Original Article

Knowledge and Practices of Women Regarding Malaria and Its Prevention: A Community-Based Study in an Area under Malaria Elimination Programme in Iran

Mehdi Zare[1], Hassan Vatandoost[2,3], *Moussa Soleimani-Ahmadi[4,5], Alireza Sanei-Dehkordi[4], Seyed Aghil Jaberhashemi[6], Shokrollah Mohseni[7]

[1]Department of Occupational Health Engineering, Faculty of Health, Hormozgan University of Medical Sciences, Bandar Abbas, Iran
[2]Department of Medical Entomology and Vector Control, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran
[3]Department of Chemical Pollutants and Pesticides, Institute for Environmental Research, Tehran University of Medical Sciences, Tehran, Iran
[4]Department of Medical Entomology and Vector Control, Faculty of Health, Hormozgan University of Medical Sciences, Bandar Abbas, Iran
[5]Social Determinants in Health Promotion Research Center, Hormozgan University of Medical Sciences, Bandar Abbas, Iran
[6]Bashagard Health Center, Hormozgan University of Medical Sciences, Bashagard, Iran
[7]Student Research Committee, Shiraz University of Medical Science, Shiraz, Iran

***Corresponding author:** Dr Moussa Soleimani-Ahmadi, E-mail: mussa.sahmadi@gmail.com

(Received 20 Oct 2021; accepted 26 Nov 2023)

Abstract

Background: Indoor residual spraying (IRS) and long-lasting insecticidal nets (LLINs) are two core interventions for control and prevention of malaria infection. This descriptive cross-sectional study aimed to determine the knowledge and practices of women regarding malaria and its preventive measures in a malarious area in the Jask County, southeast of Iran.

Methods: Data was collected from 400 households through a two-stage random cluster sampling method in six villages. Pre-tested structured questionnaire was used to collect data. During the survey, visual observations were also made by the interviewers to check use of LLINs and IRS. The data were analyzed by SPSS software version 21.

Results: The majority of households had a high level of knowledge about symptoms (98%, n=392) and transmission (74.5%, n=298) of malaria. The main preventive measures against malaria were: LLINS (39.5%, n=158), IRS (32%, n=128), and screens on doors/windows (16.7%, n=67). In addition, participants with primary or higher educational level reported that they practice more malaria preventive measures, compared to those who were illiterate (OR=3.3, 95% CI= 1.6–6.6, p=0.0001, Table 6). In spite of positive perceptions about IRS and LLINs, only 35.5% (n=142) and 17% (n=68) of households used IRS and LLINs, respectively.

Conclusion: According to the results of this study, despite a high level of knowledge about malaria and its preventive measures, a small number of participants use LLINs and IRS for malaria prevention. Therefore, implementation of effective educational interventions is recommended to improve preventive practices against malaria in the study area.

Keywords: Knowledge; Practice; Indoor residual spraying; Malaria prevention; Long-lasting insecticidal nets

Introduction

Despite being a curable and preventable disease, malaria is still a major public health problem in 84 countries worldwide including Iran (1). According to the recent world malaria report, almost half of the population of the world is at risk of malaria infection and approximately 247

http://jad.tums.ac.ir
Published Online: Dec 31, 2023

million malaria cases and 619000 malaria deaths occurred in 2021 (1).

In 1951 a comprehensive programme for eradication of malaria was initiated in Iran, and in 1985 it changed to malaria control because of the restrictions and challenges (2). This country has been in the malaria elimination phase since 2010 and is aiming to become entirely malaria-free by 2025 (3). According to the recent world malaria report, zero indigenous malaria cases were reported in 2018 and 2019 from Iran and this country is poised to seek WHO certification of malaria-free status by 2021(1).

Despite a significant decrease in malaria transmission in Iran, the disease is still a public health problem in south and southeast of the country including Kerman, Sistan-Baluchestan, and Hormozgan Provinces. Approximately 10% of the 81-million Iranian populations live in the malarious areas and four-fifths of malaria cases have been reported from these regions (4).

Hormozgan Province constitutes about 10% of the total population of Iran, and 38% of all country malaria cases have occurred in this province (5). Jask County is a low socioeconomic area in the east of Hormozgan Province which contains active foci of malaria, where malaria transmission occurs regularly, and its infected population can play role as mobile reservoirs to spread the disease to other areas (6). In this county 347 confirmed malaria cases were recorded during 2010-2020, out of which 291 (83.86%) and 56 (16.14%) cases were attributed to *Plasmodium vivax* and *P. falciparum*, respectively (6). Four potential malaria vectors, including *Anopheles stephensi*, *An. culicifacies* s.l., *An. dthali*, and *An. fluviatilis* s.l have been reported as malaria vectors in this County (6)

In this County, like other malarious regions, vector control measures such as indoor residual spraying (IRS), application of long-lasting insecticidal nets (LLINs), and larvicides have been applied towards malaria elimination (6). Vector control is one of the most important strategies for control and prevention, and for subsequent elimination of malaria. LLINs and IRS which are aimed to prevent the contact between the anopheline mosquitoes and people are the main preventive measures currently in practice (7). Since several studies have shown that these methods reduce the occurrence of malaria effectively, malaria prevention programmes have focused on reducing the malaria transmission mainly using LLINs and IRS (8, 9). LLINs have a significant impact on anopheline mosquito density and sporozoite rates and it has been well known that if 75% of the population use LLINs, malaria would be eliminated in the community (10). However, the effectiveness of LLINs is highly influenced by the attitudes and socio-cultural context of the population (11). In addition to accessibility of LLINs, compliance with bed net use is the other important issue which determines the success of any LLINs programme (12). Moreover, individuals perceive the benefits of LLINs through the apparent reduction of malaria episodes and mosquito nuisance, which may persuade them to apply bed nets more effectively (13).

IRS is also one of the malaria control approaches which prevents malaria transmission through vector control (14, 15). This control method has been widely used in different malaria endemic areas including Asia, Europe, Africa, and Latin America to eliminate the malaria (16). Some of the factors which affect the application and success of IRS interventions are spraying coverage, community awareness and cooperation, household acceptance, type and situation of houses, and informing the community about the benefits of IRS during the IRS campaign (17). The perceived negative side effects of IRS can decrease the acceptance of this type of intervention (18). Therefore, it is highly necessary to evaluate the community knowledge and attitude about indoor insecticide spraying, to guarantee the success of IRS programmes (19).

Community participation is considered as one of the most important components of malaria elimination programmes, and it has been revealed that increasing community knowledge

http://jad.tums.ac.ir
Published Online: Dec 31, 2023

about malaria control measures can promote the preventive practices of individuals (20). It has been reported that a key factor to achieve the IRS goals, is identifying and accounting for the behavioural factors which influence the IRS refusal. In this regard, increasing the public's knowledge regarding malaria control measures such as IRS can result in the behavioural changes which, in turn, would lead to effective and sustainable malaria control programs (21).

To ensure the sustainability and success of the malaria elimination program in Iran, this community-based study was designed to evaluate the women's knowledge and practices regarding malaria and its prevention in Jask County, southeast of Iran. This study provides baseline data which can be used in the implementation of educational plans for the prevention and elimination of malaria, design of interventions based on active community participation, and decision-making processes.

Materials and Methods

Study area

Jask County is a low socioeconomic area which is located between longitudes 57°10'–59°16' E and latitudes 25°23'–26°13' N in Hormozgan Province, southeast of Iran (Fig. 1). The area of County is 10,702 km^2 and it has 58,884 populations according to 2016 census from which 49% and 51% were respectively females and males. The study region has a tropical climate with temperate winters and hot summers. The average annual temperature in this region is 27.3 °C ranging from 21.1 °C to 32.4 °C. Typically, in this region the rainy season is from December to May with the annual average of 213.1 mm. The highest and lowest averages of relative humidity are 80% and 60 % in September and November, respectively. Less than 10% of the study area is mountainous with an altitude of more than 400 m and the rest is plain coastal area. This county is considered as an agricultural area which is irrigated by permanent and seasonal rivers that are favorable breeding places for anopheline mosquitoes. Agriculture, livestock herding, fishing, and trading are the main occupational activities in the study area.

Jask County is one of the most important active malaria foci in the southeast of Iran and malaria episodes occur in this region all around the year with peaks after the two rainy seasons (September–December and April–June) (14).

Study design and data collection

This cross-sectional study was carried out from January to March in 2020 in Jask County. By assuming the community knowledge and practices about malaria prevention measures to be 50% and a precision of 5%, the sample size was calculated by the Cochran's formula to be 400.

The participants were selected using a two-stage randomized cluster sampling method. In the first stage, six villages with the same epidemiological conditions, where IRS and LLINs have been ongoing, were randomly selected. In the second stage, 400 households were randomly selected from the villages, proportional to their populations.

The mothers of the households were interviewed using a pre-tested structured questionnaire (22), and where the mothers were not available, other members of the families were interviewed, instead.

The questionnaires were completed by trained interviewers (Fig. 2). The questionnaire consisted of items such as demographic characteristics and knowledge and practices regarding malaria and its preventive measures including malaria symptoms and transmission, drying, washing, and use of LLINs, IRS coverage, negative and positive effects of the IRS, and the frequency of spraying. Moreover, to investigate the use of IRS and LLINs and housing conditions including construction materials, water containers, status of windows, and indoor plumbing a checklist was completed by direct observations.

http://jad.tums.ac.ir
Published Online: Dec 31, 2023

Inclusion and Exclusion Criteria

Inclusion criteria included being the mothers of households (a woman or head of the household), and willing to participate in the study. The exclusion criterion was not willing to continues the interview and complete the questionnaires.

Statistical analysis

Data were analyzed using SPSS ver.21 software. To determine frequencies, percentages, and averages of the variables descriptive statistics were used. The association between the respondent's knowledge and practices about malaria and other variables was analyzed using Chi-squared test. Odds ratio with a confidence interval of 95% was used to determine the factors associated with knowledge about malaria and use of protective measures. The results of statistical analysis were considered significant at 5% levels of significance ($P< 0.05$).

To evaluate the knowledge of participants about malaria disease, the responses to four questions including symptoms and signs of malaria, transmission route, prevention methods, and knowledge about mosquito breeding places were considered. The respondents who provided correct responses to at least three out of the four questions were classified as having good knowledge about malaria and those who gave less than three correct responses were classified as having poor knowledge about malaria. For evaluation of practices regarding malaria prevention, the responses to the four questions about the use of indoor residual spraying, sleeping under LLINs, use of door/window screens, and Chemoprophylaxis were assessed. The respondents who provided appropriate responses to at least three questions were classified as having good practices and those with less than three appropriate responses were considered to have poor practices.

Results

Socio-demographic characteristics

A total of 400 households enrolled in this study. The average age of participants was 38.4 years, ranging from 15 to 80 years. More than half of the respondents were illiterate (57.5%), and about one-third (32.7%) had finished primary school. The majority of the respondents (95.5%) were housewives, and the rest were either employed or farmer/stockbreeder. The mean family size was 4.7 people ranging from 1 to 10 people. Socio-demographic characteristics of the participants are presented in Table 1.

Most of the participants lived in cement blocks houses (97.7%), and only 7% of houses had screens over the window openings (Table 2). Majority of the households had access to sanitary tap water (98%), and most of them (98.5%) had electricity in their houses. Approximately 65% of the study population had cooling system in their houses (Table 2).

Malaria knowledge and practices

Most participants (74.5%) knew that malaria is a disease which is transmitted by mosquitoes and this awareness was significantly associated with the level of education ($X^2= 101$, df= 16, P= 0.0001). Inhaling polluted air, drinking dirty water, and eating contaminated food were also reported by the participants to be the ways of malaria transmission (Table 3).

Most of women (98%) mentioned two or more symptoms of malaria, with fever being the most frequently stated symptom (61%). Only a few numbers of participants (2%) did not know how malaria is characterized (Table 3). The level of knowledge about the symptoms and signs of malaria disease was significantly higher among respondents with secondary and higher educational level ($X^2= 187$, df= 20, P= 0.0001).

According to the results of this study, the main mosquito breeding place, according to the respondents' opinion, was stagnant water (72.5 %). Garbage was also mentioned as a mosquito breeding place and about 10% of respondents did not know the breeding places of mosquitoes (Table 3). A statistically significant association was observed between the educational level of respondents and their knowledge

http://jad.tums.ac.ir
Published Online: Dec 31, 2023

about mosquito breeding places (X^2= 31, df= 16, P= 0.013).

Approximately 88% of the participants stated malaria as a curable and preventable disease and more than 39% of them mentioned bed nets as a preventive measure against malaria. Indoor insecticide spraying (32%), screen on windows/ doors (16.7%), and chemoprophylaxis (6.3%) were also reported as malaria prevention measures (Table 3). Chi square test showed significant association between the respondents' educational level and their knowledge related to preventive measures of malaria (X^2= 295, df = 16, P= 0.0001).

The most reported malaria information sources were Community health workers (64.2 %), followed by the mass media including radio, television, newspapers, books and religious leaders (Table. 3).

In this study, 68% of the respondents reported that they were volunteers to participate in malaria prevention campaign (Table 3). In this regard, a statistically significant relationship was observed between the educational level of the households and their interest in participation in malaria prevention campaign as a volunteer (X^2= 139, df= 4, P= 0.002).

Knowledge and practice regarding LLINs

Almost all participants (92.5%, n= 370) reported they received LLINs by government. About half of the families (51.2%, n= 205) reported that they use LLIN. But, only 17% (n= 68) of them used LLINs regularly as it was visually checked by the interviewers in the morning hours (Table 4). The results of the analysis showed a significant relationship between the regular use of bed nets and educational level of respondents (X^2= 453, df= 8, P= 0.0001).

Out of the 205 households who use bed nets, 60.5% of them stated that all their family members sleep under bed nets and 30.7% and 8.8% of them stated that only children and parents use bed nets, respectively (Table 4).

The results also indicated that out of those who used bed nets, 37.6% used LLINs all the time during the night and 62.4% used LLINs only over the sleeping time (Table 4). A significant association also was found between educational level and the percentage of respondents who slept inside a LLINs all the time at night (X^2=173, df=4, P=0.0001).

According to the respondents' reports, avoiding mosquito nuisance was the primary reason for using bed nets (81.5%). The other reasons were having a night sleep without harassment by protection from scorpion stings (8.7%) and other insects' nuisance (6.5%) (Table 4). A statistically significant association was observed between the respondents' educational level and accepting the use of bed nets (X^2= 67, df= 12, P= 0.0001).

As shown in Table 4, some of the complications and difficulties reported by households using LLINs were feeling of discomfort, due to lack of airflow and heat, when sleeping under the bed nets (58.5%) and respiratory disorders (28.2%) (Table 4).

According to the result of this study, only 35% of respondents reported that they received information about washing and drying of bed nets by health workers who distributed the LLINs. In this regard, 64.7% of the households had washed the LLINs at least once in the last 6 months and the main reason reported reason for washing bed nets was accumulation of dirt. Moreover, only 26.7% of the respondents reported that, in line with manufacturer's guidance, they dry the LLINs in the shade following the washing, and the rest (73.3%) reported that they dry the bed nets in sunlight, as they do it for drying wet cloths (Table 4). In this case also there was a statistically significant association between the households' educational level and drying the LLINs in the shade (X^2= 87, df= 6, P= 0.002).

Knowledge and practices regarding IRS

In this study, majority of the respondents (93.7%) had previously heard that IRS were used for malaria control. Out of which, 344 (86%) of them reported that IRS would be beneficial.

Approximately, 35% of households reported that their houses were sprayed previous sum-

http://jad.tums.ac.ir
Published Online: Dec 31, 2023

mer and most of them (76.5%) mentioned that IRS should be performed every summer. In this regard, 52.2%, 30.7%, 10.3%, and 5.5% of the respondents stated that the inner surfaces of walls and roof, the surfaces of inner walls, the inner side of the roof, and the surfaces of outer walls should be sprayed, respectively (Table 5).

Regarding the importance of performing IRS, 74.5% of participants mentioned that it is necessary because it kills mosquitoes, 12% reported that it kills other insects, 11.2% mentioned that it protects against scorpion stings, and 2.3% did not know the importance of IRS. The results of this study showed a significant association between the level of households' education and IRS acceptability (X^2=101, df =12, P=0.0001).

According to the results of this study, about one third (35.3%) of participants declared that IRS may cause negative health effects including respiratory disorders and headache. Other reasons for IRS refusal were discolouring of house walls, contaminating the foods, and difficulty in movement of furniture (Table 5).

Relationship between the education level and malaria related knowledge and practice

Statistical analysis was performed to assess any association between the educational level of households and their knowledge and practices about malaria. The results showed that, compared to those who were illiterate, the respondents who had primary or higher educational level, had higher level of knowledge about malaria (OR= 5.1, 95% CI 2.8–9.2, p= 0.0001; Table 6). In addition, participants with primary or higher educational level reported that they practice more malaria preventive measures, compared to those who were illiterate (OR= 3.3, 95% CI 1.6–6.6, p= 0.0001; Table 6).

The results showed that, compared to those who had a case of malaria disease in their family, respondents with no history of malaria infection in their family had higher level of knowledge about malaria, (OR= 14.6, 95% CI 7.8–27.2, p= 0.0001; Table 6). Additionally, respondents with no history of malaria infection in their family reported higher level of preventive practices against malaria, compared to those who had a malaria case in their family (OR= 60, 95% CI 27.3–134.1, p= 0.0001; Table 6).

Table 1. Socio-demographic characteristics of the study population in Jask County, southeast Iran, 2020

Characteristics	Frequency	Percent
Age groups (years)		
15–24	46	11.5
25–34	131	32.7
35–44	114	28.5
≥45	109	27.3
Education Level		
Illiterate	230	57.5
Primary	131	32.7
Secondary	23	5.8
High school	10	2.5
University	6	1.5
Household size		
1–2	52	13.0
3–4	154	38.5
5–6	130	32.5
>7	64	16.0
Occupation		
Housewife	382	95.5
Employed	10	2.5
Farmer/Stockbreeder	8	2.0

http://jad.tums.ac.ir
Published Online: Dec 31, 2023

Table 2. Characteristics of residential houses of the study population in Jask County, southeast Iran, 2020

Characteristics	Frequency	Precent
Type of house		
Cement- blockhouse	391	97.7
Shed	9	2.3
Window screens		
Yes	28	7.0
No	372	93.0
Water supply		
Yes	392	98.0
No	8	2.0
Water saving container		
Yes	370	92.5
No	30	7.5
Electricity		
Yes	394	98.5
No	6	1.5
Air conditioner		
Yes	259	64.7
No	141	35.3

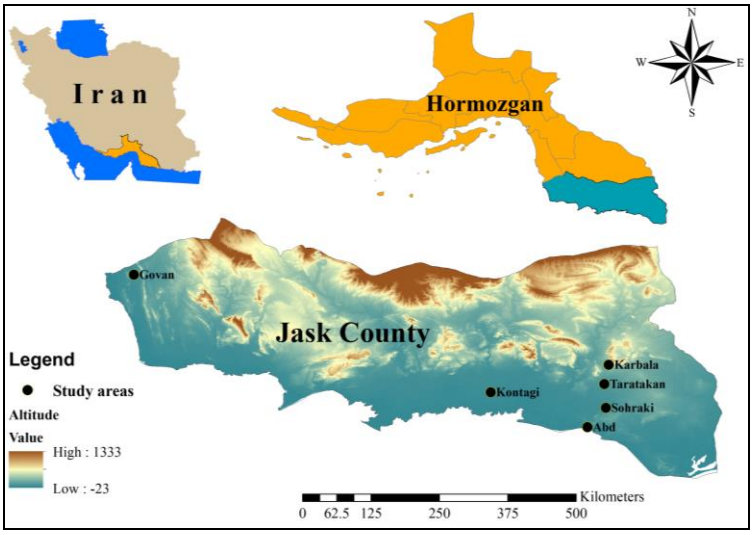

Fig. 1. Map of Iran showing Hormozgan Province and location of Jask County, southeastern Iran

Fig. 2. Completing the questionnaire by trained interviewers in Jask County, southeastern Iran

http://jad.tums.ac.ir
Published Online: Dec 31, 2023

Table 3. Knowledge and practices regarding malaria in the study population in Jask County, southeast Iran, 2020

Parameters	Frequency	Percent
Malaria transmission		
Mosquito bites	298	74.5
Drinking dirty water	49	12.2
Eating contaminated food	17	4.3
Inhaling polluted air	10	2.5
Do not know	26	6.5
Malaria symptoms		
Fever	244	61.0
Chill	73	18.3
Headache	42	10.5
Bone pain	21	5.2
Nausea	12	3.0
Don't know	8	2.0
Mosquito breeding places		
Stagnant water	290	72.5
Garbage	54	13.5
Others	15	3.8
Do not know	41	10.2
Malaria preventive measures		
Use of long-lasting insecticidal nets	158	39.5
Use of indoor residual spraying	128	32.0
Use of door/window screens	67	16.7
Chemoprophylaxis	25	6.3
Others	22	5.5
Source of malaria information		
Health worker	257	64.2
Radio/ television	87	21.8
Newspapers, books	38	9.5
Religious leaders	18	4.5
Interested in participation in malaria prevention measures as a volunteer		
Yes	272	68.0
No	128	32.0

Table 4. Knowledge and practices regarding LLINs in the study population in Jask County, southeast Iran, 2020

Variables	Frequency	Percent
Ever heard of LLINs		
Yes	364	91.0
No	36	9.0
Frequency of bed nets use		
Regular use (every night)	68	17.0
Irregular use (some nights)	137	34.2
Not using	195	48.8
Family members who use bed nets		
All family members	124	60.5
Children	63	30.7
Father and mother	18	8.8
Bed nets use during night		
All the time at night	77	37.6
Only when sleeping	128	62.4
Reason for use of bet nets		
Prevention of mosquito nuisance	326	81.5

http://jad.tums.ac.ir
Published Online: Dec 31, 2023

Table 4. Continued ...

Prevention of scorpion stings	35	8.7
Prevention of other insects nuisance	26	6.5
Others	13	3.3
Reason for not using bed nets		
Heat and lack of airflow in the sleeping space	234	58.5
Respiratory disorder	113	28.2
Do not know	53	13.3
Washing bed nets during last 6 months		
Yes	259	64.7
No	141	35.3
Drying the bed nets		
Dry in the sunlight	293	73.3
Dry in the shade	107	26.7

Table 5. Knowledge and practices regarding IRS in the study population in Jask County, southeast Iran, 2020

Variables	Frequency	Percent
Ever heard IRS		
Yes	375	93.7
No	25	6.3
Spraying residential houses in previous summer		
Yes	142	35.5
No	258	64.5
The exact parts of the house to be sprayed during IRS		
On the surfaces of inner walls and roof	209	52.2
On the surfaces of inner walls	123	30.7
On the inner surfaces of the roof	41	10.3
On the surfaces of outer walls	22	5.5
Do not know	5	1.3
Reason for use of IRS		
Prevention of mosquito nuisance	298	74.5
Prevention of other insects nuisance	48	12.0
Prevention of scorpion stings	45	11.2
Do not know	9	2.3
Reason for not using IRS		
Respiratory disorder and hedache	141	35.3
Discoloring of inner house wall	85	21.3
Difficalty in furnitur's movment	74	18.5
Unpleasant odor	54	13.5
Food contamination	46	11.4

Table 6. Factors associated with knowledge and practices regarding malaria in the study population in Jask County, southeast Iran, 2020

Factors	No.	Good knowledge (%)	Crude OR (95% CI)	p-value	No.	Good practices (%)	Crude OR (95% CI)	p-value
Education Level								
Primary/ Secondary/ High school/ University	154	90.6	5.1 (2.8–9.2)	0.0001	159	93.5	3.3 (1.6–6.6)	
Illiterate	150	65.2	1		187	81.3	1	0.0001
Previous malaria infection in family members								

http://jad.tums.ac.ir
Published Online: Dec 31, 2023

Table 6. Continued ...

No	286	85.1	14.6 (7.8–27.2)	0.0001	325	96.7	60.5 (27.3–134.1)	0.0001
Yes	18	28.1	1		21	32.8	1	
Occupation								
Employed/ Farmer/Stockbreeder	17	94.4	5.6 (0.7–42.8)		16	88.9	1.2 (0.2–5.6)	
Housewife	287	75.1	1	0.061	330	86.4	1	0.76

OR: Odds ratio, CI: Confidence interval

Discussion

To achieve the malaria elimination goal and inhibit reoccurrence of the disease, it is essential to implement effective and strong surveillance systems to prevent malaria transmission by quickly detection of all malaria infections in the region (23). The success of such surveillance system depends largely on the community involvement and the practices of the populations (24).

WHO has recommended IRS and insecticide-treated bed nets (ITNs) as the two major interventions for malaria vector control (25).

ITNs have been reported to reduce the malaria incidence and mortality of children and are an important intervention in the control of malaria. IRS is also an approach to prevent malaria, but, in this method, the household coverage should be high (≥ 80%) to maximize the effectiveness of this method. The protection obtained by indoor residual spraying lasts approximately for 3–6 months (26).

In this study, the participants demonstrated a high level of knowledge regarding malaria symptoms and transmission. This is like studies conducted in malaria-endemic areas, in Iran where knowledge about the malaria transmission and symptoms was found to be relatively high (27–29).

The knowledge of people about malaria transmission is usually high in malaria endemic countries such as Bangladesh, Malawi, and Ghana (30-32). High level of knowledge about malaria symptoms has also been reported from other malarious countries such as Malawi, Pakistan, and Saudi Arabia (33–35).

Despite high illiteracy (57.5%, n= 230), the knowledge of participants about symptoms and causes of malaria was high, which could be due to their long-term exposure to malaria and also educational materials received from local health workers. Health workers have been reported previously as the main source of information about malaria and can play an important role in prevention of the diseases (27). In the malarious areas of Iran, the health centers are primary level of health care. For this reason, one of the most important sources of people's information is the education received from health care workers in the health centers. Community health workers have been reported as one of the main sources of malaria related knowledge in different malaria endemic regions throughout the world (36).

Results of this study also showed a significant association between the knowledge of the participants about the malaria sign and symptoms and the history of malaria disease in their families. High level of knowledge about the symptoms of malaria, which can be a key factor for seeking early treatment, has been previously reported from malarious areas, where malaria infections occur frequently (37, 38).

In this study, although knowledge about the use of bed net to prevent mosquito bite was high among the study population and almost all the participants (92.5%, n= 370) had LLINs available at home, LLINs were used regularly by only 17% of the participants, as it was checked visually by the interviewers in the morning hours. It could be due to low perceived suscep-

tibility of participants about the malaria disease. Moreover, factors such as educational status of the mother of the household and the problems related to LLINs use such as discomfort due to heat and lack of airflow under LLINs were reported by the households to affect their LLINs usage. Similar observations from Tanzania, and Uganda have recognized that low use of bed nets in the tropical areas is related to the heat discomfort due to poor airflow caused by the bed nets (39, 40). As a protective tool, LLINs are the most effective instruments for protection against mosquito bites and malaria transmission (41). However, unavailability of LLINs and discomfort due to extra heat, have lowered their use.

According to the results of this study, the regular use of LLINs is noticeably lower than 80% which is the targeted coverage of the Roll Back Malaria program (42). This rate of LLINS use is lower than the LLINs coverage in the other malaria-endemic area in the southeast of Iran (22). This rate of LLINs use, is also noticeably lower than the LLINs coverage in other malaria endemic countries, such as India (79.2%) and Uganda (87.1%) (13, 43). Additionally, in this study about 38% of the participants declared that they use bed nets all the time at night. Considering that malaria is being transmitted throughout the year in the study area and it has been reported that most of the malaria vectors (65.9%) such as *An. stephensi*, *An. dthali*, *An. culicifacies* s.l and *An. fluviatilis* s.l. in this area are active at the first half of the night (44), individuals who spend earlier times of night out of the LLINs may be bitten more frequently by mosquitoes and are at greater risk of malarial infection. Therefore, it can be suggested that a key strategy for malaria control is preventing the *Anopheles* bites by use of LLINs, especially at the first half of the night. Several studies have confirmed that regular use of bed nets increases when people are informed about benefits of using LLINs (34, 45). In a previous study in the neighboring County, an educational intervention resulted in the increase of LLINs use, from 58.3% to 92.5% (46). Therefore, appropriate educational interventions should be considered for increasing the use of LLINs in the study population. An important issue that must be considered in the educational interventions is considering the crucial role of women in the community. Since women are influential role models for their families, raising their knowledge and involving them in malaria control and prevention programs can promote the practices of the whole family members against malaria including the regular use of LLINs in the households (47).

In this study majority of the respondents lived in houses built with minimal material resources and lacked window mosquito screens (93%). Living in poorly constructed houses with no door/window screens facilitates the entry of anopheline mosquitoes, which, in turn, increases the risk of malaria infection (48). Previous studies have revealed that use of mosquito screens and improving house design, in areas with low to moderate malaria transmission, decrease the *Anopheles* densities and reduce malaria transmission (49). In addition, mosquito screens have been reported to be appropriate, acceptable, affordable, and long-lasting protection against malaria infection in different communities (50). Therefore, the house improvements, including the use of window screens and blocking of eaves, could be considered for reducing indoor malaria transmission in the study area.

This study revealed noticeable knowledge gaps about IRS and positive perceptions about its use in the study population. In this regard, majority of participants (64.5%) had not applied IRS in the last three months and 74.5% of them mentioned IRS as an efficient tool against mosquito, but, according to the households' reports, only 35.5% of the houses had been sprayed by insecticides. Although this rate of IRS coverage is noticeably higher than previous reports from malarious areas in Iran (27, 28), it is significantly lower than the WHO targeted coverage of 80% (51).

http://jad.tums.ac.ir
Published Online: Dec 31, 2023

The level of IRS coverage in this study is similar to the reports from Ethiopia, and Sudan (52, 53), but it is noticeably lower than those reported from some of malaria-endemic countries, such as Mozambique, and Namibia (54, 55). Therefore, in the study area, the coverage of IRS as a key global method for malaria prevention, is much lower than the coverage level necessary for effective control of anopheline mosquitoes. This may be due to the community's negative perceptions about IRS. In this regard, about two-third (64.7%) of the respondents reported that IRS would have negative effects such as respiratory disorders, headache, discoloring of inner house wall, unpleasant odor, and food contamination. Parallel to this finding, a previous study reported the main reasons for IRS refusal to be the mess left by the sprayers, the insecticide smell, and the difficulty of displacing household items before spraying (56). Results of other studies in Tanzania, and Mexico also showed that community acceptance of IRS has been impeded by mess left by the sprayers, insecticide smell, difficulty of displacing furniture before spraying, perceived ineffectiveness and side effects of insecticides, and increased prevalence of other insects (16, 18). Poisoning of children and domestic animals and infertility of family members have been reported as another reasons for IRS refusal (57). Other reasons for low IRS application in the study area, as it has been reported from different malarious regions in Uganda, and Yemen may be the perceived low severity of and perceived low exposure and susceptibility to malaria disease in the community (43, 57).

In the malarious areas of Iran, the majority of the malaria vectors are endophilic; therefore, an appropriate approach for controlling *Anopheles* mosquitoes is the application of IRS in the houses (58). The high effectiveness of IRS in the control of malaria is the main reason that Iranian government accepted IRS as one of the main control methods. However, according to the results of this study, the IRS coverage is not satisfactory in the study area. Therefore, for effective malaria control and elimination, the IRS coverage needs to be increased by promoting the attitude and practice of individuals regarding IRS.

This study is in parallel to the policy of Ministry of Health and Medical Education of Iran as part of National Malaria Elimination Program. Considering that our manuscript is the result of a field study which has been conducted in a malaria endemic area and since malaria control and elimination programs are being established in some parts of the world, this article would provide good information for authorities to apply in malaria elimination as announced by World Health Organization.

A limitation of this study was that the majority of the respondents were illiterate, as a result in some cases it took a lot of time to complete the questionnaires correctly.

Conclusion

This study revealed that the people in the study area have high levels of knowledge about transmission, symptoms, and preventive measures of malaria. However, there are some misunderstandings and gaps about the use of LLINs and IRS as the two main prevention measures against mosquito bites and subsequently malaria control and elimination. Therefore, malaria prevention campaigns accompanied with educational interventions towards changing the attitude and practice of people about LLINs and IRS should be considered for malaria control and elimination in the study population. In addition, continuous monitoring and assessment of preventive measures and directing more studies on knowledge, attitude, and practices of the community are essential for improving the coverage and utilization of malaria prevention measures towards a sustainable and efficient malaria elimination program.

http://jad.tums.ac.ir
Published Online: Dec 31, 2023

Acknowledgements

The authors of this article are grateful for the support of the director and the staff of Jask Health Center who cooperated and participated in this study. We also would like to appreciate the collaboration received from Mr A Mahtabi, Mr Y Taja, Y Niamedli, Mr M Shayhi, Mr A Gholami, and M Jamadari personnel of Jask Health Center for their cooperation in the field.

Ethical considerations

This study has been registered and approved by Hormozgan University of Medical Sciences Ethical Committee (Code No: IR.HUMS.REC.1398.283).

Conflict of interest statement

The authors declare there is no conflict of interests.

References

1. WHO (2022) World Malaria Report 2022. World Health Organization, Geneva. Available at https://www.who.int/teams/global-malaria-programme/reports/world-malaria-report-2022.
2. Nazari N, Hamzavi Y, Rezaei M, Khoshbo P (2022) A brief review of malaria epidemiological trend in Kermanshah province, Iran, 1986–2014. J Med Life. 15(3): 392–396
3. UCSF Global Health Group (2015) Eliminating malaria in Iran. Available at: https://globalhealthsciences.ucsf.edu/sites/globalhealthsciences.ucsf.edu/files/pub/iran2015-final.pdf.
4. Schapira A, Zaim M, Raeisi A, Ranjbar M, Kolifarhood G, Nikpour F, Amlashi M, Faraji L (2018) History of the successful struggle against malaria in the Islamic Republic of Iran. Tehran: Neekpey.
5. Ghahremani L, Azizi M, Moemenbellah-Fard MD, Ghaem H (2019) Malaria preventive behaviors among housewives in suburbs of Bandar-Abbas City, south of Iran: interventional design based on PRECEDE model. Pathog Glob Health. 113(1): 32–38.
6. Hosseinpoor M, Fekrijaski S, Zare S, Soleimani-Ahmadi M (2023) Analysis of Malaria Situation in Jask County During the Implementation of the Elimination Programme in 2010–2020. Hormozgan Medical Journal. 27(2): 68-72.
7. WHO (2014) WHO recommendations for achieving universal coverage with long lasting insecticidal nets in malaria control. World Health Organization, Geneva. Available at: https://www.afro.who.int/sites/default/files/2017-06/who_recommendations_universal_coverage_llins.pdf
8. Pryce J, Richardson M, Lengeler C (2018) Insecticide-treated nets for preventing malaria. Cochrane Database Syst Rev. 11 (11): CD000363.
9. Pryce J, Medley N, Choi L (2022) Indoor residual spraying for preventing malaria in communities using insecticide-treated nets. Cochrane Database Syst Rev. 1(1): CD012688.
10. Agusto FB, Del Valle SY, Blayneh KW, Ngonghala CN, Goncalves MJ, Li N, Zhao R, Gong H (2013) The impact of bed-net use on malaria prevalence. J Theor Biol. 320: 58–65.
11. Afai G, Rossetto EV, Baltazar CS, Candrinho B, Saifodine A, Zulliger R (2022) Factors associated with knowledge about malaria prevention among women of reproductive age, Tete Province, Mozambique, 2019–2020. Malar J. 21: 76.
12. Kumar R, Farzeen M, Ahmed J, Lal M, Somrongthong R (2021) Predictors of knowledge and use of long-lasting insecticidal nets for the prevention of ma-

laria among the pregnant women in Pakistan. Malar J. 20: 347.
13. Passah M, Nengnong CB, Wilson ML, Carlton JM, Kharbamon L, Albert S (2022) Implementation and acceptance of government-sponsored malaria control interventions in Meghalaya, India. Malar J. 21(1): 200.
14. Zare M, Soleimani-Ahmadi M, Davoodi SH, Sanei-Dehkordi A (2016) Insecticide susceptibility of Anopheles stephensi to DDT and current insecticides in an elimination area in Iran. Parasit Vectors. 9: 571.
15. Zaim M, Naseeri-Nejad D, Azoordegan F, Emadi AM (1997) Knowledge and practice of residents about malaria in southeast Iran (1994). Acta Trop. 64(3–4): 123–130.
16. Suuron VM, Mwanri L, Tsourtos G, Owusu-Addo E (2020) An exploratory study of the acceptability of indoor residual spraying for malaria control in upper western Ghana. BMC Public Health. 20(1): 465.
17. Sakeni M, Khorram A, Majdzadeh R, Raiesi A (2015) Indoor residual spraying coverage and acceptability rates to control malaria and the householders' reasons of acceptance or rejection of spraying, in south-east of Iran. Int J Infect. 2: e31548.
18. Brown ZS, Kramer RA, Ocan D, Oryema C (2016) Household perceptions and subjective valuations of indoor residual spraying programmes to control malaria in northern Uganda. Infect Dis Poverty. 5 (1): 100.
19. WHO (2006) Use of indoor residual spraying for scaling up global malaria control and elimination, global malaria Programme. A WHO position statement. World Health Organization, Geneva. Available at: http://apps.who.int/iris/bitstream/10665/69386/1/WHO_HTM_MAL_2006.1112_eng.pdf.
20. Munajat MB, Rahim MA, Wahid W, Seri Rakna MI, Divis PC, Chuangchaiya S, Lubis IN, Osman E, Mohd Kasri MR, Idris ZM (2021) Perceptions and prevention practices on malaria among the indigenous Orang Asli community in Kelantan, Peninsular Malaysia. Malar J. 20(1): 202.
21. Ushona SI, Sheehama JA, Iita H (2022) Sociocultural factors that influence the prevention of malaria in Ohangwena region, Namibia. Afr J Prim Health Care Fam Med. 14(1): 1–10.
22. Soleimani-Ahmadi M, Vatandoost H, Zare M, Alizadeh A, Salehi M (2014) Community knowledge and practices regarding malaria and long-lasting insecticidal nets during malaria elimination programme in an endemic area in Iran. Malar J. 13: 511.
23. Douglas NM, Burkot TR, Price RN (2022) Malaria eradication revisited. Int J Epidemiol. 51(2): 382–392.
24. Adhikari B, Phommasone K, Pongvongsa T, Kommarasy P, Soundala X, Henriques G, White NJ, Day NP, Dondorp AM, Von Seidlein L, Cheah PY (2017) Factors associated with population coverage of targeted malaria elimination (TME) in southern Savannakhet Province, Lao PDR. Malar J. 16: 424.
25. Nasir SI, Amarasekara S, Wickremasinghe R, Fernando D, Udagama P (2020) Prevention of re-establishment of malaria: historical perspective and future prospects. Malar J. 19(1): 452.
26. Ashley EA, Poespoprodjo JR (2020) Treatment and prevention of malaria in children. Lancet Child Adolesc Health. 4(10): 775_789.
27. Madani A, Soleimani-Ahmadi M, Davoodi SH, Sanei-Dehkordi A, Jaberhashemi SA, Zare M, Aghamolaei T (2017) Household knowledge and practices concerning malaria and indoor residual spraying in an endemic area earmarked for malaria elimination in Iran. Parasit Vectors. 10 (1): 600.
28. Hanafi-Bojd AA, Vatandoost H, Oshaghi MA, Eshraghian MR, Haghdoost AA, Abedi F, Zamani, G, Sedaghat MM, Ra-

shidian A, Madani AH, Raeisi A (2011) Knowledge, attitudes and practices regarding malaria control in an endemic area of southern Iran. Southeast Asian J Trop Med Public Health. 42(3): 491–501.
29. Nejati J, Moosa-Kazemi SH, Saghafipour A, Soofi K (2018) Knowledge, attitude and practice (KAP) on malaria, from high malaria burden rural communities, southeastern Iran. J Parasit Dis. 42(1): 62–67.
30. Alam MS, Kabir MM, Hossain MS, Naher S, Ferdous NE, Khan WA, Mondal D, Karim J, Shamsuzzaman AK, Ahmed BN, Islam A (2016) Reduction in malaria prevalence and increase in malaria awareness in endemic districts of Bangladesh. Malar J. 15(1): 552.
31. Tizifa TA, Gowelo S, Kabaghe AN, McCann RS, Malenga T, Nkhata RM, Kadama A, Chapeta Y, Takken W, Phiri KS, van Vugt M (2022) Community-based house improvement for malaria control in southern Malawi: Stakeholder perceptions, experiences, and acceptability. PLOS Glob Public Health. 2(7): e0000627.
32. Attu H, Adjei JK (2018) Local knowledge and practices towards malaria in an irrigated farming community in Ghana. Malar J. 17(1): 150.
33. Sixpence A, Nkoka O, Chirwa GC, Milanzi EB, Mangani C, Mathanga DP, Ntenda PA (2020) Levels of knowledge regarding malaria causes, symptoms, and prevention measures among Malawian women of reproductive age. Malar J. 19(1): 225.
34. Kumar R, Farzeen M, Hafeez A, Achakzai BK, Vankwani M, Lal M, Iqbal R, Somrongthong R (2020) Effectiveness of a health education intervention on the use of long-lasting insecticidal nets for the prevention of malaria in pregnant women of Pakistan: a quasi-experimental study. Malar J. 19(1): 232.
35. Khairy S, Al-Surimi K, Ali A, Shubily HM, Al Walaan N, Househ M, El-Metwally A (2017) Knowledge, attitude and practice about malaria in south-western Saudi Arabia: a household-based cross-sectional survey. J Infect Public Health. 10 (5): 499–506.
36. Ferreira ED, Alexandre MA, Salinas JL, de Siqueira AM, Benzecry SG, de Lacerda MV, Monteiro WM (2015) Association between anthropometry-based nutritional status and malaria: a systematic review of observational studies. Malar J. 14: 346.
37. Bauserman M, Conroy AL, North K, Patterson J, Bose C, Meshnick S (2019) An overview of malaria in pregnancy. Semin Perinatol. 43(5): 282–290.
38. Andrew EV, Pell C, Angwin A, Auwun A, Daniels J, Mueller I, Phuanukoonnon S, Pool R (2015) Knowledge, attitudes, and practices concerning malaria in pregnancy: results from a qualitative study in Madang, Papua New Guinea. PLoS One. 10(4): e0119077.
39. Lwetoijera DW, Kiware SS, Mageni ZD, Dongus S, Harris C, Devine GJ, Majambere S (2013) A need for better housing to further reduce indoor malaria transmission in areas with high bed net coverage. Parasit Vectors. 6: 57.
40. Kwiringira A, Nanziri C, Nsubuga EJ, Migamba SM, Ntono V, Atuhaire I, Ahirirwe SR, Asio A, Senyange S, Nakamya P, Masanja V(2022) Ownership and use of long-lasting insecticidal nets three months after a mass distribution campaign in Uganda, 2021. Malar J. 21(1): 367.
41. Tungu P, Kirby M, Malima R, Kisinza W, Magesa S, Maxwell C, Batengana B, Pigeon O, Rowland M (2016) Interceptor® long-lasting insecticidal net: phase III evaluation over three years of household use and calibration with Phase II experimental hut outcomes. Parasit Vectors. 9: 204.
42. WHO (2005) The Global Strategic Plan 2005–2015 Roll Back Malaria. World Health Organization, Geneva. Available at:

http://rollbackmalaria.org/multimedia/partnership publications. html.
43. Musoke D, Miiro G, Ndejjo R, Karani G, Morris K, Kasasa S, Nakiyingi-Miiro J, Guwatudde D, Musoke MB (2018) Malaria prevention practices and associated environmental risk factors in a rural community in Wakiso District, Uganda. PLoS One. 13(10): e0205210.
44. Yeryan M, Basseri HR, Hanafi-Bojd AA, Raeisi A, Edalat H, Safari R (2016) Bioecology of malaria vectors in an endemic area, Southeast of Iran. Asian Pac J Trop Med. 9(1): 32–38.
45. Hill J, Lines J, Rowland M (2006) Insecticide-treated nets. Adv Parasitol. 61: 77–128.
46. Soleimani-Ahmadi M, Vatandoost H, Shaeghi M, Raeisi A, Abedi F, Eshraghian MR, Aghamolaei T, Madani AH, Safari R, Jamshidi M, Alimorad A (2012) Effects of educational intervention on long-lasting insecticidal nets use in a malarious area, southeast Iran. Acta Med Iran. 50: 279–287.
47. Argaw MD, Mavundla TR, Gidebo KD (2021) Community and healthcare providers' perceptions of quality of private sector outpatient malaria care in Northwestern Ethiopia: a qualitative study. Malar J. 20(1): 153.
48. Iyer M, Skelton J, de Wildt G, Meza G (2019) A qualitative study on the use of long-lasting insecticidal nets (LLINs) for the prevention of malaria in the Peruvian Amazon. Malar J. 18(1): 301.
49. Bofu RM, Santos EM, Msugupakulya BJ, Kahamba NF, Swilla JD, Njalambaha R, Kelly AH, Lezaun J, Christofides N, Okumu FO, Finda MF (2023) The needs and opportunities for housing improvement for malaria control in southern Tanzania. Malar J. 22(1): 69.
50. Furnival-Adams J, Olanga EA, Napier M, Garner P (2021) House modifications for preventing malaria. Cochrane Database of Systematic Reviews. 2021(1). Cochrane Database Syst Rev. 1(1): CD013398.
51. WHO (2015) Indoor residual spraying: an operational manual for indoor residual spraying (IRS) for malaria transmission control and elimination. World Health Organization, Geneva. Available at: http://apps.who.int/iris/bitstream/10665/177242/1/9789241508940_eng.pdf.
52. Tarekegn M, Tekie H, Dugassa S, Wolde-Hawariat Y (2021) Malaria prevalence and associated risk factors in Dembiya District, North-western Ethiopia. Malar J. 20(1): 372.
53. Valadez JJ, Berendes S, Odhiambo J, Vargas W, Devkota B, Lako R, Jeffery C (2020) Is development aid to strengthen health systems during protracted conflict a useful investment? The case of South Sudan, 2011–2015. BMJ Glob Health. 5 (4): e002093.
54. Magaço A, Botão C, Nhassengo P, Saide M, Ubisse A, Chicumbe S, Zulliger R (2019) Community knowledge and acceptance of indoor residual spraying for malaria prevention in Mozambique: a qualitative study. Malar J. 18(1): 27.
55. Chanda E, Ameneshewa B, Angula HA, Iitula I, Uusiku P, Trune D, Islam QM, Govere JM (2015) Strengthening tactical planning and operational frameworks for vector control: the roadmap for malaria elimination in Namibia. Malar J. 14: 302.
56. Musoke D, Karani G, Ssempebwa JC, Etajak S, Guwatudde D, Musoke MB (2015) Knowledge and practices on malaria prevention in two rural communities in Wakiso District, Uganda. Afr Health Sci. 15: 401–412.
57. Bamaga OA, Mahdy MA, Mahmud R, Lim YA (2014) Malaria in Hadhramout, a southeast Province of Yemen: prevalence, risk factors, knowledge, attitude and practices (KAPs). Parasit Vectors. 7: 351.
58. Nejati J, Tabatabaei SM, Salehi M, Saghafipour A, Mozafari E (2017) Some

probable factors affecting the malaria situation before and at the beginning of a pre-elimination program in southeastern Iran. J Parasit Dis. 41(2): 503–509.

http://jad.tums.ac.ir
Published Online: Dec 31, 2023