

RESEARCH ARTICLE

Culturally Tailored Adherence-Support Intervention for 14-Day Primaquine Treatment in *Plasmodium vivax* Malaria

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ABSTRACT

Introduction: *Plasmodium vivax* is a major cause of recurrent malaria in Papua, Indonesia, because dormant liver hypnozoites can trigger relapses. Adherence to radical cure with 3-day dihydroartemisinin–piperaquine (DHP) plus 14-day primaquine is essential for relapse prevention but is often hindered by sociocultural factors, risk perception, and treatment duration. This study evaluated a culturally tailored adherence-support intervention centred on an adherence card developed from a Papuan emic perspective to improve adherence among patients with *P. vivax* malaria.

Methods: A cluster-randomised controlled trial was conducted in six primary health centres in Jayapura City (three intervention clusters and three control clusters) from February to June 2025. A total of 278 participants were recruited from the randomised PHC clusters; 137 participants were in the intervention clusters and received the culturally tailored adherence-support intervention, including the adherence card, education, medication monitoring, and cadre follow-up, while 141 participants in the control clusters received standard malaria services. Adherence was assessed using pill count and self-report, with intention-to-treat (ITT) as the primary analysis. Intervention effects were expressed as cluster-adjusted risk ratios (RRs), and factors associated with 14-day primaquine adherence were explored using cluster-adjusted regression analysis.

Results: In the intention-to-treat analysis, full adherence to the complete DHP and 14-day primaquine regimen, confirmed by pill count and self-report, was higher in the intervention group than in the control group (85.0% vs 44.4%; RR = 1.91; 95% CI: 1.07–3.41; $p = 0.039$). In the exploratory cluster-adjusted analysis of 14-day primaquine adherence, study arm was the only factor significantly associated with adherence after adjustment (aOR = 7.04; 95% CI: 1.41–35.18; $p = 0.028$).

Conclusion: The culturally tailored adherence-support intervention improved full adherence to the DHP and 14-day primaquine regimen among patients with *P. vivax* malaria in the participating PHCs in Jayapura. The findings support further evaluation of this intervention in other settings.

Keywords: *Plasmodium vivax*; Adherence; Culturally Tailored Intervention; Papua

INTRODUCTION

Plasmodium vivax remains a significant cause of malaria in many endemic regions, including Papua, Indonesia (1,2). Unlike *Plasmodium falciparum*, which rarely causes relapse, *P. vivax* has a dormant liver stage—known as the hypnozoite stage—that can reactivate weeks to months after the initial infection (3,4). This unique biological feature necessitates a different treatment approach: a radical cure combining a 3-day course of dihydroartemisinin–piperaquine (DHP) to clear blood-stage parasites and a 14-day course of primaquine to eradicate latent liver forms (5).

However, adherence to a prolonged regimen remains a significant challenge in many endemic settings (6). Data from multiple countries demonstrate wide variability but generally low adherence rates. In Tanzania, adherence to malaria regimens was reported at only 14.9% (7), whereas in Sierra Leone, Kenya, and the Democratic Republic of the Congo, rates ranged from 37.5% to 73.1% (8,9). In Indonesia, a study in Timika reported that only 68.8% of patients completed the 14-day primaquine course, and more than 40% of unsupervised patients reported stopping treatment prematurely (10). High levels of nonadherence contribute to sustained community transmission, increased healthcare burden, and waste of medical resources.

Efforts to improve adherence have employed a variety of technological and nontechnological strategies. The use of short message service (SMS) reminders and mHealth applications has been shown to be effective in some countries, such as China and Ghana (11,12). However, the results have been inconsistent in settings with limited technological access, low rates of personal mobile phone ownership, and poor digital literacy, as observed in parts of Tanzania, Zambia, and Kenya (13,14). Directly observed therapy (DOT) has been shown to improve adherence in Brazil and Indonesia (15,16); however, its large-scale implementation is challenging due to substantial personnel, time, and cost requirements. These barriers highlight the need for more context-specific and sustainable approaches. Nevertheless, evidence remains limited on adherence-support interventions for *P. vivax* radical cure that are developed from local cultural perspectives and combine a simple reminder tool with education, medication monitoring, and community-based follow-up.

Papua presents a complex sociocultural context characterised by ethnic and linguistic diversity and culturally embedded concepts of health and illness that strongly influence treatment behaviours (17,18). Language barriers, differing perceptions of healthcare services, geographic remoteness, and high population mobility often limit the success of malaria treatment programmes (10). Interventions that do not account for local cultural aspects are less likely to be accepted and effective in the long term.

This study tested a culturally tailored adherence-support intervention centred on a medication adherence card developed from a Papuan emic perspective. The card incorporated symbols, language, and messages derived from the local context, while the intervention package also included education, medication monitoring, and cadre follow-up. The objective of this cluster-randomised controlled trial was to evaluate the effectiveness of this culturally tailored adherence-support intervention in improving treatment adherence among patients with *P. vivax* malaria in Jayapura, Papua. The findings are expected to inform the development and further evaluation of culturally appropriate adherence-support strategies for *P. vivax* treatment.

METHODS

Study Design and Setting

This study was a cluster-randomised controlled trial (cluster RCT) with two parallel arms: intervention and control. The cluster RCT design uses randomisation at the group (cluster) level rather than at the individual level to minimise information contamination between groups (19,20). The trial was conducted in Jayapura City, Papua Province, Indonesia, from February to June 2025. Of the 14 primary health centres (PHCs) in Jayapura City capable of conducting malaria diagnostics, six PHCs were randomly selected as study clusters by drawing lots from all 14 PHCs. The six selected PHCs were subsequently allocated by a second draw conducted by the investigator, with three assigned to the intervention arm and three to the control arm. No matching or stratification was used. Cluster allocation was completed before participant recruitment. Allocation was not concealed from PHC staff during participant recruitment. The trial was not registered. The study protocol was prepared before trial implementation and was submitted as part of the ethical review process. A separate statistical analysis plan was not prepared.

Participants

The study participants were *P. vivax* malaria patients seeking treatment at primary health centres (PHCs), which were designated as intervention or control sites. The inclusion criteria were patients aged over five years who were diagnosed with *P. vivax* infection through clinical assessment and microscopic examination by PHC healthcare staff; who received standard treatment for uncomplicated malaria according to national guidelines (5), namely, a 3-day course of dihydroartemisinin–piperaquine (DHP) plus a 14-day course of primaquine; and who had permanent residence in the catchment area of the study PHC. DHP was administered according to the weight-based regimen in the national malaria treatment guideline, and primaquine was administered at 0.25 mg/kg/day for 14 days. The first dose was not directly observed. The study did not determine eligibility for primaquine treatment, perform G6PD testing, or conduct other clinical safety procedures. These clinical decisions and procedures, including G6PD assessment, management when G6PD status was unknown, monitoring for adverse clinical effects, and treatment discontinuation or referral when indicated, were part of routine malaria care provided by PHC clinicians according to the national treatment protocol.

The exclusion criteria included patients aged five years or younger, pregnant women with malaria, patients with severe malaria, *patients with P. vivax malaria receiving second-line treatment*, and patients with contraindications to the standard regimen according to the national malaria treatment protocol. Participants who developed severe adverse events or clinical deterioration were managed according to the national malaria treatment protocol, including treatment discontinuation and referral when indicated, and remained in the intention-to-treat population. Dropout criteria included participants who withdrew consent, violated the study protocol, or were lost to follow-up. Protocol violations included moving outside the study PHC catchment area during follow-up, receipt of the adherence card by a participant in the control arm, or obtaining medication from another healthcare facility or receiving additional medication outside the assigned treatment pathway.

Sample size

The sample size was calculated using a simple design-effect approach for the cluster-randomised design (21). The calculation assumed a two-sided significance level of 0.05, 80% statistical power, an average cluster size of 25 participants, and an intraclass correlation coefficient (ICC) of 0.075, which is consistent with estimates reported in malaria cluster trials in the Greater Mekong Subregion (22). The assumed control-group adherence proportion was 0.638, informed by published evidence (23). The intervention-group adherence proportion was set at 0.329 in the design-stage calculation. The individual-level calculation used the two-sample proportion formula $n = \frac{(Z_{\alpha/2} + Z_{\beta})^2 [p_1(1-p_1) + p_2(1-p_2)]}{(p_1 - p_2)^2}$ and required approximately 37 participants per group. A design effect of 2.8, calculated as $1 + (m - 1) \text{ ICC}$, increased the requirement to 104 participants per group. Six PHCs, three per trial arm, were planned, with unequal cluster sizes anticipated because participant allocation was proportional to the recent *P. vivax* case burden. The original sample-size calculation applied the design effect to account for within-cluster correlation but did not explicitly incorporate the fixed number of six PHC clusters. To account for an anticipated 20% loss to follow-up or dropout, the target sample size was increased to at least 125 participants per group (total 250 participants). Sample allocation across clusters was performed proportionally to the average *P. vivax* case burden at each primary health centre over the preceding six months.

Recruitment

Participant recruitment began when patients presented to the primary health centre (PHC) with fever or a history of fever, with or without additional symptoms such as headache, nausea, vomiting, diarrhoea, myalgia, or generalised body aches. All patients underwent a clinical examination, and malaria diagnosis was confirmed by microscopic examination performed by healthcare staff. Patients who were diagnosed with uncomplicated *Plasmodium vivax* malaria and prescribed a regimen of dihydroartemisinin–piperaquine (DHP) plus a 14-day course of primaquine were recorded as potential candidates (eligible patients). Eligible participants were recruited by PHC staff after cluster allocation.

Patients who did not meet the inclusion criteria were classified as excluded, were not enrolled in the study, and received standard care following the national malaria treatment guidelines. For eligible patients, PHC staff provided a comprehensive explanation of the study's purpose and procedures, potential benefits and risks, possible implications for *P. vivax* parasite recurrence, and the participants' right to withdraw at any time without affecting their access to healthcare services. Instructions for using the adherence card were provided only to participants in the intervention arm. Participants in the control arm received standard malaria care, including DHP plus a 14-day course of primaquine and routine counselling at medication dispensing on dosage, treatment duration, and possible adverse effects. No additional adherence support or home visits were provided. This study was conducted as an open-label trial, with no masking or blinding of either participants or healthcare providers delivering the intervention. Participants in the intervention group were aware of the intervention they received. Healthcare providers responsible for prescribing treatment also delivered and explained the use of the adherence card and were therefore aware of the intervention allocation.

Intervention

The intervention group received a culturally tailored adherence-support intervention centred on the *P. vivax* malaria medication adherence card. The card was developed from formative qualitative work in Jayapura using rapid ethnographic assessment. Twenty-four informants were selected purposively, with snowball sampling used to reach participants with relevant experience. Data sources included in-depth interviews, document review, and a 12-participant co-design focus group discussion. The 12 focus group participants were drawn from the 24 informants. Findings from the in-depth interviews were presented to all 12 focus group participants for member checking and further discussion. Participants represented former malaria patients, malaria cadres, PHC personnel, clinicians, community leaders, and an anthropologist. The qualitative data were analysed using a hybrid inductive-deductive thematic approach with iterative coding, constant comparison, and triangulation across data sources. Themes concerning local meanings, treatment practices, and family roles were mapped as deep-structure findings and translated into surface-structure elements of the card, including language, terminology, visual cues, message content, and the medication-monitoring format. The draft card was subsequently reviewed by three experts in Papuan anthropology, health promotion, and Papuan linguistics. Feedback from the focus group and expert review led to revisions in wording, the formulation of educational messages, and the cultural familiarity of the messages before the card was finalised for use in the trial.

The card's content employed familiar terms to replace complex medical terminology. For example, common Papuan greetings such as "*Pace, Mace, Kaka Ade, Dorang Semuua...*" were used as a pan-Papuan form of address. Papua Malay expressions and colour-based medication labels were also used to reflect terminology identified during the formative work. The card,

printed on waterproof A4 art paper for durability in humid tropical conditions, was double-sided. The front included patient identification details and a 14-day medication monitoring panel, with daily markers (Days 1–3 for DHP and Days 1–14 for primaquine) represented as circles to be ticked by the patient or malaria cadre. The emic Papua-based medication adherence card is provided in Supplementary Material 1.

The reverse side contained the contact information of the assigned malaria cadre, national guideline-based dosing instructions, and educational messages emphasising the importance of completing therapy to prevent relapse, complications, and onward transmission. Messages were presented as short dialogues and everyday analogies derived from the formative findings. Trained malaria cadres conducted two home visits during the first and second weeks of treatment to monitor adherence and provide ongoing support. Because the intervention included the card, accompanying education, medication monitoring, and cadre follow-up, the trial did not estimate the independent effect of the card.

Outcomes and data collection

The primary outcome was full adherence to the complete DHP and 14-day primaquine regimen at Day 15, confirmed by both pill count and self-report. Secondary adherence outcomes included full adherence to the 3-day DHP regimen based on pill count on Day 4, full adherence to the 14-day primaquine regimen based on pill count on Day 15, combined full adherence to DHP and primaquine based on pill count, and self-reported adherence. Pill count adherence was evaluated by inspecting remaining medication for both the 3-day dihydroartemisinin–piperaquine (DHP) regimen and the 14-day primaquine regimen during scheduled assessment visits. Patients were classified as adherent if no tablets remained, indicating complete (100%) consumption; the presence of any remaining tablets indicated nonadherence. Self-reported adherence was measured via a five-item yes/no questionnaire adapted from the five-item self-reported questionnaire described by Almeida et al. (24), which was derived from the original four-item Morisky questionnaire. The five items asked whether participants had: (1) ever forgotten to take their pills; (2) ever taken their pills incorrectly; (3) ever missed taking their pills when feeling better; (4) ever missed taking their pills because they felt sick; and (5) ever doubled the dose when feeling sick. Patients were categorised as adherent only if they answered “no” to all items; any affirmative response indicated nonadherence. Participants were instructed at enrolment to retain their medication packaging for pill count assessment. If the medication packaging was unavailable, adherence was assessed by self-report; however, no medication packages were unavailable at the scheduled assessments.

The covariates collected included age, sex, highest educational attainment, employment status, household income (below or above the Papua minimum wage), malaria episode history, time from symptom onset to healthcare visit, self-reported adverse drug events assessed on Days 7 and 15, household or close contact exposure to malaria, and recent travel history within the preceding month. Data were collected through face-to-face interviews conducted by trained enumerators and verified against medical records when available. Pill count assessments were performed by trained enumerators in both trial groups on Day 4, following completion of the DHP regimen, and on Day 15, one day after completion of the primaquine regimen. The same outcome assessment procedures were used in both groups, and enumerators were aware of cluster allocation. In the control group, the Day 4 and Day 15 visits were limited to outcome assessment, whereas intervention participants also received the two cadre follow-up visits described above.

Data analysis

The baseline characteristics of the participants in the intervention and control groups were summarised descriptively and presented as the means $\pm$ standard deviations for continuous variables and frequencies with percentages for categorical variables. The primary analysis of intervention effectiveness used the intention-to-treat (ITT) approach and included 278 participants recruited from the randomised PHC clusters. Missing outcome data in the ITT analysis were handled using multiple imputation by chained equations with 20 imputed datasets and 10 iterations. The imputation model included age, sex, education, ethnicity, previous malaria episode history, and PHC fixed indicators. Convergence was assessed using iteration traces, and observed and imputed outcome distributions were compared. Sensitivity analyses were performed via complete-case and worst-case scenario (WCS) approaches. The complete-case analysis included participants with observed outcome data, whereas the WCS analysis assumed that all participants with missing or incomplete data in the intervention group were nonadherent and that those in the control group were adherent.

Intervention effectiveness was assessed by comparing adherence proportions between groups using pill counts and self-report, and the results were expressed as risk ratios (RRs) with 95% confidence intervals (CIs). To account for cluster randomisation, intervention effects for binary adherence outcomes were estimated using an unweighted cluster-level analysis on the log-risk scale, with PHC as the unit of clustering and t-based inference using 4 degrees of freedom. For the ITT analysis, estimates across the 20 imputed datasets were combined using Rubin's rules. The primary-outcome intraclass correlation coefficient (ICC) was estimated from observed primary-outcome data using a treatment-adjusted one-way random-effects ANOVA estimator. A two-sided p value < 0.05 was considered statistically significant. The number needed to treat (NNT) was calculated to estimate the clinical relevance of the intervention. Agreement between pill count and self-reported adherence measures was evaluated via the kappa coefficient and interpreted according to the Landis and Koch criteria (25). Factors associated with adherence were explored using generalised estimating equations (GEE) for binary outcomes, with full adherence to 14-day primaquine based on pill count as the modelled event (1 = adherent; 0 = nonadherent). PHC was specified as the clustering unit, with an exchangeable working correlation structure and a Mancl–DeRouen bias-reduced covariance estimator to account for the small number of clusters. Crude and adjusted odds ratios (ORs) with 95% CIs were estimated, with ORs greater than 1 indicating higher odds of adherence. The adjusted exploratory model included study arm,

age, sex, occupation, education, ethnicity, previous malaria episode history, and travel or stay in other areas. Covariates were retained on the basis of substantive relevance rather than bivariable p-value screening. For the ITT regression analysis, estimates from the 20 multiply imputed datasets were combined using Rubin's rules. All analyses were conducted using SPSS version 25 and R version 4.5.1.

Ethical considerations

This study received ethical approval from the Health Research Ethics Committee of the Faculty of Public Health, Hasanuddin University (No. 1701/UN4.14.1/TP.01.02/2024) and the Health Research Ethics Committee of the Jayapura Health Polytechnic (No. 112/KEPK-J/VIII/2024). Written informed consent was obtained from adult participants. For participants younger than 18 years, written permission was obtained from a parent or legal guardian on behalf of the participant. A separate child assent procedure was not used because, following ethical review, the intervention was limited to an educational medication-adherence card; written permission from a parent or legal guardian was considered sufficient.

RESULTS

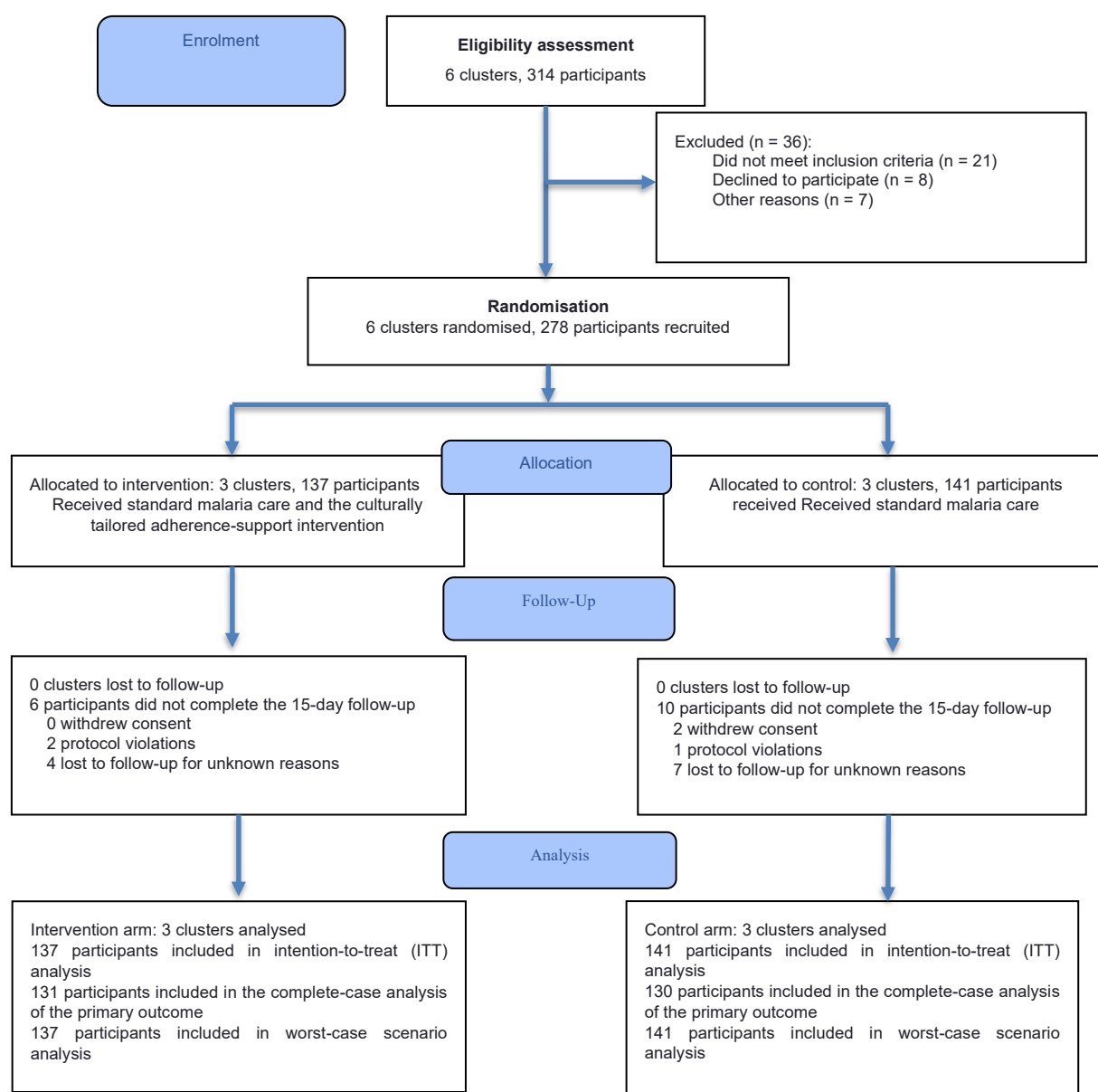


Figure 1. CONSORT flow diagram

Figure 1 presents the CONSORT flow diagram for the cluster-randomised controlled trial. Among 314 individuals screened across six clusters, 36 were excluded, leaving 278 participants recruited from three intervention clusters (n = 137) and three control clusters (n = 141). During follow-up, six participants in the intervention group and ten in the control group did not complete the 15-day follow-up. One additional participant in the control group had incomplete primary-outcome data at Day 15. All randomised clusters were included in the analyses. The intention-to-treat and worst-case scenario analyses included

all 137 intervention and 141 control participants, while the complete-case analysis of the primary outcome included 131 intervention and 130 control participants.

Characteristics of participants

Table 1. Baseline characteristics (n = 278)

Variable	Intervention (n = 137)	Control (n = 141)	Total (n = 278)
Age, mean $\pm$ SD (years)	24.09 $\pm$ 14.81	23.20 $\pm$ 13.20	–
Body weight, mean $\pm$ SD (kg)	52.76 $\pm$ 17.51	53.77 $\pm$ 18.95	–
Sex			
Male	80 (58.4%)	95 (67.4%)	175 (62.9%)
Female	57 (41.6%)	46 (32.6%)	103 (37.1%)
Education			
Primary/no formal education	42 (30.7%)	32 (22.7%)	74 (26.6%)
Secondary/tertiary	95 (69.3%)	109 (77.3%)	204 (73.4%)
Occupation			
Unemployed	83 (60.6%)	88 (62.4%)	171 (61.5%)
Employed	54 (39.4%)	53 (37.6%)	107 (38.5%)
Household income			
< Papua minimum wage	121 (88.3%)	53 (37.6%)	174 (62.6%)
$\geq$ Papua minimum wage	16 (11.7%)	88 (62.4%)	104 (37.4%)
Ethnicity			
Papuan	98 (71.5%)	111 (78.7%)	209 (75.2%)
Non-Papuan	39 (28.5%)	30 (21.3%)	69 (24.8%)
Time from symptom onset to healthcare visit (n = 277), mean $\pm$ SD (days)	2.92 $\pm$ 1.27	3.33 $\pm$ 1.85	–
Malaria episode status			
First episode	66 (48.2%)	55 (39.0%)	121 (43.5%)
Previous episodes	71 (51.8%)	86 (61.0%)	157 (56.5%)
Household/housemate malaria case			
Yes	57 (41.6%)	53 (37.6%)	110 (39.6%)
No	80 (58.4%)	88 (62.4%)	168 (60.4%)
Travel/stay in a high malaria endemic area (n = 277)			
Yes	34 (25.0%)	31 (22.0%)	65 (23.5%)
No	102 (75.0%)	110 (78.0%)	212 (76.5%)

The baseline characteristics of the participants are summarised in Table 1. The mean age was 24.09 $\pm$ 14.81 years in the intervention group and 23.20 $\pm$ 13.20 years in the control group; mean body weight was 52.76 $\pm$ 17.51 kg and 53.77 $\pm$ 18.95 kg, respectively. Male participants comprised 58.4% of the intervention group and 67.4% of the control group, while Papuan participants comprised 71.5% and 78.7%, respectively. Previous malaria episodes were reported by 51.8% of intervention participants and 61.0% of control participants. Household income showed a marked imbalance between groups, with 88.3% of participants in the intervention arm and 37.6% in the control arm reporting household income below the Papua minimum wage. Other participant characteristics are presented in Table 1. Cluster-level baseline characteristics are presented in Supplementary Table 1.

Table 2. Malaria history and perceived or experienced adverse events

Malaria history and perceived or experienced adverse events	Intervention (n/total, %)	Control (n/total, %)
Among participants with previous malaria episodes		
Number of previous malaria episodes, mean $\pm$ SD (times)	2.58 $\pm$ 0.97	1.64 $\pm$ 0.70
Time since last malaria episode		
Within the past year	20/71 (28.2%)	35/85 (41.2%)
More than 1 year ago	51/71 (71.8%)	50/85 (58.8%)

Malaria history and perceived or experienced adverse events	Intervention (n/total, %)	Control (n/total, %)
Type of previous malaria infection		
<i>P. vivax</i>	27/71 (38.0%)	39/85 (45.9%)
<i>P. falciparum</i>	11/71 (15.5%)	21/85 (24.7%)
Mixed infection	20/71 (28.2%)	3/85 (3.5%)
Unknown/cannot recall	13/71 (18.3%)	22/85 (25.9%)
Type of malaria in household members		
<i>P. vivax</i>	36/56 (64.3%)	21/52 (40.4%)
<i>P. falciparum</i>	7/56 (12.5%)	7/52 (13.5%)
Mixed infection	4/56 (7.1%)	7/52 (13.5%)
Unknown/cannot recall	9/56 (16.1%)	17/52 (32.7%)
Reported/perceived adverse events		
Headache	2/27 (7.4%)	4/37 (10.8%)
Fever	4/27 (14.8%)	4/37 (10.8%)
Vomiting	3/27 (11.1%)	1/37 (2.7%)
Dizziness	8/27 (29.6%)	9/37 (24.3%)
Diarrhoea	0/27 (0.0%)	1/37 (2.7%)
Muscle or joint pain	1/27 (3.7%)	2/37 (5.4%)
Bitter taste in the mouth	0/27 (0.0%)	4/37 (10.8%)
Loss of appetite	1/27 (3.7%)	3/37 (8.1%)
Gastrointestinal symptoms (diarrhoea, vomiting, anorexia, nausea)	8/27 (29.6%)	9/37 (24.3%)

Note: Denominators vary across items according to the number of participants with available responses for each item.

Table 2 shows that the mean number of previous malaria episodes was 2.58 ± 0.97 in the intervention group and 1.64 ± 0.70 in the control group. Most patients in both groups reported their last malaria episode more than one year prior, with the highest proportion in the intervention group (71.8%). The most commonly reported previous malaria type was *P. vivax* in both the intervention (38.0%) and control (45.9%) groups. A proportion of respondents reported mixed *P. vivax*/*P. falciparum* infections, with a higher proportion in the intervention group than in the control group (28.2% vs 3.5%). Table 2 also indicates that *P. vivax* was the most commonly reported malaria type among household members in the intervention group (64.3%), while the corresponding proportion in the control group was 40.4%. Regarding perceived or experienced adverse events during therapy, gastrointestinal symptoms, including diarrhoea, nausea, vomiting, and anorexia, were reported by 8/27 (29.6%) of intervention participants and 9/37 (24.3%) of control participants included in the adverse-event item denominators. Other complaints, including headache, fever, dizziness, and loss of appetite, were reported at low frequencies in both groups.

Adherence to DHP and primaquine on the basis of pill count

Table 3. Adherence to DHP and primaquine on the basis of pill count

Drug & Adherence Category	Intervention	Control	Cluster-adjusted RR (95% CI)	p value	NNT
Complete-case analysis					
DHP (3 days)					
Fully adherent	129/131 (98.5%)	117/130 (90.0%)	1.10 (0.99–1.23)	0.074	12
Nonadherent	2/131 (1.5%)	13/130 (10.0%)			
Primaquine (14 days)					
Fully adherent	116/131 (88.5%)	68/130 (52.3%)	1.74 (1.18–2.58)	0.017*	3
Nonadherent	15/131 (11.5%)	62/130 (47.7%)			
Combined DHP + primaquine					
Fully adherent (both)	116/131 (88.5%)	67/130 (51.5%)	1.81 (1.20–2.74)	0.016*	3
Nonadherent to one or both regimens	15/131 (11.5%)	63/130 (48.5%)			
Worst-case scenario sensitivity analysis					

Drug & Adherence Category	Intervention	Control	Cluster-adjusted RR (95% CI)	p value	NNT
DHP (3 days)					
Fully adherent	129/137 (94.2%)	128/141 (90.8%)	1.04 (0.92–1.18)	0.393	26
Nonadherent	8/137 (5.8%)	13/141 (9.2%)			
Primaquine (14 days)					
Fully adherent	116/137 (84.7%)	79/141 (56.0%)	1.51 (0.96–2.36)	0.064	4
Nonadherent	21/137 (15.3%)	62/141 (44.0%)			
Combined DHP + primaquine					
Fully adherent (both)	116/137 (84.7%)	78/141 (55.3%)	1.53 (1.00–2.34)	0.048*	4
Nonadherent to one or both regimens	21/137 (15.3%)	63/141 (44.7%)			

Note: * $p < 0.05$.

Table 3 presents secondary adherence outcomes based on pill count. In the complete-case analysis, full adherence to primaquine was 88.5% in the intervention group and 52.3% in the control group (cluster-adjusted RR = 1.74; 95% CI: 1.18–2.58; $p = 0.017$). Combined DHP and primaquine adherence was 88.5% and 51.5%, respectively (RR = 1.81; 95% CI: 1.20–2.74; $p = 0.016$). Full adherence to DHP was 98.5% in the intervention group and 90.0% in the control group (RR = 1.10; 95% CI: 0.99–1.23; $p = 0.074$).

In the worst-case scenario, combined DHP and primaquine adherence was 84.7% in the intervention group and 55.3% in the control group (RR = 1.53; 95% CI: 1.00–2.34; $p = 0.048$). The corresponding RR for primaquine adherence was 1.51 (95% CI: 0.96–2.36; $p = 0.064$), while the RR for DHP adherence was 1.04 (95% CI: 0.92–1.18; $p = 0.393$).

Table 4. Mean percentages of medication consumed based on pill count in the complete-case analysis

Drug regimen	Intervention (n = 131), cluster mean $\pm$ SD (%)	Control (n = 130), cluster mean $\pm$ SD (%)	Cluster-adjusted mean difference, percentage points (95% CI)	p value
DHP (3 days)	99.44 $\pm$ 0.71	97.19 $\pm$ 1.77	2.25 (–0.81 to 5.31)	0.110
Primaquine (14 days)	96.51 $\pm$ 1.67	77.97 $\pm$ 6.89	18.54 (7.17 to 29.91)	0.011*

Note: * $p < 0.05$.

Table 5. Primary outcome: full adherence to DHP and 14-day primaquine based on combined pill count and self-report

Analysis	Intervention	Control	Cluster-adjusted RR (95% CI)	p value	NNT
ITT analysis (20 multiple imputations)	85.0%	44.4%	1.91 (1.07–3.41)	0.039*	3
Complete-case sensitivity analysis	111/131 (84.7%)	62/130 (47.7%)	1.89 (1.31–2.75)	0.009*	3
Worst-case scenario sensitivity analysis	111/137 (81.0%)	73/141 (51.8%)	1.54 (1.08–2.20)	0.028*	4

Note: ITT, intention-to-treat. The ITT analysis included all 278 participants recruited from the randomised PHC clusters. Missing primary outcome data were handled using multiple imputation with 20 imputed datasets. The displayed ITT arm risks, RR, and NNT were estimated using the same unweighted cluster-level framework. Numerator/denominator counts are not presented for the multiply imputed ITT analysis. * $p < 0.05$ denotes statistical significance.

Table 4 presents the cluster-level mean percentages of medication consumed. For DHP, the mean was 99.44% in the intervention arm and 97.19% in the control arm, with a cluster-adjusted mean difference of 2.25 percentage points (95% CI: –0.81 to 5.31; $p = 0.110$). For primaquine, the corresponding means were 96.51% and 77.97%, with a mean difference of 18.54 percentage points (95% CI: 7.17 to 29.91; $p = 0.011$). Table 5 presents the primary outcome. In the ITT analysis with 20 multiple imputations, estimated full adherence to both DHP and the 14-day primaquine regimen, confirmed by pill count and self-report, was 85.0% in the intervention arm and 44.4% in the control arm. The cluster-adjusted RR was 1.91 (95% CI: 1.07–3.41; $p = 0.039$), with an NNT of 3. The direction of effect was consistent in the complete-case analysis (RR = 1.89; 95% CI: 1.31–2.75; $p = 0.009$) and the worst-case scenario analysis (RR = 1.54; 95% CI: 1.08–2.20; $p = 0.028$). The agreement between pill count and self-reported adherence was substantial ($\kappa = 0.726$; $p < 0.001$) according to the Landis and Koch criteria. The treatment-adjusted ICC for the primary outcome was 0.017. Cluster-specific observed primary-outcome adherence is presented in Supplementary Table 2.

Factors associated with adherence to 14-day primaquine (intention-to-treat analysis)

Table 6. Exploratory factors associated with adherence to 14-day primaquine: intention-to-treat analysis

Variable	Adherent (%)	Nonadherent (%)	Crude OR (95% CI)	p value	Adjusted OR (95% CI)	p value
Study arm						
Intervention	88.2	11.8	7.09 (1.71–29.42)	0.019*	7.04 (1.41–35.18)	0.028*
Control (Ref.)	51.7	48.3	1.00		1.00	
Age category (years)						
≥30	64.8	35.2	0.50 (0.26–0.95)	0.041*	1.58 (0.36–7.00)	0.438
15–29	67.3	32.7	0.55 (0.21–1.42)	0.155	1.65 (0.29–9.23)	0.466
<15 (Ref.)	78.2	21.8	1.00		1.00	
Sex						
Male	66.9	33.1	0.75 (0.45–1.26)	0.197	0.80 (0.40–1.61)	0.428
Female (Ref.)	74.5	25.5	1.00		1.00	
Occupation						
Employed	63.7	36.3	0.61 (0.32–1.16)	0.099	0.44 (0.17–1.15)	0.077
Unemployed (Ref.)	73.4	26.6	1.00		1.00	
Education						
Primary/no formal education	85.1	14.9	2.83 (1.51–5.30)	0.010*	4.08 (0.76–21.91)	0.081
Secondary/tertiary (Ref.)	64.1	35.9	1.00		1.00	
Ethnicity						
Non-Papuan	78.1	21.9	1.46 (0.66–3.25)	0.260	2.24 (0.52–9.55)	0.198
Papuan (Ref.)	66.9	33.1	1.00		1.00	
Malaria episode history						
First episode	78.1	21.9	1.55 (0.64–3.72)	0.240	2.53 (0.65–9.80)	0.129
Previous episode(s) (Ref.)	63.2	36.8	1.00		1.00	
Travel/stay in other areas						
Yes	74.3	25.7	1.33 (0.60–2.93)	0.380	1.94 (0.83–4.58)	0.098
No (Ref.)	68.3	31.7	1.00		1.00	

Note: The modelled event was full adherence to 14-day primaquine (1 = adherent; 0 = nonadherent); therefore, OR > 1 indicates higher odds of adherence. The ITT regression analysis used 20 multiply imputed datasets. PHC was treated as the clustering unit. OR, odds ratio; CI, confidence interval; ITT, intention-to-treat; Ref., reference category. *p < 0.05.

Table 6 presents the exploratory intention-to-treat analysis of factors associated with adherence to 14-day primaquine. Participants in the intervention arm had higher odds of adherence than those in the control arm in both the crude analysis (OR = 7.09; 95% CI: 1.71–29.42; $p = 0.019$) and the adjusted analysis (aOR = 7.04; 95% CI: 1.41–35.18; $p = 0.028$). Primary or no formal education was associated with higher odds of adherence in the crude analysis (OR = 2.83; 95% CI: 1.51–5.30; $p = 0.010$), but the association was not statistically significant after adjustment (aOR = 4.08; 95% CI: 0.76–21.91; $p = 0.081$). No other covariates were significantly associated with adherence in the adjusted intention-to-treat analysis.

The direction of the intervention effect was consistent in the sensitivity analyses. In the complete-case analysis, the intervention remained associated with higher odds of adherence (aOR = 6.77; 95% CI: 1.09–42.10; $p = 0.044$). In the worst-case scenario analysis, the adjusted estimate remained in the same direction but did not reach statistical significance (aOR = 4.30; 95% CI: 0.85–21.74; $p = 0.067$). The complete-case and worst-case scenario results are presented in Supplementary Tables 3 and 4.

DISCUSSION

This study showed that the culturally tailored adherence-support intervention centred on the medication adherence card improved medication adherence among patients with *P. vivax* malaria. In the ITT analysis, full adherence to the complete DHP and 14-day primaquine regimen, confirmed by pill count and self-report, was higher in the intervention group than in the control group. The complete-case and WCS analyses showed effects in the same direction, supporting the consistency of the primary finding under alternative assumptions for missing outcome data. The greater impact observed for primaquine than for DHP aligns with previous literature suggesting that longer regimens require greater adherence efforts than shorter regimens do (8, 10).

Although the intervention was not developed a priori using the health belief model (HBM), its components can be interpreted post hoc in relation to HBM constructs. The HBM conceptualises health behaviour as the result of interactions between perceived threats, benefits, barriers, and cues to action (26). In this intervention, messages on the card may be interpreted as addressing perceived susceptibility by emphasising the high risk of relapse if the treatment course was not completed,

using local narratives and analogies such as “the illness keeps coming back.” Perceived severity may similarly be reflected by providing information about medical consequences—such as splenomegaly and reduced productivity—that were aligned with sociocultural values in Papua. Perceived benefits were highlighted by explaining that completing treatment can clear parasites and prevent complications, relapse, and transmission, as communicated in simple local language, for example, “Finish your malaria medicine so you stay healthy” (23, 27). These HBM interpretations are post hoc and do not establish the mechanisms through which the intervention produced its effect.

This intervention also included components that may address perceived barriers through a card design incorporating icon-based dosage guidance, a daily monitoring panel, information on mild side effects, and the number of contacts with community health volunteers. This approach is consistent with evidence from Sierra Leone showing that characteristics of antimalarial treatment regimens can influence adherence (28). A systematic review of interventions to improve adherence to antimalarial treatment also found that approaches incorporating visual media, verbal information, community education, and medication supervision can support treatment adherence (29). The role of the card as a cue to action was reinforced by follow-up visits from trained volunteers during the first and second weeks. This approach is also consistent with evidence from Papua indicating that treatment supervision and encouragement by community-based health workers, together with explanations adapted to the patient’s socio-cultural context, may help support completion of 14-day primaquine treatment (10). Because the intervention combined the card with education, medication monitoring, and cadre follow-up, the observed effect cannot be attributed to the card alone.

In the exploratory cluster-adjusted analysis, study arm was the only factor significantly associated with adherence to the 14-day primaquine regimen after adjustment. Previous malaria episode history was not significantly associated with adherence. Previous studies have nevertheless reported relationships between repeated malaria episodes and treatment behaviour (4, 16, 30). Experiencing or perceiving side effects has been reported as a barrier to adherence, as reported in studies from Africa and Asia (9, 30–32). Perceived adverse events were not included as baseline covariates because they were assessed after randomisation. In this study, the intervention addressed this issue through anticipatory counselling and by including information on side-effect management directly on the card, a strategy previously recommended by Banek, Webb (28) and Gerstl, Namagana (33).

Ethnic background was not significantly associated with adherence after adjustment. Although sociocultural context may influence treatment behaviour, the association with ethnicity should be interpreted cautiously because the estimate was imprecise and may also reflect differences in PHC cluster and local context (10, 34). Employment status was also not significantly associated with adherence after adjustment, although socioeconomic factors have been identified as determinants of treatment adherence in previous studies (14, 35, 36).

From a programmatic perspective, these findings support further evaluation of culturally tailored adherence-support interventions for *P. vivax* treatment in Papua. Other approaches to supporting adherence have included mHealth and directly observed therapy (12, 15). Integration of the adherence card with volunteer home visits or SMS reminders for those with mobile phones could be evaluated in future implementation studies, which is consistent with recommendations from the global technical strategy for malaria 2016–2030 (37). Cost, acceptability, scalability, and population-level effects were not assessed in this study and therefore require further evaluation.

This study has several acknowledged limitations. The measurement of medication adherence via a combination of pill counts and interviews may have introduced reporting bias and social desirability bias, potentially resulting in adherence estimates that are higher than actual behaviour. Although the scheduled outcome-assessment procedures were the same in both groups, enumerators were aware of cluster allocation and participants in the intervention arm received additional cadre contacts; therefore, differential measurement and contact-intensity effects cannot be excluded. Because participant recruitment occurred after cluster allocation and PHC staff were aware of allocation, identification bias cannot be excluded. The specific research context in Papua, with its unique sociocultural characteristics, language, and malaria epidemiology, limits the generalisability of the findings beyond the six participating PHCs in Jayapura. The exploratory regression analysis was based on only six PHC clusters, which limited the precision of the adjusted estimates, and residual confounding remains possible, particularly given the marked between-arm imbalance in household income. Furthermore, the involvement of community health volunteers as intervention implementers may have introduced variability in implementation due to differences in communication style, emphasis of messages, and frequency of home visits, which could influence the homogeneity of the intervention’s effect. Because the intervention was delivered as a package comprising the card, education, medication monitoring, and cadre follow-up, the independent effect of the card itself could not be determined.

CONCLUSION

The culturally tailored adherence-support intervention centred on the medication adherence card improved full adherence to the DHP and 14-day primaquine regimen among patients with *P. vivax* malaria in the participating PHCs in Jayapura. In the exploratory cluster-adjusted analysis, study arm was the only factor significantly associated with 14-day primaquine adherence after adjustment. These findings support further evaluation of culturally tailored adherence-support interventions for *P. vivax* treatment in Papua before broader implementation in other settings.

DECLARATIONS

Author contributions: MS: Conceptualization, methodology, investigation, data curation, formal analysis, writing – original draft, writing – review & editing, supervision. ECW: Methodology, formal analysis, writing – review & editing. IJHT: Investigation, field coordination, data collection, writing – review & editing. N: Investigation, data collection, data validation, writing – review & editing. A: Laboratory support, validation, writing – review & editing.

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REFERENCES

1. Surjadaja C, Surya A, Baird JK. Epidemiology of Plasmodium vivax in Indonesia. *The American Journal of Tropical Medicine and Hygiene*. 2016;95(6 Suppl):121-32. <https://doi.org/10.4269/ajtmh.16-0093>.
2. Auburn S, Cheng Q, Marfurt J, Price RN. The changing epidemiology of Plasmodium vivax: Insights from conventional and novel surveillance tools. *PLOS Medicine*. 2021;18(4): e1003560. <https://doi.org/10.1371/journal.pmed.1003560>.
3. Thriemer K, Ley B, von Seidlein L. Towards the elimination of Plasmodium vivax malaria: Implementing the radical cure. *PLoS Medicine*. 2021;18(4): e1003494. <https://doi.org/10.1371/journal.pmed.1003494>.
4. Chu CS, White NJ. The prevention and treatment of Plasmodium vivax malaria. *PLoS Medicine*. 2021;18(4): e1003561. <https://doi.org/10.1371/journal.pmed.1003561>.
5. Kemenkes RI. Buku Saku Tatalaksana Kasus Malaria. Jakarta: Kementerian Kesehatan Republik Indonesia; 2020.
6. Sahiddin M, Ishak H, Arsin AA, Mallongi A, Arsyad M, Hamid F. Non-adherence to medication, malaria relapse, and asymptomatic reservoirs in malaria transmission: A narrative review. *Public Health of Indonesia*. 2025;11(4):10-21. <https://doi.org/10.36685/phi.v11i4.1032>.
7. Minzi O, Maige S, Sasi P, Ngasala B. Adherence to artemether-lumefantrine drug combination: a rural community experience six years after change of malaria treatment policy in Tanzania. *Malaria journal*. 2014; 13:267. <https://doi.org/10.1186/1475-2875-13-267>.
8. Banek K, Webb EL, Doogue EB, Smith SJ, Chandramohan D, Staedke SG. Factors associated with access and adherence to artemisinin-based combination therapy (ACT) for children under five: a secondary analysis of a national survey in Sierra Leone. *Malaria journal*. 2021;20(1):56. <https://doi.org/10.1186/s12936-021-03590-9>.
9. Ntamabyaliro NY, Burri C, Lula YN, Nzolo DB, Engo AB, Ngale MA, et al. Determinants of Patients' Adherence to Malaria Treatment in the Democratic Republic of the Congo. *Tropical Medicine and Infectious Disease*. 2022;7(7):138. <https://doi.org/10.3390/tropicalmed7070138>.
10. Rahmalia A, Poespoprodjo JR, Landuwulang CU, Ronse M, Kenangalem E, Burdam FH, et al. Adherence to 14-day radical cure for Plasmodium vivax malaria in Papua, Indonesia: a mixed-methods study. *Malaria Journal*. 2023;22(1):162. <https://doi.org/10.1186/s12936-023-04578-3>.
11. Raifman JR, Lanthorn HE, Rokicki S, Fink G. The impact of text message reminders on adherence to antimalarial treatment in northern Ghana: a randomized trial. *PloS one*. 2014;9(10): e109032. <https://doi.org/10.1371/journal.pone.0109032>.
12. Huang H-L, Li Y-CJ, Chou Y-C, Hsieh Y-W, Kuo F, Tsai W-C, et al. Effects of and satisfaction with short message service reminders for patient medication adherence: a randomized controlled study. *BMC medical informatics and decision making*. 2013; 13:127. <https://doi.org/10.1186/1472-6947-13-127>.
13. Talisuna AO, Oburu A, Githinji S, Malinga J, Amboko B, Bejon P, et al. Efficacy of text-message reminders on paediatric malaria treatment adherence and their post-treatment return to health facilities in Kenya: a randomized controlled trial. *Malaria journal*. 2017;16(1):46. <https://doi.org/10.1186/s12936-017-1702-6>.
14. Bruxvoort K, Goodman C, Kachur SP, Schellenberg D. How patients take malaria treatment: a systematic review of the literature on adherence to antimalarial drugs. *PLoS One*. 2014;9(1): e84555. <https://doi.org/10.1371/journal.pone.0084555>.
15. Poespoprodjo JR, Burdam FH, Candrawati F, Ley B, Meagher N, Kenangalem E, et al. Supervised versus unsupervised primaquine radical cure for the treatment of falciparum and vivax malaria in Papua, Indonesia: a cluster-randomised, controlled, open-label superiority trial. *The Lancet Infectious Diseases*. 2022;22(3):367-76. [https://doi.org/10.1016/S1473-3099\(21\)00358-3](https://doi.org/10.1016/S1473-3099(21)00358-3).
16. Dinelly KMO, Vitor-Silva S, Brito-Sousa JD, Sampaio VS, Silva MGO, Siqueira AM, et al. Evaluation of the effect of supervised anti-malarial treatment on recurrences of Plasmodium vivax malaria. *Malaria journal*. 2021;20(1):266. <https://doi.org/10.1186/s12936-021-03793-0>.
17. Ananta A, Utami DRWW, Handayani NB. Statistics on ethnic diversity in the land of Papua, Indonesia. *Asia & the Pacific Policy Studies*. 2016;3(3):458-74. <https://doi.org/10.1002/app5.143>.
18. Apay F, Tafor D, Yaroserai MM. Peran Kepemimpinan Ondoafi Dalam Mendukung Program Pelayanan Kesehatan di Distrik Sentani Barat Kabupaten Jayapura. *Jurnal Keperawatan Tropis Papua*. 2019;2(1):80-9. <https://doi.org/10.47539/jkt.v2i1.59>.
19. Zabor EC, Kaizer AM, Hobbs BP. Randomized Controlled Trials. *Chest*. 2020;158(1s): S79-s87. <https://doi.org/10.1016/j.chest.2020.03.013>.

20. Cook AJ, Delong E, Murray DM, Vollmer WM, Heagerty PJ. Statistical lessons learned for designing cluster randomized pragmatic clinical trials from the NIH Health Care Systems Collaboratory Biostatistics and Design Core. *Clinical trials* (London, England). 2016;13(5):504-12. <https://doi.org/10.1177/1740774516646578>.
21. Rutterford C, Copas A, Eldridge S. Methods for sample size determination in cluster randomized trials. *Int J Epidemiol*. 2015;44(3):1051-67. <https://doi.org/10.1093/ije/dyv113>.
22. Peerawaranun P, Landier J, Nosten FH, Nguyen T-N, Hien TT, Tripura R, et al. Intraclass correlation coefficients in the Greater Mekong Subregion for sample size calculations of cluster randomized malaria trials. *Malaria Journal*. 2019;18(1):428. <https://doi.org/10.1186/s12936-019-3062-x>.
23. Cohen J, Saran I. The impact of packaging and messaging on adherence to malaria treatment: evidence from a randomized controlled trial in Uganda. *Journal of Development Economics*. 2018; 134:68-95. <https://doi.org/10.1016/j.jdeveco.2018.04.008>.
24. Almeida ED, Rodrigues LC, Vieira JL. Estimates of adherence to treatment of vivax malaria. *Malaria Journal*. 2014; 13:321. <https://doi.org/10.1186/1475-2875-13-321>.
25. Landis JR, Koch GG. The measurement of observer agreement for categorical data. *Biometrics*. 1977;33(1):159-74. <https://doi.org/10.2307/2529310>.
26. Orji R, Vassileva J, Mandryk R. Towards an effective health interventions design: an extension of the health belief model. *Online journal of public health informatics*. 2012;4(3): e61050. <https://doi.org/10.5210/ojphi.v4i3.4321>.
27. Deressa A, Gamachu M, Birhanu A, Mamo Ayana G, Raru TB, Negash B, et al. Malaria risk perception and preventive behaviors among elementary school students, southwest Ethiopia. Generalized structural equation model. *Infection and drug resistance*. 2023; 16:4579-92. <https://doi.org/10.2147/IDR.S415376>.
28. Banek K, Webb EL, Smith SJ, Chandramohan D, Staedke SG. Adherence to treatment with artemether-lumefantrine or amodiaquine-artesunate for uncomplicated malaria in children in Sierra Leone: a randomized trial. *Malaria journal*. 2018;17(1):222. <https://doi.org/10.1186/s12936-018-2370-x>.
29. Fuangchan A, Dhippayom T, Kongkaew C. Intervention to promote patients' adherence to antimalarial medication: a systematic review. *Am J Trop Med Hyg*. 2014;90(1):11-9. <https://doi.org/10.4269/ajtmh.12-0598>.
30. Amponsah AO, Vosper H, Marfo AF. Patient related factors affecting adherence to antimalarial medication in an urban estate in Ghana. *Malaria research and treatment*. 2015; 2015:452539. <https://doi.org/10.1155/2015/452539>.
31. Camara A, Moriarty LF, Guilavogui T, Diakité PS, Zoumanigui JS, Sidibé S, et al. Prescriber practices and patient adherence to artemisinin-based combination therapy for the treatment of uncomplicated malaria in Guinea, 2016. *Malaria Journal*. 2019;18(1):23. <https://doi.org/10.1186/s12936-019-2664-7>.
32. Saita S, Roobsoong W, Khammaneechan P, Sukchan P, Lawpoolsri S, Sattabongkot J, et al. Community acceptability, participation, and adherence to mass drug administration with primaquine for Plasmodium vivax elimination in Southern Thailand: A mixed methods approach. *Malaria journal*. 2023;22(1):17. <https://doi.org/10.1186/s12936-023-04443-3>.
33. Gerstl S, Namagana A, Palacios L, Mweshi F, Aprile S, Lima A. High adherence to malaria treatment: promising results of an adherence study in South Kivu, Democratic Republic of the Congo. *Malaria journal*. 2015; 14:414. <https://doi.org/10.1186/s12936-015-0933-7>.
34. Muela Ribera J, Hausmann-Muela S, Gryseels C, Peeters Grietens K. Re-imagining adherence to treatment from the "other side": local interpretations of adverse anti-malarial drug reactions in the Peruvian Amazon. *Malaria Journal*. 2016;15(1):136. <https://doi.org/10.1186/s12936-016-1193-x>.
35. Sahiddin M, Gentindatu SJ. Hubungan Pengetahuan, Dukungan Keluarga Dan Persepsi Kepala Keluarga Tentang Malaria Dengan Perilaku Pencegahan Malaria Di Wilayah Kerja Puskesmas Nimbokrang. *Jurnal Keperawatan Tropis Papua*. 2019;2(2):110-4. <https://doi.org/10.47539/jktp.v2i2.68>.
36. Bawate C, Callender-Carter ST, Guyah B, Ouma C. Factors influencing patients' adherence to malaria artemisinin-based combination therapy in Kamuli District, Uganda. *Malaria Journal*. 2024;23(1):1. <https://doi.org/10.1186/s12936-023-04824-8>.
37. WHO. Global Technical Strategy for Malaria 2016 - 2030. Geneva: World Health Organization, 2021.



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