

Knowledge, practices and perceptions which affect acquiring malaria in man-made malarious area in Khartoum State, Sudan

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ABSTRACT: A cross-sectional descriptive study was carried out among people of ElAzergab area. This area was chosen as a model to study Sudanese malaria knowledge attitude and practices (KAP) in man-made malarious areas. This area is situated along the eastern bank of the River Nile north of Khartoum North, in Khartoum State. The aim is to determine risk factors associated with malaria. Data were collected from 167 households. The survey deals with sociodemographic characteristics, history of malaria, knowledge, attitudes, practices, preservation measures and treatment seeking behaviour. Ninety one percent of household heads reported malaria attack among household members in the previous year. Risk of malaria attack was significantly associated with family grade of education, occupation of household head, water and electric supply, economic status of the family, number of rooms, expenses of treatment, treatment seeking behaviour. About 76.6% of household heads reported delayed treatment seeking behaviour for malaria. Knowledge, attitude and practice have no association with malaria attacks except for a 2-fold increased risk of malaria in people obtaining water from irrigation canals.

Introduction:

The estimated annual number of malaria cases is about 15 million, out of which 95% are believed to occur in four countries: Sudan is one of them. It produces more than half, (67%) of the total estimated malaria cases in the Region (WHO, EMRO, 2006). According to the Sudanese Federal Ministry of Health (2004), malaria is a major public health problem, it accounts for up to 30% of all attendants to health facilities and 15.9% of total deaths. Malaria not only poses a high risk to health, but the repeated clinical consequences of infection in endemic areas during early life and adulthood and outbreaks in epidemic prone areas place a burden on households, on the health services and ultimately on the economic growth of communities and the nation. Socioeconomic conditions of the community have direct bearing on the problem of malaria. Ignorance and impoverished conditions of people contribute in creating source and spread of

malaria and hinder disease control strategy (Wessen, 1972; Collins et al., 1997; Yadav et al., 1999). Prevention of the disease through better knowledge and awareness is the appropriate way to keep it away. And people remain healthy, as illness confusion and health-seeking behaviour may enhance or interfere with the effectiveness of control measures (Klein et al., 1998). Studies pertaining to knowledge, attitude and practices (KAP) showed that direct interaction with community, plays an important role in circumventing malaria problem (Collins et al., 1997; Singh et al., 1998).

Poor people are at increased risk both of becoming infected with malaria and of having this more frequently. Child mortality rates are known to be higher in poorer households and malaria is responsible for a substantial proportion of their deaths. Poor families live in dwellings that offer little protection against mosquitoes and are less able to afford possessing insecticide-treated nets. Poor people are also less likely to be able to pay either for effective malaria treatment or for

transportation to a health facility capable of treating the disease (WHO, RBM, 2003). Anthropogenic factors may alter malaria transmission dynamics by (1). Increasing the emergence of efficient vectors through increasing the number of breeding sites affiliated to land use change or agricultural project expansion (2). Reduction in vector control activities and (3) increasing contact between man and vector through occupational activities or seasonal migration. Within man-made malaria, excluding the migration of non-immunes to endemic areas, the most important impacts on transmission are probably brought about by water resource development and land use change. Human modification to the environment also can create larval development sites and malaria (Denise et al, 2003). Micro-environments may exist for malaria with heterogeneous incidence within small geographic areas. This may especially be true for man-made malaria in which man by his farming activity or any other activity may create the environments which suit mosquito breeding and protective measures may be widely distributed. The identification of predictors of malaria incidence could provide a useful means of identifying targets for intervention of man-made malaria (Ghebreyesus et al, 2000). Proven effective options to reduce malaria morbidity and mortality include early diagnosis combined with prompt, effective therapy. This is complemented by malaria prevention through reduction of human-vector contact, emphasizing the use of insecticide-treated nets (ITNs). Surveys in Africa revealed that 80–90% of presumed malaria cases were treated at home (Thera et al. 2000; Fawole & Onadeko 2001; Nyamongo 2002). Frequently formal health care is sought only if initial treatment fails (Denise et al, 2003). Households' behaviour in response to signs of disease is influenced by several factors including: knowledge, attitudes and practices (KAP) towards malaria; accessibility and availability of health services; socio-economic factors, and perceptions of severity of the illness (Tarimo

et al. 1998). Understanding the communities' perceptions (particularly the household's head) of cause, symptoms identification, and treatment of malaria is an important step towards developing strategies aimed at controlling the disease (Munguti 1998).

In this study, our objectives were to describe malaria-related KAP among households; identify associations between households' characteristics and positive KAP towards malaria. Transmission levels and disease risk have generally been estimated at the population level together with the independent predictors of malaria incidence in man-made malarious area North Khartoum State.

Study Area

Khartoum, the capital of the Sudan (Fig. 1), is located at 15° 37' N 3° 30' E and has an average altitude of 380 meters above sea level. Its surface area is 28000 square kilometre with a population of 5,548,784 and an annual growth rate of 3.67%. About 79% of its population live in urban canters and 21% live in peripheries and rural parts. It is located in a transitional semi-desert zone between the hot dry desert to the North of the Sudan and the wood land savannah to the South. Thus, it has a typical tropical arid climate. Temperature of Khartoum has a fairly wide range (7°-46°). January is the coolest month and temperature rises to reach its maximum in June (Sudan Meteorological Department, Khartoum office, 2005) Khartoum State is partly enclosed by both the Blue Nile and the White Nile. It experiences annual flood, in addition, there are intense farming activities in areas surrounding cities and towns of the State (the study area). These are the main factors which create a suitable environment for breeding of mosquitoes. The problem of malaria is furtherly aggravated by the intensive population movement from different States of the country to the Capital. Various epidemiological changes have occurred recently in Khartoum State. The aforementioned changes are mainly due to

urbanization, influx of displaced people and refugees as well as intense farming activities. Irrigated fruit farms, small holder irrigation schemes, increased rainfall and flooding create many suitable breeding sites for mosquitoes.

Study site

The study was conducted at ElAzergab area which is part of Khartoum North locality, situated on the eastern bank of the River Nile, 16 km North of Khartoum. The area is surrounded by fruits and vegetables farms with intense farming and construction activities. Red brick manufacturing is another activity which flourishes on the River Nile bank near the area. Water for preparing bricks is drawn from the River Nile and kept in open containers. During the period of the study, there were 2 basic and 1 secondary schools. Health services are provided in 3 clinics one governmental, plus a non governmental organization unit (NGO) and a private one with many pharmacies nearby. The electricity and water networks are only for people outside the farms. Those in camps or working in farms have no electric supply and obtain water from the River Nile by pumps used for irrigation of farms.

Study Population

According to local authorities, the estimated population of the area was 4318 individuals, contained in 664 households. The mean number of family members per household was 6 individuals. The area is largely an urban slum with high population density, unemployment rate, and rural-urban migration rates. Household incomes are derived mainly from formal and informal work within Khartoum State. This community is comprised of a mixture of several Sudanese tribes but Northern and Western tribes are the major local components

The majority of the study populations were residents of the area with free possession houses. People living in camps are those who migrated from their homeland due to famine, war or seeking better work chances or jobs

between 1979 and the present day. Household heads work mainly as farmers, formals, or unskilled workers and some were unemployed.

Study Design

A cross-sectional descriptive study was carried out during the period November 2005 to December 2006. Stratified cluster, random sampling design was used for selection of houses. Stratification was based upon housing conditions whether poor, acceptable or good. In order to secure a representative sample of the study population, the sampling plan was stratified according to the stratum size (WHO, 2003). A household was defined as a group of people living within one domicile and usually sharing meals together. The sample size was proportionate to the population of the area. A household head was defined as the person within the household who provided most of the family's financial support, day-to-day care and seeking health care in case of illness. Information regarding malaria-related KAP was collected beside demographics of the household, measures of socio-economic status, and household/environmental characteristics. Several questions included specified prompts to facilitate data accuracy and comparison. To confirm household characteristics and preventive measures used, direct observation was used whenever possible. A team of well-trained and closely supervised local interviewers conducted the household survey using a pre-tested questionnaire to interview the head of each household. At each household the aim of the study was clearly explained and informed consent was obtained from the head of the family. Information about frequency of malaria attacks and the number of malaria attacks suffered by household members during the previous year were also recorded. Variables used for assessing respondents' attitudes and practices included: means of avoiding getting malaria, keeping mosquitoes away, use of bed nets, conservative measures

concerning the use of water, the first and second action when feeling malaria-like symptoms or noticing symptoms in their children. Questions asked included (1) whether they do laboratory investigation when they feel malaria-like symptoms (2). how much they trust it (3) reasons for abandoning laboratorial investigation (4) drug use (5) stopping treatment before improvement (6) whether they prefer tablets or injections (7) drinking lemon, orange, grapefruit, Karkade or milk before the antimalarials (8) using traditional remedies and antimalarials during pregnancy (9) lost working and school days. Variables used for assessing Knowledge included: (1) cause of malaria (2) symptoms of malaria (3) drugs used (4) doses of each drug (5) other names for malaria and, whether it is treatable. The responses scored (1) for a correct answer and (2) for incorrect answer. Total scores were calculated for 3 domains- knowledge, attitude and practice, and treatment-seeking behaviour. These were classified as 'good' if the total score was less than median for the sample and 'poor' if greater than the median.

Data management and analysis

Data analysis was carried out using SPSS version 14. Univariate chi-square test was applied to compare statistical analysis between proportions and to produce an estimate of the odds ratio associated with each factor. And multivariate (logistic regression) analysis was performed to find any association between variables and to obtain the adjusted odds ratio for the final model.

Results

The total of 167 household heads were interviewed during the survey. The socio-characteristics of the respondents are shown in **Table 1** and **Fig. I**. Most household heads were young, 55.2% (age 25-40). Male constituted (153) of the interviewees of the total population (167), 80.2% were married, 6% were

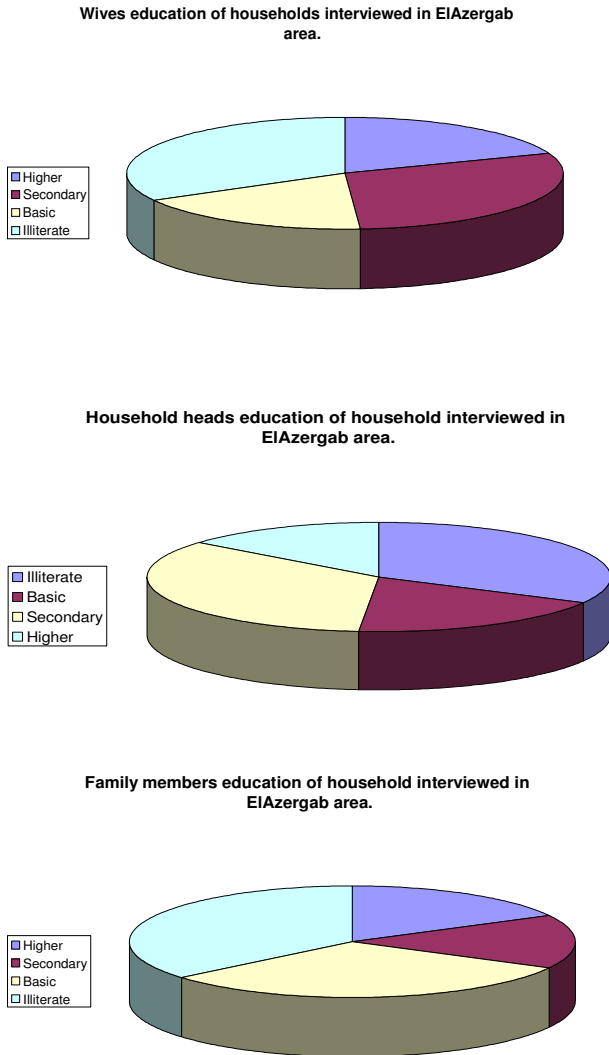
Table 1: Sociodemographic characteristics of the heads and members of households interviewed in ElAzergab area

Characteristics	No.(%)
Household Heads:	
Sex:	
Male	153 (91.6)
Female	14 (8.4)
Age/ years:	
20-40	53(31.7)
41-60	96 (57.5)
>60	18 (10.8)
Family Members:	
Sex:	
Male	499 (42.6)
Female	672 (57.4)
Wives:	
Age/years:	
<25	10 (6.8)
25-40	80 (55.2)
41-60	53 (36.6)
>60	2 (1.4)
Number of Children:	
1-2	14 (8.4)
+3	151(91.6)
Number of Rooms:	
1-2	96 (57.5)
<2	71 (42.5)
Electric Supply:	
Yes	114 (68.3)
No	53 (31.7)
Piped Water:	
Yes	119 (71.3)
No	48 (28.7)
Keeping Animals:	
Yes	42 (25.1)
No	125 (74.9)
House Located in a Low Position:	
Yes	11 (6.6)
No	156 (93.4)
Access to Latrine:	
Yes	121 (72.5)
No	46 (27.5)
Air Conditioner:	
Yes	62 (37.1)
No	105 (62.9)
Housing Conditions:	
Good	32 (19.2)
Acceptable	57 (34.1)
Poor	78 (46.7)

single, 7.2 were divorced and 6.6% were widowed. (38.3%) of the respondents had little formal education, 32.9% were illiterate (**Fig I**). Seventy seven percent (77.1%) were not earning a regular income. As regards to wives' occupation, 72.4% were housewives, 20.7% were informal labourers and 6.9% were students .Concerning sex of family

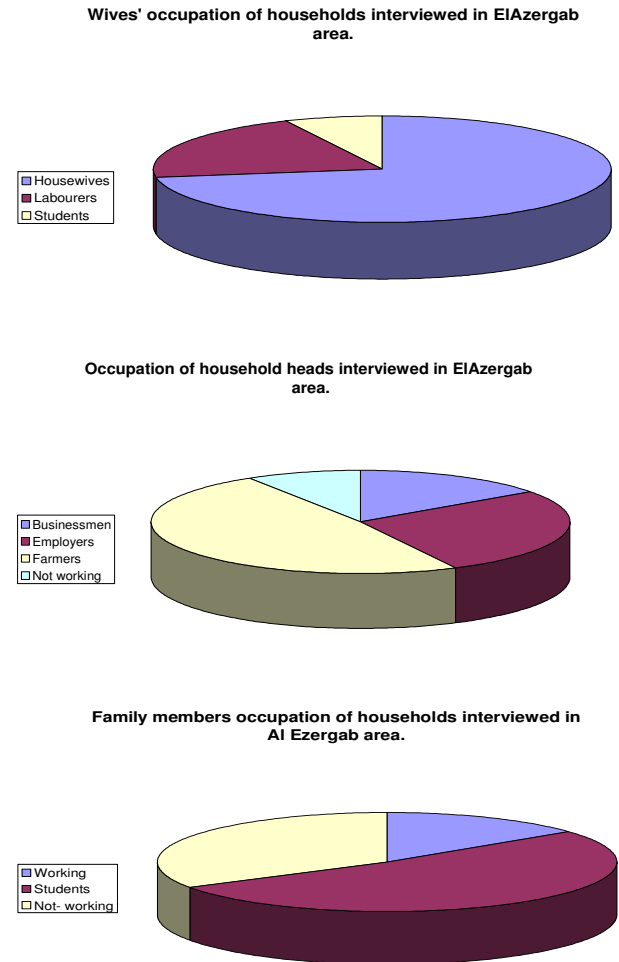
members, 34.5% were males and 65.5% were females. More than one third of them were illiterate (36.1%), and 46.8% were semi-literate (Fig I).

Fig I: Showing education of household heads, wives and family members of households interviewed in ElAzergab area.



were mostly characterized by crowded condition (≥ 4 people sleeping in the same.

Fig II: Showing occupation of household heads, wives and family members of households interviewed in ElAzergab area



The mean number of children per household was 6 and 90.4% of households had more than 2 children. Concerning household members occupation, 14.4% were employed, 52.1% were students and 33.5% (above 18 years) were not employed (Fig II). As in Fig III most houses (55.7%) were free possession, (15%) rent houses and (29.3%) were camps. Those constructed of red bricks were (60.4%), mud/clay bricks (19.2%), or thatched (20.4%). They

room). The dominant tribes were from northern Sudan (62.8%), the rest were predominantly from the western part (27.2%). The main language was Arabic. Most of the population had access to clean piped water (71.3%), the remainder obtained water from irrigation canals of orchards. One hundred thirty nine of respondents kept water for more than one week in plastic and metal containers, 34.9% covered them tightly and 65.1% cleaned and dried them every week. Fifty six of respondents had roof water tanks, (87.1%) of them kept them tightly closed, only (3.4%) cleaned and dried them periodically. Concerning electric supply, (68.3%) had access to it and 26, 3% kept the

light on over night at sleeping sites. About (72.5%) had access to latrines; 31.2%, siphon system, 67.2% pit latrine and 1.6% suckers. Only eleven household heads (6.6%) believed that their houses were located in a relatively low position (**Table 1**). No free health service was provided, all hospitals and health centers used to charge a small fixed fee per patient for the physician and for each laboratorial investigation.

Fig III: Showing characteristics of houses of household interviewed in ElAzergab area

Fig b: Showing construction materials of houses of households interviewed in Alezergab area.

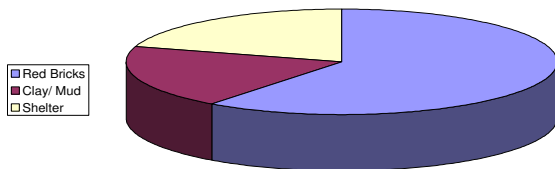


Fig a: Showing site of accommodation of households interviewed in Alezergab area.

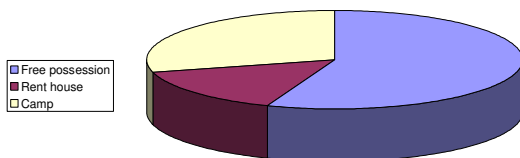
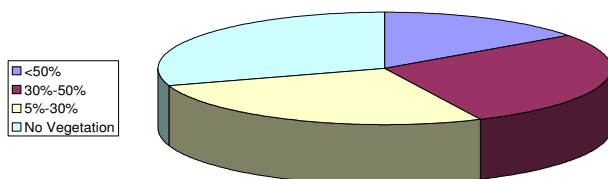


Fig c: Showing vegetation cover of houses of the households interviewed in Alezergab area.



Households Heads Knowledge, Attitude, Practices and Treatment Seeking Behaviour:

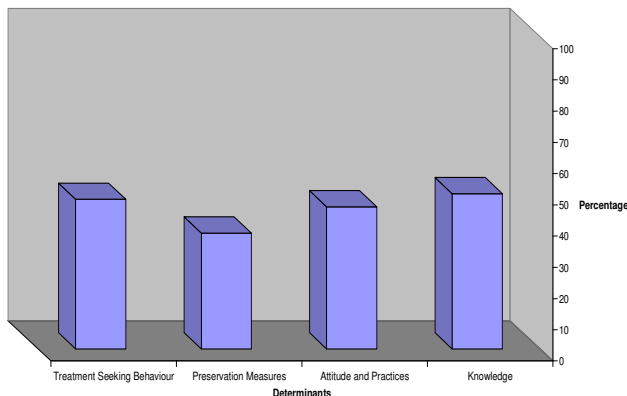
Knowledge

Malaria - related knowledge, attitude, practices and treatment seeking behaviour of

households' heads are summarized in **Fig IV**. Mosquitoes or malaria parasite were recognized as causes of fever by (97.2%). Other attributed causes of malaria to (1) hunger and fatigue (6%) (2) bathing with hot water (5%) (3) houseflies (6%) (4) all insects (13%) and (5) eating certain types of food (15%). Households heads had a poor understanding of how to recognize fever, with (71.3%) reporting feeling hot. The recognition of severe malaria was similar to non-severe with the exception that 24.6% recognized convulsions as signs of severe disease. Knowledge regarding antimalarial therapy was generally limited. Only (53%) of households heads knew Artesunate (AS) + Sulphadoxine Pyrimethamine (SP) combination is government-recommended first-line of treatment for malaria, 31.2% knew the correct dose of treatment, although treatment protocol was found in posters in all health centers and hospitals. Most households who knew the new treatment for malaria, believe that "the new" antimalarial is not well-tolerated and that it has serious side effects and patients become even more ill after administration than before. They called it "rajimat". Eighty three of households were receiving injectable form (47.3% completed the 7 injections), one fifth of respondents (21%) used tablets (55.7% completed the whole dose) and (29.9%) said it did not matter whether they used injections or tablets. Different reasons were given for high usage rate of injectable form. These included household heads and family members preference, compliance, cost and less side effects.

The score for good knowledge about malaria among heads of households was (49.7%). Out of 167 respondents, 55.7% believed that malaria is a serious disease, and (94.6%) and (89.8%) identified fever and headache respectively as the most common symptoms associated with malaria. Other terms were used for malaria by 20.4% of the respondents and 82% mentioned mosquito bites as the cause of malaria.

Fig IV: Showing determinants of frequency of malaria attacks in ElAzergab area.



Attitudes, Practices and Treatment seeking Behaviour

Reported means of preventive measures were limited, insecticides were used by (22.9 %) of respondents, followed by bed nets (23.9 %), whereas screened windows were used by quarter of the respondents (25.8%) and (39.5%) reported no attempt to use any preventive measures. Health centers were regarded as the first resort of malaria treatment by (83.2%), private clinics were mentioned by (62.9%), while hospitals were cited by (42.5%) of respondents. Thirty four of respondents stated that they need a cooperative staff in health services, (98.2%) confirmed drug availability, (34.1%) criticized the official treatment of patients and only (21%) reported that they received educational programme. Most of respondents (81.4%) stated that health services costs have greatly increased, (16.2%) of respondents mentioned slight increase, (2.4%) reported non increment and (67.7%) stated that it is beyond their financial affordance. When asked what they did if they had malaria, most household heads reported that they would seek care from health centers (83.2%). Seeking care at hospital or private clinics was reported by (16.8%) of household heads as their first action. Reasons given for abandoning laboratorial investigation when feeling malaria-like symptoms were; (1) uncertainty by 75 (77.2%) (2) economic

factors 69 (62.7%) and (3) time consuming process 34 (30.9%) of respondents while, 57 (34.1%) of respondents still insist on it. Those reporting self treatment as their first action were (37.7%). The majority said they would administer chloroquine (78.4%) or artesunate (21.6%). Sixty two household heads reported that they may seek care from traditional healers specially in chronic cases of fever. No household head reported seeking care from traditional remedies for his/her children. Most of household heads (87.4%) reported that they would seek care at private clinics if their household members did not respond to their first action. Delays of 3 or more days in seeking treatment for malaria at health services were mentioned by (76.6%) of respondents specially adult members of households. Reason for this include (1) Lack of money (22.8%) (2) awaiting self improvement (40.2%) and (3) waiting for the effect of traditional remedies (37.1%).

Predictors of malaria incidence

We explored potential predictor variables using univariate and multivariate analyses. Potential predictors of malaria incidence included age, gender, primary water source, electric supply, number of people sleeping in the same room, number of people sleeping in the same house, density of vegetation in house, rearing of animals in house, malaria preventive measures, educational level of household head and family members, interval of absenteeism of household head, relatives' and children from work or school, renting/owning a house, housing conditions, number of rooms in the house, expenses of treatment in regards to overall income, number of air conditioners (if any), household property (a marker of economic status), primary household occupation and malaria attacks in the previous year (2005). Of the 19 factors modeled nine showed significant associations with malaria incidence (**Table 2**)

The household head age was found to be a significant predictor of incidence of malaria,

being highest in respondents aged 24–41, this may be attributed to that this is the most vulnerable section either being in close contact with vector (farmers) or by exhaustion of work. The primary water

Table 2: Some of the determinants of frequency of malaria attacks during the previous year (2005) in ElAzergab area.

Determinant	Frequency of Malaria Attacks previous Year (2005)		p-value
	>5 Attacks No. (%)	5-15 Attacks No. (%)	
Site of Accommodation:			.000
Free Possession	74(65%)	7(18.4%)	
Rent House	16(14%)	5(13.2%)	
Camp	23(21%)	26(68.4%)	
Number of Rooms:			.001
>2	56(49.1%)	35(92.1%)	
2-4	45(39.5%)	3(7.9%)	
<5	13(11.4%)	0(0%)	
Treatment Seeking Behaviour:			.001
Correct	72(63.2%)	8(21.1%)	
Incorrect	42(36.8%)	30(78.9%)	
Expenses of Treatment:			.000
<25%	31(27.2%)	0(0%)	
25%-50%	38(33.3%)	7(18.4%)	
>50%	45(39.5%)	31(81.6%)	

source and electric supply for the household were also significantly associated with the incidence of malaria (**Fig V**). Households using open water sources (irrigation canal) and had no electric supply had almost twice the rate of malaria compared to those using closed water sources (e.g. household taps), and have electric supply. These could be explained by that open water is suitable for mosquitoes breeding and thus increase the chance to be infected by malaria. Needless to say that the place from which these people obtain water is a suitable site for breeding of mosquitoes. Contrary to this electric supply is used to drive mosquitoes away by keeping light on at night or by using electric fans to drive them away. The frequency of malaria attacks was associated with household head education, family grade of education, occupation, economical status, number of rooms, renting or owning a house, treatment seeking behaviour, expenses of malaria, housing conditions and interval of absenteeism from work/ school (**Table 2**). Malaria incidence varied widely between the three economically distinct strata. In **Fig V** the stratum with the highest incidence (poor economic status) had more than tripled the rate of malaria incidence relative to the stratum with the lowest one (those with good economic status).

Fig V: Showing some determinants of frequency of malaria attacks in households interviewed in ElAzergab area

Fig a: Showing economic status as determinant of frequency of malaria attacks in ElAzergab area

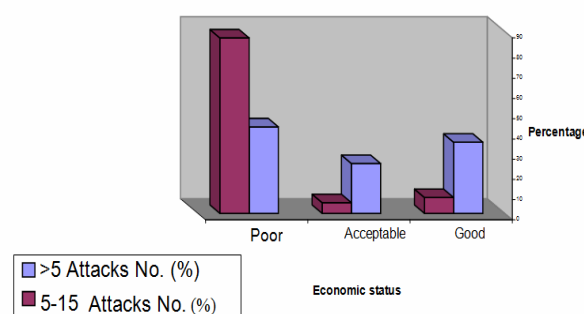




Fig b: Household heads' occupation as determinant of frequency of malaria attacks in Alezergab area.

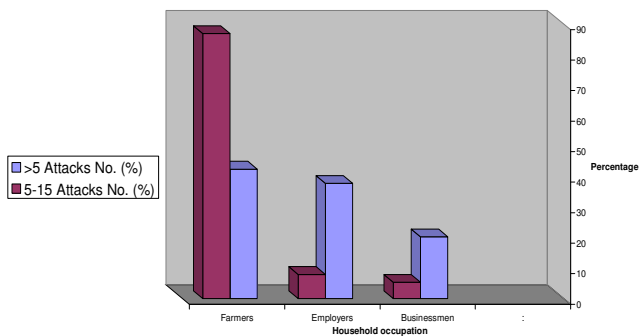


Fig f: Showing primary water resource as determinant of frequency of malaria attacks in EIAzergab area.

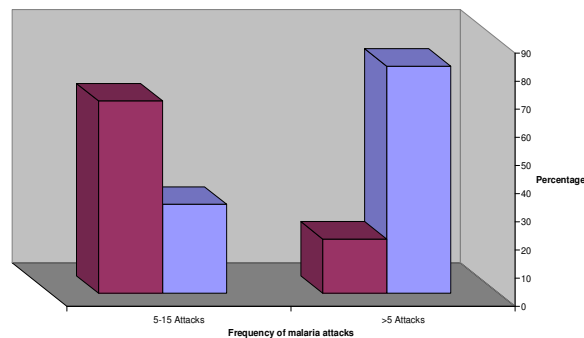


Fig c: Showing site of accomodation as determinant of frequency of malaria attacks in EIAzergab area.

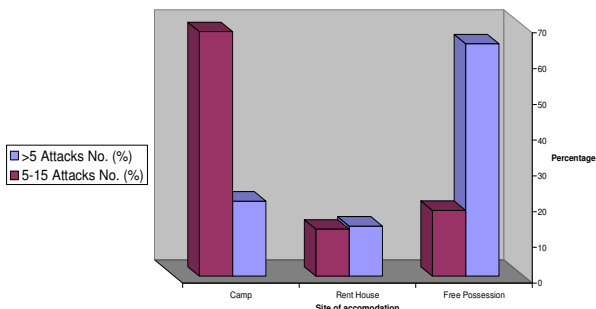


Fig d: Showing family grade of education as dterminant of frequency of malaria attacks in EIAzergab area.

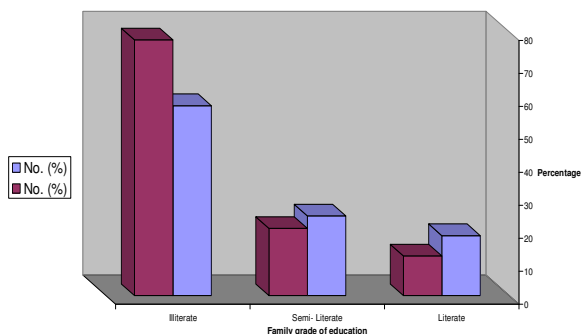
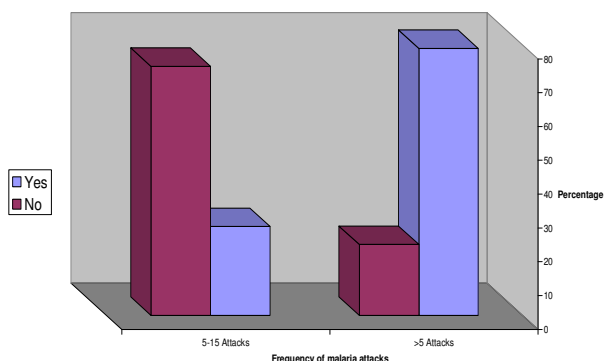


Fig e: Showing electric supply as determinant of frequency of malaria attacks in EIAzergab area.



Discussion

To understand the epidemiology of malaria in sub-urban setting like Khartoum State it is important to cater for demographic changes resulting from the recent migration and flow of people from different parts of Sudan. In this study it appears that household heads knowledge in ElAzergab area increases with education, property, and the economical status of the family in general. A high percentage of household heads was knowledgeable about malaria and/or mosquitoes as a cause of fever but far less so knowledgeable about their correct management. Indeed, in ElAzergab camps the words "wirrda" and "umbarid" means fever caused by mosquitoes. And every fever there was diagnosed and treated mostly at home as malaria. It is likely that many cases of fever of other causes were misdiagnosed and treated as malaria. This relatively higher level of knowledge in a sub-urban area is probably due to household education and economic status which facilitate greater access to media-information and contact with modern health services compared to those with poor education or economic status. Household heads in this study were highly receptive to the use of modern health care facilities for the treatment of their children from malaria. Eighty-two per cent would go to a hospital or clinic as their first or second action if their child was thought to have fever. For household heads the formal public health facilities are often the last source of treatment used along the pathway to cure. Often malaria



care initially involves leftover medicines from the home (from previously incomplete malaria or other treatment regimes), the purchase of cheaper herbal medicines or un-prescribed conventional medicines. The problems of obtaining treatment from a health facility may be exacerbated by the need to obtain permission from an authority figure, absence from work and loss of income. Though home treatment with antimalarials is a very common practice especially among adult people, the knowledge of proper administration of antimalarials in this study was limited. Only 29% of household heads knew the correct dose of (AS+SP), the first-line drug recommended for the treatment of uncomplicated malaria. Malaria control depends heavily on prompt, effective treatment and so ignorance of the correct dose may be a barrier to effective case management. Given these results, in a sub-urban setting, public health interventions for promoting proper anti-malarial treatment may best be focused on the training and supplying of formal health facilities where care is most frequently sought. Such a strategy might also limit the improper use of self-administered anti-malarial drugs which has become increasingly important with the spread of drug resistance and the move to more complicated regimens like the combination therapy which is now used in Sudan.

In this study risk factors and variability of the incidence of malaria were considered. The impact of the environment on the risk of malaria in micro-environments was examined. Proximity to the River Nile increases malaria incidence by 4- folds in ElAzergab area than those living far away. Again malaria incidence varied significantly across different small geographic areas and was dependently associated with the use of open water sources, which were potential mosquito breeding sites. The results showed that individuals obtaining water from irrigation canals (open source) reported a higher malaria incidence than those having piped water because the former kept water

for more than one week (28.7%). The association between electric supply, number of air conditioners and owning or renting a house with malaria incidence in this study was evident. This may be attributed to the fact that, mosquitoes may be driven away by fans and light. Possession of air conditioners may decrease exposure to mosquitoes by sleeping inside rooms as well as it may be an indicator of good economic standard together with owning a house. Delay in seeking malaria treatment is associated with high malaria incidence. The wide spread practices of self treatment in the present study were mainly related to the cost of medical services and cultural beliefs as stated by (50.9%) of respondents. Less than one third of respondents still rely completely on laboratory investigations for malaria diagnosis. The rest reported that they do not trust laboratories and that they would use anti-malarial drugs even if the result was negative as long as they feel malaria-like symptoms. However economic factors may sometimes hinder people to go for treatment. This association between expenses of malaria treatment in regards to overall income and housing conditions with frequency of malaria attacks was evident in the present study. Poor people are more frequently attacked by malaria and they spent more than half their income (46.1%) in treatment. This was a vicious cycle of deepening poverty in the most vulnerable sections of society in ElAzergab area. Also poor families live in dwellings that offer little protection against mosquitoes. Lost working or school days and occupation were more associated with the frequency of malaria attacks in poorer families in the study area. This is in agreement with earlier reports by WHO, (1998).

In ElAzergab area, the rainy season was often a time of intense agricultural activity, when poor families earn most of their annual income. Malaria made these families even poorer by lost working days and lost income. In poor families malaria has led to chronic school absenteeism, 43.6% of school children were absent for more than three days every

month thus impairing the learning ability of children.

In this study only 22% of household heads reported use of bed nets, although an additional 63% were aware of their effectiveness in prevention of malaria but they either could not afford buying them or they claim that use of bed nets is impractical. These results emphasize cost of nets as an important barrier to bed nets use and urge people concerned to make bed nets more accessible and affordable.

Sub-urban malaria is an important public health issue in Sudan and knowledge of unique characteristics in this growing population may be important for planning targeted malaria control interventions. In contrast to rural settings, here household heads are knowledgeable about the cause and symptoms of malaria and are highly receptive to the use of modern health facilities. Malaria incidence was heterogeneous and could be predicted by a few easily identifiable risk factors.

Acknowledgment

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