referral by CHWs *vs* antenatal care services and referral by CHWs at community health posts	≥3 IPTp-SP doses, ≥1 antenatal care visits, and ≥4 antenatal care visits	Under-5 mortality	Repeated cross-sectional surveys in women ≤12 months postpartum	Risk ratio	No information	5112
Mixed-methods studies (n=2)										
Mbonye (2007)[56,57]	Uganda	2003–05	Quasi experimental, non-randomised trial: 21 intervention and 4 control parishes, with qualitative assessment of the acceptability of antenatal care promotion by CHWs and c-IPTp-SP	c-IPTp-SP‡ *vs* IPTp-SP in antenatal care only	≥2 IPTp-SP doses§, ≥4 antenatal care visits, barriers and facilitators of IPTp-SP, and ICER of IPTp-SP	Proportion of adolescents and primigravidae reached by the intervention, gestational age at recruitment, and proportion who received two doses of IPTp-SP	At birth, between groups	..	Mean age 23·9 years (range 14–46); first pregnancy in 588/2785 (21·1%) women	2785
Okedo-Alex¶ (2022)[58,59]	Nigeria	2019	Baseline perception and acceptability and endline satisfaction of c-IPTp-SP, with surveys and focus-group discussions: 817 community members	c-IPTp-SP plus antenatal care promotion	Barriers and facilitators of IPTp-SP	Perceptions of and acceptability of c-IPTp-SP	Baseline semi structured-interviewer-administered questionnaires and focus-group discussions	..	..	817
Qualitative studies (n=2)										
Burke (2021)[60]	Burkina Faso	2017–18	Before-and-after intervention acceptability study	c-IPTp-SP *vs* IPTp-SP in antenatal care only	Barriers and facilitators of IPTp-SP	Perceptions of facility health care workers and CHWs regarding implementation of the new c-IPTp-SP programme	Baseline semi-structured interviews	..	..	139
Alonso‖ (2022)[61,62]	DR Congo Madagascar, Mozambique, and Nigeria	2018–21	Before, during, and after intervention acceptability and feasibility study	c-IPTp-SP *vs* IPTp-SP in antenatal care only	Barriers and facilitators of IPTp-SP	Key factors influencing c-IPTp-SP acceptability among trial and non-trial participants, antenatal-care providers, CHWs, health management representatives, and community members	4 yearly in-depth interviews, focus-group discussions, and non-participant observation	..	..	3235

(Table 1 continues on next page)

	Country	Study period	Study design	Comparison	Main outcome used for review	Primary outcome	Outcome assessment	Effect measure reported	Age; gravidity*	Sample size, n
(Continued from previous page)										
**Economic studies	(n=3)****									
Mbonye (2008)[43]	Uganda	2003–05	Cost-effectiveness analysis, quasi experimental, non-randomised study: 21 intervention and 4 control parishes	c-IPTp-SP vs IPTp-SP in antenatal care only	ICER of IPTp-SP	≥2 IPTp-SP doses, parasitaemia, low birthweight, and ICER	At birth, between groups and health facility antenatal care cost data	..	Mean age 23·9 years (range 14–46); first pregnancy in 588/2785 (21·1%) women	2785
Orobaton (2016)[35]	Nigeria	2014–15	Cost-effectiveness analysis, scale-up implementation trial, non-randomised study: 3 intervention and 1 control local government areas	c-IPTp-SP and community health information vs IPTp-SP in antenatal care only	Cost of delivery of 3 IPTp-SP doses	IPTp-SP coverage, child head circumference, stillbirth rate, and cost of delivery of 3 IPTp-SP doses	Antenatal care routine data at endline using IPTp-SP eligibility estimates	..	Not available†	31493
Cirera (2023)[42]	DR Congo, Madagascar, Mozambique, and Nigeria	2018–21	Quasi-experimental, non-randomized study with cost-effectiveness analysis: 12 regions and 458 health facility areas, with staggered implementation	of c-IPTp-SP vs IPTp-SP in antenatal care only	ICER of IPTp-SP	Cost of delivery of 3 IPTp-SP doses, cost-effectiveness of c-IPTp-SP, DALYs associated with clinical malaria, neonatal mortality, anaemia at delivery, low birthweight, and ICER	Repeated cross-sectional surveys in women ≤6 months postpartum	..	Mean age 25–27·8 years (SD 5·7–7·2); first pregnancy in 484/1752 (27·6%) women	18215

CHW=community health worker. c-IPTp-SP=intermittent preventive treatment with sulfadoxine–pyrimethamine delivered by community health workers (in addition to antenatal care). DALY=disability-adjusted life-year. ICER=incremental cost-effectiveness ratio. IPTp-SP=intermittent preventive treatment with sulfadoxine–pyrimethamine. IST=intermittent malaria screening and treatment if diagnostic test is positive. *Ranges provided when the information on age and gravidity were not available for the whole sample size, but only by subgroups. †In the subgroup with stillbirth information (n=6711), 1225 (18·3%) women were in their first pregnancy. ‡CHW included traditional birth attendants, drug-shop vendors, community reproductive health workers, and adolescent peer mobilisers. §Denominator for two or more IPTp-SP doses was women who had received one dose of IPTp-SP. ¶Combines data from Okedo-Alex et al (2020)[38] and Okedo-Alex et al (2022).[39] ||Combines data from Alonso et al (2022)[40] and from Enguita-Fernandez et al (2020)[41] and is part of the study reported in Gonzalez et al (2023).[25,36] **These are cost analyses of some of the studies already listed. Mbonye et al (2008)[43] is the cost analysis of the study reported in Mbonye et al (2007)[13]; the study reported in Orobaton et al (2016)[35] included a cost analysis; Cirera et al (2023)[42] is the cost analysis of the study reported by Gonzalez 2023.[25,36]

Table 1: **Study characteristics**

Mistrust in public health services was expressed by some women in Nigeria who thought sulfadoxine–pyrimethamine was used for birth control, and in DR Congo, where some women thought CHWs were sent to kill people with a drug.[40]

Second, women's lack of knowledge on malaria in pregnancy and its consequences and awareness of prevention influenced their antenatal care-seeking practice, impeding IPTp-SP uptake when the first IPTp-SP dose was given at antenatal care. In one study, few women were aware of malaria prevention with IPTp-SP,[40] and post-intervention studies found that women did not attend antenatal care because they were unaware of the importance of antenatal care visits[10,33] or prevention of malaria in pregnancy.[13]

Third, fear associated with IPTp-SP was the most common reason why women refused to take sulfadoxine–pyrimethamine in one multi-country study[40] and a study in Uganda.[33] In the multi-country study, women in Mozambique and DR Congo thought that sulfadoxine–pyrimethamine caused overdue pregnancies and large babies, leading to complications in birth and, in Nigeria, that the drug was associated with infertility.[40] In a Ugandan trial, some women who participated in c-IPTp and experienced side-effects with the first dose did not take the second dose.[13]

Fourth, traditional gender roles were a barrier to c-IPTp in some settings.[10,40,41] For male CHWs, it was considered culturally inappropriate for them to discuss pregnancy matters with married women,[10] and female CHWs needed their husband's permission to conduct home visits and found it more challenging to persuade men in the community to allow their wives to participate in c-IPTp.[10,40] An exception was Mozambique, with a matrimonial power dynamic in which the mother-in-law or female relatives made household decisions, giving women more leeway in health-related decision making.[40]

Fifth, cultural traditions in several settings where pregnant women were expected not to disclose their pregnancy until visibly pregnant were a barrier to CHWs identifying pregnant women eligible for IPTp-SP.[10,33,40] In Burkina Faso and Uganda, the reason for this concealment was fear for the baby's safety from witchcraft.[10,33] In DR Congo, some religious groups not receptive of modern medicine forbade their followers to seek care at a health facility or consume biomedical drugs.[40]

Sixth, organisation of health service delivery and inadequate CHWs working conditions were common barriers across studies and settings. In studies promoting IPTp-SP through antenatal care, long distances to health facilities, long waiting times, high costs of services, and frequent sulfadoxine–pyrimethamine shortages discouraged women from attending antenatal care,[10,13,40] even where services were free of charge.[33,40] Organisation of health service delivery was also a barrier to c-IPTp-SP in countries where the first IPTp dose was to be given at

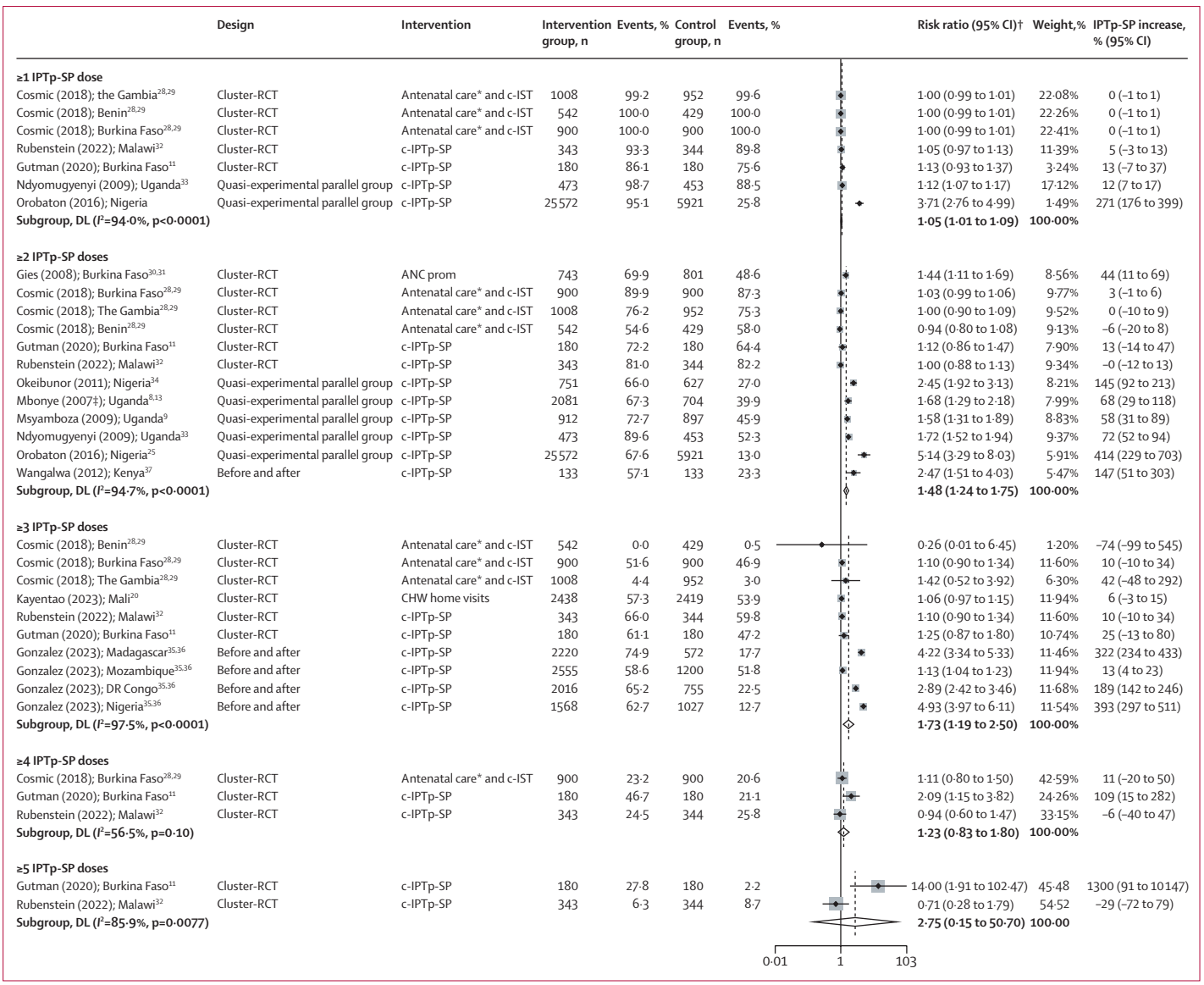

Figure 2: **Forest plot showing the effect of interventions with CHW involvement on coverage of IPTp-SP by dose of IPTp-SP, sub-Saharan Africa, 2008–23**
Sample size and prevalence percentages represent the raw data. CHW=community health worker. c-IPTp-SP=intermittent preventive treatment with sulfadoxine–pyrimethamine delivered by CHWs (in addition to antenatal care). c-IST=intermittent screening and treatment delivered by CHWs. ICC=intra-cluster correlation coefficient. RCT=randomised controlled trial. *Intervention by CHWs to promote antenatal care attendance and IPTp-SP coverage. †Adjusted for clustering with an ICC of 0·06 for studies that did not have an estimate adjusted for clustering available. These include Mbonye (2007; Uganda),[8,13] Msyamboza (2009; Uganda),[9] Ndyomugyenyi (2009; Uganda),[33] Okeibunor (2011; Nigeria),[34] Orobaton (2016; Nigeria),[25] Rubenstein (2022; Malawi),[32] and Wangalwa (2012; Kenya).[37] For Gutman (2020; Burkina Faso) an ICC of 0·09 was used as reported by the study for IPTp-SP.[11] ‡Denominator for two or more IPTp-SP doses was women who had received one dose of IPTp-SP.

antenatal care. CHWs commonly complained about insufficient resources,[10,40] the need for transportation, and inadequate remuneration.[40]

Six overarching themes on facilitators of c-IPTp emerged (appendix p 27).

First, trust in and the traits of CHWs played an important role in the success of c-IPTp. IPTp-SP uptake was facilitated when CHWs were said to be kind, approachable, and sympathetic,[13] and when they reminded women about their next dose.[33] Other attributes included CHWs' commitment regardless of incentives, CHW's finding IPTp-SP easy to deliver, and CHWs' acknowledgment of their role in improving health in the community.[10] The possibility of having both male and female CHWs for home visits was considered an asset; male CHWs were thought to be able to sensitise and convince husbands to support their wives' participation, and female CHWs were considered appropriate for pregnancy-related issues.[13] Trust was an important facilitator of c-IPTp. Women trusted CHWs who they were familiar with—ie, from the same community[13] or relatives.[33] Trust also stemmed from perceived

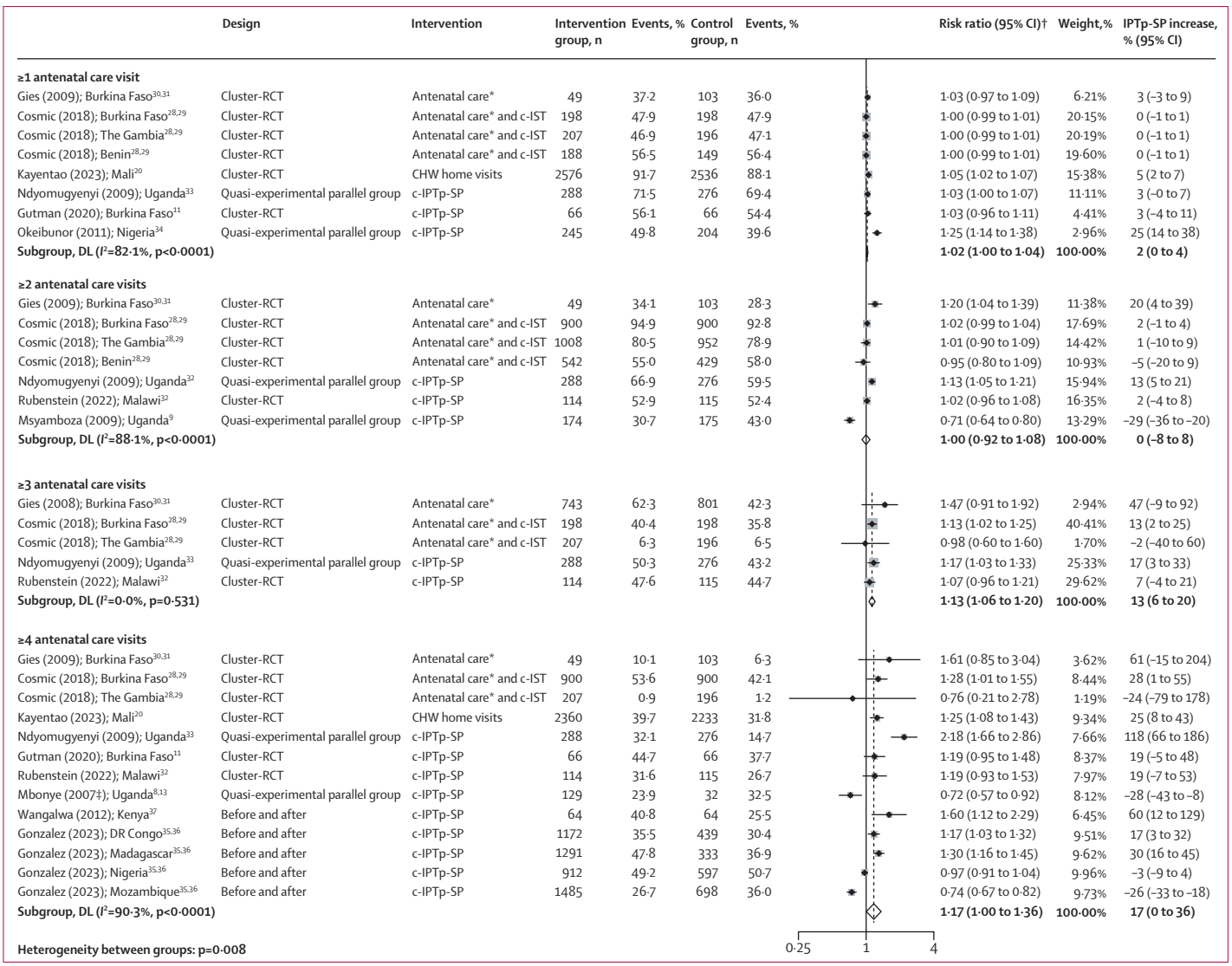

Figure 3: **Forest plot showing the effect of interventions with CHW involvement on antenatal care attendance by number of antenatal care visits, sub-Saharan Africa, 2007–23**
Sample size and prevalence percentages represent the raw data. CHW=community health worker. c-IPTp-SP=intermittent preventive treatment with sulfadoxine–pyrimethamine delivered by CHWs (in addition to antenatal care). c-IST=intermittent screening and treatment delivered by CHWs. ICC=intra-cluster correlation coefficient. RCT=randomised controlled trial. *Intervention by CHWs to promote antenatal care attendance and IPTp-SP coverage. †Adjusted for clustering with an ICC of 0·06 for studies that did not have an estimate adjusted for clustering available. These include Mbonye (2007; Uganda),[8,13] Msyamboza (2009; Uganda),[9] Ndyomugyenyi (2009; Uganda),[33] Okeibunor (2011; Nigeria),[34] Orobaton (2016; Nigeria),[25] Rubenstein (2022; Malawi),[32] and Wangalwa (2012; Kenya).[37] For Gutman (2020; Burkina Faso) an ICC of 0·09 was used as reported by the study for IPTp-SP.[11] ‡Denominator for two or more IPTp-SP doses was women who had received one dose of IPTp-SP.

competence and linkage with health facilities.[40,41] CHW selection by the community was found to be a crucial factor in building trust.[40,41]

Second, CHW capabilities and their role in linking the community with health facilities was highlighted in several settings.[10,40] CHWs were thought to bridge the gap where understaffing prevented health-care providers from reaching remotes areas[33] and, therefore, needed to be integrated with health facilities with appropriate supervision.[13] Both health-facility providers and CHWs considered training and ongoing supervision to provide c-IPTp essential and noted c-IPTp could alleviate health-facility providers' workload.[10,40] CHW training credentials were recommended to be made public to increase community confidence in CHW competencies.[40]

Third, CHW accessibility was a big factor in driving demand for c-IPTp. Increased c-IPTp uptake was seen in Uganda, where CHWs were easily accessible and convenient.[13] The convenience of not having to walk long distances to a health facility was also recognised.[40] Health-care providers appreciated that CHWs could reach women who do not attend antenatal care.[13]

Fourth, community sensitisation and engagement played a crucial role in c-IPTp uptake. Sensitisation in Uganda increased women's knowledge of malaria in

	Country	Study period	Outcome	Health facility cost, US$	Community cost, US$ or DALYs	Difference	Incremental cost-effectiveness ratio, US$
Mbonye (2008)[43]	Uganda	2003–05	Sulfadoxine–pyrimethamine pills	$447·15	$316·63	$130·51	$1·1 per DALY
Mbonye (2008)[43]	Uganda	2003–05	Supply of IPTp-SP	$1461·86	$1887·78	$425·92	..
Mbonye (2008)[43]	Uganda	2003–05	Transport and time to seek IPTp-SP	$1374·46	$1399·02	$24·56	..
Orabaton (2016)[25]	Nigeria	2015	3 doses of IPTp-SP	$6·98	$0·9–1·45	..	..
Orabaton (2016)[25]	Nigeria	2015	4 doses of IPTp-SP	$9·21	$1·21–1·89	..	..
Cirera (2023)[42]	DR Congo	2018–21	Incremental cost	..	$6138–47 177 per 100 000 women	..	
Cirera (2023)[42]	DR Congo	2018–21	DALYs		396	..	$15–119 per DALY averted
Cirera (2023)[42]	Madagascar	2018–21	Incremental cost	..	$5552–31 552 per 100 000 women	..	..
Cirera (2023)[42]	Madagascar	2018–21	DALYs	..	591	..	$9–53 per DALY averted
Cirera (2023)[42]	Mozambique	2018–21	Incremental cost	..	$10 202–53 221 per 100 000 women	..	..
Cirera (2023)[42]	Mozambique	2018–21	DALYs	..	98	..	$104–543 per DALY averted
Cirera (2023)[42]	Nigeria	2018–21	Incremental cost	..	$667–28 645 per 100–000 women	..	..
Cirera (2023)[42]	Nigeria	2018–21	DALYs	..	435	..	$2–66 per DALY averted

IPTp-SP=intermittent preventive treatment of malaria in pregnancy with sulfadoxine–pyrimethamine. DALY=disability-adjusted life-year.

Table 2: **Outcomes and cost and cost-effectiveness of IPTp-SP *vs* health facility delivery**

pregnancy and convinced them of the benefits of IPTp-SP.[13] Sensitisation of community members to remind or accompany women to the health facility supported antenatal care referrals by CHWs, especially when the first dose was required at the health facility.[10,40] CHWs in Burkina Faso believed involvement of the community was crucial to fostering community–clinic partnerships.[10] Community members in Nigeria felt community played an important role in the sustainability of c-IPTp by being involved and contributing funds.[39]

Fifth, women's knowledge on malaria, positive view of sulfadoxine–pyrimethamine and c-IPTp, and perceived benefits were motivating factors for c-IPTp uptake. Women took sulfadoxine–pyrimethamine because they wanted to have healthy babies and an absence of side-effects after the first IPTp dose meant that they were eager to get a second dose.[13] Women were satisfied with c-IPTp and preferred receiving sulfadoxine–pyrimethamine in the community than at a health facility.[38] CHWs and health providers were positive about c-IPTp across multiple studies and settings because the strategy was thought to improve reach and community health.[10,33,39,40]

Sixth, support from husbands and relatives was found to promote antenatal care attendance and IPTp uptake. Studies that targeted men during sensitisation improved levels of support, including accompanying wives to the health facility, providing transport fees, therefore improving referral observance, especially when the first dose was required at the health facility.[13]

Three studies assessed the difference between the cost or cost-effectiveness of delivering IPTp-SP in the community and of delivering IPTp-SP in the health facility.[25,42,43] We compared studies against the CHEERS checklist and, overall, they were good quality. The studies done in Uganda, Nigeria, Madagascar, DR Congo, and Mozambique found community-based approaches to be cost-effective, with low-cost ratios per 1–3 doses, and incremental cost-effectiveness ratios ranging from US$1·1 to $543 per disability-adjusted life-year averted depending on the country and the threshold used (table 2).

Discussion

We assessed available quantitative and qualitative information on CHW involvement to improve IPTp-SP coverage. Overall, community-based approaches with CHW involvement with or without IPTp-SP delivery had a positive effect on the uptake of IPTp-SP and, in most studies, did not decrease antenatal care visits; however, study heterogeneity was high. In subgroup analyses, the effect of CHW involvement on receiving three or more IPTp doses was lower in cluster-randomised controlled trials compared with other designs. Among studies in which CHWs delivered IPTp-SP, we found no difference in coverage of three or more IPTp doses in studies in which the first dose was provided by the CHW versus antenatal clinic. Facilitators of c-IPTp included trust in CHWs, CHW traits and capabilities, well-established linkages between CHWs and the health system, community knowledge on malaria and the benefits of IPTp-SP, and community engagement.

In the study in Mozambique,[35,36] the authors attributed the decreased antenatal care visits to the effect of a tropical cyclone and suggested that high baseline levels

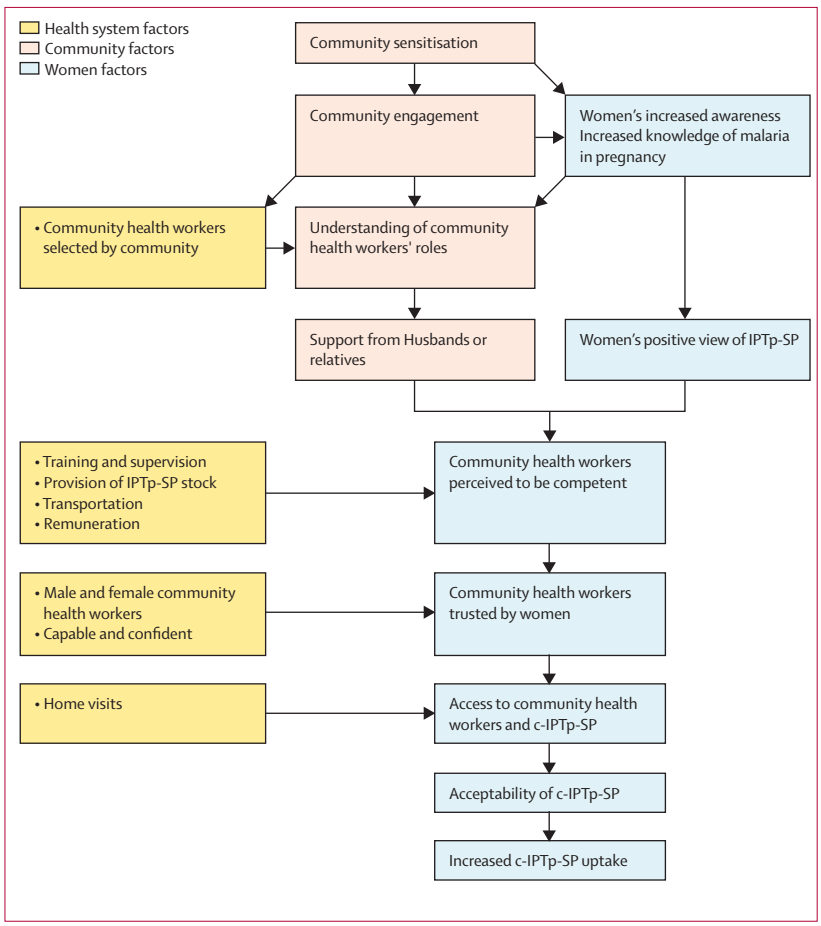

Figure 4: **Theory of how women, community, and CHW factors promote c-IPTp-SP acceptability and uptake**
Our line-of-argument theory posits that when the community is informed and sensitised about the consequences of malaria in pregnancy, and of the role of CHWs in the promotion of antenatal care or administration of IPTp-SP, they are more likely to engage. An engaged community where women receive information and support can weigh the benefits against the fear of side effects. The community is also more involved in fostering the link between CHWs and the health system by contributing to CHW selection and being aware of the training and supervision they receive. These actions build community and women's trust in CHWs, making them more receptive to receiving IPTp-SP from CHWs. Targeted training of a sufficient number of male and female CHWs on c-IPTp-SP, in addition to adequate resources, remuneration, transportation and supervision, increase CHW competence and capacities to meet pregnant women's needs. Subsequently, women's trust in CHWs increases and women accept SP from CHWs. By conducting home visits, CHWs increase women's access to IPTp-SP and its uptake. CHW=community health worker. c-IPTp-SP=intermittent preventive treatment with sulfadoxine–pyrimethamine delivered by CHWs. IPTp-SP=intermittent preventive treatment with sulfadoxine–pyrimethamine.

of IPTp-SP might reduce intervention effects.[35,36] We explored this hypothesis in a subgroup analysis using cutoff points for baseline or control group coverage of IPTp-SP and antenatal care. We did not see an effect of either IPTp-SP or antenatal care baseline levels for the cutoff points used (appendix 2 pp 11–12, 17). In further subgroup analyses, increases in IPTp-SP uptake were seen when CHWs delivered IPTp-SP versus other strategies (ie, antenatal care promotion without c-IPTp) and when CHWs were allowed to administer the first dose of IPTp-SP compared with when the first dose of SP was to be given in the antenatal clinic. Although c-IPTp was the most frequently used strategy in our review, we found no significant difference in effect between c-IPTp and CHW promotion of antenatal care and intermittent screening and treatment provision.

For most studies, CHWs were already engaged in the health system, which might have contributed to community trust and familiarity with CHWs, increasing c-IPTp acceptance among women.[13,33,39–41] A review on the effectiveness of CHWs in the provision of basic preventive and curative services noted the greatest effect when CHWs worked in their own communities, as found in our review.[44] In the studies assessed here, participants and health-facility providers expressed the need for greater integration between the health system and the community, with CHWs forming the bridge. This finding was highlighted in another review, which found that CHWs should be integrated into the health system to ensure sustainability.[5]

Training, close supervision, and accompaniment of CHWs by health facility providers were important for effective c-IPTp. Sunguya and colleagues similarly found that lack of training decreases a community's confidence in CHWs.[5] Resource allocation also plays an important role in CHW capacity to effectively carry out tasks, including for transportation and remuneration.[5] Although we lacked sufficient data to assess effectiveness of c-IPTp by the ratio of CHWs to pregnant women, workload seems to play a role in CHW effectiveness. Bigirwa and colleagues reported that for CHWs to be effective, the ratio of CHWs per population must be ideal and the volume of services they deliver adapted.[44]

Gender inequities stemming from traditional gender roles were important barriers in CHWs ability to deliver services as found in a review by Kok and colleagues, who found that maternal and newborn health services were more appropriate for female CHWs, whereas male CHWs were more effective at engaging men.[45] Programmes therefore need to consider gender roles in c-IPTp implementation.

Women having a positive view of sulfadoxine–pyrimethamine as an effective antimalarial was a facilitator of c-IPTp, as found in our previous review.[7] Increased awareness of IPTp-SP among women and their husbands was associated with an increase in the uptake of IPTp-SP in another review.[2] We found community sensitisation and engagement to be essential for effective c-IPTp, in line with a Cochrane review in which women were more likely to consider interventions with community engagement and consistent messaging by CHWs than those without.[46] Community-based approaches with engaged communities might enable countries to achieve their target IPTp-SP coverage.[2] Our theory of how women's, CHW's, and community factors interact to improve IPTp-SP uptake can be a useful tool for framing c-IPTp planning and implementation.

The low cost of c-IPTp reported by one study[25] and its cost-effectiveness by two studies[42,43] suggest c-IPTp is a suitable intervention in sub-Saharan African countries,

especially when integrated into the existing health system. However, these results should be interpreted with caution. None of the studies used the CHEERS checklist for reporting. Only one study compared the incremental cost-effectiveness ratio (ICER) of c-IPTp with facility IPTp-SP delivery. Even though one study compared the ICER of c-IPTp with that of health facility delivery, the comparison used an assumed c-IPTp delivery through a programmatic mode.

A strength of this review is that we included all available studies to assess the effects, barriers and facilitators, and costs of community-based approaches on IPTp-SP and antenatal care coverage. There are several limitations. The effects on some outcomes were more pronounced in studies using a before-and-after design compared with randomised controlled trials, and these designs are subject to confounding because of the absence of randomisation. Given the relationship with time and the presence of control groups, the interventions in studies were assumed to result in the change in IPTp coverage. However, alternative explanations might exist for the associations; some studies noted contextual factors and conditions that might have affected the lack of effects, such as weather events that affected the antenatal care infrastructure and antenatal care visits,[35,36] or sulfadoxine–pyrimethamine stock issues.[32] Another limitation was the diversity of the effect measures; we used RRs, which could be calculated from the raw data available from all studies, requiring adjustment for clustering for which we used an ICC from two studies. The results using the reported range of ICC were robust and similar. The paucity of qualitative studies nested within the trials did not permit further exploration to identify for whom and how c-IPTp worked best. We found high heterogeneity for most analyses and could not do further subgroup analyses because of insufficient information available. Only one study assessed costs for beneficiaries. No study assessed the sustainability of CHW involvement. Furthermore, inclusion of only published studies might have missed unpublished experiences and might have biased the overall outcomes.

Our findings suggest that the involvement of CHWs in the promotion or delivery of IPTp-SP can increase IPTp-SP uptake without decreasing antenatal care visits and can be cost-effective. Community sensitisation in addition to the training of trusted CHWs are important for the success of interventions. Public health officials and policy makers could consider integrating community-based IPTp-SP strategies for the prevention of malaria in pregnancy.

Contributors

AMVE and JH conceived the study and designed the study together with KKo. KKo and AMVE curated and analysed the quantitative data, and KKo and JH curated and analysed the qualitative data. KKo and EW curated and synthesised cost and cost-effectiveness data. KKo, AMVE, JH, KK, and EW validated the analysis. KKo wrote the first draft of the manuscript with contributions from JH and AMVE. KKo, AMVE, and JH accessed and verified the underlying data reported in the manuscript. All authors had full access to the data included in the study, participated in reviewing and editing the manuscript, and approved the final version of the manuscript. AMVE, JH, and KKo accessed and verified the underlying data reported in the manuscript. All authors had final responsibility for the decision to submit for publication.

Declaration of interests

We declare no competing interests.

Data sharing

The search strategy, list of the included and excluded studies, data extracted, analysis plans, quality assessment, assessment of the publication bias, and relevant data are available in the Article. The protocol is available in PROSPERO.

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References

1 WHO. WHO policy brief for the implementation of intermittent preventive treatment of malaria in pregnancy using sulfadoxinepyrimethamine (IPTp-SP). Geneva: World Health Organization, 2014.
2 Roman E, Andrejko K, Wolf K, et al. Determinants of uptake of intermittent preventive treatment during pregnancy: a review. *Malar J* 2019; 18: 372.
3 van Eijk AM, Hill J, Larsen DA, et al. Coverage of intermittent preventive treatment and insecticide-treated nets for the control of malaria during pregnancy in sub-Saharan Africa: a synthesis and meta-analysis of national survey data, 2009–11. *Lancet Infect Dis* 2013; **13:** 1029–42.
4 WHO. Technical consultation to assess evidence on community-based delivery of intermittent preventive treatment in pregnancy for malaria: report of a virtual meeting, June 21–23, 2022. Geneva: World Health Organization, 2023.
5 Sunguya BF, Mlunde LB, Ayer R, Jimba M. Towards eliminating malaria in high endemic countries: the roles of community health workers and related cadres and their challenges in integrated community case management for malaria: a systematic review. *Malar J* 2017; **16:** 10.
6 WHO. WHO guideline on health policy and system support to optimize community health worker programmes. Geneva: World Health Organization, 2018.
7 Hill J, Hoyt J, van Eijk AM, et al. Factors affecting the delivery, access, and use of interventions to prevent malaria in pregnancy in sub-Saharan Africa: a systematic review and meta-analysis. *PLoS Med* 2013; **10:** e1001488.
8 Mbonye AK, Magnussen P, Bygbjerg IB. Intermittent preventive treatment of malaria in pregnancy: the effect of new delivery approaches on access and compliance rates in Uganda. *Trop Med Int Health* 2007; **12:** 519–31.
9 Msyamboza K, Senga E, Tetteh-Ashong E, Kazembe P, Brabin BJ. Estimation of effectiveness of interventions for malaria control in pregnancy using the screening method. *Int J Epidemiol* 2007; **36:** 406–11.
10 Burke D, Tiendrebeogo J, Emerson C, et al. Community-based delivery of intermittent preventive treatment of malaria in pregnancy in Burkina Faso: a qualitative study. *Malar J* 2021; **20:** 277.
11 Gutman JR, Stephens DK, Tiendrebeogo J, et al. A cluster randomized trial of delivery of intermittent preventive treatment of malaria in pregnancy at the community level in Burkina Faso. *Malar J* 2020; **19:** 282.
12 Mbonye AK, Bygbjerg I, Magnussen P. Intermittent preventive treatment of malaria in pregnancy: a community-based delivery system and its effect on parasitemia, anemia and low birth weight in Uganda. *Int J Infect Dis* 2008; **12:** 22–29.
13 Mbonye AK, Bygbjerg I, Magnussen P. Intermittent preventive treatment of malaria in pregnancy: evaluation of a new delivery approach and the policy implications for malaria control in Uganda. *Health Policy* 2007; **81:** 228–41.

14 Hartmann KE, Matchar DB, Chang SM. Table 6–1, Using the PICOTS framework to assess and describe applicability of medical tests. 2012. https://www.ncbi.nlm.nih.gov/books/NBK98234/table/ch6.t1/ (accessed July 31, 2022).

15 NHLBI, NIH. Study Quality Assessment Tools. https://www.nhlbi.nih.gov/health-topics/study-quality-assessment-tools (accessed Aug 4, 2022).

16 Sterne JAC, Savović J, Page MJ, et al. RoB 2: a revised tool for assessing risk of bias in randomised trials. *BMJ* 2019; **366:** l4898.

17 Critical Appraisal Skills Programme. CASP qualitative checklist. 2018. https://casp-uk.net/casp-tools-checklists (accessed July 31, 2022).

18 O'Cathain A, Murphy E, Nicholl J. The quality of mixed methods studies in health services research. *J Health Serv Res Policy* 2008; **13:** 92–98.

19 Husereau D, Drummond M, Augustovski F, et al. Consolidated health economic evaluation reporting standards (CHEERS) 2022 explanation and elaboration: a report of the ISPOR CHEERS II Good Practices Task Force. *Value Health* 2022; **25:** 10–31.

20 Kayentao K, Ghosh R, Guindo L, et al. Effect of community health worker home visits on antenatal care and institutional delivery: an analysis of secondary outcomes from a cluster randomised trial in Mali. *BMJ Glob Health* 2023; **8:** e011071.

21 Higgins JPT, Eldridge S, Thomas J, Chandler J, Li T, Welch VA. Chapter 23: including variants on randomized trials. Cochrane Handbook for Systematic Reviews of Interventions version 6.3 (updated February, 2022). https://training.cochrane.org/handbook/current/chapter-23 (accessed June 13, 2023).

22 Zhang J, Yu KF. What's the relative risk? A method of correcting the odds ratio in cohort studies of common outcomes. *JAMA* 1998; **280:** 1690–91.

23 Higgins JP, Thompson SG, Deeks JJ, Altman DG. Measuring inconsistency in meta-analyses. *BMJ* 2003; **327:** 557–60.

24 Egger M, Davey Smith G, Schneider M, Minder C. Bias in meta-analysis detected by a simple, graphical test. *BMJ* 1997; **315:** 629–34.

25 Orobaton N, Austin AM, Abegunde D, et al. Scaling-up the use of sulfadoxine-pyrimethamine for the preventive treatment of malaria in pregnancy: results and lessons on scalability, costs and programme impact from three local government areas in Sokoto State, Nigeria. *Malar J* 2016; **15:** 533.

26 Noblit GW, Hare RD. Meta-ethnography: synthesizing qualitative studies. Newbury Park, CA: SAGE, 1988.

27 Munro SA, Lewin SA, Smith HJ, Engel ME, Fretheim A, Volmink J. Patient adherence to tuberculosis treatment: a systematic review of qualitative research. *PLoS Med* 2007; **4:** e238.

28 Consortium C. Community-based malaria screening and treatment for pregnant women receiving standard intermittent preventive treatment with sulfadoxine–pyrimethamine:a multicenter (the Gambia, Burkina Faso, and Benin) cluster-randomized controlled trial. *Clin Infect Dis* 2019; **68:** 586–96.

29 Mens P, Schallig H. The COSMIC consortium community-based scheduled screening and treatment of malaria in pregnancy for improved maternal and infant health. *Trop Med Int Health* **18:** 146.

30 Gies S, Coulibaly SO, Ky C, Ouattara FT, Brabin BJ, D'Alessandro U. Community-based promotional campaign to improve uptake of intermittent preventive antimalarial treatmentin pregnancy in Burkina Faso. *Am J Trop Med Hyg* 2009; **80:** 460–69.

31 Gies S, Coulibaly SO, Ouattara FT, Ky C, Brabin BJ, D'Alessandro U. A community effectiveness trial of strategies promoting intermittent preventive treatment with sulphadoxine-pyrimethamine in pregnant women in rural Burkina Faso. *Malar J* 2008; **7:** 180.

32 Rubenstein BL, Chinkhumba J, Chilima E, et al. A cluster randomized trial of delivery of intermittent preventive treatment of malaria in pregnancy at the community level in Malawi. *Malar J* 2022; **21:** 195.

33 Ndyomugyenyi R, Tukesiga E, Katamanywa J. Intermittent preventive treatment of malaria in pregnancy (IPTp): participation of community-directed distributors of ivermectin for onchocerciasis improves IPTp access in Ugandan rural communities. *Trans R Soc Trop Med Hyg* 2009; **103:** 1221–28.

34 Okeibunor JC, Orji BC, Brieger W, et al. Preventing malaria in pregnancy through community-directed interventions: evidence from Akwa Ibom State, Nigeria. *Malar J* 2011; **10:** 227.

35 Gonzalez R, Manun'Ebo MF, Meremikwu M, et al. The impact of community delivery of intermittent preventive treatment of malaria in pregnancy on its coverage in four sub-Saharan African countries (Democratic Republic of the Congo, Madagascar, Mozambique, and Nigeria): a quasi-experimental multicentre evaluation. *Lancet Glob Health* 2023; **11:** e566–74.

36 Pons-Duran C, Llach M, Sanz S, Ramírez M, Méndez S, Roman E, et al. Community delivery of malaria intermittent preventive treatment in pregnancy: protocol of a quasi-experimental evaluation through multistage cluster sampling household surveys in four sub-Saharan African countries. *BMJ Open* 2021; **11:** e044680.

37 Wangalwa G, Cudjoe B, Wamalwa D, et al. Effectiveness of Kenya's community health strategy in delivering community-based maternal and newborn health care in Busia County, Kenya: non-randomized pre-test post test study. *Pan Afr Med J* 2012; **13** (suppl 1)**:** 12.

38 Okedo-Alex IN, Akamike IC, Alo CN, et al. Reaching the unreached: effectiveness and satisfaction with community-directed distribution of sulfadoxine–pyrimethamine for preventing malaria in pregnancy in rural south-east, Nigeria. *Malar J* 2020; **19:** 394.

39 Okedo-Alex IN, Akamike IC, Nwafor JI, et al. Community malaria knowledge, experiences, perceived roles, and acceptability of community-directed distribution of intermittent preventive therapy for pregnancy in rural southeast Nigeria. *J Parasitol Res* 2022; 2022: 8418917.

40 Alonso Y, Lusengi W, Manun'Ebo MF, et al. The social dimensions of community delivery of intermittent preventive treatment of malaria in pregnancy in Madagascar, Mozambique, Nigeria and the Democratic Republic of the Congo. *BMJ Glob Health* 2022; **7:** e010079.

41 Enguita-Fernandez C, Alonso Y, Lusengi W, et al. Trust, community health workers and delivery of intermittent preventive treatment of malaria in pregnancy: a comparative qualitative analysis of four sub-Saharan countries. *Glob Public Health* 2021; **16:** 1889–903.

42 Cirera L, Sacoor C, Meremikwu M, et al. Cost-effectiveness of community-based distribution of intermittent preventive treatment of malaria in pregnancy in Madagascar, Mozambique, Nigeria, and the Democratic Republic of Congo. *BMJ Glob Health* 2023; **8:** e010238.

43 Mbonye AK, Hansen KS, Bygbjerg IC, Magnussen P. Intermittent preventive treatment of malaria in pregnancy: the incremental cost-effectiveness of a new delivery system in Uganda. *Trans R Soc Trop Med Hyg* 2008; **102:** 685–93.

44 Bigirwa P. Effectiveness of community health workers (CHWS) in the provision of basic preventive and curative maternal, newborn and child health (MNCH) interventions: a systematic review. *Health Policy Dev* 2009; **7:** 162–72.

45 Kok MC, Kane SS, Tulloch O, et al. How does context influence performance of community health workers in low- and middle-income countries? Evidence from the literature. *Health Res Policy Syst* 2015; **13:** 13.

46 Mbuagbaw L, Medley N, Darzi AJ, Richardson M, Habiba Garga K, Ongolo-Zogo P. Health system and community level interventions for improving antenatal care coverage and health outcomes. Cochrane Database Syst Rev 2015; 2015: CD010994.