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Abstract:	<p>Malaria remains a major public health concern worldwide. Malaria is endemic in Mozambique, with seasonal fluctuations throughout the country. Although the number of malaria cases in Mozambique have dropped by 11% from 2020 to 2021, there are still hotspots in the country with persistent high incidence and low insecticide-treated bed net usage.</p> <p>The aim of this study is to evaluate the factors associated with the use of long-lasting insecticidal nets by pregnant women and women with children under 5 years old in two hotspot districts in the Gaza province, Mozambique.</p> <p>A descriptive, qualitative cross-sectional study was conducted between June 15th and 21st 2022. An in-depth interview process was conducted with pregnant women and mothers with children under five years old, exploring their beliefs, experiences, and perception of messages conveyed by health professionals when long-lasting insecticidal nets were being supplied.</p> <p>A total of 48 women participated (24 pregnant women and 24 women with children under 5 years). Most participants recognized the protective effects of long-lasting insecticidal nets in preventing malaria, and understood that women and children were high risk groups. The nets were reported to cause side effects and difficulty breathing by 100% of pregnant women, while 54.2% of mothers with children under 5 reported no side effects. The majority of women in both groups reported that their health professionals did not educate them about how to use or handle the nets properly. Only 16.7% of mothers with children under 5 received correct handling instructions. Providing clear, culturally sensitive, and practical information on the correct use of LLINs, as well as regular monitoring of their proper use, would be a great step forward for Mozambique's national malaria program.</p>
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Factors associated with the use of long-lasting insecticidal nets in pregnant women and mothers with children under five years of age in Gaza province, Mozambique

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Abstract

Malaria remains a major public health concern worldwide. Malaria is endemic in Mozambique, with seasonal fluctuations throughout the country. Although the number of malaria cases in Mozambique have dropped by 11% from 2020 to 2021, there are still hotspots in the country with persistent high incidence and low insecticide-treated bed net usage.

The aim of this study is to evaluate the factors associated with the use of long-lasting insecticidal nets by pregnant women and women with children under 5 years old in two hotspot districts in the Gaza province, Mozambique.

A descriptive, qualitative cross-sectional study was conducted between June 15th and 21st 2022. An in-depth interview process was conducted with pregnant women and mothers with children under five years old, exploring their beliefs, experiences, and perception of messages conveyed by health professionals when long-lasting insecticidal nets were being supplied.

A total of 48 women participated (24 pregnant women and 24 women with children under 5 years). Most participants recognized the protective effects of long-lasting insecticidal nets in preventing malaria, and understood that women and children were high risk groups. The nets were reported to cause side effects and difficulty breathing by 100% of pregnant women, while 54.2% of mothers with children under 5 reported no side effects. The majority of women in both groups reported that their health professionals did not educate them about how to use or handle the nets properly. Only 16.7% of mothers with children under 5 received correct handling instructions.

Providing clear, culturally sensitive, and practical information on the correct use of LLINs, as well as regular monitoring of their proper use, would be a great step forward for Mozambique's national malaria program.

Introduction

Malaria remains a major public health concern worldwide. According to the World Health Organization (WHO), an estimated 247 million cases of malaria and 619,000 deaths occurred worldwide in 2021. There were 95% of cases and deaths in the WHO African region alone, and 55% of all cases and 50% of deaths occurred in 6 countries in the region, including Mozambique (1).

Malaria is endemic in Mozambique, with seasonal fluctuations throughout the country. There is a wide variation in malaria prevalence across provinces, with higher prevalence rates in northern provinces (e.g. 57.3% in Cabo Delgado province) than southern provinces (e.g. 1% in Maputo city, 16.9% in Gaza province). There was also a high prevalence of malaria in rural areas and among children in Mozambique. Children under 5 years of age and pregnant women are considered high-risk groups (2). The number of malaria cases in Mozambique dropped by 11% from 11.3 million in 2020 to 10.6 million in 2021 following targeted campaigns (3).

In order to combat malaria, Mozambique distributes large amounts of long-lasting insecticidal nets (LLINs) to all districts every three years. However, the country still ranks fourth among 11 countries globally with the highest malaria burden in terms of estimated cases and deaths(1).

According to the national Malaria Control Strategic Plan 2017-2022, 85% of the population should be covered with at least one vector control intervention (indoor residual spraying and use of LLINs) in all districts(4). According to the Malaria Indicators Survey (Inquérito Nacional sobre Indicadores de Malária, IIM) conducted in Mozambique in 2018, 18% of respondents reported not sleeping under a LLIN the night before the survey. The majority had no LLIN at home, while 15% said they didn't use the net because there weren't any mosquitoes and 10% didn't like it(5).

It was found in IIM 2018 that Gaza province had the second lowest LLIN usage percentage, around 66.8%, with at least one LLIN for two people at the time of the survey, while Cabo Delgado province had the highest rate of 88.8%. Among children under 5, Gaza had a lower percentage of children who slept under LLINs before the survey, with 66.3%, compared with Cabo Delgado province, with 92.9% (5).

In a study by Wetzler et al (2022), researchers showed that due to the mass distribution of LLINs an estimated 14,040 under 5 child deaths were averted between 2012 and 2018 due to increase coverage (6). However, it is vital that this coverage is accompanied by education on the benefits, correct use and handling of LLINs in order to build on the gains reached up to date. More and more studies are reporting on the nefarious effects of lack of awareness on the proper use of LLINs. Populations have been reported in East Africa and northern Mozambique to be using LLINs for fishing thereby harming the environment and negatively impacting the economy for short term economic gains (7–9).

Approximately a third of Gaza's malaria cases come from Chibuto and Limpopo districts. Despite the widespread distribution of LLINs every three years in these Gaza districts, malaria cases remain alarming despite the implementation of this initiative (10). Several studies have been conducted to understand factors that influence LLIN usage to reduce malaria burden, but few have addressed the quality of key messages provided by net distributors in communities and health facilities (mass distributions of LLINs and antenatal consultations).

The aim of this study is to evaluate the factors associated with the use of LLINs (including key messages received) by pregnant women and women with children under 5 years old in Limpopo and Chibuto districts, Mozambique.

Materials and Methods

Study design

A descriptive, qualitative cross-sectional study was conducted between 15th and 21st June 2022 (1-week period). An in-depth interview method was conducted with pregnant women and mothers with children under five years old, exploring their beliefs, experiences, and perception of messages conveyed by health professionals when LLINs were being supplied.

Study site and population

The study was carried out in two rural districts of Gaza Province in Mozambique - Chibuto and Limpopo. With 154,121 residents, Limpopo district has seven primary health centres (PHCs, or health centres). Chibuto is home to 222,540 people and 19 PHCs. In both districts, agriculture, cattle raising, and fishing are the primary economic activities (11).

We randomly selected one high volume and one low volume PHC in each district. In Chibuto district the following centres were selected: Centro de Saúde de Chibuto and Centro de Saúde de Chaimite; and in Limpopo district: Centro de Saúde de Chicumbane and Centro de Saúde de Licilo, high and low volume respectively.

Participant selection and sample size

Pregnant women were identified at the antenatal clinic (ANC). Mothers of children under 5 years were identified in the outpatient (OPD) consultations, in the post-natal consultations, the consultations of children at risk (CCR) and healthy children (CCS).

The study investigator explained the study and study procedures to all the women before their consultation. The clinician screened the women for eligibility to the study during the consultation (see **Table 1**), and only those who were eligible were recruited and sent to the investigator. Following that, each woman was interviewed individually in a private consultation room at the PHC by the study investigator.

Table 1: Inclusion and exclusion criteria

Group	Inclusion criteria	Exclusion criteria
Pregnant women	<ul style="list-style-type: none">● Pregnant women ≥ 18 years in the ANC● Given informed consent for the study	<ul style="list-style-type: none">● Pregnant women with mental health disorder
Mothers of children under 5 years old	<ul style="list-style-type: none">● Mothers ≥ 18 years old with children under 5 years old coming for consultation at the PHC● Given informed consent for the study	<ul style="list-style-type: none">● Women accompanying children under 5 years who are not their actual mothers

In both groups, convenient non-probabilistic sampling was used based on the availability of potential study participants and their consent. An overall sample size of 48 women was determined by data saturation; 24 in Chibuto (14 in CS Chibuto, 10 in CS Chaimite) and 24 in Limpopo (14 in CS Chicumbane, 10 in CS Licilo) (see **Table 2**).

For a variety of reasons, we chose a convenient non-probabilistic sampling method: 1) cost concerns; the study did not have any funding, and random sampling would have been more expensive in such a large and dispersed population, 2) The study was time sensitivity to provide quick answers to a programmatic issue on the ground; 3) this was an exploratory study aimed at generating hypotheses for future studies using random sampling to be more comprehensive.

During the study, we included women who presented at the selected health centres with characteristics of interest. To determine sample size, we used theoretical or data saturation, but with the predicted minimum of 14 women in high-volume health centres and 10 in low-volume health

canterers. In this study, we were able to saturate the information without exceeding the minimum amount predicted.

Table 2: Distribution of the sample size per PHC

District	PHC	Sample	Sample
Chibuto	CS Chibuto	Pregnant women	7
		Mothers with children under 5 years	7
	CS Chaimite	Pregnant women	5
		Mothers with children under 5 years	5
Limpopo	CS Chicumbane	Pregnant women	7
		Mothers with children under 5 years	7
	CS Licilo	Pregnant women	5
		Mothers with children under 5 years	5
Total			48

Procedure

During morning health talks conducted at both health facilities, study investigators identified participants in both groups. Potential participants were informed of the study's procedures and importance. After their routine consultations, they were informed that if they wished to participate, they would be accompanied by a study team member to an in-depth interview room after giving their informed consent.

Three well-trained study surveyors conducted in-depth interviews in a separate consultation room so as to protect patient privacy. Patients were interviewed individually, without the presence of family members or friends. A 45-minute interview, including informed consent, was conducted for each person. An average of four interviews were conducted per day by each surveyor; the interviews were completed within 1-week period (4 days at high volume PHCs and 3 days at low volume PHCs). We conducted the interviews in Portuguese or Changana (local languages) and recorded them. Following transcription and translation (for interviews conducted in Changana), the interviews were analysed. Translations were carried out by one of the study surveyors and double checked by the principal investigator.

All participants were interviewed using an interview guide (Annex 1). It included closed questions to characterize them and open questions to determine their interests. The interview guide was study specific and has not been utilized in a previous study.

As women presented at the consultation and an investigator was available to interview them, they were recruited. If all investigators were conducting interviews, some women might have come for consultation and left without being interviewed. A daily average of 10 -15 pregnant women and 18-25 mothers with children under 5 years attend the health centre for consultation.

Data management and analysis

After recording the in-depth interviews on paper, the transcripts were transferred to Microsoft Word (2010) with questions and responses arranged by participant placement. There were two databases created, one for pregnant women and one for women with children under five. The instruments and informed consents used in the study were kept in a secure locker at the Gaza Provincial Health Directorate, with only the principal investigator having access. The archive will be stored for 5 years before being destroyed.

The transcripts were read by three investigators (AVN, AM and IC). Based on the discussion of patterns of facts and events that regularly came up within and between the groups, the three investigators constructed emerging themes. A set of codes along with their respective guidelines for applying them were developed in response to these emerging themes. Each investigator coded the transcripts independently, and they held regular meetings to discuss and reconcile their respective codes to ensure agreement. Coding the transcripts and extracting coding reports were done using Maxqda software, version 12, which was then used to prepare the data reduction and summary tables. In the final phase of data analysis, all researchers discussed the results. Analysis, interpretation of the data and elaboration of the final report were conducted between July 2022 and February 2023.

Ethics statement

This study was conducted according to the Declaration of Helsinki principles and obeyed Good Clinical Practice (GCP) guidelines. Ethical approval (for protocol and written informed consent documents) was granted by the Institutional Review Board of the Faculty of Health and the Central Hospital of Maputo, the Gaza Institutional Ethics Committee and the scientific council of the Faculty of Health of the University of Eduardo Mondlane. Considering that the study involved vulnerable populations, it was also submitted and approved by the National Health Bioethics Committee (CNBS) in Mozambique (ref # 34/CNBS2022).

Results

58.3% of the women interviewed were between 18 and 27 years old. In both groups of women, majority had a primary school education (52.1%), were married or in a de facto union (79.2%) and were unemployed (89.6%). Sociodemographic characteristics are summarized in table 3.

Table 3. Socio-demographic characteristics of participants

Characteristics	Frequency (%)	
	Mothers with children under 5 years old	Pregnant women
<i>Age</i>		
18 – 22	12 (50.0)	4 (16.7)
23 – 27	5 (20.8)	7 (29.2)
28 – 32	2 (8.3)	6 (25.0)
33 – 37	2 (8.3)	4 (16.7)
38 – 42	2 (8.3)	2 (8.3)
≥ 43	1 (4.2)	1 (4.2)
<i>Education level</i>		
No formal education	3 (12.5)	4 (16.7)
Primary	14 (58.3)	11 (45.8)
Secondary	7 (29.2)	9 (37.5)

<i>Marital status</i>		
Single	3 (12.5)	6 (25.0)
Married/Union	20 (83.3)	18 (75.0)
Widow	1 (4.2)	0
Divorced/separated	0	0
<i>Occupation</i>		
Stay-at-home (no paid activity reported)	22 (91.7)	21 (87.5)
Employed (incl. civil servants)	1 (4.2)	1 (4.2)
Self-employed	1 (4.2)	2 (8.3)

According to table 4, nine themes emerged with their respective codes to standardize the data analysis. We identified the following themes: 1) perceptions of LLIN use, 2) awareness of vulnerable groups in malaria prevention by mothers, 3) misconceptions about LLIN use, 4) barriers to personal use of LLINs, 5) barriers to the use of LLINs within communities, 6) seasonal preferences for LLIN use, 7) health professionals' key messages during the distribution of LLINs in health centres, and 8) key messages from health professionals during community distribution of LLINs. In addition, factors that facilitate the use of LLINs were discussed with participants.

Table 4: Definitions, codes and main results per emerging themes

Theme	Definition	Codes	Pregnant women* (N=24) n/ (%)	Mothers of children under 5years* (N=24) n/ (%)
Perceptions of LLIN use	Emerged when the interviews discussed: <ul style="list-style-type: none"> The importance of using LLINs to protect themselves from malaria The use of LLINs by interviewees, both those who mentioned they were using them appropriately and inappropriately The use of LLINs by neighbours and acquaintances, both appropriately and inappropriately 	Prevent mosquito bites and malaria	20 (83.3)	18 (75.0)
		Prevent other diseases such as cholera	4 (16.7)	4 (16.7)
		Protect the foetus	0	
		Use o LLINs for fishing by others	0	2 (8.3)
Awareness of vulnerable groups in malaria prevention by mothers	Emerged when interviewees discussed: <ul style="list-style-type: none"> Groups traditionally considered vulnerable in malaria prevention Reasons why pregnant women and children under 5 years old cannot be the only group considered priority in the use of LLINs. 	Pregnant women and children	13 (54.2)	19 (79.2)
		No specific risk group	7 (29.2)	5 (20.8)
		Pregnant women and postpartum women < 25years old	2 (8.3)	0
Misconceptions about LLIN use	Emerged when interviewees discussed: <ul style="list-style-type: none"> Interviewees beliefs regarding the use of LLINs Interviewees and community leaders' opinions on the use of LLINs Rumours associated with the use of LLINs 	Increase in number of mosquitoes	3 (12.5)	0
		Increase in other diseases		0
		No myths or taboos heard	21 (87.5)	24 (100.0)
Barriers to personal use of LLINs	Emerged when interviewees discussed the difficulties that they have in utilizing LLINs adequately	No problems experienced	0	13 (54.2)
		Experienced side effects (e.g. phobia, allergy and increase in temperature)	20 (83.3)	4 (16.7)
		Difficulty breathing	4 (16.7)	
		Discomfort in getting in and out of the LLINs	0	2 (8.3)
		Use of alternative prevention methods	0	5 (20.8)
Barriers to the use of LLINs within communities	This theme was created in response to the interviewees discomfort in speaking about their own difficulties with LLINs use but were reporting that other people had mentioned having	Experienced side effects	16 (66.7)	22 (91.7)
		Alcoholic habits and perception that LLINs are ineffective	2 (8.3)	

	problems such as allergies, increase temperature when using LLINs	Dislike LLINs		0
		Fell ill with the flu due to LLIN use	6 (25.0)	2 (8.3)
Seasonal preferences for LLIN use	<p>Emerged when interviewees discussed:</p> <ul style="list-style-type: none"> • Preferential use of LLINs in the winter • Preferential use of LLINs in the summer • Use of LLINs in both winter and summer • Reasons behind the preferential use of LLINs in one season vs another 	Prefer to use LLIN in summer because there are no mosquitoes in winter	14 (58.3)	3 (12.5)
		Prefer to use LLIN in summer and winter alike	10 (41.7)	17 (70.8)
Health professionals' key messages during the distribution of LLINs in <u>health centres</u>	<p>Emerged when interviewees discussed:</p> <ul style="list-style-type: none"> • Information received on the importance of LLINs use • Precautions to be taken before LLINs use • Not having received any information about LLINs use • Having received correct information on the precautions to be taken before LLINs use • Having received incorrect information on how to care for LLINs before use 	No information given	11 (45.8)	17 (70.8)
		Wash LLIN with detergent and/or dry it under the sun	5 (20.8)	1 (4.2)
		Wash LLIN with water and dry it in the shade	5 (20.8)	0
		Air LLIN in the shade, before use	0	4 (16.7)
		Told not to use for fishing or cover flowerbeds	4 (16.7)	0
Key messages from health professionals during <u>community</u> distribution of LLINs	<p>Emerged when interviewees discussed:</p> <ul style="list-style-type: none"> • Information received on the importance of LLINs use • Precautions to be taken before LLINs use • Not having received any information about LLINs use • Having received correct information on the precautions to be taken before LLINs use • Having received incorrect information on how to care for LLINs before use 	No information given	12 (50.0)	15 (62.5)
		Wash LLIN with detergent and/or dry it under the sun	5 (20.8)	2 (8.3)
		Wash LLIN with water and dry it in the shade	0	0
		Air LLIN in the shade, before use	0	4 (16.7)
		Told not to use for fishing or cover flowerbeds	4 (16.7)	0

*In cases where responses exceeded the number of women in the group, some women provided responses that fit into more than one category. In cases where the total number of responses is less than the total number of women, some women declined to answer or did not know what the answer was.

LLINs are perceived to prevent mosquito bites and malaria by a majority of pregnant women (PW; 83.3%) and mothers with children under 5 years (MCU5; 75.0%). LLINs are believed to protect against other diseases such as cholera by 16.7% of individuals in each of the two groups, and a minority of MCU5 believes LLINs are useful for fishing.

79.2% of MCU5 are aware that pregnant women and children are vulnerable groups in malaria prevention compared with 54.2% of PW. Both groups believe all groups should be prioritized, including pregnant and postpartum women under 25.

The majority of women in both groups (87.5% PW and 100% MCU5) reported no myths or taboos about LLINs. Three pregnant women report misperceptions about LLINs increasing mosquito populations and spreading diseases. MCU5 (54.2%) reported no side effects or problems associated with personal use of LLINs. In contrast, 83.3% of PW reported side effects from LLIN usage. Four women reported difficulty breathing while using LLINs in both groups. In five of the MCU5, alternative methods of prevention were used instead of LLINs (such as sprays or plants with mosquito repellent effects). In response to a question regarding barriers to LLIN usage in the community, 66.7% of the PW and 91.7% of the MCU5 reported having heard that community members had experienced side effects from LLINs.

A majority of MCU5 (70.8%) reported using LLINs year-round, with no seasonal preference. In contrast, 58.3% of PW stated they preferred to use LLINs in the summer because they believed winter was mosquito-free. Most MCU5 (70.8%) reported not receiving any information at the health centres when they received LLINs, compared to 45.8% of PW. In only 4 MCU5, the correct message about what to do before using LLINs. According to four PW, they were only told not to use LLINs for fishing or to cover flowerbeds. As part of the community mass distribution, 62.5% of MCU5 and 50% of PW stated they had not received information regarding LLIN care before usage. Similarly, only 4 MCU5 received the correct message on what to do before using LLINs.

During the survey, women in both groups reported that a health professional's explanation of how to use and care for LLINs at the health centres or during mass distribution was very important to them. Participant suggestions included monitoring LLIN usage and delivering health talks on LLINs and malaria prevention in schools and communities on top of the distribution of LLINs. According to some women, to be able to get the net for free from the government is a good thing, as they could not afford it.

“even now they gave us the net, but they didn't explain to me what I should do before starting to use it, so the Ministry of Health should review this and tell the nurses as well as the distributors of mosquito nets in the community to give a good explanation of the use of mosquito nets. Others open it and use it right away and suffer from allergies, so they may decide not to use the mosquito net anymore after this” (PW number 10, 37 years old)

“Health authorities should also use schools, our local chiefs so that they can teach us how to use to mosquito nets correctly, and monitor the use in the community so that people are not using it in the mangroves and for fishing.” (MCU5 number 20, 18 years old)

“The government must always distribute mosquito nets because, for example, they are very expensive for the money we make and it can happen that others don't have the money to buy mosquito nets and die of malaria” (PW number 10, 37 years old)

Discussion

A majority of women in both study groups knew that LLNIs prevented mosquito bites, which in turn prevented malaria. The findings are consistent with those of other African countries (South Africa and Ethiopia), where pregnant women and mothers with young children have stated that LLNIs provide a physical barrier between them and mosquitoes, decreasing mosquito bite risk. According to the same studies, LLNIs also disorient or kill resting mosquitoes by their repellent effect(12,13).

According to a study in Malawi, respondents did not reveal the truth because they feared that the government would paralyze net distribution. Rather than focusing on what respondents knew about LLNIs, they sought to learn what other community members knew. As a result of drought and food insecurity, people believed they could sell or use the nets for fishing in order to increase family income (7). A number of other studies have also reported adverse environmental and economic effects of the widespread use of LLNIs for fishing in East Africa and northern Mozambique (8,14). We did not find this to be a major finding in our study even though fishing is a primary economic activity in these communities. This is despite the fact that participants were questioned about their friends and community members' opinions when they showed reluctance to answer questions. Only a few (less than 10%) reported that community members used LLNIs for fishing or covering flowerbeds.

For the majority of women in both study groups, pregnant women and young children were identified as the most vulnerable populations in need of priority attention for malaria prevention. This is aligned with a study conducted in Ethiopia which reported that the population understood the importance of protecting children and pregnant women (15). As in a similar study conducted in Madagascar, we found that 50% of the women in our study felt that other vulnerable groups living around them should be equally protected (16). Researchers in the Central region of Mozambique found that school-aged children are at greater risk of malaria infection and severe disease (17).

A small portion of pregnant women (12.5%) believed LLNIs would increase the mosquito population and spread diseases. This is in line with one study in Ethiopia, where respondents believed that LLNIs breed bed bugs (small parasitic insects that feed exclusively on humans and domestic animals' blood)(12). There were no misconceptions reported by respondents in the MCU5 group. Possibly, pregnant women may be more sensitive to anything that may harm their unborn children, making them vulnerable to misinformation.

While most MCU5 did not report any problems with LLINs, 100% reported experiencing side effects and difficulty breathing from using LLINs during pregnancy. A number of studies have identified side effects of LLINs, particularly if they are not used properly. Among other things, users may experience itchiness, heat, discomfort, and respiratory problems (18–21). Pregnant women might experience side effects from LLINs due to increased sensitivity during pregnancy and possible reactions to the chemicals in the nets, which could account for the discrepancy between PW and MCU5. However, when asked about the community 91.7% of MCU5 reported having heard about others experiencing side effects with LLIN usage. A reluctance to answer the question honestly might also have played a part. According to a study in Ghana, community members used alternative methods of malaria prevention, such as herbs, grass, burning range peels, or sprays.(19). In our study, few MCU5 reported using alternative methods of mosquito prevention. These products are believed to contain effective insect repellents.

The study groups differed in their seasonal preferences. Majority of pregnant women preferred to use the LLIN in summer. According to studies conducted in Myanmar and Madagascar,

women use LLIN more in summer because they believe there is no mosquito activity in winter (16,22). A study in Nigeria found, however, that pregnant women did not use LLINs in summer due to the higher temperatures (23). As mosquitoes are observed at all times of the year, 70.8% of the MCU5 reported using LLINs throughout the year, in line with findings from other studies (24).

Health professionals should inform the targeted population of what to do before using LLINs and how to care for them once they receive LLINs from health centres or in the community. Communication should focus on how LLINs should be used, installed, maintained, handled, how to deal with side effects, when to replace, and special advice for pregnant women (25). We found that both groups of women received insufficient or no information in our study. Among those who received information about what to do before using the nets, only 16.7% received the correct information. The lack of knowledge about the proper use and care of LLINs may hinder their utilization and increase malaria transmission. As a result, it is not surprising that when women were asked how LLINs can be used more effectively, they suggested getting better information about how to use and care for them, monitoring the use and care of them in the community, and engaging the community by delivering health talks at schools and community gathering places.

Limitations

The study had some notable limitations. Women were hesitant to participate in the study, because participation meant staying for a longer period than initially planned in the health centre. To minimize this limitation, during the health talks in the waiting rooms the women were informed beforehand about the study and its procedures. Observer bias was an additional limitation and to address this the investigators used follow up questions whenever necessary. Women were also hesitant about participating in the study in fear of suffering retaliation and being excluded from future LLINs distribution campaigns. These fears were also addressed during the health talks and before the interviews, to ensure they understood that their responses would not influence current or future healthcare provision and that they were free to stop their participation anytime they felt uncomfortable.

Additionally, there are several limitations and potential sources of bias associated with convenient non-probabilistic sampling, which may affect the validity and generalizability of the findings. Hence, results should be interpreted with caution since it does not give a representative sample of the larger population.

Conclusion

Providing clear, culturally sensitive, and practical information on the correct use of LLINs, as well as regular monitoring of their proper use, would be a great step forward for Mozambique's national malaria program. Communities will be empowered to minimize risks and maximize effectiveness in preventing malaria.

Acknowledgments

The authors would like to thank the women who participated in the study, the data collectors and the health professionals in the facilities selected for the study.

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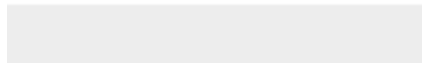
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List of Legends:

1. Interview Guide
2. Ethics approval letter (Portuguese)
3. Ethics approval letter (English translation)
4. Translation certificate
5. Data: demographics
6. Data: PW interview transcripts
7. Data: MCU5 interview transcripts

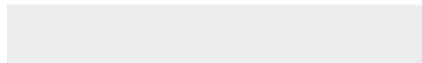


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Annex 1_Interview guide.pdf





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Factors associated with the use of ~~mosquito-long-lasting insecticidal~~ nets in pregnant women and mothers with children under five years of age in Gaza province, Mozambique

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Abstract

Introduction

Malaria remains a major public health concern worldwide. Malaria is endemic in Mozambique, with seasonal fluctuations throughout the country. Although the number of malaria cases in Mozambique have dropped by 11% from 2020 to 2021, there are still hotspots in the country with persistent high incidence and low insecticide-treated bed net usage.

Objective

The aim of this study is to evaluate the factors associated with the use of ~~mosquito-nets~~long-lasting insecticidal nets by pregnant women and women with children under 5 years old in two hotspot districts in the Gaza province, Mozambique.

Methods

A descriptive, qualitative cross-sectional study was conducted between June 15th and 21st 2022. An in-depth interview process was conducted with pregnant women and mothers with children under five years old, exploring their beliefs, experiences, and perception of messages conveyed by health professionals when ~~mosquito-net~~long-lasting insecticidal nets were being supplied.

Findings

A total of 48 women participated (24 pregnant women and 24 women with children under 5 years). Most participants recognized the protective effects of ~~mosquito-nets~~long-lasting insecticidal nets in preventing malaria, and understood that women and children were high risk groups. ~~Participants reported side effects such as allergies associated with the use of the net. They showed differing knowledge on the correct handling and usage of the mosquito net. The nets were reported to cause side effects and difficulty breathing by 100% of pregnant women, while 54.2% of mothers with children under 5 reported no side effects. The majority of women in both groups reported that their health professionals did not educate them about how to use or handle the nets properly. Only 16.7% of mothers with children under 5 received correct handling instructions.~~

Conclusion

Providing clear, culturally sensitive, and practical information on the correct use of LLINs, as well as regular monitoring of their proper use, would be a great step forward for Mozambique's national malaria program. There is a knowledge gap amongst the participants and their communities on the correct use of the mosquito nets. Monitoring coverage of insecticide-treated bed net use should be accompanied by regular community awareness campaigns, regular monitoring of correct use and extensive community engagement.

Introduction

Malaria remains a major public health concern worldwide. According to the World Health Organization (WHO), an estimated 247 million cases of malaria and 619,000 deaths occurred worldwide in 2021. There were 95% of cases and deaths in the WHO African region alone, and 55% of all cases and 50% of deaths occurred in 6 countries in the region, including Mozambique (1).

Malaria is endemic in Mozambique, with seasonal fluctuations throughout the country. There is a wide variation in malaria prevalence across provinces, with higher prevalence rates in northern provinces (e.g. 57.3% in Cabo Delgado province) than southern provinces (e.g. 1% in Maputo city, 16.9% in Gaza province). There was also a high prevalence of malaria in rural areas and among children in Mozambique. Children under 5 years of age and pregnant women are considered high-risk groups (2). The number of malaria cases in Mozambique dropped by 11% from 11.3 million in 2020 to 10.6 million in 2021 following targeted campaigns (3).

In order to combat malaria, Mozambique distributes large amounts of long-lasting insecticidal nets (LLINs) to all districts every three years. However, the country still ranks fourth among 11 countries globally with the highest malaria burden in terms of estimated cases and deaths. On a three-year basis, Mozambique distributes massive amounts of insecticide-treated nets (ITNs) across all districts, as part of its malaria prevention strategies, but the country still ranks fourth among the 11 countries with the highest malaria burden in estimated malaria cases and deaths (1).

According to the national Malaria Control Strategic Plan 2017-2022, 85% of the population should be covered with at least one vector control intervention (indoor residual spraying and use of ~~ITNs~~LLINs) in all districts(4). According to the Malaria Indicators Survey (Inquérito Nacional sobre Indicadores de Malária, IIM) conducted in Mozambique in 2018, 18% of respondents reported not sleeping under a ~~mosquito net~~LLIN the night before the survey. The majority had no ~~mosquito net~~LLIN at home, while 15% said they didn't use the net because there weren't any mosquitoes and 10% didn't like it(5).

It was found in IIM 2018 that Gaza province had the second lowest ~~mosquito net~~LLIN usage percentage, around 66.8%, with at least one ~~mosquito net~~LLIN for two people at the time of the survey, while Cabo Delgado province had the highest rate of 88.8%. Among children under 5, Gaza had a lower percentage of children who slept under ~~mosquito nets~~LLINs before the survey, with 66.3%, compared with Cabo Delgado province, with 92.9% (5).

In a study by Wetzler et al (2022), researchers showed that due to the mass distribution of LLINs an estimated 14,040 under 5 child deaths were averted between 2012 and 2018 due to increase coverage (6). However, it is vital that this coverage is accompanied by education on the benefits, correct use and handling of LLINs in order to build on the gains reached up to date. More and

more studies are reporting on the nefarious effects of lack of awareness on the proper use of LLINs. Populations have been reported in East Africa and northern Mozambique to be using LLINs for fishing thereby harming the environment and negatively impacting the economy for short term economic gains (7–9).

Approximately a third of Gaza's malaria cases come from Chibuto and Limpopo districts. Despite the widespread distribution of ~~ITNs-LLINs~~ every three years in these Gaza districts, malaria cases remain alarming despite the implementation of this initiative (10). Several studies have been conducted to understand factors that influence ~~mosquito-netLLIN~~-usage to reduce malaria burden, but few have addressed the quality of key messages provided by net distributors in communities and health facilities (mass distributions of ~~mosquito-nets-LLINs~~ and antenatal consultations).

~~(7)(8–10)~~

The aim of this study is to evaluate the factors associated with the use of ~~mosquito-netsLLINs~~ (including key messages received) by pregnant women and women with children under 5 years old in Limpopo and Chibuto districts, Mozambique.

Materials and Methods

Study design

A descriptive, qualitative cross-sectional study was conducted between ~~June 15th and 21st 2022~~ 15th and 21st June 2022 (1 week period). An ~~in-depth interview method~~ in-depth interview process was conducted with pregnant women and mothers with children under five years old, exploring their beliefs, experiences, and perception of messages conveyed by health professionals when ~~mosquito-netsLLINs~~ were being supplied.

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Study site and population

The study was carried out in two rural districts of Gaza Province in Mozambique - Chibuto and Limpopo. With 154,121 residents, Limpopo district has seven ~~primary health unitscentres~~ (PHCs, or health centres). Chibuto is home to 222,540 people and 19 ~~PHCshealth-care facilities~~. In both districts, agriculture, cattle raising, and fishing are the primary economic activities (11).

We randomly selected one high volume and one low volume ~~health facility-PHC~~ in each district. In Chibuto district the following centres were selected: Centro de Saúde de Chibuto and Centro de Saúde de Chaimite; and in Limpopo district: Centro de Saúde de Chicumbane and Centro de Saúde de Licilo, high and low volume respectively.

Participant selection and sample size

Pregnant women were identified at the antenatal clinic (ANC). Mothers of children under 5 years were identified in the outpatient (OPD) consultations, in the post-natal consultations, the consultations of children at risk (CCR) and healthy children (CCS).

The study investigator explained the study and study procedures to all the women before their consultation. The clinician screened the women for eligibility to the study during the consultation (see **Table 1**), and only those who were eligible were recruited and sent to the investigator. Following that, each woman was interviewed individually in a private consultation room at the ~~health facilityPHC~~ by the study investigator.

Table 1: Inclusion and exclusion criteria

Group	Inclusion criteria	Exclusion criteria
Pregnant women	<ul style="list-style-type: none"> • Pregnant women ≥ 18 years in the ANC • Given informed consent for the study 	<ul style="list-style-type: none"> • Pregnant women with mental health disorder
Mothers of children under 5 years old	<ul style="list-style-type: none"> • Mothers ≥ 18 years old with children under 5 years old coming for consultation at the health-facilityPHC • Given informed consent for the study 	<ul style="list-style-type: none"> • Women accompanying children under 5 years who are not their actual mothers

In both groups, convenient non-probabilistic sampling was used based on the availability of potential study participants and their consent. An overall sample size of 48 women was determined by data saturation; 24 in Chibuto (14 in CS Chibuto, 10 in CS Chaimite) and 24 in Limpopo (14 in CS Chicumbane, 10 in CS Licilo) (see Table 2).

For a variety of reasons, we chose a convenient non-probabilistic sampling method: 1) cost concerns; the study did not have any funding, and random sampling would have been more expensive in such a large and dispersed population, 2) The study was time sensitivity to provide quick answers to a programmatic issue on the ground; 3) this was an exploratory study aimed at generating hypotheses for future studies using random sampling to be more comprehensive.

During the study, we included women who presented at the selected health centers with characteristics of interest. To determine sample size, we used theoretical or data saturation, but with the predicted minimum of 14 women in high-volume health centres and 10 in low-volume health centers. In this study, we were able to saturate the information without exceeding the minimum amount predicted.

Table 2: Distribution of the sample size per [health-facilityPHC](#)

District	Health-facilityPHC	Sample	
Chibuto	CS Chibuto	Pregnant women	7
		Mothers with children under 5 years	7
	CS Chaimite	Pregnant women	5
		Mothers with children under 5 years	5
Limpopo	CS Chicumbane	Pregnant women	7
		Mothers with children under 5 years	7
	CS Licilo	Pregnant women	5

		Mothers with children under 5 years	5
Total			48

Procedure

During morning health talks conducted at both health facilities, study investigators identified participants in both groups. Potential participants were informed of the study's procedures and importance. After their routine consultations, they were informed that if they wished to participate, they would be accompanied by a study team member to an in-depth interview room after giving their informed consent.

Three well-trained study surveyors conducted in-depth interviews in a separate consultation room so as to protect patient privacy. Patients were interviewed individually, without the presence of family members or friends. A 45-minute interview, including informed consent, was conducted for each person. An average of four interviews were conducted per day by each surveyor; the interviews were completed within 1-week period (4 days at high volume PHCs and 3 days at low volume PHCs). We conducted the interviews in Portuguese or Changana (local languages) and recorded them. Following transcription and translation (for interviews conducted in Changana), the interviews were analysed. Translations were carried out by one of the study surveyors and double checked by the principal investigator.

All participants were interviewed using an interview guide (Annex 1). It included closed questions to characterize them and open questions to determine their interests. The interview guide was study specific and has not been utilized in a previous study.

As women presented at the consultation and an investigator was available to interview them, they were recruited. If all investigators were conducting interviews, some women might have come for consultation and left without being interviewed. A daily average of 10 -15 pregnant women and 18-25 mothers with children under 5 years attend the health center for consultation.

Data management and analysis

After recording the in-depth interviews on paper, the transcripts were transferred to Microsoft Word (2010) with questions and responses arranged by participant placement. There were two databases created, one for pregnant women and one for women with children under five. The instruments and informed consents used in the study were kept in a secure locker at the Gaza Provincial Health Directorate, with only the principal investigator having access. The archive will be stored for 5 years before being destroyed.

The transcripts were read by three investigators (AVN, AM and IC). Based on the discussion of patterns of facts and events that regularly came up within and between the groups, the three investigators constructed emerging themes. A set of codes along with their respective guidelines for applying them were developed in response to these emerging themes. Each investigator coded the transcripts independently, and they held regular meetings to discuss and reconcile their respective codes to ensure agreement. Coding the transcripts and extracting coding reports were done using Maxqda software, version 12, which was then used to prepare the data reduction and summary tables. In the final phase of data analysis, all researchers discussed the

results. [Analysis, interpretation of the data and elaboration of the final report were conducted between July 2022 and February 2023.](#)

Ethics statement

This study was conducted according to the Declaration of Helsinki principles and obeyed Good Clinical Practice (GCP) guidelines. Ethical approval (for protocol and written informed consent documents) was granted by the Institutional Review Board of the Faculty of Health and the Central Hospital of Maputo, the Gaza Institutional Ethics Committee and the scientific council of the Faculty of Health of the University of Eduardo Mondlane. Considering that the study involved vulnerable populations, it was also submitted and approved by the National Health Bioethics Committee (CNBS) in Mozambique (ref # 34/CNBS2022).

Results

1.— Characteristics of the participants

Over half of the 48 (58.3% of the women interviewed (28/48) were between 18 and 27 years old, had a primary school education, were stay-at-home women (those who reported no paid activity on a daily, weekly or monthly basis) and were married (including de facto unions). In both groups of women majority had a primary school education (52.1%), were married or in a de facto union (79.2%) and were unemployed (89.6%). Sociodemographic characteristics are summarized in table 3.

Table 3. Socio-demographic characteristics of participants

Characteristics	Frequency (%)	
	Mothers with children under 5 years old	Pregnant women
<i>Age</i>		
18 – 22	12 (50.0)	4 (16.7)
23 – 27	5 (20.8)	7 (29.2)
28 – 32	2 (8.3)	6 (25.0)
33 – 37	2 (8.3)	4 (16.7)
38 – 42	2 (8.3)	2 (8.3)
≥ 43	1 (4.2)	1 (4.2)
<i>Education level</i>		
No formal education	3 (12.5)	4 (16.7)
Primary	14 (58.3)	11 (45.8)
Secondary	7 (29.2)	9 (37.5)
<i>Marital status</i>		
Single	3 (12.5)	6 (25.0)
Married/Union	20 (83.3)	18 (75.0)
Widow	1 (4.2)	0
Divorced/separated	0	0

<i>Occupation</i>		
Stay-at-home <u>(no paid activity reported)</u>	22 (91.7)	21 (87.5)
Employed (incl. civil servants)	1 (4.2)	1 (4.2)
Self-employed	1 (4.2)	2 (8.3)

According to table 4, nine themes emerged with their respective codes to standardize the data analysis. We identified the following themes: 1) perceptions of LLIN use, 2) awareness of vulnerable groups in malaria prevention by mothers, 3) misconceptions about LLIN use, 4) barriers to personal use of LLINs, 5) barriers to the use of LLINs within communities, 6) seasonal preferences for LLIN use, 7) health professionals' key messages during the distribution of LLINs in health centres, and 8) key messages from health professionals during community distribution of LLINs. In addition, factors that facilitate the use of LLINs were discussed with participants.

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Table 4: Definitions, codes and main results per emerging themes

<u>Theme</u>	<u>Definition</u>	<u>Codes</u>	<u>Pregnant women* (N=24) n/ (%)</u>	<u>Mothers of children under 5years* (N=24) n/ (%)</u>
<u>Perceptions of LLIN use</u>	<u>Emerged when the interviews discussed:</u> <ul style="list-style-type: none"> <u>The importance of using LLINs to protect themselves from malaria</u> <u>The use of LLINs by interviewees, both those who mentioned they were using them appropriately and inappropriately</u> <u>The use of LLINs by neighbours and acquaintances, both appropriately and inappropriately</u> 	<u>Prevent mosquito bites and malaria</u>	<u>20 (83.3)</u>	<u>18 (75.0)</u>
		<u>Prevent other diseases such as cholera</u>	<u>4 (16.7)</u>	<u>4 (16.7)</u>
		<u>Protect the foetus</u>	<u>0</u>	
		<u>Use o LLINs for fishing by others</u>	<u>0</u>	<u>2 (8.3)</u>
<u>Awareness of vulnerable groups in malaria prevention by mothers</u>	<u>Emerged when interviewees discussed:</u> <ul style="list-style-type: none"> <u>Groups traditionally considered vulnerable in malaria prevention</u> <u>Reasons why pregnant women and children under 5 years old cannot be the only group considered priority in the use of LLINs.</u> 	<u>Pregnant women and children</u>	<u>13 (54.2)</u>	<u>19 (79.2)</u>
		<u>No specific risk group</u>	<u>7 (29.2)</u>	<u>5 (20.8)</u>
		<u>Pregnant women and postpartum women < 25years old</u>	<u>2 (8.3)</u>	<u>0</u>
<u>Misconceptions about LLIN use</u>	<u>Emerged when interviewees discussed:</u> <ul style="list-style-type: none"> <u>Interviewees beliefs regarding the use of LLINs</u> <u>Interviewees and community leaders' opinions on the use of LLINs</u> <u>Rumours associated with the use of LLINs</u> 	<u>Increase in number of mosquitoes</u>	<u>3 (12.5)</u>	<u>0</u>
		<u>Increase in other diseases</u>		<u>0</u>
		<u>No myths or taboos heard</u>	<u>21 (87.5)</u>	<u>24 (100.0)</u>
<u>Barriers to personal use of LLINs</u>	<u>Emerged when interviewees discussed the difficulties that they have in utilizing LLINs adequately</u>	<u>No problems experienced</u>	<u>0</u>	<u>13 (54.2)</u>
		<u>Experienced side effects (e.g. phobia, allergy and increase in temperature)</u>	<u>20 (83.3)</u>	<u>4 (16.7)</u>
		<u>Difficulty breathing</u>	<u>4 (16.7)</u>	
		<u>Discomfort in getting in and out of the LLINs</u>	<u>0</u>	<u>2 (8.3)</u>

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		<u>Use of alternative prevention methods</u>	<u>0</u>	<u>5 (20.8)</u>
<u>Barriers to the use of LLINs within communities</u>	<u>This theme was created in response to the interviewees discomfort in speaking about their own difficulties with LLINs use but were reporting that other people had mentioned having problems such as allergies, increase temperature when using LLINs</u>	<u>Experienced side effects</u>	<u>16 (66.7)</u>	<u>22 (91.7)</u>
		<u>Alcoholic habits and perception that LLINs are ineffective</u>	<u>2 (8.3)</u>	
		<u>Dislike LLINs</u>		<u>0</u>
		<u>Fell ill with the flu due to LLIN use</u>	<u>6 (25.0)</u>	<u>2 (8.3)</u>
<u>Seasonal preferences for LLIN use</u>	<u>Emerged when interviewees discussed:</u> <ul style="list-style-type: none"> • <u>Preferential use of LLINs in the winter</u> • <u>Preferential use of LLINs in the summer</u> • <u>Use of LLINs in both winter and summer</u> • <u>Reasons behind the preferential use of LLINs in one season vs another</u> 	<u>Prefer to use LLIN in summer because there are no mosquitoes in winter</u>	<u>14 (58.3)</u>	<u>3 (12.5)</u>
		<u>Prefer to use LLIN in summer and winter alike</u>	<u>10 (41.7)</u>	<u>17 (70.8)</u>
<u>Health professionals' key messages during the distribution of LLINs in health centres</u>	<u>Emerged when interviewees discussed:</u> <ul style="list-style-type: none"> • <u>Information received on the importance of LLINs use</u> • <u>Precautions to be taken before LLINs use</u> • <u>Not having received any information about LLINs use</u> • <u>Having received correct information on the precautions to be taken before LLINs use</u> • <u>Having received incorrect information on how to care for LLINs before use</u> 	<u>No information given</u>	<u>11 (45.8)</u>	<u>17 (70.8)</u>
		<u>Wash LLIN with detergent and/or dry it under the sun</u>	<u>5 (20.8)</u>	<u>1 (4.2)</u>
		<u>Wash LLIN with water and dry it in the shade</u>	<u>5 (20.8)</u>	<u>0</u>
		<u>Air LLIN in the shade, before use</u>	<u>0</u>	<u>4 (16.7)</u>
		<u>Told not to use for fishing or cover flowerbeds</u>	<u>4 (16.7)</u>	<u>0</u>
		<u>No information given</u>	<u>12 (50.0)</u>	<u>15 (62.5)</u>
<u>Key messages from health professionals during community distribution of LLINs</u>	<u>Emerged when interviewees discussed:</u> <ul style="list-style-type: none"> • <u>Information received on the importance of LLINs use</u> • <u>Precautions to be taken before LLINs use</u> • <u>Not having received any information about LLINs use</u> • <u>Having received correct information on the precautions to be taken before LLINs use</u> 	<u>Wash LLIN with detergent and/or dry it under the sun</u>	<u>5 (20.8)</u>	<u>2 (8.3)</u>
		<u>Wash LLIN with water and dry it in the shade</u>	<u>0</u>	<u>0</u>
		<u>Air LLIN in the shade, before use</u>	<u>0</u>	<u>4 (16.7)</u>
		<u>No information given</u>	<u>12 (50.0)</u>	<u>15 (62.5)</u>

	<ul style="list-style-type: none"> • <u>Having received incorrect information on how to care for LLINs before use</u> 	<u>Told not to use for fishing or cover flowerbeds</u>	<u>4 (16.7)</u>	<u>0</u>
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*In cases where responses exceeded the number of women in the group, some women provided responses that fit into more than one category. In cases where the total number of responses is less than the total number of women, some women declined to answer or did not know what the answer was.

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LLINs are perceived to prevent mosquito bites and malaria by a majority of pregnant women (PW; 83.3%) and mothers with children under 5 years (MCU5; 75.0%). LLINs are believed to protect against other diseases such as cholera by 16.7% of individuals in each of the two groups, and a minority of MCU5 believes LLINs are useful for fishing.

79.2% of MCU5 are aware that pregnant women and children are vulnerable groups in malaria prevention compared with 54.2% of PW. Both groups believe all groups should be prioritized, including pregnant and postpartum women under 25.

The majority of women in both groups (87.5% PW and 100% MCU5) reported no myths or taboos about LLINs. Three pregnant women report misperceptions about LLINs increasing mosquito populations and spreading diseases. MCU5 (54.2%) reported no side effects or problems associated with personal use of LLINs. In contrast, 83.3% of PW reported side effects from LLIN usage. Four women reported difficulty breathing while using LLINs in both groups. In five of the MCU5, alternative methods of prevention were used instead of LLINs (such as sprays or plants with mosquito repellent effects). In response to a question regarding barriers to LLIN usage in the community, 66.7% of the PW and 91.7% of the MCU5 reported having heard that community members had experienced side effects from LLINs.

A majority of MCU5 (70.8%) reported using LLINs year-round, with no seasonal preference. In contrast, 58.3% of PW stated they preferred to use LLINs in the summer because they believed winter was mosquito-free. Most MCU5 (70.8%) reported not receiving any information at the health centres when they received LLINs, compared to 45.8% of PW. In only 4 MCU5, the correct message about what to do before using LLINs. According to four PW, they were only told not to use LLINs for fishing or to cover flowerbeds. As part of the community mass distribution, 62.5% of MCU5 and 50% of PW stated they had not received information regarding LLIN care before usage. Similarly, only 4 MCU5 received the correct message on what to do before using LLINs.

During the survey, women in both groups reported that a health professional's explanation of how to use and care for LLINs at the health centres or during mass distribution was very important to them. Participant suggestions included monitoring LLIN usage and delivering health talks on LLINs and malaria prevention in schools and communities on top of the distribution of LLINs. According to some women, to be able to get the net for free from the government is a good thing, as they could not afford it.

2.— Knowledge about the correct use of mosquito nets

a.— General perceptions on the use of mosquito nets

Pregnant women reported that the mosquito net protected them from mosquitoes and thereby prevented malaria in over half (20/24) of the cases:

"The mosquito net is important because it helps when there are mosquitoes to protect me and my children from getting malaria. I wash the net, stretch it out in the sun." (PW number 07, 23 years old)

"...the mosquito net is useful for many things. It kills mosquitoes and protects us from getting malaria." (PW number 16, 34 years old)

According to 17% of pregnant women (4/24), mosquito nets provide additional protection against other diseases as well:

“In my opinion, apart from protecting us from malaria, it can protect us from getting cholera and many other diseases” (PW number 02, 18 years old)

“The mosquito net protects from mosquitoes, to prevent malaria. It also serves to avoid other diseases” (PW number 21, 39 years old)

In addition, the majority (18/24) of **mothers with children under 5** believe mosquito nets prevent malaria by keeping mosquitoes at bay:

“...By using a mosquito net, you can avoid being bitten by mosquitoes and catching malaria.” (M number 24, 38 years old)

“for me, the net is good for mosquitoes, and it also prevents other diseases because without the net, mosquitoes will bite you a lot” (M number 16, 22 years old)

It was reported by two mothers with children under five years of age that they used mosquito nets to prevent malaria, but some also used the nets to fish:

“...I have used the mosquito net to prevent malaria, but I have seen other people take the net for fishing” (M number 14, 42 years old)

“...I use it to protect myself from mosquitoes, and prevent malaria and other diseases. But there are other people who use the mosquito net for fishing” (M number 13, 20 years old)

b.—General perceptions on the use of mosquito nets in vulnerable groups

Over 50% of **pregnant women** (13/24) believe that malaria must be prevented for children and pregnant women by using mosquito nets. In order to avoid infecting the foetus, pregnant women should stay healthy; and healthy children need protection because of their fragile immune systems:

“I can prioritise pregnant women and children. The child has the right to sleep inside the mosquito net every day, and not just the child, the adult too, because the disease does not choose. They must sleep inside the mosquito net because if I get bitten by a mosquito, as soon as I'm pregnant, I may not feel anything, but the disease can affect what's inside me, now, when the baby comes out, it comes out with diseases, many diseases, in short, I already run the risk of being in the hospital.” (PW number 01, 18 years old)

“In the case I get a few nets, I'll give them to pregnant women and the little ones, since adults can protect themselves with blankets, but kids don't know how to protect themselves.” (PW number 12, 22 years old)

7 out of 24 pregnant women believe that all groups (pregnant women, children, adults, and elderly) are vulnerable to malaria, therefore mosquito nets should be used by all of them:

“The net is a plus and should be used by all groups, but especially for pregnant women so that they have a healthy pregnancy and their baby is not born ill” (PW number 16, 34 years old)

“We should all sleep inside the mosquito net and I don't think there is a specific group for using the mosquito net” (PW number 11, 33 years old)

According to two pregnant women, pregnant and postpartum women under 25 years of age are the most vulnerable to mosquito bites due to their limited level of responsibility for caring for their children:

“For me, the priority should be pregnant women and women with very small babies as well as the young women who become mothers before age 25. The very young mothers under 18 years or under 25 years are not responsible enough to protect themselves and their babies.” (PW number 18, 23 years old)

19 out of 24 **women with children under five years** believe that women and children are the most vulnerable groups:

“we can give it to children and pregnant women because if they don’t get a net, the pregnant woman won’t be well and the children don’t know how to cover themselves” (M number 16, 22 years old)

“Small babies, pregnant women, if we don’t use the net, the children inside will come out with illnesses, but we, who are big, should use mosquito nets otherwise we catch malaria” (M number 17, 19 years old)

Within this group women with children under five years, there are some who think that all age groups should use the nets:

“We all need to be protected from malaria, but I can first give a net to the children, then to the adults.” (M number 04, 19 years old)

“Everyone can use it, even pregnant women, children, and adults, to avoid malaria” (M number 23, 21 years old)

3. — Myths, taboos and beliefs related to the use of mosquito nets

There were no myths or taboos among **pregnant women** (21/24) in the community, on the contrary they were motivated to use mosquito nets to prevent malaria by their community leaders:

“they said we should take care of the mosquito net, it is forbidden to use it to cover veggie gardens or for fishing.” (PW number 17, 23 years old)

“We only heard that we should use mosquito nets to protect children and not to protect gardens” (PW number 13, 19 years old)

Only a few pregnant women (3/24) reported hearing that mosquito nets increased the number of mosquitoes and thus led to more diseases:

“No, I haven’t heard a lot of things about the use of mosquito nets. what I have heard sometimes is that the net may cause infections or increase the presence of insects when used.” (PW number 03, 18 years old)

“I’ve never heard anything about myths, I just know that they say the net has diseases and we can’t use it, but I know they’re fooling us and they say that we only cover ourselves so the

mosquito doesn't get in, it's not because the mosquito net kills mosquitoes.” (PW number 02, 32 years old)

There have never been any myths or taboos associated with mosquito nets among **women with children under 5 years of age**:

“I never heard anything about the mosquito net, apart from knowing the importance of the mosquito net” (M number 13, 20 years old)

“In the community we have never heard information or myths about the use of mosquito nets, I have never heard anything strange about mosquito nets” (M number 02, 18 years old)

4.—Personal barriers to the use of mosquito nets

In insects impregnated in mosquito nets, almost all **pregnant women** report experiencing adverse effects such as allergies, phobias, and feeling of rising temperatures. According to them, they had such effects because the mosquito net hadn't been washed before use and was not stretched properly:

“Before I knew that the net had to be washed first, once I took the net without washing it and that medicine that is in the nets caused me allergies and I was breathing badly, but I didn't know what to do, but a brother also appeared and I told him that I would not use the mosquito net anymore because it created allergies and he said not to use the net before washing and letting it air outside and I did that. After that, I see the net helps a lot” (PW number 09, 40 years old)

“Even if I don't like it I still use it so I don't die of malaria. The net creates allergies, gives me pimples and heat up a lot...” (PW number 05, 37 years old)

Pregnant women (4/24) also reported breathing difficulties and allergies:

“women always say that [breathing and pimples] can be cause by mosquito nets, and can be worse when the person is pregnant.” (PW number 17, 23 years old)

Among **women with children under 5** (13/24), more than half said they had never experienced any adverse reactions to the insecticide impregnated net:

“Nothing has ever happened to me. The first time I used the mosquito net it made my face itch a lot, but after a while it passed, I didn't need to go to the hospital and it didn't take long” (M number 06, 36 years old)

“Nothing strange has ever happened to me with the net, I always like the net and I don't feel good outside the net anymore” (M number 22, 23 years old)

Four out of 24 women with children under 5 reported adverse events while using the mosquito net, including increased body temperature, allergies, and suffocation:

“When I don't wash the net it gives me pimples, but when I wash it doesn't give me pimples. Also, the net can heat up, but it is alright because it does not allow mosquitoes to enter” (M number 19, 27 years old)

“Nothing, nothing has ever happened to me because I like the mosquito net, but sometimes it happened that I got inside the mosquito net and I didn’t feel well, but I never stopped using it [...], I didn’t breathe well.” (M number 02, 18 years old)

Two women with children under 5 said that entering and exiting the mosquito net was uncomfortable in the event of necessity:

“...hiiiiii! For me it makes it very difficult to go out to pee and go back to sleep, sometimes it bothers me because if I don’t close it well and mosquitoes get in...” (M number 17, 25 years old)

Additionally, some of the women with children under five years of age report not using mosquito nets regularly because they are using other malaria prevention methods:

“I use mafurraira [Trichilia emetic] tree leaves for mosquitoes” (M number 20, 18 years old)

“...to protect my health, I use baygon [insecticide]” (M number 03, 19 years old)

5.— Community barriers to the use of mosquito nets

During the interview, 16 out of 24 pregnant women identified allergies, feelings of suffocation, and rising temperatures as barriers to neighbours and acquaintances using mosquito nets effectively:

“Some people say that they prefer to use dragão [insecticide] because the mosquito net is uncomfortable, and they are unable to breathe well” (PW number 10, 42 years old)

“Many people speak ill of mosquito nets, for example, they say that they can’t breathe well, it gives them pimples and they prefer not to use the mosquito net and I always convince them that one day they will get used to it” (PW number 05, 37 years old)

The perception that mosquito nets do not prevent malaria, and alcoholic habits, were listed as additional barriers by two pregnant women. Moreover, these barriers contribute to the incorrect use of nets (e.g. for fishing):

“The people who don’t like mosquito nets are usually those who abuse alcohol, so when they come back home drunk, they are unable to stretch and use the net and get bitten by mosquitoes. Others also say that the nets cause allergies and asphyxiate them, but if they washed the net before using it these effects would be reduced.” (PW number 11, 33 years old)

“People say they don’t like using mosquito nets because they don’t have mosquitoes and don’t see the importance of using them. Other people drink too much and forget to use them or take their nets to go fishing.” (PW number 13, 19 years old)

Some pregnant women claim that some people refuse to use nets because they aren’t concerned about their health, have allergies, or have suffocated. Consequently, the nets are used to cover hen houses and other items:

“For me, I don’t know how to explain it, but I can say some people are careless about their health and others just don’t like using the mosquito net.” (PW number 24, 20 years old)

“Other people use the mosquito net as a hen house for chickens and ducks. Some neighbours say that the net heats up and tends to cause pimples and because of that they prefer to use dragão [insecticide]” (PW number 22, 21 years old)

According to the majority of **women with children under 5 years** (22/24) neighbours and acquaintances have complained of allergies and suffocation caused by the nets:

“Other people say that when they stretch the mosquito net, they have allergies and a lot of pimples come out and others say that they don't sleep well in the mosquito net because they can't breathe well.” (M number 13, 44 years old)

“Others say that it makes the skin itchy, but I always advise them not to stop using it” (M number 11, 37 years old)

According to two women with children under 5 years of age, acquaintances who used mosquito nets without washing them reported that they had flu:

“They just say it causes allergies and also causes you to have the flu when you use it without washing it, they might say other things but I don't know” (M number 04, 19 years old)

6. Preferential use of mosquito net by seasons

Most **pregnant women** (13/24) prefer to use mosquito nets during summer because mosquitoes are absent during winter (see table 4):

“...I use the net more in hot weather because it's the time with a lot of mosquitoes due to the stagnant water we find there in our areas and when it gets dark the mosquitoes increase. In winter, I don't use mosquito nets much because I use the blanket more so I don't get bitten by mosquitoes” (PW number 22, 21 years old)

In one pregnant woman's experience, mosquito nets don't allow for enough air circulation in the winter, leading to discomfort:

“I use the mosquito net more in the summer than in the winter. The air does not come out because of the cold and this causes me discomfort.” (PW number 06, 20 years old)

More than half (17/24) of **women with children under 5 years** use mosquito nets throughout the year (see table 4):

“Very much in the summer, because there are a lot of mosquitoes, but as the weather has changed, even this winter there are a lot of mosquitoes, but I always used it even though it was winter” (M number 22, 23 years old)

Table 4: Preferential use of mosquito net by season

Seasons	Pregnant women (24) (n)	Women with children under 5 years (24) (n)
Only in summer	14	3
Throughout the year	10	17

7. Key messages from healthcare workers during the distribution of mosquito nets at the ANC

Approximately half of the **pregnant women** (11/24) reported only receiving the mosquito net, without any instructions on how to care for it:

“Here at the hospital they just gave me the mosquito net and didn’t say anything else” (PW number-04, 36 years old)

“Here at the hospital they didn’t say anything else, they just gave me the net and told me to use it” (PW number-08, 41 years old)

In the ANC, five pregnant women were told that before using the mosquito net, it should be washed, laid in the sun for the insecticide to evaporate:

“The distributors said that before I use the mosquito net I should wash the net, let it out in the sun so that the medicine on it disappears. In very hot conditions, it should be left to cool down, soak up the sun for a period of two days. I was told to wash it in the basin, using detergent soap” (PW number-08, 41 years old)

“They said we should spread the net in the sun so that medicine evaporates and we don’t itch” (PW number-19, 38 years old)

A further five pregnant women were instructed not only to wash the mosquito net before use, but also to refrain from using it for fishing and even to cover their flowerbeds:

“they said that the nets are for preventing mosquitoes so we don’t have malaria, they are not to be used to cover the flower beds” (PW number-14, 19 years old)

Among women with children under 5 years, most (17/24) said they were only instructed to use nets to prevent mosquito bites, but not how to care for them:

“Here, they only told me that I should use the mosquito net to prevent malaria, otherwise this person inside my belly could come out with malaria or other diseases, and they didn’t say anything else.” (M number-18, 22 years old)

“here at the hospital they didn’t tell us anything, they just gave us the net, we were told most things by those who distributed the net in the communities.” (M number-03, 19 years old)

Four women with children under 5 years were informed at the ANC that they should wash and stretch the net in the shade to reduce the insecticide adverse effects:

“Here at the hospital they told me to wash the net and stretch it out to avoid mosquito bites. They said I should wash it with soap and hang it in the shade, but I can’t remember for how long.” (M number-08, 34 years old)

“...they told me to spread it out in the shade to reduce the medicine, they didn’t tell me to wash it.” (M number-04, 19 years old)

8. — Key messages from healthcare workers during the large scale distribution of mosquito nets

Half of the pregnant women (12/24) said that they were not informed about how to take care of the mosquito net:

“They didn’t say anything they just gave us the mosquito nets” (PW number-13, 19 years old)

“...they said we should use the net to prevent malaria and they didn’t say anything else” (PW number-02, 18 years old)

A few pregnant women (5/24) were instructed to wash the net in powder detergent and stretch it in the sun to prevent adverse effects from the insecticide:

“they said that we should wash it with OMO before using it so that the medicine in the net doesn’t cause side effects and that we could also lay it out in the sun” (PW number 07, 23 years old)

“Those who distributed the nets in the community said that they were not for washing, but for stretching out in the sun so that the medicine would not harm me” (PW number 22, 21 years old)

Four pregnant women were told to use the nets for malaria prevention and not for fishing or covering flower beds:

“They said they don’t want to see the nets stretched out to protect the gardens and they also don’t want to see us use the nets for fishing in the lake and they didn’t say anything else” (PW number 20, 32 years old)

“They said that the nets were to be used to prevent mosquitoes so we wouldn’t get malaria, they weren’t to be used to cover the flowerbeds” (PW number 17, 23 years old)

The majority of ~~women with children under 5 years~~ (15/24) reported that the health professionals only told them mosquito nets were for preventing mosquito bites. No instructions were given about how to maintain the nets:

“They said I should keep myself inside the net and they didn’t tell me anything else” (M number 01, 27 years old)

“They didn’t say anything they just gave us the mosquito nets and didn’t explain” (M number 21, 24 years old)

In some cases, women with children under 5 years were also advised to wash the nets with a detergent and lay them out in the sun; in others, they were simply instructed to lay them out in the sun or in the shade without specifying a period of time:

“they said we should hang out the net in the shade, the time/duration I don’t know anymore. And that we shouldn’t spread the net in the sun either and I don’t remember the rest anymore” (M number 18, 22 years old)

“they said to wash it with detergent soap, lay it out in the sun to dry and then stretch it indoors.” (M number 15, 29 years old)

9. — Facilitating factors that may influence the use of mosquito nets in pregnant women and women with children under 5 years

It is expected that the women should be able to explain everything about mosquito net care before they use them if the health professionals provided key messages about mosquito nets during mass distribution and at the ANC. This would prevent the women from becoming discouraged by side effects which may influence them to stop using mosquito nets:

“even now they gave us the net, but they didn’t explain to me what I should do before starting to use it, so the Ministry of Health should review this and tell the nurses as well as the distributors of mosquito nets in the community to give a good explanation of the use of

mosquito nets. Others open it and use it right away and suffer from allergies, so they may decide not to use the mosquito net anymore after this" (PW number 10, 37 years old)

There were some participants who believed that the ministry of health shouldn't just distribute mosquito nets. Additionally, it should monitor mosquito net usage and deliver health talks in schools and communities:

"To make things easier and encourage people to use the mosquito net properly, after giving us the nets, they should talk about it in schools and teach us how to use it." (PW number 15, 42 years old)

"Health authorities should also use schools, our local chiefs so that they can teach us how to use to mosquito nets correctly, and monitor the use in the community so that people are not using it in the mangroves and for fishing." (MCU5 number 20, 18 years old)

Other participants reported that the distribution of mosquito nets by the government is already an important facilitator:

"For me and my family, it is important that the ministry of health continues to distribute mosquito nets" (M number 07, 47 years old)

"The government must always distribute mosquito nets because, for example, they are very expensive for the money we make and it can happen that others don't have the money to buy mosquito nets and die of malaria" (PW number 10, 37 years old)

Discussion

Knowledge about the correct use of mosquito netting

A majority of women in both study groups knew that LLINs prevented mosquito bites, which in turn prevented malaria. The findings are consistent with those of other African countries (South Africa and Ethiopia), where pregnant women and mothers with young children have stated that LLINs provide a physical barrier between them and mosquitoes, decreasing mosquito bite risk. According to the same studies, LLINs also disorient or kill resting mosquitoes by their repellent effect. In this study, it was found that more than 50% of pregnant women and mothers with children under five years of age knew mosquito nets prevent mosquito bites, and, consequently, malaria. In studies conducted in African countries (South Africa and Ethiopia), pregnant women and mothers with young children have stated that ITNs always serve as a physical barrier between them and mosquitoes, reducing the risk of mosquito bites. According to the same studies, ITNs also disorient or kill resting mosquitoes by their repellent effect (12,13).

According to a study in Malawi, respondents did not reveal the truth because they feared that the government would paralyze net distribution. Rather than focusing on what respondents knew about LLINs, they sought to learn what other community members knew. As a result of drought and food insecurity, people believed they could sell or use the nets for fishing in order to increase family income. Considering that participants might be reluctant to give honest answers about mosquito nets, participants were also asked about the opinions of their closest friends. Several interviewees mentioned that their neighbours used the nets to fish and protect flowerbeds due to the smell and increased heat. Those findings are consistent with those found in a study conducted in Malawi, which concluded that respondents did not reveal the truth for fear that the government would paralyze net distribution. Researchers in that study sought to

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find out what other people knew about ITNs and how they were being used. Answers varied, but the main one was that participants believed the nets could be sold or used for fishing in order to increase family income due to drought and food insecurity (7). A number of other studies have also reported adverse environmental and economic effects of the widespread use of LLNIs for fishing in East Africa and northern Mozambique (8,14). We did not find this to be a major finding in our study even though fishing is a primary economic activity in these communities. This is despite the fact that participants were questioned about their friends and community members' opinions when they showed reluctance to answer questions. Only a few (less than 10%) reported that community members used LLNIs for fishing or covering flowerbeds.

Knowledge about the use of mosquito nets in vulnerable groups

For the majority of women in both study groups, pregnant women and young children were identified as the most vulnerable populations in need of priority attention for malaria prevention. This is aligned with a study conducted in Ethiopia which reported that the population understood the importance of protecting children and pregnant women. Among the interviewees who were knowledgeable about vulnerable groups for malaria and which groups should be prioritized for mosquito nets, pregnant women and young children were identified as the most vulnerable groups in need of special protection such as continuous provision of mosquito nets. These results corroborate the results of a study carried out in Ethiopia that, when using ITNs, the population understands how important it is to protect children and pregnant women (15).

As in a similar study conducted in Madagascar, we found that 50% of the women in our study felt that other vulnerable groups living around them should be equally protected

Despite the fact that they may live with children or pregnant women who are easily susceptible to malaria, some women understand that all age groups need equal attention. In Madagascar, a study concluded that other groups should also be protected to prevent them from contaminating vulnerable groups living around them (16). Researchers in the Central region of Mozambique found that school-aged children are at greater risk of malaria infection and severe disease (17).

Myths, taboos and beliefs related to the use of mosquito nets

A small portion of pregnant women (12.5%) believed LLNIs would increase the mosquito population and spread diseases. This is in line with one study in Ethiopia, where respondents believed that LLINs increase the population of insects and diseases. It was found that some participants believed the use of mosquito nets would increase the population of insects and diseases. According to a study conducted in Ethiopia, respondents believed that ITNs breed bed bugs (small parasitic insects that feed exclusively on humans and domestic animals' blood) (12). There were no misconceptions reported by respondents in the MCU5 group. Possibly, pregnant women may be more sensitive to anything that may harm their unborn children, making them vulnerable to misinformation.

Personal barriers to the use of mosquito nets

While most MCU5 did not report any problems with LLINs, 100% reported experiencing side effects and difficulty breathing from using LLINs during pregnancy. A number of studies have identified side effects of LLINs, particularly if they are not used properly. Among other things, users may experience itchiness, heat, discomfort, and respiratory problems. According to the

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study, many mothers with children under five do not encounter any difficulties while using the ITN and no longer feel comfortable sleeping without it. While they mention allergies, increased temperatures and suffocation as direct challenges for neighbours or acquaintances who don't use the nets or don't use them regularly. Unlike the pregnant women, they responded openly and said that, both for themselves, as well as for their neighbours and acquaintances, they had already experienced allergies, suffocation, and increased temperatures, especially during the summer, which led to using ITNs for fishing and protecting flowerbeds and yards.

Two studies conducted in Ghana and Rwanda found similar results. Based on these studies, all respondents rated heat and discomfort under nets as major barriers to consistent use(16). The most common reasons respondents gave for not using ITNs were the feeling of warmth and itching when using them(17). In addition to physical discomfort, concerns about chemicals impregnated in the ITN are also common reasons not to use one (18–21). Pregnant women might experience side effects from LLINs due to increased sensitivity during pregnancy and possible reactions to the chemicals in the nets, which could account for the discrepancy between PW and MCU5. However, when asked about the community 91.7% of MCU5 reported having heard about others experiencing side effects with LLIN usage. A reluctance to answer the question honestly might also have played a part.

According to a study conducted in Rwanda, respondents were not using ITNs because they simply didn't have them, contrary to the findings of this study (20). Since 2011, Mozambique has been implementing massive mosquito net distribution campaigns every three years. The lack of mosquitoes and insufficient ITNs have been reported by several studies in central Mozambique as reasons for not using ITNs(15).

It was also stated that mothers whose children were under five were uncomfortable leaving and entering the net at night, but that at some point they became comfortable and didn't prioritize the use of the net because they had already sprayed their homes or used other methods to repel mosquitoes, such as plants.

According to a study in Ghana, community members used alternative methods of malaria prevention, such as herbs, grass, burning orange peels, or sprays.

A study in Ghana found that there were other reasons why ITNs were not used. There are a number of reasons for this, including the use of herbs, grass, burning orange peels, and mafur tree peels as alternatives. It is believed that these peels repel mosquitoes effectively. Some people believed that their surroundings did not have any mosquitoes, while others said they sprayed their rooms, so there were no mosquitoes and they did not need ITNs (19). In our study, few MCU5 reported using alternative methods of mosquito prevention. These products are believed to contain effective insect repellants.

In addition, the difficulty of getting in and out of the RTI at night was cited as a barrier to utilization. Sleeping under the net restricted some participants' movement during the night and made it difficult for them to get in and out of bed (16).

Preferential use of mosquito net by seasons

The study groups differed in their seasonal preferences. Majority of pregnant women preferred to use the LLIN in summer. According to studies conducted in Myanmar and Madagascar, women use LLIN more in summer because they believe there is no mosquito activity in winter. According to the present study, pregnant women use ITNs in summer because there are

more mosquitoes during this period than during winter. The results of two studies, one in Thai-Myanmar and the other in Madagascar, indicate that women use ITNs more in summer because they believe there are no mosquitoes in winter (16,22). A study in Nigeria found, however, that pregnant women did not use LLINs in summer due to the higher temperatures. These results corroborate those found in the present study, in contrast to a study carried out in Nigeria that concluded pregnant women do not use the ITN in the summer because it is uncomfortable given the rise in temperature in the summer than in winter (23). As mosquitoes are observed at all times of the year, 70.8% of the MCU5 reported using LLINs throughout the year, in line with findings from other studies

Several mothers with children under five years of age reported using the ITN throughout the year, as they observed mosquitoes during both seasons (24).

Health professionals should inform the targeted population of what to do before using LLINs and how to care for them once they receive LLINs from health centres or in the community. Communication should focus on how LLINs should be used, installed, maintained, handled, how to deal with side effects, when to replace, and special advice for pregnant women (25). We found that both groups of women received insufficient or no information in our study. Among those who received information about what to do before using the nets, only 16.7% received the correct information. The lack of knowledge about the proper use and care of LLINs may hinder their utilization and increase malaria transmission. As a result, it is not surprising that when women were asked how LLINs can be used more effectively, they suggested getting better information about how to use and care for them, monitoring the use and care of them in the community, and engaging the community by delivering health talks at schools and community gathering places.

Key messages in prenatal consultations and mass ITN distribution campaigns

Results of the present study show that participants were informed effectively about the use of mosquito nets for malaria prevention during ANC consultations and mass distribution. However, the care for mosquito nets before use was not effectively transmitted. In this scenario, it is possible that mosquito nets were misused or were not used properly, resulting in adverse reactions to the insecticide, which can cause strong allergies. According to studies, radio/TV advertisements and key messages from national leaders influenced women to use ITNs, despite not receiving appropriate messages in health facilities (9,17).

During prenatal consultations and during the campaign, interviewees were told they should wash mosquito nets with powdered detergent and lay them out in the sun before using them, but this is incorrect information given by health care providers. The detergent removes all the insecticide impregnated in the mosquito net, so it becomes merely a physical barrier against mosquitoes, reducing its effectiveness.

According to a study with health professionals in eight units, they generally provided comprehensive information about ITNs before their use. The information provided included tips on how to prepare the ITNs before use, how to dry them in the shade for 24 hours to avoid allergies caused by the chemicals used to treat them, how to prevent malaria during pregnancy, and how to protect the body from mosquito bites by using ITNs. When expecting mothers need

to be outdoors for long periods of time during the night, they were advised to wear long-sleeved dresses to prevent mosquito bites. A dialogue sometimes occurred between pregnant women who were reluctant to receive ITNs and health professionals at the ANC, where health professionals attempted to ease their fears and misconceptions about ITNs causing heat and itching in the body and eyes (17).

Facilitating factors that may influence the use of mosquito nets in pregnant women and women with children under 5 years

As a facilitator for the efficient use of ITNs, the study highlighted the need for sufficient and accurate information during the distribution of ITNs at the ANC and integrated (multisectoral) post-campaign awareness events. In Nigeria, Francis Ugwu (2023) found that awareness after the distribution of ITNs was a determining factor for ITN use (24). According to a study conducted in a school context, ITNs should continue to be distributed for free in low-income countries and students should be mobilized to promote their use (25). In Gaza, a study found that community groups can help disseminate key messages and facilitate the use of ITN (26).

Limitations

The study had some notable limitations. Women were hesitant to participate in the study, because participation meant staying for a longer period than initially planned in the ~~health facility~~ health centre. To minimize this limitation, during the health talks in the waiting rooms the women were informed beforehand about the study and its procedures. Observer bias was an additional limitation and to address this the investigators used follow-up questions whenever necessary. Women were also hesitant about participating in the study in fear of suffering retaliation and being excluded from future ITN/LLIN distribution campaigns. These fears were also addressed during the health talks and before the interviews, to ensure they understood that their responses would not influence current or future healthcare provision and that they were free to stop their participation anytime they felt uncomfortable.

Additionally, there are several limitations and potential sources of bias associated with convenient non-probabilistic sampling, which may affect the validity and generalizability of the findings. Hence, results should be interpreted with caution since it does not give a representative sample of the larger population.

Conclusion

Providing clear, culturally sensitive, and practical information on the correct use of LLINs, as well as regular monitoring of their proper use, would be a great step forward for Mozambique's national malaria program. Communities will be empowered to minimize risks and maximize effectiveness in preventing malaria. Despite extensive distribution of mosquito nets at health facilities and in communities, there still exists a large knowledge gap amongst the participants and their communities on the correct use of the mosquito nets. There are still reports of misuse of the mosquito nets in the community as a result of side-effects from incorrect use and misinformation. This may explain in part the persistent high incidence of malaria in these districts. It is crucial for the health professionals, ministry of health and its partners to review current strategies to include extensive community engagement (community awareness campaigns) and regular monitoring of correct use of ITNs (not just coverage).

Acknowledgments

The authors would like to thank the women who participated in the study, the data collectors and the health professionals in the facilities selected for the study.

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List of Legends:

1. Interview Guide
2. Ethics approval letter (Portuguese)
3. Ethics approval letter (English translation)
4. Translation certificate
5. Data: demographics
6. Data: PW interview transcripts
7. Data: MCU5 interview transcripts

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Response to reviewers

PGPH-D-23-01427

Title: **Factors associated with the use of long-lasting insecticidal nets in pregnant women and mothers with children under five years of age in Gaza province, Mozambique**

Dear editor,

We humbly thank the reviewers for their time and valuable comments, that have helped us improve the manuscript. Please find enclosed our point by point responses to their queries. The manuscript is also attached in track changes to show the modifications, and in a clean version.

Editor comments:

Please review your reference list to ensure that it is complete and correct. If you have cited papers that have been retracted, please include the rationale for doing so in the manuscript text, or remove these references and replace them with relevant current references. Any changes to the reference list should be mentioned in the rebuttal letter that accompanies your revised manuscript. If you need to cite a retracted article, indicate the article's retracted status in the References list and also include a citation and full reference for the retraction notice.

- We do not have not cited any retracted papers. We have added references in the revision due to the comments from reviewers. These have been added to the end of the letter.

We have noticed that you have uploaded Supporting Information files, but you have not included a list of legends. Please add a full list of legends for your Supporting Information files after the references list.

- Added to the manuscript below the reference list

In the online submission form, you indicated that "The datasets analysed during the current study are available from the corresponding author on reasonable request". All PLOS journals now require all data underlying the findings described in their manuscript to be freely available to other researchers

- The data has been uploaded as supplementary

Reviewer #1:

The MS has a good question to understand the risk of pregnant ladies however few observations are seen

In Methods Residents living in both province are quite good in number why the convenient non-probabilistic sampling was done and only 48 pregnant and child bearing mother were taken in study which gives a lower confidence in the study authors should justify the sample size

- Thank you for the observation. For a variety of reasons, we chose a convenient non-probabilistic sampling method: 1) cost concerns; the study did not have any funding, and random sampling would have been more expensive in such a large and dispersed

population, 2) The study was time sensitive to provide quick answers to a programmatic issue on the ground; 3) this was an exploratory study aimed at generating hypotheses for future studies using random sampling to be more comprehensive.

During the study, we included women who presented at the selected health centers with characteristics of interest. To determine sample size, we used theoretical or data saturation, but with the predicted minimum of 14 women in high-volume health centres and 10 in low-volume health centers. In this study, we were able to saturate the information without exceeding the minimum amount predicted.

- This was included in the manuscript under methods: Participant selection and sample size
- These limitations were included in the manuscript.

Results As we are interested in the perception and not in the who gave the answers therefore these answers may be point wise or percent wise can be put in the MS rather using their answers. Put data in a paragraph form the answers by the respondent can be used in passive form and in percent perception etc. The result section should have such paragraphs or results and percentages as written in discussion.

- Thank you. We have reorganized and rewritten the result section as advised.

In discussion authors may consider writing a contentious discussion on the awareness and why the results were observed so.

- The discussion section was revised and rewritten as advised.

Reviewer #2:

The manuscript's title is somewhat unclear, as it mentions mosquito nets, while a portion of the manuscript specifically focuses on LLINs. Consider revising the title to reflect the broader scope of LLIN usage.

- Thank you for the advice. The title has been revised.

The title page of the manuscript lists authors in a different sequence than the submitted author list, and the affiliation of the corresponding author on the title page differs. These discrepancies need to be addressed.

- Thank you for noticing this, it has been addressed. The correct order is on the manuscript.

The use of the terms "mosquito nets" and "LLIN" appears inconsistent throughout the manuscript. It is advisable to use a consistent term for all types of nets.

- Thank you for the advice. The term LLIN has been used throughout the manuscript.

A thorough review of the English language and grammar is necessary, as some sentences are difficult to decipher, and punctuation issues arise, particularly in the results section.

- The manuscript has undergone English revision. Thank you.

The abstract format does not align with the 'Plos Global Public Health' guidelines, and it should not contain subheadings. Additionally, consider shortening the conclusion section by one or two lines.

- Thank you, this has been addressed and the abstract has been revised as per PLOS GPH criteria.

In the introduction section:

Properly format the reference "WH, 2022" in a standard referencing style. Clarify whether Cabo Delgado is a state or district in line 3 of paragraph 2. Replace the phrase "massive amount" with a more scientifically appropriate term, and specify the relevant authority's name in paragraph 3.

- Thank you, reference revised. Cabo Delgado is a province, this has been added to the manuscript. Massive amount has been replaced with 'large amounts'. The authority name has been added to the manuscript.

Clarify whether Mozambique ranks 11th in Africa or globally in paragraph 3, line 4. Add the prefix "national" to the malaria control strategic plan's name in paragraph 5, line 1.

- Thank you, this has been clarified in the text (globally), and prefix added in the text.

Consider mentioning studies from other African countries working on the same factors to highlight the existing research and identify gaps. Clearly articulate the gap in knowledge if studies on the mentioned factors are available.

- Studies have been added to highlight and clearly articulate the research gap.

The study's aim should include the country name, as mentioned in the abstract.

- This has been added to the text.

In the "Materials and Methods" section:

Revise "in depth interview process" to "in-depth interview method."

- Thank you. The revision has been made

Specify whether the study was conducted within a one-month or one-week time period.

- Study was conducted in 1-week time period. This has been clarified in the methods

Clarify whether healthcare facilities and health units are considered the same class of health centers.

- They are the same primary health centres, however, for clarity we used health centres.

Explain how the sample size remained consistent across both districts, considering potential data variations. It appears that the sample size was pre-determined, with interviews conducted accordingly based on the different categories.

- Thank you for the observation. For a variety of reasons, we chose a convenient non-probabilistic sampling method: 1) cost concerns; the study did not have any funding, and random sampling would have been more expensive in such a large and dispersed population, 2) The study was time sensitivity to provide quick answers to a programmatic issue on the ground; 3) this was an exploratory study aimed at generating hypotheses for future studies using random sampling to be more comprehensive. During the study, we included women who presented at the selected health centers with characteristics of interest. To determine sample size, we used theoretical or data saturation, but with the predicted minimum of 14 women in high-volume health centres and 10 in low-volume health centers. In this study, we were able to saturate the information without exceeding the minimum amount predicted.
- This was included in the manuscript under methods: Participant selection and sample size
- These limitations were included in the manuscript.

Clarify whether the interviews were conducted individually or in the presence of family members.

- Thank you. This has been clarified in the text. They were conducted individually.

Provide information on who translated the past questions and responses when the native language was used.

- Translations were carried out by one of the study surveyors and double checked by the principal investigator. This has been added to the manuscript.

Specify how many individuals were contacted and how many agreed to participate in the study.

- As women presented at the consultation and an investigator was available to interview them, they were recruited. If all investigators were conducting interviews, some women might have come for consultation and left without being interviewed. A daily average of 10 -15 pregnant women and 18-25 mothers with children under 5 years attend the health center for consultation.

Elaborate on the timeline and individuals responsible for data analysis.

- Analysis, interpretation of the data and elaboration of the final report were conducted between July 2022 and February 2023.

If the interview module used was developed in 2021 and used in the 2022 study, please reference the source of the interview module if it was utilized in a previous study.

- The interview guide was study specific and has not been utilized in a previous study.

In the "Results" section:

Address the discrepancy between the occupation categories and the module questions, particularly regarding the "stay at home" and "white stick whites" categories. Provide a brief overview of the data presentation before presenting the actual data. Consider including a table of themes and subthemes to enhance reader comprehension. In paragraph 2, line 3, discuss the relevance of "Nets to fish and protect flower beds due to smell and increased heat" in the results section, as it was not previously mentioned.

- The results section was revised and rewritten as advised.

Discuss the study results in the context of previous research conducted on the same cohort in African and global populations.

- The discussion section was revised and rewritten as advised.

The following references were added during the revisions:

- Wetzler EA, Park C, Arroz JAH, Chande M, Mussambala F, Candrinho B. Impact of mass distribution of insecticide-treated nets in Mozambique, 2012 to 2025: Estimates of child lives saved using the Lives Saved Tool. *PLOS Global Public Health*. 2022 Apr 26;2(4):e0000248.
- Berthe S, Harvey SA, Lynch M, Koenker H, Jumbe V, Kaunda-Khangamwa B, et al. Poverty and food security: drivers of insecticide-treated mosquito net misuse in Malawi. *Malaria Journal*. 2019 Sep 18;18(1):320.
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- Gutiérrez-Jara JP, Vogt-Geisse K, Cabrera M. Collateral Effects of Insecticide-Treated Nets on Human and Environmental Safety in an Epidemiological Model for Malaria with Human Risk Perception. *Int J Environ Res Public Health*. 2022 Dec 6;19(23):16327.
- 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. *Malaria Journal*. 2020 Jun 29;19(1):232.

We hope that we have addressed their points satisfactorily and appreciate the opportunity to submit the new manuscript according to reviewers' comments. All authors have seen and approved the revised version. We look forward to hearing from you soon.

Kind regards,

Isabelle Munyangaju

(Corresponding author)