Publics’ Malaria Knowledge, Prevention and Treatment Practices, A Cross-sectional Survey From Khartoum, Sudan

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Research

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Abstract

**Background:** Malaria is one of the major health problems in Sudan with high prevalence among children under five years age and pregnant women. Effective control of the disease needs contribution of the community, health authorities as well as political commitment. This research was conducted to assess the public's knowledge, and practice regarding malaria prevention and treatment.

**Methods:** A cross-sectional survey was conducted among publics in Khartoum State. Data was collected using a self-administered questionnaire. Publics were assessed for their knowledge about malaria symptoms and complications, knowledge and utilization of prevention methods and drugs knowledge and treatment behaviors.

**Results:** About 457 of the public participated in the survey. Despite that the publics showed good knowledge regarding malaria symptoms, complications and drugs knowledge, self-treatment practices were there. Noncompliance to treatment in form of stopping treatment upon symptoms relieve and upon developing adverse drug reactions was also reported. Underuse of prevention methods was reported.

**Conclusions:** Inappropriate treatment and prevention practices among the community could be an obstacle in the way of malaria elimination in Sudan. More efforts towards involvement of the community in malaria control through community education are needed.

Background

Malaria is a serious disease with the highest prevalence in Sub Saharan African countries in which more than ninety percent of malaria cases and deaths were reported [1]. In Sudan, the latest Malaria Indicator Survey showed that almost all the people in Sudan are at risk of malaria. The highest prevalence was reported among males, pregnant women, children less than five years of age and in rural areas [2]. Malaria knowledge, treatment and prevention practices could affect the process of malaria control. Malaria knowledge, treatment seeking behaviors, use of treatment and prevention methods vary among communities of different countries [3-5]. Even the communities in one country may show different patterns of knowledge and practices regarding malaria prevention and treatment [6, 7]. In Sudan, the community knowledge about malaria was not studied in big communities and not many of the research that has been published investigated the public knowledge of antimalarial drugs and their drugs use behavior. In this research, our objective was to assess the public knowledge about malaria causes, symptoms and complications, to assess their treatment seeking behavior, antimalarial drugs knowledge, use and compliance to treatment. The research was also investigated the public knowledge and use of prevention methods.

Methods

Study setting
This survey was carried out in Khartoum State, Sudan between September to December 2016.

**Study population**

Publics of different socioeconomic classes, educational levels, and jobs in different public places were targeted for the study.

**Study design and sampling procedure**

A descriptive cross-sectional survey was carried among the public in Khartoum state. The sample size was calculated by Raosoft sample size calculator based on 95% confidence level and 5% confidence interval. The sampling frame was the population of Khartoum state. The calculated sample was 385 participants.[8, 9]

Adults (18 and above) who agreed to participate in the study were included after verbal consent.

Healthcare professionals and students of any health-related institutes were excluded.

Adults with hearing, visual and mental problems and those who refused to participate in the study were excluded. Illiterates excluded as they were unable to complete the self-administered questionnaire.

**Data collection**

Data was collected via a structured self-administered questionnaire. The questionnaire was developed by the researcher after reviewing the literature, piloted and tested for reliability and internal consistency (Cronbach's alpha (0.744). The questionnaire then translated to the Arabic language since it is the mother tongue language of the surveyed population. Forward and backward translation was carried. Different public places were approached for sample collection (two public markets, school, engineering workshop, a private company, bank, Quran learning center, industrial complex and military complex). Data was collected by the researcher and two trained data collectors. About 500 questionnaires were distributed and 457 were retrieved giving a response rate of 91.4%.

**Data Analysis**

Data was entered checked and analyzed using Statistical Package for Social Sciences (SPSS version 23). Descriptive statistics were conducted such as frequencies and percentages. Chi-square test was used to test correlations between categorical variables. Probability values of < 0.05 considered as statistically significant for all results.

**Ethical approval**

Ethical approval was obtained from the National Ethical Committee, Federal Ministry of Health, Sudan.

Verbal consent was obtained from the surveyed publics after they were informed about the research objectives.
Results

Demographics

Publics from the three cities (Khartoum, Omdurman and Khartoum North) participated in the survey. The majority of the respondents were university graduates and Private-employees. About 53 participants did not report their monthly income and most of them those who were not working (Table 1).

Table 1 Demographic data of the public participated in the study
| Variable              | Frequency (N) | Percentage (%) |
|-----------------------|---------------|---------------|
| **Gender**            |               |               |
| Males                 | 269           | 58.9          |
| Females               | 188           | 41.1          |
| **Residence**         |               |               |
| Khartoum              | 136           | 29.8          |
| Omdurman              | 152           | 33.3          |
| Khartoum North        | 169           | 36.9          |
| **Education**         |               |               |
| Primary education     | 24            | 5.3           |
| Secondary education   | 86            | 18.8          |
| University graduate   | 273           | 59.7          |
| Postgraduate degree   | 74            | 16.2          |
| **Job**               |               |               |
| Not working           | 101           | 22.1          |
| Self-employed         | 72            | 15.8          |
| Private – employee    | 183           | 40            |
| Governmental-employee | 101           | 22.1          |
| **Monthly income (Sudanese Pounds)** |     |               |
| <1000                 | 99            | 21.7          |
| 1000-1900             | 117           | 25.6          |
| 2000-3000             | 89            | 19.5          |
| >3000                 | 99            | 21.7          |

*53 (11.5%) did not report their monthly income*

**Public Knowledge**

About 86.9% of the public could relate malaria to mosquito bites however wrong believe about contaminated food as a cause of malaria was mentioned by 11.2% of the respondents. Fever, headache
and body aches were known malaria symptoms among the public. Dehydration, anemia and cerebral malaria were the most mentioned malaria complications (Table 2).

Table 2 Knowledge of the surveyed publics about malaria causes, symptoms and complications

| Variable                  | Frequency (N) | Percentage (%) |
|---------------------------|---------------|----------------|
| **Malaria cause**         |               |                |
| Mosquito bites            | 397           | 86.9           |
| Walking in the sun        | 35            | 7.7            |
| Dirty environment         | 145           | 31.7           |
| Contaminated food         | 51            | 11.2           |
| **Malaria symptoms**      |               |                |
| Fever                     | 385           | 84.2           |
| Nausea and vomiting       | 263           | 57.5           |
| Sweating                  | 109           | 23.9           |
| Headache                  | 340           | 74.4           |
| Chills                    | 262           | 57.3           |
| Diarrhea                  | 81            | 17.7           |
| Body aches                | 317           | 69.4           |
| Cough                     | 14            | 3.1            |
| **Malaria complications** |               |                |
| Cerebral malaria          | 158           | 34.6           |
| Severe anemia             | 187           | 40.9           |
| Dehydration               | 306           | 67             |
| Renal failure             | 56            | 12.3           |
| Jaundice                  | 81            | 17.7           |
| Hepatic failure           | 21            | 4.6            |

**Malaria treatment**
Diagnosis of malaria by symptoms was practiced by near thirteen percent of the surveyed publics and 6.1% practice self-treatment mainly due to financial reasons. Self-treatment with drugs was common. About 17.7% seek malaria treatment at the community pharmacy because they perceive the pharmacist as a knowledgeable health care provider who could manage malaria. About 79.2% mentioned that their drugs were selected mainly by the pharmacist at the community pharmacy and near one-quarter of the surveyed population (24.7%) claimed that the pharmacists dispensed the antimalarials for them upon their request without asking about prescription or laboratory result. A significant relationship between malaria treatment and the level of education was reported. Less educated publics were more likely to practice self-treatment (Tables 3,4,5,6).

Table 3 Malaria diagnosis of the surveyed publics

| Variable                           | Frequency(N) | Percentage (%) |
|------------------------------------|--------------|----------------|
| Malaria diagnosis                  |              |                |
| Self-assessment by symptoms        | 58           | 12.7           |
| Self-assessment by symptoms + lab diagnosis | 399     | 87.3           |

Table 4 Malaria treatment-seeking behavior of the surveyed publics
| Variable                                                                 | Frequency (N) | Percentage (%) |
|-------------------------------------------------------------------------|---------------|----------------|
| **Malaria treatment**                                                   |               |                |
| Self –treatment                                                         | 28            | 6.1            |
| Seek pharmacist advice at a community pharmacy                         | 81            | 17.7           |
| Seek medical advice at the hospital or health center                    | 348           | 76.1           |
| **Reasons for self –treatment**                                         |               |                |
| Financial reasons                                                       | 14            | 50             |
| Unavailability of health facility                                       | 5             | 17.9           |
| **Other reasons**                                                       |               |                |
| Do not want to discover other diseases                                  | 1             | 3.6            |
| Know the disease and treatments                                         | 3             | 10.7           |
| Lack of confidence in doctors                                           | 1             | 3.6            |
| Lack of confidence in lab results                                       | 1             | 3.6            |
| Prefer herbalist                                                        | 1             | 3.6            |
| **What used for self- treatment**                                       |               |                |
| Self- treatment using drugs                                             | 18            | 66.7           |
| Self- treatment using herbs                                             | 10            | 37             |
| **Why seek pharmacist advice**                                          |               |                |
| Pharmacists knowledgeable to manage malaria                             | 67            | 82.7           |
| Cannot afford to go to the hospital or clinic                           | 26            | 32.1           |

*Inaccurate percentages due to missing data

Table 5 Relationship between sociodemographics and treatment behavior of the surveyed publics
| Variable                        | Frequency (Percentage (%)) | Gender | Males | Females | Education | Primary education | Secondary education | University graduate | Postgraduate degree | Monthly Income | P-value |
|--------------------------------|---------------------------|--------|-------|---------|-----------|-------------------|--------------------|-------------------|-------------------|----------------|---------|
|                                |                           |        |       |         | Primary education | 6 (25%)          | 8 (33.3%)          | 10 (41.7%)         |                   |                | 0.000   |
|                                |                           |        |       |         | Secondary education | 7 (8.1%)          | 12 (14%)           | 67 (77.9%)         |                   |                |         |
|                                |                           |        |       |         | University graduate | 11 (4%)           | 48 (17.6%)         | 214 (78.4%)        |                   |                |         |
|                                |                           |        |       |         | Postgraduate degree | 5 (5.4%)          | 13 (17.6%)         | 57 (77.0%)         |                   |                |         |
|                                |                           |        |       |         | Monthly Income | <1000 | 10 (10.1%) | 17 (17.2%) | 72 (72.7%) | 0.209 |
|                                |                           |        |       |         | 1000-1900 | 9 (7.7%) | 16 (13.7%) | 92 (78.6%) |         |
|                                |                           |        |       |         | 2000-3000 | 5 (5.6%) | 20 (22.5%) | 64 (71.9%) |         |
|                                |                           |        |       |         | >3000     | 2 (2%)   | 20 (20.2%) | 77 (77.8%) |         |

Table 6 Antimalarial drugs dispensing practices at the community pharmacy as described by the surveyed publics.

| Variable                          | Frequency (N) | Percentage (%) |
|-----------------------------------|---------------|----------------|
| How pharmacist dispense drugs     |               |                |
| On your request                    | 113           | 24.7           |
| Ask for prescription              | 255           | 55.8           |
| Ask for a lab result              | 89            | 19.5           |
| Drugs obtained from the pharmacy  |               |                |
| Selected by the pharmacist         | 262           | 79.2           |
| Requested by the patient          | 95            | 20.8           |
Antimalarial drugs knowledge and use behavior

About three-quarter (75.1%) of the surveyed publics knew the combination of Artesunate +Sulphadoxine/Pyrimethamine. It was the 1st line drug for treatment of uncomplicated malaria at the time of the study. In the translated Arabic version of the questionnaire, it was given the name by which it was known among the community (Rajimat). As reported by the public the main source of drug knowledge was the medical doctors (57.3%) however, 36.5% reported that they get their information about drugs from their families members and friends. About 10.7% claimed that they developed adverse reactions due to antimalarial drugs use. Gastrointestinal adverse reactions were the most reported. Artesunate +Sulphadoxine/Pyrimethamine combination was reported as the drug that responsible for the majority of the reported adverse reactions. Stop treatment upon development of adverse drugs reaction was reported by 20.5% of the respondents (Table 7,8).

Table 7 Antimalarial drugs knowledge of the surveyed publics

| Variable                          | Frequency(N) | Percentage (%) |
|-----------------------------------|--------------|----------------|
| **Drugs Knowledge**               |              |                |
| Artesunate +Sulphadoxine/Pyremethamine | 343          | 75.1           |
| Chloroquine                       | 148          | 32.4           |
| Quinine                           | 206          | 45.1           |
| Artemether                        | 255          | 55.8           |
| **Drugs knowledge source**        |              |                |
| Pharmacist                        | 98           | 21.4           |
| Medical doctor                    | 262          | 57.3           |
| Media                             | 84           | 18.4           |
| Family members and friends        | 167          | 36.5           |

Table 8 The pattern of antimalarial adverse drugs reactions reported by the surveyed publics
| Variable                               | Frequency(N) | Percentage (%) |
|----------------------------------------|--------------|----------------|
| Incidence of adverse drug reactions(ADRs) |              |                |
| Yes                                    | 49           | 10.7           |
| No                                     | 408          | 89.3           |
| Type of adverse drug reactions         |              |                |
| Fever                                  | 13           | 28.9           |
| Nausea                                 | 26           | 57.8           |
| Vomiting                               | 24           | 53.3           |
| Diarrhea                               | 5            | 11.1           |
| Fatigue                                | 21           | 46.7           |
| Skin rash                              | 1            | 2.3            |
| Tinnitus                               | 1            | 2.3            |
| Anemia                                 | 5            | 11.1           |
| Drugs that cause adverse reactions     |              |                |
| Artemether                             | 3            | 14.3           |
| Artesunate +Sulphadoxine/Pyremethamine | 13           | 61.9           |
| Quinine                                | 5            | 23.8           |
| Actions taken to manage adverse drug reactions |        |                |
| Stop treatment                         | 9            | 20.5           |
| Consult pharmacist                     | 5            | 11.4           |
| Consult the medical doctor             | 12           | 27.3           |
| Ignore it and continue treatment       | 18           | 40.9           |

*Percentage of reactions calculated out of 45 as 3 respondents did not mention the ADRs they developed

Treatment compliance

The results of the assessment of patients compliance showed that 22.8% of the patients stop their treatment when their symptoms disappeared and 7.2% stop their treatment if they vomit the first dose of their antimalarial drugs. There was no significant relationship between the sociodemographic characteristics of the respondents and their compliance with treatment (Table 9,10 ).
Antimalarial drugs were available (93.9%) and available (82.5%) for the majority of the respondents. (Table 11)

Table 9 Compliance of the surveyed publics to malaria treatment

| Variable                              | Frequency(N) | Percentage (%) |
|---------------------------------------|--------------|----------------|
| **Actions when prescribed antimalarial treatment** |              |                |
| Complete the course of treatment      | 353          | 77.2           |
| Stop treatment when symptoms disappeared | 104          | 22.8           |
| **Actions taken if vomit the first dose** |              |                |
| Repeat the dose                       | 129          | 28.2           |
| Continue without repeating the dose   | 131          | 28.7           |
| Discontinue treatment                 | 33           | 7.2            |
| Consult doctor or pharmacist for advice | 164          | 35.9           |

Table 10 The relation between demographics and compliance with malaria treatment among the surveyed publics
| Variable                      | Frequency (Percentage %) | P-value |
|-------------------------------|--------------------------|---------|
|                               | Complete treatment course | Stop treatment after symptoms disappear |         |
| Gender                        |                          |         |
| Males                         | 206 (76.6%)              | 63 (23.4%) | 0.387 |
| Females                       | 147 (78.2%)              | 41 (21.8%) |       |
| Education                     |                          |         |
| Primary education             | 16 (66.7%)               | 8 (33.3%) | 0.653 |
| Secondary education           | 67 (77.9%)               | 19 (22.1%) |       |
| University graduate           | 212 (77.7%)              | 61 (22.3%) |       |
| Postgraduate degree           | 58 (78.4%)               | 16 (21.6%) |       |
| Monthly Income                |                          |         |
| <1000                         | 72 (72.7%)               | 27 (27.3%) | 0.576 |
| 1000-1900                     | 91 (77.8%)               | 26 (22.2%) |       |
| 2000-3000                     | 72 (80.9%)               | 17 (19.1%) |       |
| >3000                         | 78 (78.8%)               | 21 (21.2%) |       |

Table 11: Availability and affordability of antimalarial drugs as reported by the surveyed publics

| Variable                     | Frequency (N) | Percentage (%) |
|------------------------------|---------------|----------------|
| **Antimalarial drugs available** |               |                |
| Yes                          | 429           | 93.9           |
| No                           | 28            | 6.1            |
| **Antimalarial drugs affordable** |         |                |
| Yes                          | 377           | 82.5           |
| No                           | 80            | 17.5           |

Malaria Prevention
The public in Khartoum State showed good knowledge regarding prevention methods. Insecticide-treated bed nets and indoor house spraying was mentioned by 81.1% and 70.2% respectively. However ner thirty percent (28.9%) did not use any prevention method. Of those who did not use prevention methods, none availability (40%) and unaffordability (21.7%) were of the main reasons mentioned of not using prevention methods (Table 12, 13). Being a female and receiving education on malaria prevention and treatment were significant predictors of prevention methods use (P-value 0.006 and 0.001 respectively) (Table 14).

Slightly more than half (54.3%) the surveyed publics received education on malaria prevention and treatment. The media (42.7%) and friends and family members (38.5%) were the main providers of education (Table 15).

Table 12 Prevention methods knowledge of the surveyed publics

| Variable                        | Frequency(N) | Percentage (%) |
|---------------------------------|--------------|----------------|
| **Knowledge of prevention methods** |              |                |
| Insecticide-treated bed nets    | 374          | 81.8           |
| Mosquito repellants and sprays  | 208          | 45.5           |
| Indoor house spraying           | 321          | 70.2           |
| **Other prevention methods**    |              |                |
| Environmental control           | 12           | 2.6            |
| Nets without insecticides       | 1            | 0.2            |
| Sleeping in closed areas        | 1            | 0.2            |
| Vaccination                     | 1            | 0.2            |

Table 13 Prevention methods use behavior of the surveyed publics
| Variables                          | Frequency(N) | Percentage (%) |
|-----------------------------------|--------------|----------------|
| **Use of prevention methods**     |              |                |
| Yes                               | 325          | 71.1           |
| No                                | 132          | 28.9           |
| **Prevention methods used**       |              |                |
| Insecticide-treated bed nets      | 188          | 57.8           |
| Topical mosquito repellants and sprays | 106          | 32.6           |
| Indoor house spraying             | 204          | 62.8           |
| Other prevention methods          | 2            | 0.6            |
| **Reasons for not using prevention methods** | | |
| Not available                     | 48           | 40             |
| Not affordable                    | 26           | 21.7           |
| **Other reasons**                 | 42           | 34.7           |
| Carelessness                      | 5            | 1.1            |
| Don't like it                     | 4            | 0.9            |
| Insecticides allergy              | 5            | 1.1            |
| Insecticides bad smell            | 2            | 0.4            |
| No need for it                    | 22           | 4.8            |
| Not effective                     | 1            | 0.2            |

*Percentage differences because some respondents didn't report why they didn't use prevention methods.

Table 14 The Predictors of prevention methods used among the surveyed population
| Variable                                | Frequency (Percentage %) | P-value |
|-----------------------------------------|--------------------------|---------|
|                                         | Use prevention methods   | Don't use prevention method |
| Gender                                  |                          |         |
| Males                                   | 179 (55.1%)              | 90 (68.2%) | 0.006 |
| Females                                 | 146 (44.9%)              | 42 (31.8%) |
| Education on malaria prevention and treatment |                      |         |
| Yes                                     | 192 (59.1%)              | 56 (42.4%) | 0.001 |
| No                                      | 133 (40.9%)              | 76 (57.6%) |
| Monthly Income                          |                          |         |
| <1000                                   | 67 (23.7%)               | 32 (26.4%) | 0.665 |
| 1000-1900                               | 86 (30.4%)               | 31 (25.6%) |
| 2000-3000                               | 64 (22.6%)               | 25 (20.7%) |
| >3000                                   | 66 (23.3%)               | 33 (27.3%) |

Table 15 Education of the surveyed publics about malaria prevention and treatment

| Variable                                | Frequency (N) | Percentage (%) |
|-----------------------------------------|---------------|----------------|
| Received education on malaria prevention and treatment |               |                |
| Yes                                     | 248           | 54.3           |
| No                                      | 209           | 45.7           |
| Education Provider                      |               |                |
| Pharmacist                              | 39            | 15.7           |
| Medical doctor                          | 81            | 32.7           |
| National Malaria Control Program        | 58            | 23.4           |
| Media (radio, television and newspapers)| 104           | 42.7           |
| Nongovernmental organizations           | 48            | 19.4           |
| Friends and family members              | 95            | 38.5           |
Discussion

The public in Khartoum state showed good knowledge about malaria causes, symptoms, and complications. The majority of the public in malaria-endemic countries could mention most of the malaria symptoms. Fever and headache were the most known symptoms and with or without different levels of knowledge about malaria causes and complications [10-13]. Two researchs in Sudan one among the public in one of the rural parts of Khartoum and in Estren Sudan revealed poor knowledge on malaria complications[10, 14]. Sudan is a big country with different sociodemographic and educational levels among different State. More research is needed for assessment of malaria knowledge among communities of different Sudanese states to help the policymakers in setting control programs in accordance of the needs of different communities.

Malaria self-diagnosis and self-treatment were reported in the current study. Malaria self-diagnosis and treatment was documented in other studies conducted in Khartoum state[15, 16] and in many other malaria-endemic countries [17, 18]. The main reason mentioned by the respondents who practiced self-treatment was financial reasons. A study from Khartoum also showed that people do seek treatment from community pharmacies because they could not afford to pay for consultation fees and that they were not satisfied by the services at the public health facilities[19]. Although the percentage that practiced self-treatment in the current study was 6.1%, part of the 17.7% who seek malaria treatment at community pharmacies could also be considered as practicing self-treatment because they mentioned that the community pharmacist dispensed antimalarials upon their request. in the current study, primary educated people were more likely to go for self-treatment however in the study carried by Awad et al, medical students were practicing malaria self-treatment more than other university students [16]. Self-treatment using herbal drugs was of the practices reported in Sudan[20, 21] as well as many African communities such as in Cameroon[6] and in Kenya [22].

Regarding drug knowledge, 75.1% of the public could recognize the drug used as 1st line treatment at the study period. The publics mentioned doctors and pharmacists as sources of information and could be reliable sources. Family members and friends were mentioned as a source of information for 36.5% of the respondents, however, the accuracy of information provided by them was questionable. Different studies showed different patients information sources[23, 24] but providing patients with adequate information on drugs and treatments from reliable sources is very important as it could affect the cure of their disease.

The majority of the reported adverse drugs reactions (ADRs) were gastrointestinal system related and was mainly caused by the combination of Artesunate+ sulphadoxine/Pyrimethamine as it was the most used drug. Although some patients consulted physicians and pharmacists when they developed ADRs it was not investigated if these ADRs were reported or not. Patients can contribute to the process of ADRs reporting and determination of drugs safety. However, inadequate patients knowledge and practices were reported in many communities [25, 26]. Lack of patients awareness about reporting systems and reporting skills could be of the barriers to patients contribution in ADRs reporting[27]. About 20.5% of
those who experienced the adverse effects stopped treatment. Stopping of treatment upon improvement of symptoms was reported by 22.8%. Discontinuation of treatment after the development of ADRs or symptoms improvement indicated a problem of patients compliance which may lead to poor prognosis and development of drugs resistance. The results showed that there was no significant relationship between patients demographics and their compliance with antimalarial drugs treatment and that was consistent with the findings of a study carried out in Uganda[28]. Stopping treatment after symptoms improvement [29] and upon the development of ADRs[30] was shown in some studies and it was found that drug knowledge and previous experience of drug use were significant predictors of adherence to treatment [31]. Patient education on noncompliance to treatment and its drawbacks not only for the patients but also for the whole country as a risk of drug resistance is very crucial.

The publics showed good knowledge about prevention methods but still near one third (28.9%) of the surveyed publics did not use the prevention methods. The difference between knowledge of prevention methods and use behavior was reported in many malaria-endemic countries such as in Cameroon [32] in Ethiopia [33] and in Ghana[34]. In Sudan underuse of preventive measures in many states [35] and inappropriateness in availability, affordability and use of preventive measures in terms of public's behavior and stakeholder's implementation was reported[36]. Of those who did not use prevention methods, 40% and 21.7% attributed that to nonavailability and unaffordability of it respectively. The recent Malaria Indicator Survey in Sudan showed the same findings of this study. Khartoum State and the Red Sea state were reported as having the lower ownership and use of insecticides treated nets (ITNs) and indoor house spraying. The highest rates of using ITNs were reported in the refugee's camps and the some targeted states in which it is distributed free of charge. Nonavailability and unaffordability were also reported as the reasons for not using prevention methods [2]. Females and those who received education in malaria prevention and treatment were more likely to use prevention methods (P-values 0.006 and 0.001 respectively). Despite the effect of education on patients, knowledge and preventive methods use behavior, slightly more than half of the surveyed people( 54.3%) received education on malaria prevention and treatment. The media (42.7%) and family and friends (38.5%) were mentioned in the top list of education providers to public. The media (radio, television and newspapers) could play an important role in malaria education [37, 38]as well as other sources of information such as books, internet and the procedures distributed in the clinics [39]. Continuous education was underscored by community members as an important tool in malaria elimination [40]. Generally, health education could help individuals and communities in improving their health conditions with extended positive habits of a healthy life to future generations[41]. More efforts in public education on malaria prevention and treatment is required for achievement of malaria elimination targets in Sudan

**Conclusion**

Although the public in Khartoum state showed good knowledge on malaria prevention and treatment, there are many inappropriate practices among the public. Self-diagnosis and treatment, noncompliance to treatment and underuse of prevention methods were of the barriers to effective control of malaria in Sudan.
Study Limitations

Majority of the respondents in the surveyed publics were university graduate which may not reflect the actual community knowledge. More socioeconomic status and illiteracy level and access to media and education may differ among the different Sudanese states which make the results not generalizable and the survey should be carried in different state to reflect the actual situation. Ethics approval and consent to participate

Declarations

Consent for publication

The authors agreed to submit this paper for publication

Availability of data and material

Data and materials used in the study are available and will be provided by the corresponding author whenever needed.

Competing interests

The authors declared that they have no competing interest.

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Authors’ contribution

Elkhanssa Abdelhameed designed the study, trained data collectors and contributed in data collection, performed the data analysis and interpretation of results. Syed Azhar contributed in interpretation of the results, provided advice and critically reviewed the study results. All authors read and approved the final manuscript

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