

Health Education Campaign to Improve Malaria Knowledge, Prevention, and Treatment Behaviors in Rural East Nusa Tenggara Province Indonesia: Protocol for a Cluster-Assigned Quasi-Experimental Study

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Abstract

Background: Malaria is a major health issue distributing across 85 countries globally including in Indonesia. Indonesia is in the progress to achieve malaria elimination and currently the high burden of malaria is in the rural eastern part of the nation including in East Nusa Tenggara Province where the number of malaria cases increased significantly during COVID-19. To achieve malaria elimination, malaria awareness should be measurable and integrated in malaria policy. Currently malaria awareness of rural community in the region is low and interventional studies to improve malaria awareness of rural community were less documented in Indonesia.

Objective: The aims of the study are to investigate the impact of local wisdom-based health education campaign combining local music, sub-district leader's voice and loudspeaker to change behavioral aspects of malaria of the rural community. Specifically, we want to assess the effect of this intervention on (1) the improvement of malaria awareness index of rural community and their associated factors, (2) the change of appropriate malaria treatment seeking behavior (AMTSB) and their associated factors, (3) the enrichment of knowledge and practice of malaria prevention measures and their associated factors, (4) the enhancement of the use of long-lasting insecticide-treated nets and their associated factors.

Methods: This study applied a cluster-assigned quasi-experimental study with a pre-test and post-test both in the control and intervention groups. Thirteen villages were in the intervention group and twelve villages in the control group. Health education campaign is conducted in the intervention group once a week for 20 weeks. Before and after the campaign, household survey was conducted to record behavioral aspects of malaria in relation to general knowledge of malaria, AMTSB, and malaria prevention measures knowledge and practice. 894 respondents participated before and after intervention. The improvement of malaria awareness index, AMTSB, good level of malaria prevention measures knowledge and practice will be determined based on the difference score in each index before and after intervention in both groups. The chi-square test would be applied to assess the difference score before and after intervention. Binary logistic regression will be applied to determined important risk factors associated with the change in each index.

Results: The intervention has been conducted since the last week of August 2024 and it will be finished on the second week of January 2025. The project is in the progress to draft some papers that will be published in peer-reviewed journals

Conclusions: This study will be expected to provide significant findings to comprehensively investigate the change of behavioral aspects of malaria due to local wisdom-based malaria education campaign. These results could help stakeholders in Indonesia to develop malaria health policy based on the local context to support the global effort to become a malaria-free zone

by 2030.

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Original Manuscript

Protocol

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Abstract

Background. Malaria is a major health issue distributing across 85 countries globally including in Indonesia. Indonesia is in the progress to achieve malaria elimination and currently the high burden of malaria is in the rural eastern part of the nation including in East Nusa Tenggara Province where the number of malaria cases increased significantly during COVID-19. To achieve malaria elimination, malaria awareness must be measurable and integrated into malaria policy. Currently malaria awareness among rural communities in the region is low and interventional studies aiming at improving malaria awareness of rural areas are poorly documented in Indonesia.

Objectives. This study aims to investigate the impact of local wisdom-based health education campaign combining local music, the voice of sub-district leader's and loudspeaker announcements to influence malaria-related behavior in rural communities. Specifically, we aim to assess the effect of this intervention on (1) improvement in the malaria awareness index among rural communities and their associated factors, (2) changes in appropriate malaria treatment-seeking behavior (AMTSB) and its associated factors, (3) enhancements in knowledge and practice of malaria prevention measures and their associated factors, (4) increased use of long-lasting insecticide-treated nets and their associated factors.

Methods. This study employs a cluster-assigned quasi-experimental design with a pre-test and post-test assessments in both control and intervention groups. The control group, consisting of twelve villages, receives malaria education integrated into routine health services provided by local health centers. The intervention group, comprising thirteen villages, receives the same education as the control, in addition to a malaria campaign conducted once a week for 20 weeks. Before and after the campaign, a household survey is conducted to assess behavioral aspects of malaria, including general knowledge of malaria, AMTSB, and malaria prevention measures knowledge and practice. A total of 894 respondents participated before and after intervention. The improvement of malaria awareness index, AMTSB, good level of malaria prevention measures knowledge and practice will be determined based on the difference score in each index before and after intervention in both groups. The chi-square test will be used to assess score differences. Binary logistic regression will be applied to identify key risk factors associated with changes in each index.

Results.

The intervention was conducted from the last week of August 2024 to the second week of January 2025. The project is currently in progress with multiple papers being drafted for publication in peer-reviewed journals.

Conclusions.

This study is expected to provide significant findings to comprehensively investigate the change of behavioral aspects of malaria due to local wisdom-based malaria education campaign. The findings could assist stakeholders in Indonesia in developing malaria health policies that are contextual relevant, thereby supporting global efforts to achieve malaria-free status by 2030.

Keywords: Malaria awareness, health education campaign, rural community, malaria health policy; malaria elimination, COVID-19

Introduction

Background

Malaria is a major health problem spreading across 85 countries globally with an estimation 249 million people suffering from malaria in 2022, of which 2% were from the Southeast Asia (SEA) region [1]. The action plan in this region indicates that the entire SEA region would be targeted to achieve malaria elimination by 2030 [2]. Two countries in the region, Maldives and Sri Lanka have obtained a malaria elimination certificate from World Health Organization (WHO) since 2015 and 2016 respectively, whilst other countries have a high burden of malaria particularly India and Indonesia contributing to 88.1% to the total number of the malaria cases in the region [1]. One important indicator for a region to be categorized as malaria elimination is the absence of the local malaria transmission cases for three consecutive years [3].

Following the global commitment, Indonesia has also set a national goal to eliminate malaria by 2030 [4]. Much progress has been obtained from this commitment. 75.7% of the total 514 districts have received malaria elimination certificates since 2023 [5] and currently malaria is concentrated in rural areas [4]. However, there is a huge disparity between Western and Eastern part of the country in this achievement. Most of district in Western part have been classified as malaria elimination zone whilst limited number of districts receiving malaria elimination certificates in the Eastern Indonesia including East Nusa Tenggara (ENT) Province [5]. ENT Province having 22 districts is the third largest contributor to malaria cases at the national level [6]. The number of malaria cases increased during the COVID-19 pandemic from 12,909 in 2019 to 15,830 in 2022 [7]. Of the total number of districts in this province, 9 districts (41%) have received malaria elimination certificates while the rest are still categorized as high, medium and low endemic malaria areas [8]. East Sumba District is one of the high malaria endemic settings in the ENT Province with the total number of malaria cases reaching 5,537 in 2022 [9] and the majority of the cases was due to plasmodium falciparum [10].

Malaria is a complex health issue influenced by multiple factors including plasmodium types [11–13], sociodemographic factors [14–16], environmental factors [17–19], and behavioral aspects of malaria [20]. The distribution of malaria cases shows the different patterns within and between regions, due to variations in the environment, vectors, and social conditions of the local community [21]. Various studies have been conducted in ENT Province as an effort to reduce the incidence of malaria in this area [22–27]. Studies of malaria parasite aspects show that the prevalence of vivax malaria is greater than falciparum malaria [22–24], this presents a major challenge in efforts to achieve malaria elimination considering that vivax malaria treatment requires high public awareness to complete the treatment for 14 days to get the optimal result of the medicine [28]. Studies on

malaria vectors in this region show that the prevalence of mosquito biting in this area peaks at midnight both indoors and outdoors [25,26]. Studies of environmental aspects show that increasing the distance of residence from mosquito larval habitat is followed by a decrease of the risk of malaria in all age groups [27]. However, studies on the behavioral aspects of local communities are very poorly documented in ENT Province, though the contribution of malaria knowledge is very significant in achieving malaria elimination [29,30]. Community behavior and their perspectives are very important in the efforts to achieve malaria elimination in certain areas [31–33].

In the context of Indonesia, several studies of community behavior regarding the knowledge and practice of malaria prevention have been conducted in various provinces [34–36]. The results of these studies indicate that community members have the awareness to practice several malaria prevention methods. However, all of those observational studies were conducted in the western part of Indonesia where most of the districts have been categorized as malaria elimination zone [6].

Some studies on the community behavior regarding of the knowledge and practice of malaria prevention had been conducted in ENT Province [37–43]. A study conducted by the National Health Research Agency in 2018 in the Eastern Indonesia including ENT Province showed that the variations between provinces in terms of malaria prevention practices of rural communities were very significant [37]. Other studies on malaria prevention measures knowledge and practice in the region indicated that the Tetun ethnic group used traditional plants to prevent malaria [38], the use of mosquitoes net was only common in rural communities of low endemic settings [43] and communities in high endemic areas have a low level of malaria prevention measures knowledge compared to community groups in low endemic areas [44]. Another study of malaria prevention measures revealed that the knowledge on long-lasting insecticide-treated nets (LLINs), which is the most effective prevention measures to prevent malaria [33,45], was only common on the high endemic settings in this province [42]. Regarding the malaria treatment seeking behavior of the local community, a current literature reveals that the prevalence of appropriate malaria treatment seeking behavior among rural communities in the province is very low [41]. Research on malaria awareness of this rural community demonstrated that the level of malaria awareness of rural communities in ENT Province was very low [39] and the variation of malaria awareness amongst ethnic group is very significant with the lowest level was in Sumba ethnic group [40]. However, all of those studies are observational studies that only observe the behavior of rural communities at a certain time. The results of study applying an experimental study on the behavior aspect of malaria to the rural

communities in ENT Province are less documented. This indicates that there have been no efforts made by various parties to increase malaria awareness for rural communities in this region. Therefore, an innovation is needed to increase malaria awareness among rural adults who are an important group of community to achieve malaria elimination [46]. Increasing malaria awareness of rural community allows them to seek the right treatment if they are sick [33,47], reduce the prevalence of malaria [48] and accelerate the achievement of malaria elimination [49].

In the global context, literature indicates that interventional studies have significantly improved malaria knowledge [50,51] encouraged communities to adopt various malaria prevention measures [51–55] and promoted early malaria treatment-seeking behavior [56]. In Indonesia, experimental studies using video media have substantially increased malaria knowledge among the elderly in Mimika District, Central Papua Province [57] and Kulon Progo District, Special Region of Yogyakarta [58]. However, these studies were conducted with small sample sizes. A current systematic review on interventional studies for malaria and dengue control indicates that the use of various media in interventions has enhanced disease knowledge among both the general population [59] and school communities [60]. However, there is a lack of studies in the Indonesia context focusing on this approach [59].

The use of loudspeaker media [61], local-based songs [62], and local government involvement [63] has been identified as highly effective in increasing health awareness among rural communities [61,62]. However, the impact of these three culturally relevant approaches on malaria-related behavioral changes in rural communities in Indonesia remains unexplored, despite rural populations contributing significantly to the country's malaria burden [4]. . Therefore, these interventional studies will fill these gaps with the following objectives:

1. Determine the impact of locally based interventions on the improvement of malaria awareness index among rural communities and their associated factors including socio-demographic factors and environmental variables
2. Investigate the effectiveness of locally based intervention on improving appropriate malaria treatment-seeking behavior among rural communities and their associated factors
3. Assess the influence of locally based intervention on enhancing knowledge and the practice of malaria prevention measures among rural communities and their associated factors
4. Estimate the effect of locally based intervention on increasing the use of long-lasting insecticide-treated nets in rural settings and their associated factors.

This study is projected to provide significant findings to comprehensively clarify the change of behavioral aspect of malaria in the rural ENT Province because of the application of locally based intervention. The improvement of malaria awareness index, the variation of malaria prevention measures knowledge and practice, and the change of malaria treatment seeking behavior among rural communities would be recognized. The findings of this study could assist public health policy makers in Indonesia in designing malaria policy to boost malaria elimination progress in the country. The findings might also be beneficial for other countries having similar of socio-demographics settings in supporting global actions to achieve the malaria free area by 2030.

Methods

Study Population

East Sumba District was selected as the study area because it is classified as a high malaria endemic region [64]. The district consists of 22 sub-districts and 156 villages [65]. The total population in the district is 248,776, with an almost equal distribution of male and female, 51.4% and 48.6% respectively. Approximately half of the population is engaged on the agricultural sector. The district has four hospitals, 22 public health centers, and 78 subsidiary public health centers across the region [65]. This study was conducted in four selected sub-districts where there is one public health center in each sub-district as indicated in **Figure 1**.

Figure 1: Map of Study Sites

Study design and sampling technique

This study protocol employed a cluster-assigned quasi-experimental design with a pre-test and post-test assessments in both control and intervention groups. The cluster unit for this study was the village. Village was not randomized because the research team aimed to implement the intervention across all villages within a selected sub-district, where the sub-district leader would serve as a role model to encourage community in improving malaria awareness. To obtain a representative sample, the research team randomly selected four out of 22 sub-districts. Two of these sub-districts was assigned as intervention groups, while the remaining two served control groups. The first three sub-district each has six villages and the fourth sub-district has seven villages, therefore the total number of villages participating in the study was 25 villages representing about 16% of the total villages in the district. Of these, 13 villages were assigned to the intervention group, while 12 villages formed the control group. The number of samples selected from each village was proportional to the number

of households in that village. Within each selected village, households were randomly sampled to serve as an experimental unit as indicated in **Figure 2**.

Figure 2: Flow chart of selection of malaria endemic settings and villager population.

Sample size calculation

To determine the required sample size for baseline prevalence of study outcomes, the research team applied the Leslie-Kish formular for calculating the sample size in cross sectional studies [66]. The

formula indicates
$$n_0 = \frac{Z^2 p(1-p)}{E^2}$$

Where n_0 is the initial sample size; p is the prevalence of malaria awareness in ENT Province = 0.48.8% [39], Z is the confidence level at 95% (standard value of 1.96), d (relative precision) = 0.05, therefore the initial sample size was 384 participants. For the population survey, a community correction factor of 2 was applied, doubling the required sample size to 768 participants. Additionally, a 15% buffer was added to account for potential incomplete data, primary due to non-response or failure to complete interviews. Thus, the final sample size was determined to be 884 participants with 442 individuals in the control group and 442 in the intervention groups. This number served as a guideline for recruiting participants for the household survey, conducted both before and after intervention.

Eligibility criteria

Individuals were eligible for recruitment if they had resided in the selected villages for at least 12 months and did not intend to migrate or relocate within the next six month after initial contact. Furthermore, participants were required to be at least 18 years of age. All participants were required to provide written informed consent. For those who were unable to read or write, the consent form was read aloud by trained research assistants (RAs), and participants provided consent using a thumbprint on an ink pad. The RAs graduated from public health degree and local nurses with prior experience in data collection and employment at local public health centers. These professionals were recruited to ensure the study's data collection process was conducted effectively.

Study procedure for malaria awareness campaign

This study followed a four-stages process to achieve its primary outcomes.

Phase I (preparation stage). During this phase, the research team submitted an application to Health Research Ethics Commission of Nusa Cendana University Kupang East Nusa Tenggara Province Indonesia to obtain the research ethics approval. Following approval, the research team coordinated with local authorities at various administrative levels, from the provincial to village level in East Sumba District to obtain permission letters for conducting the study in the selected areas.

Phase II (baseline phase). After securing the necessary approvals and obtaining the recommendation letter from the relevant authorities, the research team conducted a household survey in both the intervention and control groups. Before data collection, respondents were provided with a general overview of the study, and informed consent forms were obtained before their participation. The survey aimed to assess behavioral aspects of malaria and was conducted using a questionnaire that had been modified from a previous study conducted in rural East Nusa Tenggara [67]. The questionnaire consisted of 40 questions designed to collect data on key malaria-related behaviors, including general knowledge of malaria, treatment-seeking behavior, and the use of malaria prevention methods. The questionnaire was completed by either the head of the household or another household member aged 18 years or older.

Phase III (intervention stage). In the control group, malaria education to the local community was integrated into routine services at the local health centre. These educational sessions were provided during: the first prenatal visit of pregnant women to the health centre; food supplement distribution activities; immunization programs conducted during integrated service post activities at the village level. These activities were conducted once per month, and malaria-related information was disseminated once per village on average. The primary audience for these sessions included pregnant women, mothers with children under five years old, and young children. Occasionally, malaria education was provided to all individuals attending the health centres. In the intervention group, malaria education followed the same structure as in the control group but was supplemented with a health education campaign targeting the entire village community.

The intervention followed these steps:

Firstly, the research team met with the sub-district head and village leaders in the two selected sub-district designated as experimental areas. After obtaining their approval, the research team recorded a campaign message delivered by each the sub-district leader. The campaign content, developed by experts in malaria related behavior, mathematical modeling and rural development, included: main symptoms of malaria, prevention strategies, and the appropriate treatment-seeking behavior for

suspected malaria cases. During the campaign, the sub-district head occasionally emphasized key points in the local language to improve comprehension. The recorded message was then combined with a locally popular song to enhance engagement. The final recording was 15 minutes long. Secondly, six health promotion staffs from Baing and Mahu Public Health Centers were selected as research assistants (RAs) to play the recording. The recording was broadcast using loudspeakers to ensure wide community outreach. Thirdly, the RAs played the recorded message once per week for 20 weeks in the 13 intervention villages. The intervention started in the fourth week of August 2024 and concluded in the second week of January 2025. In each selected village, the intervention was conducted in four different locations per week to ensure that all community members were reached. The principal investigator maintained weekly communication with the RAs to ensure that the intervention was being conducted properly. Over the 20-week intervention period, the research team monitored implementation by visiting the experimental villages once a month for five months.

Phase IV (evaluation stage). At this stage, the research team conducted a household survey in both the intervention and the control groups, using the same questionnaire that was administered during the baseline phase of the study. The final data collection was done from the third week of January 2025 to the second week of February 2025. Since the research aims to assess the impact of the intervention on all rural adults, participants surveyed before and after the intervention may differ, depending on respondent availability during the data collection period.

Data collection methods

Data were collected by face-to-face interviews, guided by a questionnaire adapted from a previously published study [67]. The questionnaire consists of five sections covering demographic characteristics, general knowledge of malaria, treatment-seeking behavior, practice of malaria prevention measures, and practice of malaria treatment-seeking behavior. Each section contained questions to capture key behavioral aspects of malaria. A detailed list of questions for each section is provided in **Multimedia Appendix 1**. Furthermore, this data collection was conducted by local nurses and health promotion workers from the selected health centers. These enumerators participated in a one-day intensive training to improve their understanding on the study background and objectives. Moreover, enumerators were trained on how to approach the potential participants to be joined in this study and how to conduct the interview following the guidance of this study and

local culture. The same enumerators were responsible for recruiting participants during both baseline data collection and the post-intervention phase. For secondary data collection, malaria register books from each public health center were reviewed to obtain data on the number of malaria cases and malaria-related deaths over a ten- year period from 2013 to 2023. Data on the number of malaria cases in each public health centers throughout the district were collected from Health Department of East Sumba District for the same period.

Independent Variables of the Study

This study considers demographic and environmental factors as independent variables. Demographic variables include gender, age, education level, occupation, and socio-economic status (SES). Respondents' SES will be measured based on ownership of durable assets such as television, refrigerator, car, electricity, telephone, radio, number of bedrooms and home infrastructure conditions such as access to drinking water sources, and the presence of water channels around the house [68]. Using principal component analysis, respondents' SES will be categorized into five quantiles ranging from the lowest (quantile 1) to the highest (quantile 5) [69]. Environmental variables in the study include the location of residence categorized as rice fields, coastal areas, or hilly areas, and the accessibility to villages, classified as easy, moderate, or difficult to access. Additionally, the study considered proximity to health facilities, including the type and distance of the nearest health facilities. Then for secondary data from the health center, the patient records from 2013 to 2023 were observed for all patients suspected with malaria and confirmed positive or negative cases based on laboratory examination results. The number of malaria cases based on gender, age group, type of plasmodium, time (year and month), location of residence, type of treatment, number of deaths since the period under review was observed in the four selected health centers.

Outcome variables

The study considers ten potential outcomes variables, with the first seven serving as the primary outcome of the intervention, whilst the remaining three represent secondary findings. The first primary outcome of the study is the improvement of malaria awareness index among rural communities. If the malaria awareness index after intervention is higher than that of before, it indicates that the health education campaign effectively enhanced malaria awareness. This index will be assessed based on 12 questions covering general knowledge of malaria, treatment-seeking behavior and knowledge of malaria prevention measures, following the methodology of a previous

study [39]. Each correct response will be assigned a score of one, whilst incorrect answers will receive a score of zero with the total possible score being 12. Participants' knowledge level will be categorized based on their accuracy rate: 0% (zero awareness), 1- 59% (poor awareness), 60- 79% (good awareness), and at least 80% (excellent awareness). Those classified as having excellent or good awareness will be considered aware of malaria, while participants in the other categories will be classified as unaware of malaria [39,70]. The malaria awareness index will be calculated before and after the intervention in both the intervention and control groups to evaluate the effectiveness of the health education campaign.

The second outcome variable in this study is the improvement of appropriate malaria treatment-seeking behavior (AMTSB). This improvement will be demonstrated if the proportion of rural adults exhibiting AMTSB after the intervention is higher than before. AMTSB is defined as seeking malaria treatment at professional health facilities within 24 hours of experiencing malaria symptoms [41]. The proportion of rural adults engaging in AMTSB will be calculated both before and after intervention in both the intervention and control groups. This assessment will be based on the three key questions from the malaria treatment-seeking behavior section of the questionnaire.

The third outcome variable in this study is the improvement in good malaria prevention measures knowledge (MPMK). This improvement will be demonstrated if the percentage of rural population with good MPMK after intervention is higher than before. A good level of MPMK is defined as the ability to correctly answer at least half of the total questions in malaria prevention measures knowledge section, as indicated in the previous study [41,59]. The level of MPMK will be assessed before and after the intervention in both the intervention and control groups.

The fourth outcome variable is the use of bed nets during the dry season in high malaria-endemic settings. The community behavior regarding bed net usage may exhibit seasonal variations, as individuals may adjust their practices depending on weather conditions [72]. This outcome will be assessed based on the participants' self-reported responses to a survey question asking whether they slept under a bed net the night before the survey.

The fifth outcome variable in this study is the variation of the use of bed net in dry and wet season. Literature indicates that the bed net usage might fluctuate based on seasonal weather conditions, as individuals adapt their malaria prevention behaviors accordingly [72,73]. This malaria awareness

campaign began at the end of August 2024, during the dry season, and concluded in the second week of January 2025, which corresponds to the wet season in the study area. The study will examine seasonal differences in the bed net use by analyzing responses to four key questions from the malaria prevention practice section of the questionnaire. The disparity in bed net usage between dry and wet seasons will be assessed for both the intervention and control groups.

The sixth outcome variable in this study is the improvement in good malaria prevention measures practice (MPMP). This improvement will be demonstrated if the percentage of rural population practicing good MPMP after the intervention is higher than before. A good level of MPMP is defined as the ability to correctly answer at least half of the total questions in the malaria prevention measures practice section, as indicated in the previous study [74,75].

The seventh outcome variable in this study is the variation in access to basic drinking water and its associated factors among rural communities in East Nusa Tenggara Province Indonesia. Household access to basic drinking water is defined based on the World Health Organization (WHO) Joint Monitoring Program (JMP) guidelines, which classify water source into four categories: no service, unimproved, limited, and basic [76]. To analyze this variable, a dichotomous classification will be used, where households will be categorized as either having access to an improved drinking water source (Yes =1) or lacking access to an improved drinking water source (No = 0). This classification will help determine disparities in access to safe drinking water and identify key factors influencing these differences.

The secondary outcomes of this study are derived from the analysis of patient medical records from four selected health centers, along with additional data from the Department of Health, East Sumba District. The eighth outcome variable focuses on the monthly number of malaria cases recorded over the past ten years, from 2013 to 2023. By integrating data from both health centers and the Meteorological Agency of East Sumba, this study aims to explore the impact of climatic variables on malaria cases fluctuation in this region, following the methodology of the previous study [77]. This analysis will provide valuable insights into seasonal and long-term trends in malaria transmission, which could help inform future malaria prevention and control strategies.

The ninth outcome variable in this study examines the demographic variation in malaria prevalence among communities residing in hilly and coastal area over the past ten years (2013 - 2023). Among the four selected health centers, Baing and Nggongi Public Health centers are located in coastal

areas, whereas Mahu and Kananggar Public Health Centers are situated in hilly region. Given that vector distribution and species composition may vary between different geographic settings [78] previous studies in Indonesia have reported significant differences in malaria prevalence between coastal and hilly areas [79]. By analyzing malaria case records from these health centres, this study aims to assess regional disparities in malaria burden and determine how demographic and environmental factors contribute to these differences. This information may help tailor malaria prevention and control efforts to the specific needs of different geographic regions.

The tenth outcome variable in this study investigates malaria prevalence and malaria-related mortality rates in East Sumba district over the past ten years (2013 - 2023). Data on the number of malaria cases and malaria-related death were obtained from malaria register books at the health centers and malaria reports from the Health Department of East Sumba District. Therefore, the trend of malaria prevalence and mortality rate over ten year period in the study area will be revealed, following the previous studies [80,81].

Statistical Analysis

For the first outcome variable, descriptive statistics will be used to summarize participants' sociodemographic characteristics and environmental variables including gender, age group, SES, education level, family size, distance to the nearest health facilities, village accessibility, and household location. A chi-square test will be applied within each study group (intervention and control) to evaluate the association of basic malaria understanding, basic malaria knowledge, the level of malaria knowledge, and the level of malaria awareness before and after intervention. Unpaired samples t-tests will be employed to investigate the statistical differences, with a p -value of less than 0.05 considered statistically significant. Comparison will be performed within groups (pre- and post-intervention) and between groups to determine the impact of the intervention [61]. Furthermore, a binary logistic regression model will be applied to identify the potential factors associated with malaria awareness in both the intervention and control groups [39]. Statistical analyses will be conducted using SPSS version 27 (IBM Corporation).

For the second outcome variables, descriptive statistics will be used to summarize participants' sociodemographic and environmental characteristics including gender, age group, SES, education level, family size, distance to the nearest health facilities, access to village, household location for both study groups. A chi-square test will be applied to evaluate the association between AMTSB and the sociodemographic and environmental characteristics of participants. Unpaired samples t-tests

were employed to assess the statistical differences, with a p -value of less than 0.05 considered statistically significant. Comparison will be conducted within and between groups for both pre- and post-intervention periods. Moreover, binary logistic regression method will be used to identify predictors associated with AMTSB among participants in both study groups [41]. Only predictors that demonstrate statistically significant differences ($P < .05$) will be retained in the final model.

For the third variable response, participants' sociodemographic characteristics and environmental variables in each group will be reported using descriptive statistics. The association between good level of malaria prevention measures knowledge with predictors will be investigated by a chi-square test. Unpaired samples t -tests will be employed to investigate the statistical differences with a p -value of less than 0.05 considered statistically significant. Comparison will be conducted within and between group for both pre- and post-intervention periods. Furthermore, binary logistic regression analysis will be performed to identify key risk factors influencing malaria prevention measures knowledge [44,71] among rural communities in both study groups.

For the fourth outcome variable, descriptive statistics will be used to summarize participants' sociodemographic characteristics and environmental variables based on the awareness that malaria can be prevented. The association between the bed net usage and its predictors will be examined using a chi-square test. Then, binary logistic regression analysis will be conducted to identify the primary risk factors associated with bed net usage during the dry season among rural communities [72].

For the fifth outcome variable, participants' sociodemographic characteristics, environmental variables, and malaria-related behavioral aspect in both the intervention and control groups will be analyzed. Data will be presented as proportion for each season (dry and wet seasons) to examine the seasonal variations in malaria prevention behaviors. The association between bed net usage and its predictors will be evaluated using a chi-square test for each season. The main risk factors of bed net usage during dry and wet season will be investigated by applying binary logistic regression analysis. The adjusted odds ratio will be applied to quantify the strength of association between bed net use and its predictors in each season [72,73].

For the sixth outcome variable, participants' sociodemographic characteristics, environmental variables, and behavioral aspects of malaria in each group will be reported using descriptive

statistics. The association between good level of malaria prevention measures practice and its predictors will be investigated by a chi-square test. Unpaired samples t-tests will be employed to investigate the statistical differences with a p -value of less than 0.05 considered statistically significant. Comparison will be performed within and between groups for both pre- and post-intervention periods. Moreover, binary logistic regression analysis will be performed to identify the primary risk factors influencing MPMP [74,75] among rural communities in both study groups.

For the seventh outcome variables, descriptive statistics will be used to summarize participants' sociodemographic characteristics, environmental variables, and malaria-related behavioral based on their source of drinking water. The association between access to improved drinking water and its predictors will be assessed using a chi-square test. Furthermore, a binary logistic regression model will be applied to determine predictors influencing access to improved drinking water [76].

For the eighth outcome variable, descriptive analyses of climatic factors across different sub-districts will be performed. Data will be aggregated at the sub-district level and statistical estimates will be generated for each variable. Specifically, the total number of malaria cases and the average of malaria incidence will be computed. Climatic variables, including maximum, minimum, and the mean values of temperature will be calculated. Moreover, data from all 22 sub-districts will be analyzed, focusing on malaria cases and climatic parameters, including maximum, minimum, and average temperature. To depict the seasonal dynamics, seasonal variations in climatic parameters and malaria cases will be plotted, covering the two main seasons. A time series for both predictor and outcome variables will be plotted to deliver an overall perspective. A map of the number of malaria cases will be generated. Scatterplots will be developed to illustrate relationships between malaria cases and predictor variables, following a previous study [77].

For the ninth outcome variable malaria cases records from 2013 to 2023 will be analyzed across different geographic areas. Data from Baing and Nggongi Public Health Centers, representing coastal regions, will be combined, while records from Mahu and Kananggar Public Health Centers, representing hilly areas will be aggregated separately. Malaria prevalence will be calculated on a monthly, yearly and cumulative basis over the study period. To visualize the demographic trends, malaria prevalence will be plotted against key demographic variables. The disparity of malaria prevalence in demographic variables will be investigated by a chi-square test [10,82].

For the tenth outcome variable, descriptive statistics will be applied to calculate frequencies and percentages of overall malaria prevalence, trends of malaria transmission considering variations by season, month, year, sex, age and species of malaria parasite. Epidemiological characteristics, including age group, sex, and *plasmodium* species adjusted malaria-related mortality rates in East Sumba District will be presented as the percentage following by their 95% confidence interval. Chi square test will be used to compare the association of malaria burden by age groups and sex. Altogether, with p-values less than 0.05 considered statistically significant. The malaria prevalence and mortality rate will be illustrated in map to assess distribution of the case geographically [80,81].

Ethics and Dissemination

The Declaration of Helsinki was adhered to ensure that the rights, integrity, and confidentiality of the respondents are strictly protected. All respondents signed consent forms before being interviewed. For this interventional study, we received human ethics approval from Human Ethics Committee of Nusa Cendana University Kupang ENT Province Indonesia (Ethics ID: 42/UN15.21/KEPK/2024) as shown in **Multimedia Appendix 2**. The research team secured official permission letters from relevant authorities at the provincial, district, sub-district, and village levels to conduct the study within the designated areas. Written consent forms were collected from all participants participating in this study. The findings of this interventional study will be disseminated through national and international conferences and published in peer-reviewed journals.

Results

The time frame of the project is presented in **Table 1**. Primary data collection for the baseline survey was conducted between August and September 2024. A total of 894 rural adults participated in face-to-face interviews in both the intervention and control groups. These participants were drawn from 25 villages across East Sumba District. The intervention commenced in the last week of August 2024 and concluded in the second week of January 2025. The project is currently in the process of drafting multiple research papers, which will be submitted for publication in peer-reviewed journals to disseminate the findings

Table 1. Timeline of research phases.

Research phases	January	June	-	August 2024	February	March
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	- May 2024	July 2024	- January 2025	2025 December 2026
Questionnaire and question guide development	✓			
Ethics approval		✓		
Training of field workers		✓		
Household surveys for pre-test data			✓	
Data entry			✓	
Data analysis			✓	
Manuscript preparation and submission			✓	
Intervention in 13 villages			✓	
Household surveys for post-test data				✓
Data entry				✓
Data analysis for the final outcome				✓
Manuscript preparation and submission				✓

Discussion

Principal Findings

This research endeavoured to examine the impact of integrating multiple media into an interventional study designed to influence malaria-related behavioral changes among rural communities. The intervention incorporated local governmental leaders, traditional music, and loudspeaker announcements, recognizing their potential to enhance community engagement and facilitate effective malaria awareness campaigns. Local authorities play a pivotal role in public health initiative as they serve as trusted figures within their communities and possess extensive experience in mobilizing local population [63,83]. Furthermore, music has been shown to be a powerful tool for fostering social connection and disseminating health information, particularly in efforts to promote preventive behaviors for infectious diseases [62]. The use of loudspeakers as a communication

medium has also been identified as an effective approach for delivering malaria health messages and ensuring continuous information dissemination in rural settings [61]. Moreover, integrating music-based education enhances learning outcomes among populations with low literacy rate [84] making it a particularly effective strategy for engaging rural communities. This is particularly relevant in East Nusa Tenggara Province, where high school dropout rates remain a challenge [85,86]. By leveraging these culturally relevant and widely accessible communication methods, this quasi-experimental study has the potential to generate a significant impact on improving the malaria awareness index, appropriate malaria treatment-seeking behavior, knowledge of malaria prevention measures, and practice of malaria prevention measures among rural adults in East Nusa Tenggara Province Indonesia.

Interventional studies have demonstrated a positive impact on improving malaria-related behaviors at the community level across various settings [50,51,55,60,87–89]. In Southeast Asia, several interventional studies have shown significant contributions to behavioral change in malaria prevention and treatment [52,61,90,91]. For instance, a study conducted in Northern Myanmar found that loudspeaker announcements delivering malaria prevention and treatment messages over six months significantly increased malaria awareness among villagers [61]. Similarly, a school-based educational intervention in India demonstrated a substantial improvement in malaria prevention and control knowledge among students in grades 9 to 12 [90]. In Pakistan, an interventional study targeting pregnant women indicated that the use of long-lasting insecticide-treated nets (LLINs) increased significantly following 12-weeks health education program [52]. In Bhutan, a community-directed educational intervention on malaria prevention, implemented over six-months, led to improvements in malaria-related knowledge, attitude, and prevention practices among rural communities in Sarpang district [91]. In Indonesia, there is a notable gap in interventional studies focused on malaria education. Most existing research has been conducted in school settings [60] and is primarily concentrated in the western region of the country [59]. To the best of our knowledge, this is the first study in Southeast Asia to investigate the combined impact of local leadership, traditional music, and loudspeaker announcements as an intervention to enhance malaria knowledge, improve prevention practices, and encourage early treatment-seeking behavior among rural communities affected by malaria.

The data collection instruments used in this study were adapted from a validated questionnaire, with modifications made to ensure ease of administration. The measurement of key variables, including

malaria awareness index, appropriate malaria treatment-seeking behavior, and malaria prevention measures knowledge and practice, was based on standardized indicators from reputable international journals. This methodological approach allows for comparability with national and international studies, enhancing the credibility and applicability of the findings. Consequently, the study's results will serve as an important reference for guiding malaria health policy in rural Indonesia and supporting the national commitment to achieving malaria elimination by 2030.

Despite its strengths, this study has several limitations. First, village selection was not randomized for the control and intervention groups, which may introduce potential selection bias. However, the allocation strategy ensured that the distribution of villages between study groups was comparable in terms of malaria endemicity, and the intervention was designed to maximize its impact by including all villages within a selected sub-district. Second, most of the data collected in this interventional study relied on self-reported responses from participants, covering aspects such as general malaria knowledge, symptoms, diagnosis, and prevention measures knowledge. This reliance on self-reported data introduces the potential for recall bias. However, to mitigate this limitation, all malaria prevention measures practice were directly observed by research assistants during data collection, improving the reliability of reported behavioral measures.

Conclusions

This study will be expected to provide significant findings to comprehensively investigate the change of behavioral aspects of malaria among rural communities following the implementation of local wisdom-based malaria intervention. The change in malaria awareness index, malaria prevention measures knowledge and practice, the disparity in using core prevention measures such as LLINs in two different seasons, the improvement of malaria treatment-seeking behavior among rural communities due to the implementation of local wisdom-based health education campaign will be recognized. These findings will provide evidence-based insights into the effectiveness of locally driven health education strategies in malaria-endemic regions. Therefore, this research will contribute to the development of contextually relevant malaria policies in Indonesia. Furthermore, it aligns with global malaria elimination efforts, supporting Indonesia's commitment to achieving a malaria-free status by 2030.

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Authors' Contributions

RDG developed the study protocol, prepared the data collection tools, conducted primary data collection for both pre and post-test, designed the analysis plan, and drafted the manuscript. ML organized data collection tools, reviewed the manuscript and provided substantial inputs. DMS coordinated the data collection tools, reviewed the paper and contributed significant revision. YPB assisted in data collection tool preparation, reviewed the manuscript and provided critical feedback. DK conducted primary data collection, reviewed the article and contributed substantially to its refinement. All authors have read, revised, and approved the final manuscript for submission.

Conflicts of Interest

The authors declare that this manuscript was approved by all authors in its form and that no competing interest exists.

Abbreviations

AMTSB: Appropriate malaria treatment-seeking behavior

ENT: East Nusa Tenggara

LLINs: long-lasting insecticide-treated bed nets

MPMK: Malaria Prevention Measures Knowledge

MPMP: Malaria Prevention Measures Practice

RAs: Research Assistants

SEA: Southeast Asia

SES: Socio-Economic Status

WHO: World Health Organization

Multimedia

The questionnaire for primary data collection in pre and post-test.

Multimedia

Ethics Approval of Nusa Cendana University Kupang East Nusa Tenggara Province Indonesia

Appendix

1

Appendix

2

Multimedia Appendix 3

Original peer-review reports from Directorate of Research, Technology, and Community Service Ministry of Education, Culture, Research, and Technology of the Republic of Indonesia.

Multimedia Appendix 4

TIDieR-PHP Checklist

References

1. World Health Organization. World Malaria Report 2023. Geneva: World Health Organization; 2023. Available: <https://www.who.int/publications/i/item/9789240086173>
2. World Health Organization. Regional Action Plan 2017–2030. Towards 0. Malaria-Free South-East Asia Region. 2017 [cited 27 Sep 2024]. Available: <https://iris.who.int/handle/10665/272389>
3. World Health Organization. The E-2020 initiative of 21 malaria-eliminating countries. 2019. Available: <https://www.who.int/publications/i/item/WHO-CDS-GMP-2019.07>
4. Asia Pacific Malaria Elimination Network. Indonesia National Strategic Plan 2020-2024. December 2020. 2021. Available: <https://www.apmen.org/resources/indonesia-national-strategic-plan-2020-2024>.
5. Ministry of Health Republic of Indonesia. Indonesia Health Profile 2023. Ministry of Health Republic of Indonesia. Jakarta; 2024. Available: <https://www.kemkes.go.id/id/profil-kesehatan-indonesia-2023>
6. Indonesia Ministry of Health. Indonesia Health Profile 2021. Jakarta: Indonesia Ministry of Health; 2022. Available: <https://www.kemkes.go.id/downloads/resources/download/pusdatin/profil-kesehatan-indonesia/Profil-Kesehatan-2021.pdf>
7. Ministry of Health Republic of Indonesia. Indonesia Health Profile 2020. Jakarta. Ministry of Health Republic of Indonesia; 2021. Available: <https://pusdatin.kemkes.go.id/folder/view/01/structure-publikasi-data-pusat-data-dan-informasi.html> (Indonesian).
8. BPS. Jumlah Kabupaten/Kota yang mencapai eliminasi Malaria 2018-2020. BPS Jakarta; 2023. Available: <https://www.bps.go.id/indicator/30/1764/1/jumlah-kabupaten-kota-yang-mencapai-eliminasi-malaria.html>
9. Central Bureau of Statistics East Nusa Tenggara. The number of disease based on the district and types of the disease from 2013 to 2022. 2 Nov 2023 [cited 16 Nov 2023]. Available: <https://ntt.bps.go.id/subject/30/kesehatan.html#subjekViewTab3>
10. Lobo M, Guntur RD, Kusumaningrum D, Bria YP. The Declined Trend of Malaria over a Ten-year Period in the Rural East Nusa Tenggara Province, Indonesia: A Medical Record Analysis. Open Access Maced J Med Sci. 2024;12: 107–115. doi:10.3889/oamjms.2024.11829
11. Dao F, Dembele L, Diarra B, Sogore F, Marin-Menendez A, Goita S, et al. The Prevalence of

- Human Plasmodium Species during Peak Transmission Seasons from 2016 to 2021 in the Rural Commune of Ntjiba, Mali. *TropicalMed*. 2023;8: 438. doi:10.3390/tropicalmed8090438
12. Hawadak J, Dongang Nana RR, Singh V. Global trend of Plasmodium malariae and Plasmodium ovale spp. malaria infections in the last two decades (2000–2020): a systematic review and meta-analysis. *Parasites Vectors*. 2021;14: 297. doi:10.1186/s13071-021-04797-0
 13. Kouna LC, Oyegue-Liabagui SL, Voumbo-Matoumona DF, Lekana-Douki JB. Malaria Prevalence in Asymptomatic and Symptomatic Children Living in Rural, Semi-Urban and Urban Areas in Eastern Gabon. *Acta Parasit*. 2024;69: 471–482. doi:10.1007/s11686-023-00783-x
 14. Villena OC, Arab A, Lippi CA, Ryan SJ, Johnson LR. Influence of environmental, geographic, socio-demographic, and epidemiological factors on presence of malaria at the community level in two continents. *Sci Rep*. 2024;14: 16734. doi:10.1038/s41598-024-67452-5
 15. Hasyim H, Dewi WC, Lestari RAF, Flora R, Novrikasari N, Liberty IA, et al. Risk factors of malaria transmission in mining workers in Muara Enim, South Sumatra, Indonesia. *Sci Rep*. 2023;13: 14755. doi:10.1038/s41598-023-40418-9
 16. Smith JL, Mumbengegwi D, Haindongo E, Cueto C, Roberts KW, Gosling R, et al. Malaria risk factors in northern Namibia: The importance of occupation, age and mobility in characterizing high-risk populations. Thet Wai K, editor. *PLoS ONE*. 2021;16: e0252690. doi:10.1371/journal.pone.0252690
 17. Sadoine ML, Smargiassi A, Liu Y, Gachon P, Fournier M, Dueymes G, et al. Differential Influence of Environmental Factors on Malaria Due to Vector Control Interventions in Uganda. *IJERPH*. 2023;20: 7042. doi:10.3390/ijerph20227042
 18. Sadoine ML, Smargiassi A, Ridde V, Tusting LS, Zinszer K. The associations between malaria, interventions, and the environment: a systematic review and meta-analysis. *Malar J*. 2018;17: 73. doi:10.1186/s12936-018-2220-x
 19. Bayode T, Siegmund A. Identifying childhood malaria hotspots and risk factors in a Nigerian city using geostatistical modelling approach. *Sci Rep*. 2024;14: 5445. doi:10.1038/s41598-024-55003-x
 20. Van Eijk AM, Choubey S, Barla P, Haque MA, Nandini P, Acharya S, et al. Malaria in Sundargarh district, Odisha, India: Epidemiological and behavioral aspects from surveys. *Acta Tropica*. 2020;211: 105647. doi:10.1016/j.actatropica.2020.105647
 21. Bannister-Tyrrell M, Verdonck K, Hausmann-Muela S, Gryseels C, Muela Ribera J, Peeters Grietens K. Defining micro-epidemiology for malaria elimination: systematic review and meta-analysis. *Malar J*. 2017;16: 164. doi:10.1186/s12936-017-1792-1
 22. Hutagalung J. Prevalence of asymptomatic submicroscopic malaria in eastern Indonesia: a cross sectional survey and spatial analysis. *The Lancet Global Health*. 2017;5: S13. doi:10.1016/S2214-109X(17)30120-1
 23. Kosasih A, Koepfli C, Dahlan MS, Hawley WA, Baird JK, Mueller I, et al. Gametocyte carriage of Plasmodium falciparum (pfs25) and Plasmodium vivax (pvs25) during mass screening and

- treatment in West Timor, Indonesia: a longitudinal prospective study. *Malar J.* 2021;20: 177. doi:10.1186/s12936-021-03709-y
24. Khaerunnissya; RL. Characteristics of Asymptomatic Malaria in Eastern Indonesia: A Cross-sectional Study. *European Journal of Molecular & Clinical Medicine.* 2021;7: 2405-2414.
 25. Ndoen E, Wild C, Dale P, Sipe N, Dale M. Dusk to dawn activity patterns of anopheline mosquitoes in West Timor and Java, Indonesia. *Southeast Asian J Trop Med Public Health.* 2011;42: 550–561.
 26. Syahrani L, Permana DH, Syafruddin D, Zubaidah S, Asih PBS, Rozi IE, et al. An inventory of human night-biting mosquitoes and their bionomics in Sumba, Indonesia. Ekpo UF, editor. *PLoS Negl Trop Dis.* 2022;16: e0010316. doi:10.1371/journal.pntd.0010316
 27. Nixon CP, Nixon CE, Arsyad DS, Chand K, Yudhaputri FA, Sumarto W, et al. Distance to *Anopheles sundanicus* larval habitats dominant among risk factors for parasitemia in meso-endemic Southwest Sumba, Indonesia. *Pathogens and Global Health.* 2014;108: 369–380. doi:10.1179/2047773214Y.0000000167
 28. Chu CS, White NJ. The prevention and treatment of *Plasmodium vivax* malaria. *PLoS Med.* 2021;18: e1003561. doi:10.1371/journal.pmed.1003561
 29. Moonen B, Cohen JM, Snow RW, Slutsker L, Drakeley C, Smith DL, et al. Operational strategies to achieve and maintain malaria elimination. *The Lancet.* 2010;376: 1592–1603. doi:10.1016/S0140-6736(10)61269-X
 30. Whittaker M, Smith C. Reimagining malaria: five reasons to strengthen community engagement in the lead up to malaria elimination. *Malar J.* 2015;14: 410, s12936-015-0931–9. doi:10.1186/s12936-015-0931-9
 31. Naserrudin NA, Hod R, Jeffree MS, Ahmed K, Culleton R, Hassan MR. The Role of Human Behavior in *Plasmodium knowlesi* Malaria Infection: A Systematic Review. *IJERPH.* 2022;19: 3675. doi:10.3390/ijerph19063675
 32. Kajeewiwa L, Thwin MM, Nosten S, Tun SW, Parker D, von Seidlein L, et al. Community engagement for the rapid elimination of malaria: the case of Kayin State, Myanmar. *Wellcome Open Res.* 2017;2: 59. doi:10.12688/wellcomeopenres.12051.1
 33. Guntur RD. The Variation of Behavioural Aspects of Malaria in East Nusa Tenggara Province Indonesia: Implication for Malaria Elimination in the Province [dissertation]. Swinburne University of Technology. 2022. Available: <http://hdl.handle.net/1959.3/470529>
 34. Yulidar Y, Wilya V. Yulidar, Y., & Wilya, V. (2016). Pengetahuan, sikap, dan perilaku terhadap malaria pada masyarakat di Kecamatan Alue Bilie, Kabupaten Nagan Raya, Aceh. *Journal of Health Epidemiology and Communicable Diseases*,. 2: 27–32. doi:10.22435/jhec.v2i1.5936.27-32
 35. Rahmasari FV, Setyonugroho W, Swarjana IK, Arisandi D, Kesetyaningsih TW. The association between demographic and attitude factors with the practice of malaria prevention among the rural community in Purworejo district, Indonesia. *Qanun Medika.* 2021;5: 113. doi:10.30651/jqm.v5i1.5416

36. Sanjana P, Barcus MJ, Bangs MJ, Ompusunggu S, Elyazar I, Marwoto H, et al. Survey of community knowledge, attitudes, and practices during a malaria epidemic in central Java, Indonesia. *Am J Trop Med Hyg.* 2006;75: 783–789.
37. Ipa M, Widawati M, Laksono AD, Kusriani I, Dhewantara PW. Variation of preventive practices and its association with malaria infection in eastern Indonesia: Findings from community-based survey. Carvalho LH, editor. *PLoS ONE.* 2020;15: e0232909. doi:10.1371/journal.pone.0232909
38. Taek M, Bambang P, Agil M. The Prevention and Treatment of Malaria in Traditional Medicine of Tetun Ethnic People in West Timor Indonesia. 1 (5)-2019. . *Open Acc J Comp & Alt Med.* 2019;1.
39. Guntur RD, Kingsley J, Islam FMA. Malaria awareness of adults in high, moderate and low transmission settings: A cross-sectional study in rural East Nusa Tenggara Province, Indonesia. Kumar R, editor. *PLoS ONE.* 2021;16: e0259950. doi:10.1371/journal.pone.0259950
40. Guntur RD, Kingsley J, Islam FMA. Ethnic Variation and Its Association With Malaria Awareness: A Cross-sectional Study in East Nusa Tenggara Province, Indonesia. *J Prev Med Public Health.* 2022;55: 68–79. doi:10.3961/jpmph.21.367
41. Guntur RD, Kingsley J, Islam FMA. Malaria treatment-seeking behaviour and its associated factors: A cross-sectional study in rural East Nusa Tenggara Province, Indonesia. Aung PL, editor. *PLoS ONE.* 2022;17: e0263178. doi:10.1371/journal.pone.0263178
42. Guntur RD, Kingsley J, Islam FMA. Knowledge of malaria prevention measures of rural adults: Implication for malaria elimination in the East Nusa Tenggara Province, Indonesia. Paramaribo-Suriname; 2022.
43. Guntur RD, Lobo M, Islam FMA. Factors associated with the utilisation of mosquito nets amongst rural adults: A cross-sectional study in East Nusa Tenggara Province Indonesia. 2023. doi:10.1101/2023.02.26.23286476
44. Guntur RD, Kleden MA, Kusumaningrum D, Amirul Islam FM. The variation of malaria prevention measures knowledge and their associated factors: A cross-sectional study in East Nusa Tenggara Province Indonesia. *Epidemiology;* 2023 Sep. doi:10.1101/2023.09.12.23295402
45. Wangdi K, Furuya-Kanamori L, Clark J, Barendregt JJ, Gattton ML, Banwell C, et al. Comparative effectiveness of malaria prevention measures: a systematic review and network meta-analysis. *Parasites Vectors.* 2018;11: 210. doi:10.1186/s13071-018-2783-y
46. Awasthi KR, Jancey J, Clements ACA, Leavy JE. Community engagement approaches for malaria prevention, control and elimination: a scoping review protocol. *BMJ Open.* 2021;11: e049812. doi:10.1136/bmjopen-2021-049812
47. Naing PA, Maung TM, Tripathy JP, Oo T, Wai KT, Thi A. Awareness of malaria and treatment-seeking behaviour among persons with acute undifferentiated fever in the endemic regions of Myanmar. *Trop Med Health.* 2017;45: 31. doi:10.1186/s41182-017-0070-9
48. Alam MS, Kabir MM, Hossain MS, Naher S, Ferdous NEN, Khan WA, et al. Reduction in

- malaria prevalence and increase in malaria awareness in endemic districts of Bangladesh. *Malar J.* 2016;15: 552. doi:10.1186/s12936-016-1603-0
49. van Eer ED, Bretas G, Hiwat H. Decreased endemic malaria in Suriname: moving towards elimination. *Malar J.* 2018;17: 56. doi:10.1186/s12936-018-2204-x
50. Atser PN, Hayat G, Okafor UB. Effect of Health Education Intervention on Knowledge and Adherence to Intermittent Preventive Treatment of Malaria in Pregnancy Among Women. *Healthcare.* 2025;13: 105. doi:10.3390/healthcare13020105
51. Onyinyechi OM, Mohd Nazan AIN, Ismail S. Effectiveness of health education interventions to improve malaria knowledge and insecticide-treated nets usage among populations of sub-Saharan Africa: systematic review and meta-analysis. *Front Public Health.* 2023;11: 1217052. doi:10.3389/fpubh.2023.1217052
52. Kumar R, Farzeen M, Hafeez A, Achakzai BK, Vankwani M, Lal M, et al. Effectiveness of a health education intervention on the use of long-lasting insecticidal nets for the prevention of malaria in pregnant women of Pakistan: a quasi-experimental study. *Malar J.* 2020;19: 232. doi:10.1186/s12936-020-03298-2
53. Sonibare OO, Bello IS, Olowookere SA, Shabi O, Makinde NO. Effect of malaria preventive education on the use of long-lasting insecticidal nets among pregnant females in a Teaching Hospital in Osun state, south-west Nigeria. *Parasite Epidemiology and Control.* 2020;11: e00182. doi:10.1016/j.parepi.2020.e00182
54. Balami AD, Said SMD, Zulkefli NAM, Norsa'adah B, Audu B. Improving malaria preventive practices and pregnancy outcomes through a health education intervention: A randomized controlled trial. *Malar J.* 2021;20: 55. doi:10.1186/s12936-021-03586-5
55. Abamecha F, Sudhakar M, Abebe L, Kebede Y, Alemayehu G, Birhanu Z. Effectiveness of the school-based social and behaviour change communication interventions on insecticide-treated nets utilization among primary school children in rural Ethiopia: a controlled quasi-experimental design. *Malar J.* 2021;20: 41. doi:10.1186/s12936-020-03578-x
56. Kebede Y, Abebe L, Alemayehu G, Sudhakar M, Birhanu Z. School-based social and behavior change communication (SBCC) advances community exposure to malaria messages, acceptance, and preventive practices in Ethiopia: A pre-posttest study. *Samy AM, editor. PLoS ONE.* 2020;15: e0235189. doi:10.1371/journal.pone.0235189
57. Sambo S, Permatasari TAE, Herlina L. The Use of Effective Video Media in Enhancing Knowledge and Attitudes towards Malaria Prevention Among the Elderly. *jppipa, pendidikan ipa, fisika, biologi, kimia.* 2024;10: 361–371. doi:10.29303/jppipa.v10iSpecialIssue.8631
58. Vesti Rahmasari F, Huriah T, Ani Yuniarti F, Setyawati I, Suratini. Enhancing Knowledge and Attitudes Towards Malaria and Dengue Through Video Education: A Comparative Study in Taiwan and Indonesia. *Sukamta, Kanafiah SNAM, Tjale MM, Matas JAV, Kamarudin MF, Hanif MU, et al., editors. E3S Web Conf.* 2024;570: 02002. doi:10.1051/e3sconf/202457002002
59. Yulfi H, Panggabean M, Darlan DM, Siregar ISs, Rozi MF. Community-based intervention in mosquito control strategy: A systematic review. *Narra J.* 2025;5: e1015.

doi:10.52225/narra.v5i1.1015

60. Chandra E, Fahri S, Johari A, Syaiful S. School-based Prevention of Mosquito-borne Diseases: A Systematic Review. *JCCNC*. 2023;9: 15–24. doi:10.32598/JCCNC.9.1.468.1
61. Aung PL, Pumpaibool T, Soe TN, Burgess J, Menezes LJ, Kyaw MP, et al. Health education through mass media announcements by loudspeakers about malaria care: prevention and practice among people living in a malaria endemic area of northern Myanmar. *Malar J*. 2019;18: 362. doi:10.1186/s12936-019-2985-6
62. Benavides JA, Caparrós C, da Silva RM, Lembo T, Tem Dia P, Hampson K, et al. The Power of Music to Prevent and Control Emerging Infectious Diseases. *Front Med*. 2021;8: 756152. doi:10.3389/fmed.2021.756152
63. Adhikari B, Pell C, Phommasone K, Soundala X, Kommarasy P, Pongvongsa T, et al. Elements of effective community engagement: lessons from a targeted malaria elimination study in Lao PDR (Laos). *Global Health Action*. 2017;10: 1366136. doi:10.1080/16549716.2017.1366136
64. Dinas Kesehatan Provinsi NTT. Profil Kesehatan Provinsi Nusa Tenggara Timur. 2020.
65. BPS Sumba Timur. Sumba Timur Dalam Angka 2023. 2023. Available: <https://sumbatimurkab.bps.go.id/publication.html>
66. Akena D, Kiguba R, Muhwezi WW, Kwesiga B, Kigozi G, Nakasujja N, et al. The effectiveness of a psycho-education intervention on mental health literacy in communities affected by the COVID-19 pandemic—a cluster randomized trial of 24 villages in central Uganda—a research protocol. *Trials*. 2021;22: 446. doi:10.1186/s13063-021-05391-6
67. Guntur RD, Kingsley J, Islam FMA. Epidemiology of Malaria in East Nusa Tenggara Province in Indonesia: Protocol for a Cross-sectional Study. *JMIR Res Protoc*. 2021;10: e23545. doi:10.2196/23545
68. Mashuri YA, Ng N, Santosa A. Socioeconomic disparities in the burden of hypertension among Indonesian adults - a multilevel analysis. *Global Health Action*. 2022;15: 2129131. doi:10.1080/16549716.2022.2129131
69. Vyas S, Kumaranayake L. Constructing socio-economic status indices: how to use principal components analysis. *Health Policy and Planning*. 2006;21: 459–468. doi:10.1093/heapol/czl029
70. Tang S, Ji L, Hu T, Wang R, Fu H, Shao T, et al. Public awareness of malaria in the middle stage of national malaria elimination programme. A cross-sectional survey in rural areas of malaria-endemic counties, China. *Malar J*. 2016;15: 373. doi:10.1186/s12936-016-1428-x
71. Aragie TB. Knowledge of malaria prevention and control methods and associated factors among rural households in west Belesa district, north west Ethiopia, 2019. *BMC Public Health*. 2020;20: 1275. doi:10.1186/s12889-020-09332-x
72. Buchwald AG, Coalson JE, Cohee LM, Walldorf JA, Chimbiya N, Bauleni A, et al. Insecticide-treated net effectiveness at preventing *Plasmodium falciparum* infection varies by age and season. *Malar J*. 2017;16: 32. doi:10.1186/s12936-017-1686-2

73. Ricotta E, Oppong S, Yukich JO, Briët OJT. Determinants of bed net use conditional on access in population surveys in Ghana. *Malar J.* 2019;18: 63. doi:10.1186/s12936-019-2700-7
74. Fikrie A, Kayamo M, Bekele H. Malaria prevention practices and associated factors among households of Hawassa City Administration, Southern Ethiopia, 2020. Di Gennaro F, editor. *PLoS ONE.* 2021;16: e0250981. doi:10.1371/journal.pone.0250981
75. Aliyo A, Golicha W, Fikrie A. Pastoral Community Malaria Prevention Practice and Associated Factors Among Households in Three Districts of the Borena Zone, Southern Ethiopia. *Health Services Research and Managerial Epidemiology.* 2023;10: 233339282211445. doi:10.1177/23333928221144555
76. Gaffan N, Kpozèhouen A, Dégbey C, Glèlè Ahanhanzo Y, Glèlè Kakai R, Salamon R. Household access to basic drinking water, sanitation and hygiene facilities: secondary analysis of data from the demographic and health survey V, 2017–2018. *BMC Public Health.* 2022;22: 1345. doi:10.1186/s12889-022-13665-0
77. Rubuga FK, Ahmed A, Siddig E, Sera F, Moirano G, Aimable M, et al. Potential impact of climatic factors on malaria in Rwanda between 2012 and 2021: a time-series analysis. *Malar J.* 2024;23: 274. doi:10.1186/s12936-024-05097-5
78. Zhou G, Afrane YA, Vardo-Zalik AM, Atieli H, Zhong D, Wamae P, et al. Changing Patterns of Malaria Epidemiology between 2002 and 2010 in Western Kenya: The Fall and Rise of Malaria. von Seidlein L, editor. *PLoS ONE.* 2011;6: e20318. doi:10.1371/journal.pone.0020318
79. Barcus MJ, Laihad F, Sururi M, Sismadi P, Marwoto H, Bangs MJ, et al. Epidemic malaria in the Menoreh Hills of Central Java. *Am J Trop Med Hyg.* 2002;66: 287–292. doi:10.4269/ajtmh.2002.66.287
80. Rodríguez SNI, Rodríguez JAI, Rodríguez JCP, Olivera MJ. Malaria mortality in Colombia from 2009 to 2018: a descriptive study. *Rev Soc Bras Med Trop.* 2021;54: e0441-2020. doi:10.1590/0037-8682-0441-2020
81. Alkadir S, Gelana T, Gebresilassie A. A five year trend analysis of malaria prevalence in Guba district, Benishangul-Gumuz regional state, western Ethiopia: a retrospective study. *Trop Dis Travel Med Vaccines.* 2020;6: 18. doi:10.1186/s40794-020-00112-4
82. Kleden MA, Guntur RD, Atti A. Seven Years Malaria Trend Analysis in Kori Public Health Centre, Southwest Sumba District East Nusa Tenggara Province, Indonesia: a Retrospective Study. *Advances in Nonlinear Variational Inequality.* 2024;27: 263–78. Available: <https://internationalpubls.com/index.php/anvi/article/view/962>
83. Adhikari B, Pell C, Cheah PY. Community engagement and ethical global health research. *Global Bioethics.* 2020;31: 1–12. doi:10.1080/11287462.2019.1703504
84. Chen S. Music as a Bridge to Literacy and Multiliteracies Development for Second Language Learners (Master's thesis,. University of Windsor. 2023. Available: <https://www.proquest.com/openview/5d47c4fae83811c591708c5d12ad69c2/1?pq-origsite=gscholar&cbl=18750&diss=y>
85. Guntur RD, Lobo M. Statistical Modelling for Dropped Out School Children (DOSC) in East

- Nusa Tenggara Province Indonesia. *J Phys: Conf Ser.* 2017;812: 012073. doi:10.1088/1742-6596/812/1/012073
86. Guntur RD, Lobo M. An Analysis of Factors that Affect Out of School Junior High Aged Children Using Logistic Regression Method. *Asia-Pacific Collaborative Education Journal.* 2015;11: 23–36. Available: <http://apcj.alcob.org/journal/article.php?code=38464>
 87. Longchamps C, Galindo MS, Lambert Y, Sanna A, Mutricy L, Garancher L, et al. Impact of Malakit intervention on perceptions, knowledge, attitudes, and practices related to malaria among workers in clandestine gold mines in French Guiana: results of multicentric cross-sectional surveys over time. *Malar J.* 2022;21: 397. doi:10.1186/s12936-022-04391-4
 88. Farea BA, Muharram AA, Baktayan NA, Assabri AM, Farea AA, Alsada MA. Impact of Health Education on KAP towards Malaria among Basic Schools Pupils in Taiz Governorate. Republic of Yemen 2013: Pre and Post Intervention Study. *Health.* 2020;12: 324–333. doi:10.4236/health.2020.124027
 89. Li W, Han LQ, Guo YJ, Sun J. Using WeChat official accounts to improve malaria health literacy among Chinese expatriates in Niger: an intervention study. *Malar J.* 2016;15: 567. doi:10.1186/s12936-016-1621-y
 90. Roja C, Seetha Lakshmi A, Anitha Rani M, Eapen A. Effect of School-Based Educational Interventions on the Knowledge of Malaria and Dengue Among Higher Secondary School Children in Chennai, India: A Pre and Post-intervention Study. *Cureus.* 2022 [cited 20 Sep 2024]. doi:10.7759/cureus.26536
 91. Tobgay T, Pem D, Dophu U, Dumre SP, Na-Bangchang K, Torres CE. Community-directed educational intervention for malaria elimination in Bhutan: quasi-experimental study in malaria endemic areas of Sarpang district. *Malar J.* 2013;12: 132. doi:10.1186/1475-2875-12-132

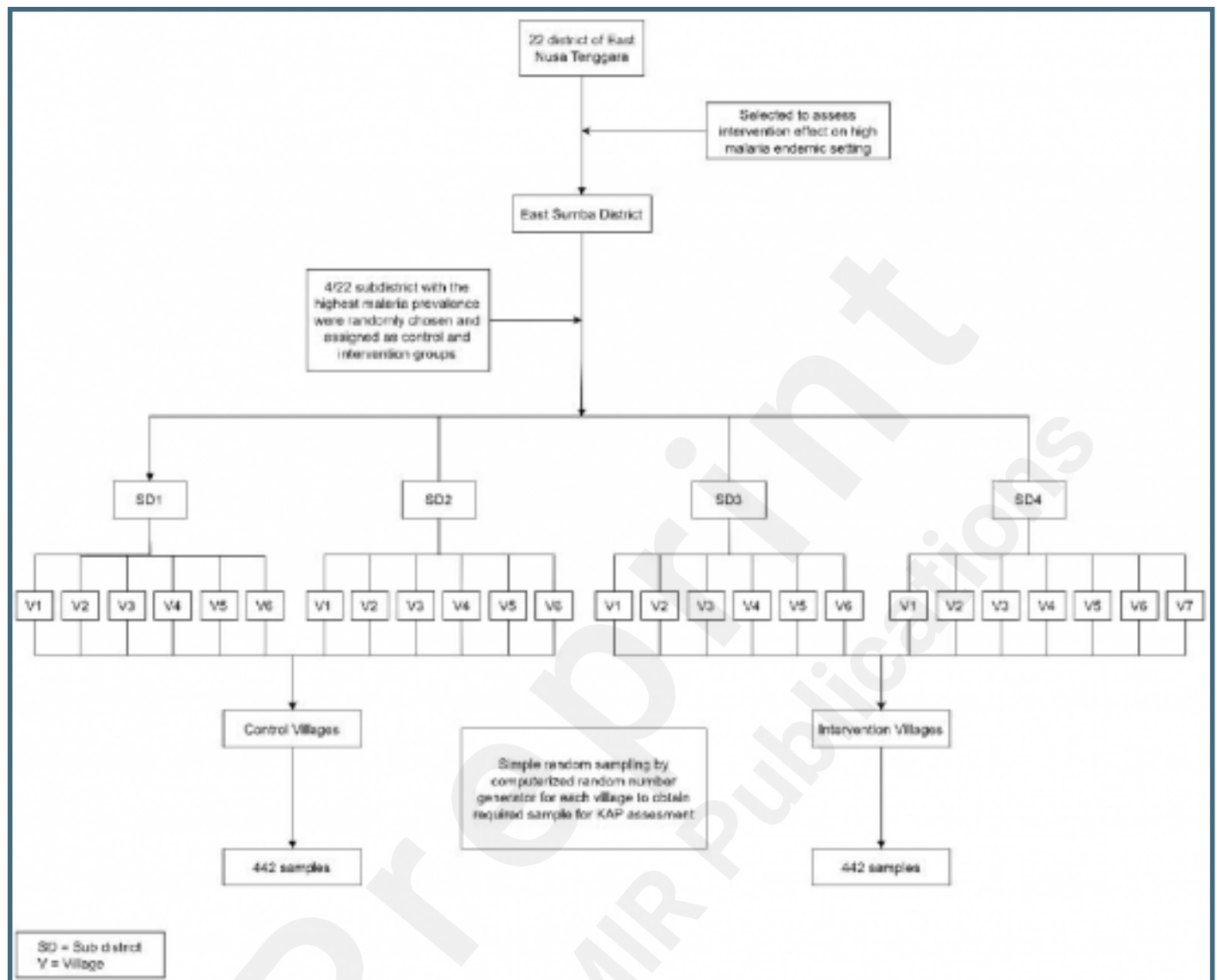
Supplementary Files

Figures

Map of Study Sites.



Flow chart of selection of malaria endemic settings and villager population.



Multimedia Appendixes

The questionnaire for primary data collection in pre and post-test.

URL: <http://asset.jmir.pub/assets/f5e4d2fee544d73834f558ba4edd3adf.pdf>

Ethics approval of nusa cendana university kupang east nusa tenggara indonesia.

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