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Malaria Prevention and Mothers: Sudan

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الأمهات والوقاية من الملاريا: السودان

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ABSTRACT

This study assessed the knowledge, attitudes, and practices (KAP) in malaria prevention using insecticide-treated bed nets (ITNs) among mothers of children under five years of age in White Nile State, Sudan. Multistage cluster sampling was used to select 761 mothers for this cross-sectional survey. There were gaps in the KAP in malaria prevention. Only 46.3% of the mothers stated personal protective measures (PPMs) as the best malaria prevention strategy; 54.9% considered ITNs as an effective means; and only 18.7% reported sleeping under an ITN every day. Older mothers were less likely to have good knowledge (OR=0.96), attitudes (OR=0.98) and practices (OR=0.98). Having a Government employee as the head of the household was positively associated with knowledge (OR=2.16) and attitudes (OR=1.96). The mother having a formal education was also positively associated with good knowledge (OR=1.55) and positive attitudes (OR=1.69). Mothers with a monthly household income of <491 Sudanese Pound were more likely to have good knowledge (OR=1.43). Mothers who had good knowledge (OR=4.99) and positive attitudes towards PPMs (OR=2.60) in malaria prevention were found to be more likely to practice preventive measures. Therefore, we recommend focusing on raising mothers' awareness of the different preventive activities to protect them and their family from malaria.

المخلص

هدفت الدراسة الحالية إلى تقييم المعرفة والمواقف والممارسات (KAP) نحو الوقاية من الملاريا باستخدام الناموسيات المعالجة بالمبيدات الحشرية (ITNs) بين أمهات الأطفال دون سن الخامسة بولاية النيل الأبيض، السودان. وبلغ حجم عينة الدراسة (761) أما، تم اختيارهن عشوائياً من خلال العينة العنقودية متعددة المراحل. حيث أوضحت نتائج الدراسة انخفاض مستوى المعرفة، وسلبية بعض المواقف، وضعف مستوى ممارسة بعض التدابير الوقائية ضد الملاريا، كما وجد أن 46.3% من الأمهات يعرفن وسائل الحماية الشخصية أفضل الطرق للوقاية من الإصابة بالملاريا، و 54.9% من الأمهات يعتبرن الناموسيات المعالجة بالمبيد وسيلة فعالة للوقاية من الملاريا، وعلى الرغم من ذلك فإن 18.7% فقط من الأمهات يستخدمن الناموسيات المعالجة يومياً. أثبتت النتائج أن عمر الأمهات له تأثير سلبي على مستوى المعرفة (OR=0.96)، والمواقف (OR=0.98) وممارسة التدابير الوقائية ضد الملاريا. وأن الوظيفة الحكومية لرب الأسرة لها ارتباط إيجابي بمستوى المعرفة (OR=2.16) والمواقف الإيجابية (OR=1.96) لدى الأمهات نحو الملاريا، بالإضافة إلى أن تعلم الأمهات في المدارس الحكومية كان له تأثير إيجابي على مستوى المعرفة (OR=1.55) وعلى مستوى المواقف (OR=1.69). وأن متوسط الدخل الشهري أكثر من (491) جنيه كان له أيضاً تأثير إيجابي على مستوى المعرفة (OR=1.43) لدى الأمهات. ونخلص إلى أن الأمهات اللاتي لديهن مستوى جيد من المعرفة (OR=4.99) ومواقف إيجابية (OR=2.60) نحو الوقاية من الملاريا أكثر ممارسة للتدابير الوقائية ضد الملاريا. وعليه نوصي بالتركيز على رفع مستوى الوعي لدى الأمهات حول الأنشطة الوقائية المختلفة لحمايةهن ضد الملاريا.

1. Introduction

Malaria is the most prevalent vector-borne disease worldwide and is endemic in 97 countries (WHO 2014). The burden of malaria is greatest in Africa, where 91% of global malaria deaths occur. Women and children under five years of age are at a greater risk of infection and adverse outcomes (Singh *et al.*, 2013), (WHO 2011, Schumacher *et al.*, 2012). In Sudan, malaria is endemic, and children of under five years of age and pregnant women are particularly vulnerable (Elmosaad *et al.*, 2016).

Malaria prevention and control activities developed by Sudan's National Malaria Control Programme (NMCP) are mainly focused on vector control, distribution of long-lasting insecticide-treated nets (LLINs) and early diagnosis along with prompt treatment. The World Health Organization (WHO) recommends the use of insecticide-treated nets (ITNs), in particular LLINs, which have been shown to reduce malarial episodes and mortality among children under five years by 50% and overall mortality by 17% (Lengeler, 2004). The Abuja Declaration made by African leaders in 2000 aimed to provide at least 80% of pregnant women with ITNs by the year 2005. However, only 54% of the high-risk population presently make use of an ITN in Sudan (Elmosaad *et al.*, 2016). Meanwhile, the overall parasite prevalence had almost doubled by 2016 compared to 2012, from 3.3% to 5.9% (FMOH 2016). The number of malaria cases in

Sudan has continued to increase, as is evident in the world malaria reports. In 2018, there were 1.48 million cases, an increase from 1.4 million in 2017 (WHO 2017 and WHO 2018). In 2019, there was a sharp increase in the number of cases, exceeding the epidemic threshold of 1.8 million (WHO 2019). This accounted for 12.4% of all diseases in Sudan, with the White Nile State being one of the worst affected (OCHA 2020).

Knowledge attitude and practice (KAP) regarding Malaria influence the effectiveness of any prevention and control programme (Singh *et al.*, 2014). Studies have indicated that in order to develop a successful malaria control programme, it is necessary to evaluate the level of KAP of people living in communities located in malaria endemic areas (Musoke *et al.*, 2016). Since the effectiveness of any malaria control programme is associated with KAP, failure to consider mothers' KAP regarding malaria may contribute to the inability of the programmes to achieve sustainable control (Singh *et al.*, 2014). People's behaviour may contribute to an increase or decrease in malaria prevalence; nevertheless, behavioural change is not easy. In this context, this study assessed the KAP regarding malaria of the mothers of children under five years of age in Kosti rural villages in the White Nile State, Sudan. Our findings are expected to contribute immensely to the sustainable control of malaria in Sudan.

2. Participants and Methods

2.1. Study Area:

This cross-sectional survey was conducted in the Kosti locality, which is one of six districts in the White Nile State, which lies to the west of the White Nile River, covering a total area of 1,220 km² with a total population of 180,000 (SMOH 2012). This area is located in the malaria hyper-endemic zone. Malaria transmission occurs throughout the year with seasonal peaks following heavy rains from January through March and September through November. The predominant malaria vector is *Anopheles Arabiensis* (*Plasmodium falciparum*) (SMOH 2012). Over the years, the area has undertaken various malaria control interventions, including ITNs distribution, due to its susceptibility to malaria epidemics.

2.2. Study Design:

A cross-sectional study of mothers of children under five years of age was conducted using a multistage cluster sampling technique in rural villages of the Kosti district, White Nile State, Sudan.

2.3. Sampling:

The Kosti district is divided into four geographical areas. Two areas near the White Nile riverbank – one in the north-east and one in the south-west – were purposively selected. These areas are surrounded by farms and have a mosquito density of approximately four mosquitoes per room all year round; they are also targeted by the NMCP for the free distribution of ITNs. Six villages were selected from each area by simple random sampling. There were 3,181 eligible mothers in the 12 selected Kosti rural villages. Of these, 54.1% of the mothers lived in villages located in the north-east and 45.9% lived in villages located in the south-west of the study area. Overall, 23.9% of these mothers were selected to be surveyed using a systematic random sampling technique. This resulted in a total of 761 mothers of children under five years of age from the 12 villages. This sample size was determined using the Israel formula (Israel 1999).

2.4. Data Collection:

The data was collected using a pre-tested structured questionnaire through face-to-face interviews in Arabic. Twelve interviewers administered the questionnaire. They were fully familiar with the local language, were sensitive to the cultural context of the study areas and were trained to conduct face-to-face interviews.

The first part of the questionnaire included variables regarding the socio-demographic characteristics of the mothers. The second part contained questions on KAP regarding malaria – vector, clinical features, exposure to malaria infection and malaria preventive measures. To ensure that the data collection tool could collect the intended data correctly and covered all dimensions or aspects targeted by the researchers, it was validated by public health physicians and specialists. The necessary corrections were made to the tool based on their inputs to ascertain content validity. The internal consistency of the KAP measures was tested using a reliability test, Cronbach's alpha. The validated questionnaire was pre-tested among 35 randomly selected mothers with children of under five years of age. The internal consistency reliability analysis showed that Cronbach's alpha for knowledge was 0.72, 0.60 for attitudes, 0.70 for practices and 0.77 for the overall KAP measures.

2.5. Data Analysis:

The data was analysed using the SPSS version 20. Frequency and percentages were calculated for the categorical variables, while the means and standard deviations (SD) were calculated for the

continuous variables. The odds ratio (OR) was calculated to check the statistical associations between the dependent and independent variables using multivariable logistic regression analysis.

The total KAP regarding malaria and its prevention and control measure scores were computed separately by adding up the scores for each question. One point was given to each correct answer, positive attitude or good practice, while zero was given to each wrong answer, negative attitude or bad practice. The mean score was used to dichotomise the KAP. Those whose total scores were equal to or above the mean were considered as having good knowledge, good practices and positive attitudes. Those whose total scores were less than the mean were considered as having poor knowledge, negative attitudes and poor practices regarding malaria and its prevention and control measures.

3. Results

Table 1. Socio-demographic characteristics of the mothers of children under five years of age, rural White Nile State, Sudan

Socio-demographic variables	Count	Percent
Age in year		
18 - 45 years	742	97.5
>45 years	19	2.5
Household occupation		
Government employee	57	7.5
Private employee/ Self employed	704	92.5
Number of children under-five years of age in the household		
1-2 children	683	90.2
3 or more children	74	9.8
Educational level of the mother		
Informal	216	28.4
Formal	545	71.6
Monthly household income		
up to 491 SP	414	57.2
>491 SP	310	42.8

Regarding the socio-demographic characteristics of the mothers (Table 1), their mean age was 29.8, with a SD of 7.3. The mothers were aged between 18–65 with the majority (97.5%) in the 18–45 age range. Most of the mothers (71.6%) had a formal education and a few heads of household were Government employees (7.5%). The average household monthly income was 491±466 Sudanese Pound (SP). The majority of the households (90.2%) had up to two children under five years of age.

Table 2. Knowledge of the mothers of children under five years of age of malaria, rural White Nile State, Sudan

Variables	Categories	Count	Percent
Ever heard of malaria	Yes	703	92.4
	No	58	7.6
Vector can transmit malaria parasite to humans	Mosquitoes	667	87.6
	Fly	21	2.8
	Cockroach	15	2.0
	Mosquito and cockroach	13	1.8
	Mosquito and fly	5	0.7
	Others	39	5.2
Mode of malaria transmission	By biting	605	79.5
	By contact	75	9.9
	By biting and contact	34	4.5
	Others	34	4.5
	Do not know	13	1.6
Signs and symptoms of malaria	Fever	619	81.3
	Joints pains	326	42.8
	Vomiting and diarrhoea	340	44.7
	All the above	89	11.7
Malaria treatment	Medicine (Drugs)	537	82.4
	Traditional drugs	27	4.1
	Medicine and traditional drugs	49	7.5
	Do not know	39	6.0
Possible reasons for malaria infection in household	Never used ITNs	27	14.2
	Low immunity	47	24.7
	Irregular use of ITNs	56	29.5
	More contact with mosquito	60	31.6

An assessment of the mothers' knowledge regarding malaria based on their responses was conducted (Table 2). It was found that 92.2% mothers had heard about malaria, while 87.6% of them knew that mosquitoes transmit malaria parasites to humans. Additionally, 79.5% of them correctly associated malaria with mosquito bites.

Fever, joint pains and vomiting and diarrhoea were the most frequently mentioned signs and symptoms of malaria, reported by 81.3%, 42.8% and 44.7% of the mothers, respectively. Furthermore, 82.4% of the mothers knew that biomedicines were important for treating and preventing malaria. Additionally, the results revealed that 25% of the households had at least one family member who had

been infected with malaria in the previous two weeks. The main causes of malaria, as cited by the mothers, was increased contact with mosquitos (31.6%) and not using ITNs daily or continuously (29.5%), followed by never using ITNs (14.2%).

Table 3. Knowledge of mothers of children under five years of age on malaria prevention and control, rural White Nile State, Sudan

Variables	Categories	Count	%
Personal methods to prevent malaria infection	ITNs	305	86.6
	Mosquito repellents	21	6.0
	Both mentioned	26	7.4
ITN is effective in malaria prevention	Yes	452	59.4
	No	236	31.0
	Do not know	73	9.6
ITN differ from non-impregnated net	Yes	325	58.2
	No	159	28.5
	Do not know	74	13.3
Know the proper way of using ITN	Yes	297	39.1
	No	382	50.2
	To some extent	80	10.5
Mechanism of ITN to prevent malaria	Makes barrier between man and mosquito	115	25.4
	Drives mosquito away from man	80	17.7
	Kills mosquito	105	23.2
	All mentioned	152	33.6

*Multiple responses were allowed

With regard to knowledge on the methods of malaria prevention (Table 3), 46.3% of mothers stated that the best way to prevent malaria was by PPMs. Of this group, 86.6% identified ITNs as the main PPM against malaria. While 58.2% of the mothers reported that they knew that ITNs differed between impregnated and non-impregnated and only 39.1% of mothers knew the proper way to use an ITN. It was evident that most mothers correctly identified the mechanism of how ITNs prevent malaria, stating that they create a barrier between human and mosquitoes (25.4%) and that mosquitoes are killed by ITNs (23.2%). Meanwhile, 33.6% of the mothers mentioned both responses (Table 3).

Table 4. Perception of mothers of children under five years of age towards malaria and ITNs as a preventive measure against malaria, rural White Nile State, Sudan

Variables	Categories	Count	Per cent
Malaria is a serious disease	Yes	574	75.4
	No	187	24.8
Malaria is a preventable disease	Yes	617	81.1
	No	107	14.1
	Do not know	37	4.9
Reasons for not owning ITN	I do not need ITN	3	9.4
	ITNs are very expensive	7	21.9
	Unavailable in the area	17	53.1
	Bad odor	5	15.6
Even ITN with large holes can protect from malaria	Yes	251	33.0
	No	510	67.0
ITN is an effective means against mosquito biting	Yes	418	54.9
	No	343	45.1
Mothers encourage their family members to use ITN	Yes	400	52.6
	No	361	47.4
Reasons for not encouraging other family members to use ITN	ITNs sticks are not available	75	20.8
	Small area of my house	48	13.3
	Difficulty in collecting ITNs	140	38.8
	Harmful to the health	42	11.6
	Uncomfortable	56	15.5
ITN is effective as a preventive measure against malaria	Yes	595	78.2
	No	58	7.6
	Some extent	108	14.2
Citizens have a role in malaria prevention	Yes	445	58.5
	No	316	41.5

With regard to the perception of the mothers towards malaria (Table 4), the study revealed that 75.4% mothers considered malaria as a serious disease, while 81.1% of them perceived it as a preventable disease. Those who did not own an ITN (4.2%) reported multiple reasons, including that they were unavailable in their area (53.1%), that they were very expensive (21.9%), that they had a bad odour (15.6%) and that they were not necessary (9.4%).

More than half of the mothers (54.9%) perceived ITNs as an effective means against being bitten by mosquitoes. Of these, 78.2% believed in the effectiveness of ITNs in preventing malaria. Unfortunately, a considerable proportion of the mothers (47.4%) did not encourage their family members to use an ITN. The justifications given for this were difficulties in hanging and collecting the ITNs leading to delaying their children going to school (38.8%), unavailability for all household members (20.8%), being uncomfortable (15.5%), small space inside their homes (13.3%) and being harmful to their health (11.6%). Moreover, 41.5% mothers believed that citizens do not have a role to play in malaria prevention (Table 4).

Table 5. Practices of preventive measures against malaria among mothers of children under five years of age, rural White Nile State, Sudan

Variables	Categories	Count	Per cent
Own ITNs	Yes	729	95.8
	No	32	4.2
Number of ITNs in household	One net	133	18.2
	Two nets	224	30.7
	Three or more nets	372	51.0
	Using ITNs	Yes	142
	No	619	81.3
Seasonal use of ITNs	All the year	44	5.8
	Only in autumn	462	60.7
	Only in winter	222	29.2
	Only in summer	33	4.3
Methods of storing ITNs when not in use	Put it very well under the mattress	280	74.1
	Put it partially under the mattress	36	9.5
	Do not put it under the mattress	19	5.0
	Keep hanging on the sticks	43	11.4
If you need to come outside of the ITN while you sleep inside an ITN, how do you keep your ITN?	Put it under the mattress	79	51.0
	Leave it free	29	18.7
	Let some holes	47	30.3
When you keep ITNs without folding under the mattress, do you expel mosquito away before sleeping	Yes	43	56.6
	No	33	43.4
Storing ITNs during the day	At the house yard under the sun light	258	35.4
	Inside the food store	375	51.4
	In the kitchen or toilet	54	7.4
		42	5.8
Methods of keeping ITNs clean	By washing	434	59.5
	Avoidance to be contacted with the dusts	179	24.6
	All above	67	9.2
	Leave it without using	49	6.7
How often do you wash your ITNs	Once every month	285	60.6
	Once every 6 months	101	21.5
	Four times every year	84	17.9
Methods of drying ITNs after washing	Under the sun	276	58.7
	Under the shadow	194	41.3
	Priority for sleeping under ITNs	Children <5 years	534
	Pregnant women	139	18.2
	Elders	69	9.1
	All family member	39	5.1

In Table 5, the results revealed that 95.8% households owned an ITN. Of this group, more than half (51%) owned at least two ITNs. Despite a high ownership rate, only 18.7% of them reported sleeping under it every day, while only 5.8% used one throughout the year. With regard to the proper way of using and storing the ITNs, the results revealed that the majority of the mothers (74.1%) were aware of the proper method of storing them under the mattress. Meanwhile, only approximately a quarter (23.5%) hung their net before sunset. Furthermore, 35.4% of the mothers with ITNs reported that they dried their net in their yard under the sunlight, while 51.4% stored their nets correctly inside their rooms.

Almost all of the mothers (93.3%) who owned an ITN kept it clean by washing it and avoiding contact with dust. Unfortunately, most of the mothers (60.0%) washed it once a month and dried it under the sun (58.7%). However, most of the mothers correctly identified children under five years of age (70.1%) and pregnant women (18.2%) as the high-risk or vulnerable groups for malaria and who were given priority to sleep under an ITN (Table 5).

Table 6. Socio-demographic predictors of KAP regarding malaria among mothers of children under five years of age, rural White Nile State, Sudan

Socio-demographic characteristics	Good Knowledge		Positive Attitudes		Good Practice	
	OR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P
Age in years	.96 (.94 – .98)	.000	.98 (.96 – .99)	.023	.98 (.96 – .99)	0.034
Household head's occupation						
Private employee/self-employed	1		1		1	
Government employee	2.16 (1.15 – 4.06)	0.017	1.96 (1.1-3.51)	0.023	1.35 (0.76 – 2.39)	0.310
Monthly household income						
>491 SP	1		1		1	
Up to 491 SP	1.43 (1.05 – 1.94)	0.025	1.21 (0.90 – 1.64)	0.214	1.44 (1.07 – 1.95)	0.018
Number of children <5yrs						
Below the mean (1.67)	1		1		1	
Mean or above	1.13 (.68 – 1.87)	0.649	.98 (.60 – 1.62)	0.95	.88 (.54 – 1.45)	0.619
Mothers' education						
Informal	1		1		1	
Formal	1.55 (1.10 – 2.18)	0.011	1.69 (1.20 – 2.38)	0.003	1.45 (1.03 – 2.03)	0.031

*1: reference category

A multivariate logistic regression model highlighted three statistically significantly socio-demographic variables associated with the mother's knowledge of malaria (Table 6). In this regard, the younger mothers were likely to have more knowledge than the older ones (OR=0.96; 95% CI: 0.94–0.98). The mothers who had a formal education were 1.55 times more likely to have good knowledge

compared to those with an informal education. It was also found that income was negatively associated with good knowledge. The mothers from households with a monthly income of up to 491 SP were 1.43 times more likely to have good knowledge compared to those in the >491 SP group. It was also found that having a Government employee as the head of the household was associated with a good knowledge of malaria. Compared to those whose head of the household was employed in the private sector or self-employed. The mothers from households where the head had a Government job were 2.16 times more likely to have a good knowledge of malaria and its prevention measures. Meanwhile, the number of children under five years of age in the household was not associated with the mothers' knowledge score regarding malaria.

Regarding the mothers' attitudes towards malaria, Table 6 demonstrates that mothers' age, education and having a Government employee as the head of household were associated with their positive attitudes towards malaria prevention and control measures. The older mothers were less likely to have positive attitudes compared to the younger mothers (OR=0.98; 95% CI: 0.96–0.99). Mothers who had a formal education were more likely to have positive attitudes than those with an informal education (OR=1.69; 95% CI: 1.20–2.38). Mothers with a Government employee as the head of the household were more likely to have positive attitudes compared to those where the head was a private sector employee or self-employed (OR=1.96; 95% CI: 1.1–3.51). However, no significant association was observed between household income and number of children under five years of age in the household and mothers' attitudes towards malaria prevention and control measures.

Additionally, the results showed that mothers' age, monthly household income and education level were statistically significantly associated with mothers' practice scores regarding malaria prevention. Consequently, the older mothers were less likely to practice good preventive measures (OR= 0.98; 95% CI: 0.96–0.99). Mothers who had a formal education were more likely to have good practices (OR=1.45; 95% CI: 1.03–2.03). Surprisingly, mothers in the lower income group – <491 SP/month – were more likely to practice good malaria prevention measures (OR=1.44; 95% CI: 1.07–1.95). However, no significant association was observed between mothers' practices of malaria prevention measures and household heads' employment status or the number of children under five years of age in the household.

Table 7: The effect of knowledge and attitudes on practices regarding malaria prevention among mothers of children under five years of age in the rural White Nile State, Sudan, multivariate logistic regression analysis

Variables	AOR (95% CI)	P-value
Knowledge		
Poor knowledge	1	
Good knowledge	4.99 (3.56 – 7.00)	0.000
Attitude		
Negative attitude	1	
Positive attitude	2.60 (1.87–3.63)	0.000
Age in years	1.00 (0.97 – 1.02)	
Household head's occupation		
Private employee/self-employed	1	
Government Employee	.89 (.46 – 1.69)	0.711
Monthly household income		
<491 SP	1	
Up to 491 SP	1.29 (0.92 – 1.80)	0.140
Number children less <5yrs		
Below the mean (1.67)	1	
Mean or above the mean	0.82 (0.48 – 1.42)	0.484
Mothers' education		
Informal	1	
Formal	1.15 (0.79 – 1.67)	0.469

*AOR: Adjusted Odds Ratio; SP: Sudanese Pound; 1: Reference category

The multivariate logistic regression analysis model explained the effect of both knowledge and attitudes on practicing preventive measures against malaria by the mothers after adjusting for the socio-demographic variables (Table 7). The mothers who had good knowledge regarding malaria and its preventive measures were found to be approximately five times more likely to practice good preventive measures than those who had poorer knowledge. This

association was statistically significant after adjusting for the effect of attitudes and socio-demographic variables (OR= 4.99; 95% CI: 3.56–7.00). In the same way that mothers who had positive attitudes towards malaria prevention were found to be 2.6 times more likely to have good practices than those who had negative attitudes, the association was statistically significant after adjusting for the effect of knowledge and socio-demographic variables (OR=2.60; 95% CI: 1.87–3.63).

4. Discussion

A community based cross-sectional study was conducted to assess the KAP of mothers of children under five years of age towards malaria and its preventive and control measures using ITNs. The findings are expected to inform strategies to prevent, control, eliminate and eradicate malaria in the study area, as well as other similar areas.

It was found that most of the mothers had a good knowledge of malaria and its treatment and preventive measures. The majority of the mothers (94.2%) had heard about malaria before. This was congruent with the findings of previous studies conducted in South Africa (Manana *et al.*, 2018) and Sudan (Elfaki *et al.*, 2017). This result was expected as the people living in malaria endemic areas are more frequently exposed to malaria infections and would therefore have at least some knowledge of the disease. However, only 87.6% of the mothers knew that the mosquito was the vector that transmits malaria. These results were slightly lower than those reported by a study conducted in Cameroon (99%) (Kimbi *et al.*, 2014), but higher than those reported in Ethiopia (85.2%) (Fuge *et al.*, 2015), Iran (77.8%) (Soleimani *et al.*, 2014) and Indonesia (69.0%) (Sanjana *et al.*, 2006). In addition, 79.5% of the mothers knew that mosquito bites are associated with malaria transmission. This finding was lower than a study conducted in Swaziland, where it was reported that 99.7% of the participants associated malaria with mosquito bites (Hlongwana *et al.*, 2009) and (Forero *et al.*, 2014).

Furthermore, 81.3% of mothers identified fever as the most common symptom of malaria, while only 50.4% of the participants in a study conducted in Saudi Arabia reported that fever was the most common symptom of malaria (Khairy *et al.*, 2017). Additionally, our findings were lower than those in studies conducted by both Abate *et al.* (94.4%) (Abate *et al.*, 2013) and Oyekale (85.0%) in other African countries (Oyekale 2015).

In this study, 82.4% of the respondents felt that biomedicine was important for treating malaria; this was supported by some previous studies (Sanjana *et al.*, 2006), (Habimana *et al.*, 2016) and (Atulomah *et al.*, 2014). In contrast, a study conducted in Nepal revealed that respondents preferred to consult traditional healers (Joshi *et al.*, 2008). Similarly, other studies conducted in Sudan (El-Rayah *et al.*, 2009) and Bangladesh (Ahmed *et al.*, 2009) reported that the respondents claimed to have used traditional medicines.

Regarding knowledge on malaria prevention and control, most mothers (86.6%) correctly identified ITNs as the main PPM against malaria due to its capabilities of creating a barrier between people and mosquitoes and for killing mosquitoes. These results were higher than those from studies conducted in Kenya (75%) (Ndwiga *et al.*, 2014) Guinea (56%) (Ruberto *et al.*, 2014) and Cameroon (57%) (Kimbi *et al.*, 2014). Nevertheless, the rate from this study was slightly lower than a study conducted by Habimana *et al.* in Rwanda, who reported it to be 100% (Habimana *et al.*, 2016). Despite a good knowledge about the fact that ITNs are an effective PPM against malaria, most mothers were unaware of the proper way of using them; this deficiency in practice has been found to be one of the main challenges in the effective utilisation of ITNs in Sudan.

The attitudes of the mothers towards malaria prevention and control was reported to be positive, 75.4% believed that malaria was a serious disease, 81.8% believed that it was preventable and 78.2% mothers viewed ITNs as an effective preventive measure against malaria. This pattern was also reported in neighbouring malaria endemic countries, including Southern Ethiopia (Fuge *et al.*, 2015), Nigeria (Chukwurah *et al.*, 2016), (Dawaki *et al.*, 2016) Rwanda (Habimana *et al.*, 2016) and Cameroon (Kimbi *et al.*, 2014), as well as East Asian countries such as Indonesia (Sanjana *et al.*, 2006).

However, the current study also revealed that negative attitudes towards malaria prevention exist in the community. In total, 33% of the mothers perceived that ITNs with large holes protected from malaria, while 47.4% did not encourage their family members to use ITNs for unconvincing reasons, such as -hanging and collecting ITNs delayed their children from going to school, they were uncomfortable, made their houses seem small and that they were harmful to their health.

Moreover, 41.5% mothers perceived that citizens did not have a role to in the prevention of malaria. This negative attitude among many of the mothers may negatively influence malaria prevention and control strategies, in particular the main intervention strategy – ITNs – approved by the Federal Ministry of Health to scale up the malaria control intervention in Sudan (FMOH, 2016). Therefore, an effective health education programme can improve the attitudes of women in general and children, who constitute the most vulnerable group.

With regard to ownership and utilisation, the results showed that 95.8% of mothers owned ITNs, which were freely provided by the NMCP. Despite a high ownership rate, only 18.7% of them reported to sleep under an ITN every day. This proportion was lower than the those of previous studies conducted in African countries, such as Southern Ethiopia (21.4%) (Fuge *et al.*, 2015), Nigeria (29.9%) (Kimbi *et al.*, 2014) and 61.5% in Zambia (Sanjana *et al.*, 2006) and (Shimaponda *et al.*, 2017). When compared with the National utilisation rate (15.7%), it was found to be slightly higher (FMOH 2016). Similarly, high rates of utilisation were reported in Asian countries, such as Saudi Arabia (13.2%) (Khairy *et al.*, 2017), Myanmar (15.3%) (Aung *et al.*, 2016) and Iran (18.5%) (Soleimani *et al.*, 2014). It is evident from these studies that the ITN utilisation rate in almost all countries where malaria is reported to be endemic is lower than the targeted coverage of 80%, which has been recommended by the WHO.

Furthermore, our findings showed that only 5.8% of the mothers used ITNs throughout the year. This indicated their usage of ITNs was not consistent and might negatively affect the rate of malaria transmission, as was postulated by Fegan *et al.*, who found that consistent use of ITNs can reduce malaria transmission by up to 90% (Fegan *et al.*, 2007).

In the current study, we found that the mothers' overall knowledge scores regarding malaria were statistically significantly associated with their age and level of education. In this regard, the younger mothers were more likely to have a higher knowledge of malaria than the older mothers. Another study in Sudan showed that younger mothers were more likely to have a better knowledge of malaria than their older counterparts (Tayseir *et al.*, 2017). Likewise, mothers who had a formal education were associated with having a good knowledge of malaria. Some other studies have reported findings similar to the present study (Dawaki *et al.*, 2016, Hanafi *et al.*, 2011 and Yaya *et al.*, 2017).

Regarding the mothers' attitudes towards malaria, the results showed that having a Government employee as the head of the household and mothers having a formal education were both associated with positive attitudes. This might be due to the fact that their formal

education contributed to an increased knowledge, as their education had lessons on malaria included in their curriculum. Household monthly income and number of children under the age of five years did not have an effect on mothers' attitudes. Regarding the age of the mothers, our results were consistent with the findings of a study in Southern Ethiopia, which reported that younger women had better attitudes than others (Fuge *et al.*, 2015 and Tayseir *et al.*, 2017).

In addition, the results of our study indicated that age, monthly income and education level were statistically significantly associated with the mothers' practice scores regarding malaria prevention. Consequently, younger mothers, mothers who had a formal education and mothers with lower monthly incomes were more likely to practice preventive measures against malaria. Several studies have found a correlation between age and household family income and the level of practicing preventive measures (Dawaki *et al.*, 2016). Similarly, many studies in different countries have demonstrated that the level of education has a significant impact on practicing preventive measures against malaria (Kimbi *et al.*, 2014), (Forero *et al.*, 2014) and (Hanafi *et al.*, 2011).

The current study highlighted that a good knowledge and positive attitudes towards malaria were the determining factors for good practices of preventive measures against malaria. This concurred with a study conducted by David *et al.*, who reported that a significant association exists between attitudes and practices of malaria prevention. However, a study in Uganda found that there was no significant association between attitudes and preventive practices for malaria (Habimana *et al.*, 2016). With regard to the effect of knowledge, a study in Northern Nigeria reported that knowledge does not necessarily translate into improvement in practices (Singh *et al.*, 2014).

5. Conclusion

This study revealed gaps in mothers' KAP regarding the methods of malaria prevention. More than half of the mothers did not encourage their family members to use ITNs, while more than one third perceived that ITNs with large holes protected against malaria. Only 18.7% of them reported to sleep under an ITN every day. Additionally, the study highlighted that good knowledge and positive attitudes towards malaria prevention measures were the determining factors for good practices of preventive measures against malaria. Therefore, we recommend health promotion activities targeting raising mothers' awareness in the methods of malaria prevention, as well as the development of positive attitudes toward malaria prevention measures.

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