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Perception of caregivers on ITNs utilisation and its effectiveness among children under 5 years of age in Chikwawa district, Malawi

Enock Benito[1*], Praveen Suthar[1†], Godfrey Banda[2†], Parthasarthi Ganguly[1] and Wamaka Msopole[3]

Abstract

Background In 2020, Malawi had 6.9 million malaria cases and 2551 deaths, mainly in children under five years of age. The 2017–2022 Malawi malaria control strategic plan promoted the consistent use of insecticide-treated nets through free distribution and mass campaigns. Despite widespread availability of the control strategy plan, Chikwawa District continues to suffer from high malaria burden especially among under five children, due to inconsistent insecticide-treated (ITN) net usage. For this reason, this study aimed at exploring caregivers' perceptions on insecticide-treated net utilisation and also find out about its effectiveness among those who consistently use them.

Methods This study used a sequential exploratory mixed methods design. The data used for quantitative analysis was drawn from the population of under-five children's caregivers within the catchment area of Chikwawa district hospital. The sample size was 96 participants, as determined by Cochran's formula. The data collection lasted from December 2023 to April 2024 and included four in-depth interviews and three focus group discussions to address the objectives qualitatively.

Results The study revealed that 91.67% of households used ITNs, with 87.50% using them daily. The significant factors influencing ITN utilisation included the number of nets, user satisfaction, perceived impact, user habits, acquisition method, and usage frequency (all p values < 0.001). Under-five malaria cases were also significant (p = 0.025). The odds of the perceived net impact influencing utilisation were 4.956 times greater. Non-usage was due to heat, quality concerns, limited access, breathing difficulties, health conditions such as asthma, and misconceptions about net treatment.

Conclusion The study revealed a strong belief in insecticide-treated net efficacy. However, some challenges such as access, durability, and misinformation of insecticide-treated nets were discovered. These challenges affected utilisation of insecticide-treated nets in agreement with some literature reviewed. The insights found in this study will help policymakers in addressing health interventions for the reduction of malaria cases in Malawi.

Keywords Insecticide-treated nets (ITNs), Utilisation, Access to ITNs, Malaria, Caregivers

†Praveen Suthar and Godfrey Banda share the final authorship, having contributed equally to the study.

*Correspondence:
Enock Benito
enockbenito@gmail.com
[1] Parul Institute of Public Health, Parul University, P.O. Box. Limda, 391760 Waghodia, Gujarat, India
[2] School of Global and Public Health, Kamuzu College of Health Sciences, P.V.T Bag 360, Chichiri Blantyre, Malawi
[3] Chikwawa District Hospital, P.O. Box 32, Chikwawa, Malawi

Background

Malaria continues to pose a significant global health challenge. Globally, an estimate of 249 million malaria cases occurred in 2022, indicating 2 million more cases than in 2021 [1]. In Africa, approximately 78.1% (453,000) of the total deaths in 2022 involved children under five years of age. Malawi is among the 15 countries with the highest burden of malaria, with over four million estimated malaria cases in 2023 [1]. The 2017–2022 Malawi Malaria Control strategic plan emphasizes activities that promote the use of ITN every night to prevent malaria complications, including free routine distribution to pregnant women through ANC and new-borns at the time of delivery and mass campaigns every 2 to 3 years.

Despite the widespread distribution and promotion of ITNs, their effectiveness is compromised by insecticide resistance among mosquito populations and variations in utilisation patterns among communities, such as the Chikwawa catchment areas [2]. The ownership of ITNs is often high, but their actual use is significantly lower, which can be influenced by cultural and socioeconomic factors [3]. This suggests that caregivers' perception and utilisation of ITNs, as well as the local context of insecticide resistance, are critical factors influencing the success of ITN programmes in all regions where malaria is a burden [3].

With respect to World Health Organization (WHO) recommendations and the provision of ITNs at no cost, the utilisation of ITNs remains alarmingly low globally. Various studies have reported ITN utilisation rates ranging from 19.5 to 51%, with under-five children in Africa experiencing rates as low as 11.5 to 51% [4]. In sub-Saharan Africa, where malaria is a significant health burden, approximately 437,000 children succumb to malaria annually despite intensified efforts to improve ITN accessibility [5].

Malawi initiated a nationwide ITN social marketing programme in 2001 to combat malaria [6]. ITN use among children under five years of age in households with at least one ITN increased from 84 to 87% between 2012 and 2014. However, from 2014–2017, it decreased from 87 to 79% [5]. In Malawi, a notable proportion of the population with access to ITNs did not utilise them consistently, as evidenced by fluctuations in non-utilisation rates from 13% in 2010 to 5% in 2012, increasing again to 12% in 2015 [6].

In 2020, Malawi faced a severe public health crisis, with 6.9 million recorded cases of malaria and 2551 reported deaths [6]. Children under the age of five bore a disproportionately heavy toll, constituting more than half of the fatalities [6]. The highest transmission areas were concentrated in the hotter, wetter, and more humid, low-lying regions in the southern part of Malawi. Among these high-risk areas, Chikwawa, situated in the southern region along the lower Shire River, has emerged as a district severely affected by malaria [7].

Some studies have shown that while ITN ownership is relatively high, actual usage remains suboptimal. Various factors influence caregivers' perceptions and practices in sub-Saharan countries [4]. Despite the known efficacy of ITNs, the burden of malaria persists in Chikwawa District, Malawi. This suggests gaps in the implementation and uptake of this intervention, which has intensified the presence of more mosquito vector breeding sites, hot temperatures, and user perceptions [8]. Malawi initiated a nationwide ITN social marketing programme in 2001 to combat malaria [9]. A comprehensive ITN distribution campaign in 2012 significantly increased household ownership from 58% in 2010 to 70% in 2014 [7].

This development was made possible through funding from the WHO, as ITN access was made accessible to everyone. Access to ITNs varies across regions and is influenced by several factors, including distribution strategies, cultural practices, and health system policies [10]. In Malawi, ITNs are distributed through public health systems and nongovernmental organizations (NGOs), with efforts to ensure equitable access to all Malawians**.** Despite the universal coverage campaign implemented in Malawi, the prevalence of malaria among children is high, and Chikwawa is one of the leading districts in Malawi.

This suggests that ITN distribution alone may not be a sufficient vector control strategy contributing to malaria control in Malawi and that factors such as insecticide resistance and inconsistent use of bed nets may undermine their effectiveness [11]. Studies have also highlighted the importance of integrating ITN distribution with other health interventions, such as mass drug administration programmes, to improve coverage and usage [12]. Several research studies have been conducted nationwide to explain the significance of ITNs in low- and middle-income countries such as Malawi. They have been proven to contribute to a 50% reduction in malaria incidence in endemic countries [13]. They are cost effective and have been shown to reduce the prevalence of malaria, particularly among vulnerable populations such as children under five years of age [14]. Among these high-risk areas, Chikwawa, situated in the southern region along the lower Shire River, emerged as one of the districts severely affected by malaria [7] (Table 1).

ITN utilisation is also attributed to several factors. Healthcare accessibility impacts how one can access insecticide treated nets in their community. Failure to access the ITN because of distance to facilities can lower the uptake of ITN usage. Knowledge and awareness of the ITN play a significant role in the perception of how

Table 1 Common factors that affect utilisation of the ITN and its effects

Factors affecting utilisation of ITN	Effects on utilisation of ITN
Health care accessibility	People living near health facilities are more likely to access ITNs and receive education on their proper use. Limited healthcare access can reduce the number of distribution points for ITNs, which leads to decreased utilisation. In areas with strong health systems, successful awareness campaigns increase ITN use
Social and economic factors	Low-income households may find it difficult to afford ITNs, even when subsidised, as they may prioritise other needs. Individuals with higher education levels tend to be more aware of the importance of ITNs, which leads to better utilisation. Poor housing conditions can reduce the effectiveness of ITNs, making people less inclined to use them consistently
Cultural beliefs and practices	In some communities, malaria is not perceived as a significant health threat, which reduces the perceived need for ITN use. Traditional health practices may lead some people to rely on alternative malaria prevention methods, undermining trust in ITNs. Additionally, cultural sleeping patterns, such as sleeping outdoors, can limit the consistent use of ITNs
Knowledge and awareness of ITN use	Communities with strong awareness campaigns about malaria prevention tend to have higher ITN usage rates. Misconceptions about ITNs, such as using them for fishing or gardening, can lead to improper use. In areas with low health literacy, even when ITNs are available, people may not use them correctly or consistently

to use the ITN. When people are aware of the significance of the use of ITNs, there is a high chance of uptake. Social and economic factors also play a significant role in determining lifestyle choices. People without financial support to collect the ITN from hospitals during delivery will have no nets. Cultural beliefs also contribute to an individual's choice of ITN use. Misconceptions about the ITN can also affect an individual's choice to use the ITN.

ITNs are a cost-effective intervention that contributes to a 50% reduction in malaria incidence in endemic countries [15]. Despite the existing knowledge on the effectiveness of ITNs and widespread accessibility initiatives, there is a substantial research gap in understanding caregivers' perceptions, which contributes to the underutilisation of ITNs among under-five children in high malaria-burden areas, such as the Chikwawa district [16]. The study objectives aimed to assess caregivers' perceptions of ITN utilisation and its effectiveness among children under five years of age in Chikwawa District, Malawi. The assessment of user satisfaction with insecticide-treated nets (ITNs) in this district was also done.

Methods

Study design

The research utilised a sequential exploratory mixed methods design. The study commenced with a cross-sectional quantitative survey, followed by qualitative part where open-ended questions were used in focused group discussions and in-depth interviews with key informants to hear the perception and experiences of these caregiver on ITN usage**.** This research design was chosen to explore the perception of ITN utilisation and its effectiveness in preventing malaria among under-five children in Chikwawa district both quantitatively and qualitatively. The caregivers were asked whether they use ITNs or not to help measure utilisation. A lot of socioeconomic and demographic explanatory variables such as primary occupation, average income, number of under five children in a household, caregivers' relationship to under five children, number of ITN per household, ITN impact, cultural believes, ITN use satisfaction.

Study population

The study population included households with children under 5 years of age in the Chikwawa district hospital catchment area, where one caregiver was selected to participate in the study after seeking consent. The under 5 years children were randomly selected from seven villages within the catchment area of Chikwawa district from malaria registers between January 2021 and December 2022 who were malaria positive. During this period the under 5 years malaria registers had complete data for Malaria.

Inclusion criteria

Under-five children's caregivers from the sampled villages who their under five years children were malaria positive and accessed at least one mosquito net through birth/ANC or during mass campaigns were enrolled in the study, and a survey instrument was administered to the caregivers (mothers/guardians) for qualitative and quantitative data collection.

Exclusion criteria

All under-five children's caregivers within the catchment area of Chikwawa district, who had not received at least one mosquito net either during birth/ANC or mass campaigns were excluded.

Study setting

The study was conducted in Chikwawa district in the southern region of Malawi, in villages within the

catchment area of Chikwawa district hospital. Malaria is among the leading causes of health problems in the area.

Study period

The study lasted six months, from December 2023 to May 2024. Data collection and analysis took place from March to April 2024.

Sampling technique

This cross-sectional study targeted caregivers of children under five years of age. Using Cochran's (1966) sampling formula for quantitative data collection, a sample of ninety-six participants was drawn from the total population. Focus group discussions and in-depth interviews were purposively conducted from the same list of participants and programme implementers respectively to ensure diverse perspectives in the distribution and user satisfaction to gain a deeper understanding of the utilisation of ITNs. The sample size of the study was obtained via Cochran's (1966) formula below:

$$n = \frac{z^2(1-p)p}{e^2}$$

where n = sample size, z = desired level of confidence (1.96), e = desired level of sampling error ± 10% and p = estimate of prevalence (= 0.5). An estimate of prevalence of 0.5 was used because the proportion of caregivers to the overall population was unknown. The resulting sample size of ninety-six was used.

Data collection

Quantitative phase: Structured surveys were conducted via a pretested questionnaire covering socioeconomic factors, knowledge and awareness, access to ITNs, and ITN utilisation, and an Open Data Kit was used to collect the data.

Qualitative phase: Four in-depth interviews were conducted with programme implementers to explore experiences, perceptions, and cultural factors influencing ITN utilisation. Three focus group discussions were conducted from the quantitative sample list.

Data analysis

Quantitative analysis: The analysis was conducted at three levels: univariate, bivariate, and multivariate. Before analysis, data entry, organisation, and cleaning were performed in Microsoft Excel. The data were stored on password-controlled computers. The dataset was imported to STATA version 17 for analysis. Descriptive statistics and inferential analyses (e.g., percentages and frequencies, chi-square tests of associations, and logistic regression) were performed via STATA 17 to assess factors associated with ITN utilisation.

Qualitative analysis: Data were recorded via a digital voice recorder. Transcription, management, and analysis were performed via NVivo Version 11 (QSR International). The qualitative study aimed to derive insights from discussions between the researcher and stakeholders, which were conducted through key informant interviews with programme implementers at the Chikwawa DHO. The research comprises two distinct qualitative datasets: focus group discussions with women and key informant interviews with key stakeholders in distributing and promoting ITN usage. The analysis was structured around research questions addressing the present ITN utilisation rates among children under five in Chikwawa, community perspectives on ITN usage, and user satisfaction levels regarding ITN quality, effectiveness, and comfort.

Qualitative data preparation for analysis involves several vital steps to ensure the systematic study of rich information within text-based sources. The process begins with transcription, where audio or video data are converted into written text to facilitate manageable data handling. After transcription, anonymization was conducted to protect privacy, removing or replacing sensitive information such as personal names or locations. Once the data were transcribed and anonymized, they were segmented into smaller units, such as paragraphs or sentences, to facilitate analysis. The researchers used selective coding to structure and interpret the data. Data cleaning was also essential for qualitative data and involved removing irrelevant or duplicate segments, correcting transcription errors, and ensuring consistency in language.

Results

Socioeconomic and demographic characteristics of the caregivers

A total of 96 mothers/caregivers participated in this study. The target population of the study comprised of households with children under five years of age in the catchment area of Chikwawa District Hospital. The utilisation of ITNs in households was 91.67%, and 8.33% did not utilise ITNs. Primarily, females responded to the questions. As shown in Table 2, the majority, 92 (95.83%), reported being mothers (parents) to the under-five children in their households, 3 (3.13%) reported being guardians, and only 1 (1.04%) reported being the grandmother to the under-five children.

The majority, 84 (87.50%), of those currently using ITNs in their households were parents of under-five children, 3 (3.13%) were guardians, and 1 (1.04%) was the grandmother of under-five children. These respondents ranged from 19–38 years, with a mean age of 27.25 years. The ages were then categorised into 19–28 and 29–38

Table 2 Socioeconomic and demographic characteristics of the respondent

Variable	ITN Utilisation		
	Yes	No	Total
	n (%)	n (%)	n = 96 (%)
Age			
19–28	64 (66.67)	4 (4.17)	68 (70.83)
29–38	24 (25.00)	4 (417)	28 (29.17)
Primary occupation			
Farming	66 (68.75)	8 (8.33)	74 (77.08)
Business	9 (9.38)	0 (0.00)	9 (9.38)
Employment	2 (2.08)	0 (0.00)	2 (2.08)
Other	11 (11.46)	0 (0.00)	11 (11.46)
Average income			
< 20,000	53 (55.21)	7 (7.29)	60 (62.50)
20,000–50000	7 (7.29)	0 (0.00)	7 (7.29)
> 5000	28 (29.17)	1 (1.04)	29 (30.21)
Under-five number			
1	66 (68.75)	4 (4.17)	70 (72.92)
2	19 (19.79)	3 (3.13)	22 (22.92)
3	2 (2.08)	1 (1.04)	3 (3.13)
13	1 (1.04)	0 (0.00)	1 (1.04)
Relationship			
Parent	84 (87.50)	8 (8.33)	92 (95.83)
Guardian	3 (3.13)	0 (0.00)	3 (3.13)
Other	1 (1.04)	0 (0.00)	1 (1.04)
Number of ITN			
1	51 (53.13)	0 (0.00)	51 (53.13)
2	31 (32.29)	0 (0.00)	31 (32.29)
> = 3	6 (6.25)	8 (8.33)	14 (14.58)
ITN acquirement			
Provided	83 (86.46)	0 (0.00)	83 (86.46)
Purchased	5 (5.21)	0 (0.00)	5 (5.21)
Gifted	8 (8.33)	0 (0.00)	8 (8.33)
Distance to ITN			
< 5 km	14 (14.58)	2 (2.08)	16 (16.67)
> 5 km	74 (77.08)	6 (6.25)	80 (83.33)
ITN frequency			
Every night	84 (87.50)	0 (0.00)	84 (87.50)
Occasionally	2 (2.08)	1 (1.04)	3 (3.13)
Rarely	2 (2.08)	0 (0.00)	2 (2.08)
Never	0 (0.00)	7 (7.29)	7 (7.29)
Cultural beliefs			
Yes	7 (7.29)	1 (1.04)	8 (8.33)
No	81 (84.38)	7 (7.29)	88 (91.67)
ITN satisfaction			
Very satisfied	9 (9.38)	1 (1.04)	10 (10.42)
Satisfied	46 (47.92)	1 (1.04)	47 (48.96)
Neutral	11 (11.46)	6 (6.25)	17 (17.71)
Dissatisfied	19 (19.79)	0 (0.00)	19 (19.79)
Very dissatisfied	3 (3.13)	0 (0.00)	3 (3.13)
Received information			
Yes	78 (81.25)	8 (8.33)	86 (89.58)
No	10 (10.42)	0 (0.00)	10 (10.42)
Under five malaria cases			
Yes	53 (55.21)	8 (8.33)	61 (63.54)
No	35 (36.46)	0 (0.00)	35 (36.46)
ITN impact			
Yes	80 (83.33)	2 (2.08)	82 (85.42)
No	7 (7.29)	0 (0.00)	7 (7.29)
Not sure	1 (1.04)	6 (6.25)	7 (7.29)

categories. Compared with the 29–38 age category 25%., the 19–28 age category represented the highest ITN utilisation percentage (66.67%).

Among the 96 mothers/caregivers interviewed individuals, 88 reported using ITNs in their households, whereas only 8 reported not using ITNs. Most respondents (86.46%) reported having been provided the ITNs for free by the government/NGO, followed by 8.33% who reported having gifted the ITNs. Only 5.21% reported purchasing ITNs. Among those individuals currently using ITNs in their households, 66 (68.75%) reported relying on farming as their main primary source of income, 9 reported relying on business, 2 reported relying on employment, and 11 reported relying on other means as their primary source of income.

The majority of respondents, 53 (55.21%) who said they currently use ITNs, reported an average monthly household income of less than MKW20,000(US$11.50). This was followed by 28 (29.17%) who reported an average monthly household income between MKW20,000 (US$11.50) and MKW50,000 (US$28.80). The fewest, 7 (7.29%), reported an average monthly household income above MKW50,000 (US$28.80).

Many respondents, 78 (81.25%), reported receiving information on malaria prevention and currently using ITNs in their households, whereas 10 (10.42%) reported not receiving information about prevention but currently using ITNs. The majority, 80 (83.33%), reported receiving malaria prevention information from healthcare facilities, 4 (4.17%) from community meetings, 2 (2.08%) from media (TV, radio), and 10 (10.42%) from other sources. Among the 88 (91.67%) individuals who reported currently using ITNs in their households, 51 (53.13%) had 1 ITN, 31 (32.29%) had 2 ITNs, and 6 (6.25%) had at least 3 ITNs in their households.

The majority, 35 (36.46%), reported not currently using ITNs in households because they feel uncomfortable using them, 14 (14.58%) reported fear of side effects of ITNs, 13 (13.54%) said they do not regularly use ITNs because of difficulty in setting them up, 5 (5.21%) individuals reported that they do not regularly use ITNs in their households because they lack knowledge of the importance of ITNs, and 29 (30.21%) respondents reported other reasons (such as not having nets, torn nets, personal interest, etc.) for not regularly using ITNs in their households.

It was reported from the majority, 88 (91.67%), that there are no cultural beliefs or practices in the community that influence the use of ITNs, whereas only 8 (8.33%) reported that some cultural beliefs or practices in the community influence the use of ITNs. Those who said there are some cultural beliefs stated that it is believed that ITNs cause pneumonia, breathing problems, skin rashes, others feel like they are in a coffin, and others do not perform well in bed.

The results also show how often ITNs are used in households, the majority of respondents, 84 (87.50%), said they use ITNs every night, 3 (3.13%) reported that they use ITNs occasionally, 2 (2.08%) reported that they rarely use ITNs in their households, and 7 (7.29%) reported that they never used ITNs in their households. Among the ninety-six interviewed individuals, 53 (55.21%) said that everyone uses ITNs in their households. This was followed by 25 (26.04%) individuals who reported that only those under five children use ITNs in their households. Ten (10.42%) reported that only adults use ITNs in their households. At last, 8 (8.33%) reported that no one uses ITNs in their households. The analysed results also revealed that many under-five children, 61 (63.54%), suffered from malaria in the past year, whereas 35 (36.46%) reported that no under-five children suffered from malaria in the past year among those who reported that children had suffered from malaria in the past year, 43 (44.79%) said that the children were using ITNs at the time of malaria infection, whereas 53 (55.21%) said that the children were not using the ITNs.

The results show that although many people in the area, 80 (83.33%), travel more than 5 km to the nearest healthcare facility from their residence, many of these households, 74 (77.08%), have ITNs. Only a few people, 16 (16.67%), travel less than 5 km to the nearest healthcare facility. Most individuals, 47 (48.96%), reported being satisfied with the ITNs provided in the area. 19 (19.76%) reported being dissatisfied with the ITNs supplied in the area, 17 (17.71%) were neutral, 10 (10.42%) were delighted with the ITNs, and only 3 (3.13%) said they were very dissatisfied with the ITNs provided in the area. This is also shown in Fig. 1.

Despite some individuals saying that they are not satisfied with the ITNs provided in the area, 82 (85.42%) respondents reported noticing a reduction in malaria cases in their households since they started using ITNs. Seven (7.29%) reported not seeing a decrease in malaria

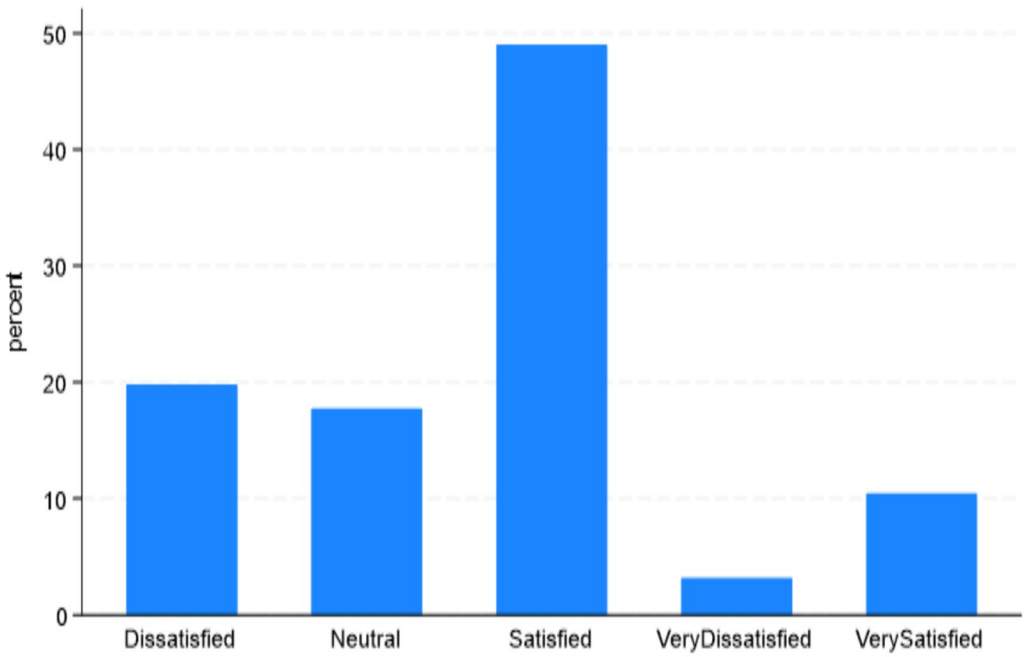

Fig. 1 Bar graph depicting the satisfaction scales

cases in their households since they began using ITNs, and another 7 (7.29%) said they were unsure if there was a reduction in malaria cases.

Inferential statistics

The study shows the associations between the binary response variable (ITN utilisation) and each categorical explanatory variable by performing a Pearson's chi-square association test at a 5% significance level in STATA. Here, the null hypothesis was that there is no positive relationship between ITN utilisation and socioeconomic and demographic factors; the alternative hypothesis was that there is a positive relationship between ITN utilisation and socioeconomic and demographic factors. A p value greater than or equal to 0.05 resulted in rejection of the null hypothesis and eventually acceptance of the alternative hypothesis.

Table 3 shows that the number of ITNs per household, ITN satisfaction, ITN impact, ITN users, ITN acquisition, and ITN use frequency are significantly associated with ITNS utilisation, all with p values of 0.001. Under-five malaria cases is also significantly associated with ITNS utilisation, with a p value of 0.025. This indicates a relationship between these variables (factors) and ITN utilisation in the area. The other variables do not have a significant relationship with ITN utilisation, as indicated by their respective p values, which are greater than the 0.05 level of significance.

The variables significantly associated with ITN utilisation were fitted into a logistic regression model to find the combined effect of explanatory variables on ITN utilisation in the area. Since the response variable is binary (Yes or No) and the observations are independent, a binary logistic regression model was used to assess this combined effect of explanatory variables on ITN utilisation. An evaluation for multicollinearity among the explanatory variables was performed, and it was found that some variables showed strong multicollinearity; two variables were omitted (ITN users and the number of ITNs). The backwards method was used to find the model that best fit the data.

After addressing the issue of multicollinearity, a logistic model was used with the following independent variables: ITN satisfaction and ITN impact. Although ITN frequency ($p=0.712$), ITN user ($p=0.430$), number of ITN (omitted), ITN acquirement (omitted) and under five malaria cases (omitted) were significantly associated with the response variable ITN utilisation in the bivariate stage, they were found to be insignificant in the combined effect as shown by their p-values greater than 0.05. The Bayesian information criterion (BIC) was used to choose the best model which had variables, frequency and ITN impact. The absolute difference in the BIC was 4.43, which is between 2 and 6, indicating that a positive model favours a model with a smaller BIC. Table 4 below shows the results of a logistic regression model.

The results of the model show that the odds of ITN utilisation are 83.6% lower (OR = 0.164; 95% CI: 0.057–0.472; $p<0.001$) among households with dissatisfied caregivers compared to those with very satisfied caregivers who use ITNs every night, controlling for ITN impact. This means that satisfaction of ITNs in households is more likely to influence ITN utilisation in the area than dissatisfaction, controlling for ITN impact.

The results in the table further show that the odds of ITN utilisation are 4.956 times higher (OR = 4.956, 95% CI: 1.538–15.976, $p<0.007$) among caregivers who perceive ITN impact (Yes) compared to those who do not perceive impact or are unsure (No/Not sure), controlling for ITN frequency. This suggest that recognising ITN's impact increase the likelihood of ITN utilisation in the community.

Qualitative analysis

Thematic analysis with NVIVO 11 software used and it involved selectively coding specific segments of data that are relevant to the research questions or emerging themes. The thematic-based FGD with ANC women was analysed, and we found the following findings:

Understanding nets and their utilisation

Caregivers generally perceived ITN use as beneficial however, barriers to access and affordability emerged significant concerns. As one participant noted:

> *"These nets are used to protect us from mosquito bites so that we don't get sick from Malaria. These nets help us a lot" (FGD 1, P1). Similarly, P4 from FGD2 said "these nets are good. The only problem is that they give us while it has already been treated such that when we wash it, we dilute the treatment".*

Caregivers understand the benefits of ITNs but have concerns about effectiveness, maintenance, and access. They noted that torn nets and washing reduce effectiveness.

Furthermore, caregivers believe nets are effective for malaria prevention but face challenges with availability and durability. This was highlighted from participant 2, FGD3 who said "*yes, it does only when the net is new. As time goes by and it wears out, mosquitos start entering".*

Effectiveness of ITN use among under five children

There is unanimous belief in the effectiveness of nets for preventing malaria in children, but concerns about net longevity and the need for regular maintenance and replacement were raised.

Table 3 Association between ITN utilisation and socioeconomic and demographic factors

Factor	Categories	Frequency (%)	P-values
Age	19–28	68 (70.83)	0.176
	29–38	28 (29.17)	
Primary occupation	Farming	74 (77.08)	0.458
	Business	9 (9.38)	
	Employment	2 (2.08)	
	Other	11 (11.46)	
Average income	< 20,000	60 (62.50)	0.299
	20,000–50000	7 (7.29)	
	> 5000	29 (30.21)	
Under-five children/household	1	70 (72.92)	0.263
	2	22 (22.92)	
	3	3 (3.13)	
	13	1 (1.04)	
Number of ITN	1	51 (53.13)	< 0.001
	2	31 (32.29)	
	> = 3	14 (14.58)	
ITN acquirement	Provided	83 (86.46)	< 0.001
	Purchased	5 (5.21)	
	Gifted	8 (8.33)	
Distance to health facility	< 5 km	16 (16.67)	0.509
	> 5 km	80 (83.33)	
ITN frequency	Every night	84 (87.50)	< 0.001
	Occasionally	3 (3.13)	
	Rarely	2 (2.08)	
	Never	7 (7.29)	
ITN user	Adults	10 (10.42)	< 0.001
	Children under_5	25 (26.04)	
	Everyone	53 (55.21)	
	Nobody	8 (8.33)	
Cultural beliefs	Yes	8 (8.33)	0.656
	No	88 (91.67)	
ITN satisfaction	Very satisfied	10 (10.42)	< 0.001
	Satisfied	47 (48.96)	
	Neutral	17 (17.71)	
	Dissatisfied	19(19.76)	
	Very dissatisfied	3 (3.13)	
Mode of transmission	Mosquito bite	90 (93.75)	0.176
	Contaminated water	2 (2.08)	
	Physical contact	1 (1.04)	
	Not sure	3 (3.13)	
Received information	Yes	86 (89.58)	0.314
	No	10 (10.42)	
Under five malaria cases	Yes	61 (63.54)	0.025
	No	35 (36.46)	
Patients used ITN	Yes	43 (44.79)	0.055
	No	53 (55.21)	
ITN Impact	Yes	82 (85.42)	< 0.001
	No	7 (7.29)	
	Not sure	7 (7.29)	

Table 4 Logistic regression results

Characteristic variable	Categories	Odds ratio	CI	P <|z|
Number of ITN	1	Omitted		
	2			
	> = 3			
ITN acquirement	Provided	Omitted		
	Purchased			
	Gifted			
ITN frequency	Every night	0.0603	0.003–1.1467	0.712
	Occasionally			
	Rarely			
	Never			
ITN user	Adults	0.022	0.001–0.888	0.43
	Children under_5			
	Everyone			
	Nobody			
ITN Satisfaction	Very satisfied	0.164	0.057–0.472	< 0.001
	Satisfied			
	Neutral			
	Dissatisfied			
	Very dissatisfied			
Under five malaria cases	Yes	Omitted		
	No			
ITN Impact	Yes	4.956	1.538–15.976	< 0.007
	No			
	Not sure			

ITN Utilisation: was measured by asking whether or no ITN was used on the household

There has been historical success in reducing malaria cases. However, challenges exist owing to floods causing ITN loss and a rise in malaria cases, low ITN usage during hot weather, and misuse issues. This was noted from KII3 saying:

> *"it has been effective, but we have some challenges along the way". Similarly, KII1 said "based on experience, the ITNs have been very helpful though there are some challenges which we encounter here in Chikwawa".*

This is highlighting that ITNs are effective but there are a lot of challenges which are making cases of Malaria rising again.

Challenges faced regarding ITNs

These challenges have been divided into two sub themes namely; cultural factors and external factors.

Cultural factors

The study did not reveal any prevalent negative cultural beliefs about ITNs, but there is a misconception that nets cause breathing issues. "*People say that when you sleep under mosquito net, you can run out of breath"* (P7, FGD2).

This highlight the misconception among ITN use that is there in the area.

External factors

This theme explored the operational challenges that are encountered during ITN distribution exercise. It also considered external factors such as environmental challenges, like the recurring floods in the district, and programmatic obstacles. According to KII1, "*the floods also play a part in the implementation of these ITN programmes".* This is highlighting external factor as a challenge. Hot weather, poor net quality and durability, limited access, health issues (asthma), and misconceptions about nets causing skin irritation are barriers to consistent net usage. The participants also mentioned discomfort from itchy nets as a barrier. Shortage of ITNs leading to increased malaria cases. Distribution inefficiencies and misuse of ITNs. It also touched upon the balance between the availability of ITNs and the needs of population. This noted from KII1 said:

"they affected us because this problem caused an increase in the total number of Malaria cases in the district due to the shortage of nets and the floods, a lot of people had no ITNs leading to Malaria cases in the district". Similarly, KII3 said "had it been that the nets are not being miss used. The current number of Malaria cases that we have been seeing as a facility and as a district would have been lower".

All these KIIs are highlighting impact of some of challenges in ITN use in the district.

Ways to facilitate regular use of ITNs

This theme looked into the responsibilities and engagement levels of stakeholders in the distribution of ITNs. Although, participants find the information on ITN usage provided by health workers and through counselling at health facilities sufficient. There is a need of community engagement and education by the Health Promotion Office, local leaders, and government involvement through the Environmental Health Department and National Malaria Department. Furthermore, it offered insights into the interactions between the stakeholders and the communities in the distribution processes. According to KII2 who said:

"my role is to ensure that insecticide treated nets are equally distributed and used properly in our various communities so that they are protected from Malaria".

This is highlighting stakeholder's role in the distribution process.

Another way of facilitating regular ITNs use is proactive community education on ITN usage, hierarchical engagement structure from district to local community levels, empowering community health workers and using van publicity as reminders and messages from local leaders for community trust. Additionally, key informants raised the point that there is a need of continuous civic education and integration with existing health services, addressing discrepancies between education efforts and ITN availability and empowering HSAs and health workers for adequate community sensitisation.

Furthermore, they said they should be reliance on outcome-based evaluations and practical methods such as premises inspections, Community Feedback Mechanism (CFM) use, and focus group discussions. Collaborative distribution efforts and adaptations within ANC programmes, recommendations for increased community engagement, addressing supply chain challenges, suggestions for more nets per household, and considering user preferences in net design.

Combining indoor residual spraying with ITN usage, empowering community health workers, ensuring a sufficient supply of ITNs, deployment of PBO and AI nets where insecticide resistance has been observed, and considering alternative net designs for improved usability.

Lastly, to ensure sustainability there is a need of expanding partnerships beyond the National Malaria Control Programme, empowering local structures like VHCs, integrating malaria awareness into routine health programmes, and addressing the need for continuous health education and activities between distribution cycles.

Discussion

The findings revealed a strong belief among caregivers in the effectiveness of nets as a primary preventive measure against malaria. The frustration of the participants with the scarcity of nets and the infrequency of distribution underscores the urgent need for more comprehensive and frequent distribution strategies. While the belief in the efficacy of nets in malaria prevention is strong, addressing the identified challenges related to access, durability, and broader health and socioeconomic impacts is crucial for enhancing malaria prevention efforts and promoting the well-being of affected communities [17].

On the basis of the insights provided regarding cultural beliefs and considerations regarding insecticide-treated nets (ITNs), the responses from participants indicated positive cultural perceptions of ITNs within the communities, with the lack of prevalent negative beliefs surrounding their use. However, one participant stated a misconception regarding the potential for ITNs to cause breathing issues. The respondent noted, *"Sometimes when one has asthma, they say they run out of breath when they use a net. That is why they do not use it."* This suggests a need for targeted education and communication efforts to address this misunderstanding and clarify the benefits and safety of ITNs.

The responses of the caregivers strongly supported the effectiveness of nets for preventing malaria, particularly in protecting children. It was also discovered from the results that ITN's impact (effectiveness) increase the likelihood of ITN utilisation in the households. The unanimous agreement among participants highlights the widespread recognition of nets as crucial components of efforts to safeguard children from mosquito bites and malaria transmission. However, significant concern has emerged regarding the longevity of net effectiveness. The participants noted that while nets are highly effective when new, their efficacy diminishes over time because they are worn and tear, allowing mosquitoes to penetrate [18]. These findings emphasize the importance of implementing strategies for the regular maintenance

and replacement of nets to sustain their effectiveness in protecting children from malaria. In conclusion, while women strongly agree regarding the efficacy of nets as child protection tools against malaria, addressing concerns about net longevity through maintenance, replacement, and distribution strategies is essential for ensuring sustained protection and improving malaria prevention within the community.

The findings revealed that a significant majority, 91.6%, of the respondents reported previous ITN usage, whereas 8.4% had not utilised ITNs before. According to the grading system utilised, among those who had used ITNs, the highest proportion, 48.96% (47 individuals), expressed satisfaction with the provided ITNs. Conversely, 19.76% (19 individuals) reported dissatisfaction, 17.71% (17 individuals) remained neutral, 10.42% (10 individuals) indicated high satisfaction, and 3.13% (3 individuals) expressed extreme dissatisfaction with the ITNs provided in the area. As shown in Fig. 1, most people who agreed that they used the ITN indicated that they were satisfied with the ITN. This descriptive analysis suggested that more people who use ITNs are satisfied with its effectiveness in protecting against malaria. The participants demonstrated a commendable understanding of the benefits of ITNs in preventing malaria, which showed an improved awareness of the importance of ITN usage for their health and well-being. This is important, because it was shown in the results that satisfaction of ITNs in households is more likely to influence ITN utilisation in the area than dissatisfaction. In agreement, one of the participants stated, *"Yes, they are. Nets protect us from malaria. However, the nets should be changed. They should be more effective in protecting us from Malaria."* The discussions also revealed significant concerns regarding the effectiveness, maintenance, and availability of ITNs, highlighting areas for improvement in malaria prevention strategies [19]. In response to these findings, straightforward suggestions for improvement emerged, including the need for better education and guidance on ITN use and maintenance through healthcare facilities. Additionally, addressing challenges related to access to and the availability of treated nets and retreatment supplies is crucial for enhancing ITN utilisation and malaria prevention efforts among ANC women.

Apart from the insights from the thematic areas derived from specific objectives in the KIIs and FGDs with the respondents, other incidental patterns could be observed from the responses. The incidental findings were necessary, as they would help enrich the arguments from the study and facilitate the creation of policies from the survey. Conclusions drawn from such patterns include the following: (i) the analysis revealed the effectiveness of community-based health education initiatives in disseminating information on malaria prevention, particularly regarding insecticide-treated nets (ITNs). (ii) Health facilities, including antenatal care (ANC) visits and government hospitals in Chikwawa, can be essential in educating individuals about ITN usage. This highlights the importance of integrating education into routine healthcare services and utilising community-level approaches to reach a wider audience.

The participants' perceptions of the sufficiency of information on ITN usage reflected their receptiveness and awareness of malaria prevention strategies [20]. While many participants believe that the information provided by health workers and through counselling sessions is adequate for protecting themselves against malaria, there is recognition of the need for ongoing education and awareness efforts.

Effective strategies are necessary to promote widespread ITN usage and improve malaria prevention efforts. Addressing these suggestions requires collaboration among healthcare authorities, community leaders, and relevant stakeholders to ensure that interventions are tailored to the specific needs and challenges faced by the community [21]. The implementation of comprehensive strategies, including quality improvement, community engagement, and targeted assistance, can effectively enhance net utilisation and strengthen malaria prevention efforts.

Stakeholders also emphasized on the importance of continuous community engagement and feedback mechanisms to ensure the success of ITN distribution programmes. Structured approaches to community engagement, such as hierarchical engagement structures and the empowerment of community health workers, were highlighted as effective strategies. Stakeholders recognise the importance of ongoing education on ITN usage and malaria prevention integrated within existing health services [22]. Adaptations based on community feedback include collaborative distribution efforts, adjustments within existing programmes, and recommendations for increased community engagement. These efforts aim to address challenges, improve coverage and effectiveness, and reduce community malaria cases.

Despite the successes of ITN distribution programmes in reducing malaria cases, stakeholders identify various challenges that affect implementation and effectiveness. Additionally, prevalent myths and misconceptions about ITNs contribute to misuse. These challenges directly impact the distribution of ITNs, leading to tangible increases in malaria cases and gaps in public health interventions [23]. To address these challenges, stakeholders recommend improving distribution efficiency, enhancing storage systems, implementing ongoing education efforts, and establishing monitoring systems. These

comprehensive strategies are essential for overcoming obstacles and strengthening the effectiveness of malaria prevention efforts within communities.

Limitations

The study has several limitations. The sample size was small and did not well represent the target population because it was self-funded. However, the results can still be helpful because there is a good connection between quantitative and qualitative data. The other limitations were; potential caregiver reporting biases, the inability to establish causality due to its cross-sectional nature, and a focus on a single district, which limits generalizability. A mixed-method approach, a sampling formula, and random selection were used to minimize these limitations. This study did not account for the physical condition of ITNs, which can affect malaria transmission; instead, it relied on subjective responses. It focused only on the perception of women, missing actual usage patterns due to recall bias, gender perception, or social desirability bias. However, the authors tried to include women of all age groups and guardians of under-five children. External factors such as insecticide resistance and ITN durability, which impact effectiveness, were outside the scope of the and identified as areas needing further research.

Conclusion

The study revealed a high utilisation of ITNs (91.67%) in Chikwawa, with 87.50% of respondents using them nightly. Despite a reduction in malaria cases (85.42%), only 10% expressed high satisfaction with ITN services. The factors influencing ITN perception include ITN impact and frequency. Factors like ITN acquirement(ownership), under five malaria cases and number of ITN on the household also showed a significant chi-square association with ITN utilisation. The key informant interviews highlighted the importance of stakeholder involvement in ITN distribution, the challenges faced (such as operational difficulties and environmental factors), and the effectiveness of community engagement. Stakeholders emphasised the need for robust feedback mechanisms and programme adaptability to improve malaria prevention.

Focused group discussions with ANC women revealed a strong belief in ITNs' benefits but concerns about their effectiveness, maintenance, and access were raised. Misconceptions about health issues caused by ITNs were noted, underscoring the need for better education. Recommendations included frequently distributing durable nets and addressing misconceptions to enhance malaria prevention efforts.

Abbreviations

ITNs	Insecticide-treated nets
WHO	World Health Organization
SSA	Sub-Saharan Africa
NMCP	National malaria control programme
NHSRC	National health sciences research committee
DHS	Demographic and health survey
QSR	Qualitative software research (as in NVivo version 11 by QSR international)
TV	Television
STATA	(Statistics/data analysis) software
NVivo	Qualitative data analysis software
ICF	International classification of functioning, disability and health
ODK	Open data kit
MWK	Malawi Kwacha (Currency of Malawi)
ID	Identification
KIIs	Key informant interviews
FGDs	Focus group discussions
HAS	Health surveillance assistant
VHC	Village health committee
US$	United states dollar (Currency of united states of America)

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Author contributions

EB conceived the study and developed the protocol. GB conducted data collection. PS, PG, and WM provided supervision and guidance. EB conducted data analysis and thesis writing. EB wrote the first draft of the manuscript. PS and GB revised, and all authors approved the final manuscript prior to submission.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

Permission to conduct this study was obtained from the Parul institute of public health technical review committee, reference number PIPH/FOM/PU/2023–2024/319, and from the Malawi national health sciences research committee (NHSRC), protocol number 24/02/4339, approval number 4339. Clearance was obtained from the Chikwawa district health directorate before the commencement of the study activities. Permission was also sought from local leaders verbally before they entered their villages. Before data collection, informed consent was obtained from each study participant to ensure voluntary participation. All necessary information about the study, including its purpose, risks, and benefits, was explained to the participants. Furthermore, the study participants were told that they had the right to withdraw from the study at any point during the study period. Those participants who agreed to be interviewed were requested to sign or thumbprint the informed consent form.

Competing interests

The authors declare no competing interests.

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