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ORIGINAL ARTICLE

Prevalence of malaria and use of malaria risk reduction measures among resettled pregnant women in South Sudan

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Background: The study assessed aspects of malaria infection, prevention and treatment in a population of resettled pregnant women in South Sudan.

Methods: During April and May 2008, a cross-sectional study was carried out to estimate malaria prevalence and to assess the use of malaria risk reduction measures and their associations with selected background characteristics. Two hundred and twenty women were tested for malaria parasitaemia and questioned about their malaria prevention and treatment practices.

Results: The results showed a prevalence of *Plasmodium falciparum* parasitaemia of 9.1%. No statistically significant associations were observed between selected background characteristics and malaria infection status. However, school attendance was significantly associated with insecticide-treated net ownership (OR = 6.52, 95% CI 2.37–17.94; p = 0.001) and access to malaria diagnosis and treatment (OR = 3.20, 95% CI 1.26–8.16; p = 0.015).

Conclusions: The results suggest that educational attainment need not be very advanced to affect practices of malaria prevention and treatment. Primary school attendance was a stronger predictor for use of malaria risk reduction measures than any of the other selected background characteristics. Educational attainment, information and communication about malaria prevention and control play a pivotal role in increasing and improving use of malaria risk reduction measures.

Keywords: Malaria, Pregnancy, Internally Displaced, Resettled Populations, South Sudan

Introduction

About 95% of South Sudan is endemic for malaria and transmission is high throughout the year. An estimated 2.3 million people are at risk of malaria across the country.[1] *Plasmodium falciparum* is reported to be the dominant malaria parasite and causes more than 90% of reported clinical cases. *Plasmodium vivax*, which occurs at the border regions with Ethiopia, causes 8% of cases. *Anopheles gambiae* s.s., *A. arabiensis* and *A. funestus* are the main mosquito vectors.[2] Malaria has been identified as one of the major causes of death and accounts for 20–40% of all visits to health facilities.[3]

Children less than 5 years old are particularly vulnerable to severe malaria infection and most malaria-related deaths occur among children in this age group.[4] The next most vulnerable group is pregnant women,[5] especially primigravidae who are the most susceptible to malaria infection.[6–8] The frequency and severity of malaria infections are greater during pregnancy and may cause severe anaemia, increasing the risk of maternal mortality.[9] The risks of fetal loss, premature delivery, intrauterine growth retardation and delivery of low birthweight infants, which is the single most important factor for neonatal mortality, have all been associated with malaria during pregnancy.[10,11]

South Sudan's malaria control strategy aims at reducing malaria morbidity and mortality and the socioeconomic impact of the disease. The strategy specifically aims at reducing under-5 mortality from 250/1000 to 140/1000 live births. The overall approach consists of an upscale of interventions for prevention and treatment of malaria delivered as a comprehensive, integrated package with a focus on the most vulnerable populations. The specific objectives seek to increase the population coverage with long-lasting insecticidal nets, indoor residual spraying and environmental management; provide wide access to appropriate diagnosis and highly efficacious artemisinin-based combination therapy using a mix of approaches that include public and private health care providers; and deliver a package

consisting of insecticide-treated nets (ITN), intermittent presumptive treatment (IPT) and effective treatment to pregnant women through comprehensive and focused antenatal care (ANC) services involving all levels of health care including the communities.

Malaria is seasonal and endemic in Unity State, South Sudan. The duration of the malaria transmission season is 4–6 months, between May and November, with either one or two peaks in August and/or October.[12] Since 2005, Unity State has received successive influxes of internally displaced persons returning from areas with stable and unstable malaria transmission. Approximately 60 000 persons have transited through Unity State and 10 000 have permanently settled in the state.[13] After years of refuge abroad or displacement in regions with unstable malaria transmission, the malaria immunity of the returning population is likely to be low. The arrival of a large population with low immunity, in areas of high transmission and little or no access to any antimalarial treatment has caused malaria epidemics and more localized outbreaks to occur.[2] Malaria and other disease prevention and control programmes have not been effectively restored. Although the malaria burden is presumed to be very high, health planners lack basic evidence, such as data on prevalence, geographic distribution and high-risk populations. The prevention and control of malaria in Unity State thus poses specific challenges. Evidence must be made available for the Ministry of Health to inform effective malaria control strategies. This study was carried out to collect relevant data which will enable health planners to estimate targets for intervention and establish a baseline for monitoring and evaluation.

Methods

Study site

The study was carried out in 11 villages in Unity State, South Sudan (Piterol, Mayom Elajoz, Engaz, Elshruta, Matar, Nouna, Chiachan, Tarawi, Bouchgai, Shati and Kuerboun). The villages are situated along the Cholpie River at the periphery of Mayom Town, Mayom County in the northwest of Unity State (9.224042N, 29.166706E). These villages were selected as their populations are entirely composed of resettled displaced persons. As one of the study's aims was to assess the use of malaria risk reduction measures (MRRM), the villages were also selected because of their proximity to a health dispensary that provides ANC and dispenses intermittent presumptive treatment for malaria in pregnancy (IPTp). In South Sudan, sulfadoxine–pyrimethamine (SP) is the drug of choice for IPTp.

The location of the villages along the Cholpie River was also important for their selection as the river is an important breeding site for malaria vectors. The major malaria vectors for *P. falciparum* breed in pools formed in streams and river beds and it is likely that people living close to such breeding sites are at higher risk of malaria than people living further away.[14–17]

Study population and subjects

The study population was originally displaced in 1987 as a consequence of the second civil war between Northern and Southern Sudan, which took place from 1983 to 2005. Some of the displaced population fled to Northern Sudan and resettled in the study area after the peace process was started and others were displaced several times within Mayom County, before resettling in the study area.

Sampling

The women enrolled in the study were selected using a systematic sampling scheme. The study site was divided into five sub-areas. The study personnel were divided into teams of two persons and each team was allocated a sub area. Each team walked around their allocated sub area and chose a centre. Starting from this centre, each team chose a direction at random by spinning a pencil on a large notebook placed on the ground and approached the fifth household in the chosen direction. The next household to be approached was the fifth counting from the first household, taking an immediate turn to the right. In the absence of pregnant women or refusal to participate, the study team proceeded to the immediate neighbouring household on the right.

Inclusion criteria

All women selected at the study site who reported being pregnant were eligible to participate and enrolled if they fulfilled the following criteria: absence of menstrual bleeding for at least 8 weeks; lack of previous history of gynaecological bleeding disorders; and had an uncomplicated singleton pregnancy. Gestational age was calculated from the last menstrual period and confirmed by obstetric examination of fundal height and fetal heart sound. The obstetric examinations were carried out clinically, i.e. without use of ultrasound by a general medical practitioner. Women with abnormal pelvic mass or other abnormalities were not enrolled.

Dependent variables

Five dependent variables were used. Malarial infection, defined as having a positive OptiMAL Malaria Test (DiaMed AG, Cressier, Switzerland). Self-reported use of DDT indoor residual spraying, defined as women who reported having their house treated indoors and/or outdoors with DDT within a 1 year period prior to or during their present pregnancy. Self-reported ownership of ITN, defined as women reporting to be in possession of at least one insecticide net, irrespective of whether the net was used consistently and properly or whether the net was damaged. Self-reported use of IPTp, defined as women who reported having received IPTp at least once during their present pregnancy. Self-reported previous malaria infection, defined as women reporting having been diagnosed by a rapid diagnostic test and treated for malaria within the last month prior to the study.

Independent variables

The independent variables were religious affiliation (Muslim or Christian vs Animist), ethnic group (Nuer vs non-Nuer), educational attainment (school attendance vs no school attendance), income (own income vs no income), parity (first or second pregnancy vs more than two pregnancies) and location during displacement (unstable malaria area vs stable malaria area)/time since resettlement. The choice of the independent variables was determined by combining the research team's knowledge

of the survey population and knowledge gathered from the existing literature about use of malaria prevention and treatment measures among displaced populations in Africa. The research team chose the six independent variables most likely to predict the survey population's use of malaria prevention and treatment measures. The associations between the independent variables and the dependent variables were measured and reported.

Data collection

Data were collected during April and May 2008. Respondents were tested for malaria parasitaemia after which they were administered a questionnaire. To test for malaria parasitaemia, fingerprick samples were collected. Approximately 10 μL of blood was collected in a microcapillary tube and immediately tested for the presence of parasitaemia using the OptiMAL test kit. The OptiMAL test detects the presence of *Plasmodium* antigen or parasite lactate dehydrogenase using monoclonal antibodies for individual diagnosis. The sensitivity and specificity of the OptiMAL test are 89.6% and 96.5%, respectively.[18–21] The questionnaire focused on respondents' religious affiliation, ethnic group, educational attainment, income, parity and location during displacement/time since resettlement and use of MRRMs.

Statistical analysis

All statistical analyses were performed using SPSS V.17.0 (SPSS Inc., Chicago, IL, USA). Logistic regression analysis was used to assess crude and adjusted associations of each independent variable with the dependent variables. Bivariate associations between independent and dependent variables were assessed. Subsequently, logistic regression analysis was used to adjust the significant associations obtained in the bivariate analysis for the effect of religious affiliation, ethnic group, educational attainment, income, parity and location during displacement/time since resettlement. Strengths of the associations were reported as ORs with 95% CIs and a p value of <0.05 was considered indicative of a statistically significant association.

Results

Characteristics of enrolled women

A total of 220 women were included in the study (Table 1). School attendance was reported by 38 (17.3%) women and of these 24 (63.1%) had attended primary school up to the fourth grade and 14 (36.1%) had attended school up to the eighth grade. Fifty-six (25.5%) women reported having an income. The majority of respondents, 159 (72.3%), reported being multigravidae, 31 (14.1%) primigravidae and 30 (13.6%) secundigravidae. One hundred and thirty-three (60.4%) women were in their third trimester, 39 (17.7%) were in their first trimester and 48 (21.8%) were in their second trimester. One hundred and twelve women (50.9%) had returned to the study area after displacement to Northern Sudan, an area of unstable malaria transmission, less than 4 years prior to the study. One hundred and eight women (49.1%) were displaced to areas of stable malaria transmission within Mayom County and had resettled in the study area more than 4 years prior to the study. Information regarding the age of the respondents was not used as only a minority of the respondents was able to report an exact year of birth.

Malaria parasitaemia among resettled pregnant women

Plasmodium falciparum infection was detected in 20 (9.1%) of the women; all were Nuer. No other malaria parasite species was identified. Among women with a Christian or Muslim and those with an Animist religious affiliation, 9.6% and 8.0% were malaria parasite positive, respectively. There were no statistically significant associations between religious affiliation, ethnic group, educational attainment, income, parity and location during displacement/time since resettlement and malaria infection.

Use of preventive and/or curative MRRMs

There were no statistically significant associations between religious affiliation, ethnic group, income, parity and location of displacement/time since resettlement and use of MRRMs (results not shown). School attendance was the only independent variable that was significantly associated with the use of MRRMs (Table 2).

Among the women with and without school attendance, 22 of 38 (57.8%) and 40 of 182 (21.1%) reported using at least one of the MRRMs, respectively. There was a statistically significant association between school attendance and use of at least one MRRM (OR = 4.37, 95% CI 1.99–9.59; $p < 0.001$) and between school attendance and use of more than two MRRMs (OR = 5.39, 95% CI 1.55–18.72; $p = 0.008$). Among the women with and without school attendance, 12 (31.5%) and 12 (6.5%) reported owning an ITN, respectively. The respondents with school attendance were more likely to own an ITN compared with those without school attendance (OR = 6.52, 95% CI 2.37–17.94; $p = 0.001$). Eleven (28.9%) of respondents who had attended school and 17 (9.3%) who had not attended school mentioned that they had accessed diagnosis and treatment within the past month, and this difference was statistically significant (OR = 3.20, 95% CI 1.26-8.16; $p = 0.015$).

There were no statistically significant associations between use of MRRMs and malaria infection status (results not shown).

Discussion

The present study measured the malaria prevalence and assessed malaria risk reduction practices among pregnant women, who after displacement, had resettled in a rural area with assumed stable malaria transmission in South Sudan. To the best of our knowledge, this study represents the first attempt to document malaria in pregnancy among the displaced populations in South Sudan. Prior data for the study area in terms of population-based malaria prevalence or estimates of malaria-related morbidity could not be identified.

We found an overall malaria prevalence rate of 9.1% at the beginning of the transmission season. Studies from Burkina-Faso,[22] Ethiopia[5] and Kenya[23] have found similar malaria prevalence rates. Other studies on malaria in pregnancy in areas of endemic and stable transmission have shown considerably higher malaria prevalence rates among pregnant women: a review of 20 studies from eight African countries, found that the prevalence of malaria infection in pregnancy ranged from

Table 1. Characteristics and outcome measures of 220 resettled pregnant women in South Sudan

Characteristic	No.	Positive parasitaemia	ITN ownership	IRS use	IPT use	Malaria diagnosis and treatment
Religion						
Muslim or Christian	145 (65.9)	14 (6.3)	19 (8.6)	10 (4.5)	19 (8.6)	21 (9.5)
Animist	75 (34.1)	6 (2.7)	5 (2.2)	3 (1.3)	5 (2.2)	7 (3)
Ethnic group						
Nuer	214 (97.3)	20 (9.1)	23 (10.4)	13 (5.9)	24 (10.9)	28 (13)
Other	6 (2.7)	0	1 (0.4)	0	0	0
Education						
Yes	38 (17.3)	4 (1.8)	12 (5.4)	3 (1.3)	8 (3.6)	11 (5)
No	182 (82.7)	16 (7.2)	12 (5.4)	10 (4.5)	16 (7.2)	17 (8)
Income						
Yes	56 (25.5)	5 (2.2)	5 (2.2)	5 (2.2)	4 (1.8)	10 (4.5)
No	164 (74.5)	15 (6.8)	19 (8.3)	8 (3.6)	20 (9)	18 (8)
Parity						
1st or 2nd pregnancy	61 (27.7)	8 (3.6)	9 (4)	4 (1.8)	6 (2.7)	10 (4.5)
More than two pregnancies	159 (72.3)	12 (5.4)	15 (6.8)	9 (4)	18 (8)	18 (8)
Displacement area						
Unstable malaria area	112 (50.9)	12 (5.4)	15 (6.8)	5 (2.2)	16 (7)	15 (7)
Stable malaria area	108 (49.1)	8 (3.6)	9 (4)	8 (3.6)	8 (3.6)	13 (6)

IPT: intermittent presumptive treatment; IRS: indoor residual spraying; ITN: insecticide-treated net.

about 10.0% to 65% and estimated the median prevalence of maternal malaria infection in all pregnant women to be 27.8%.[11] Another review of 11 studies estimated the median prevalence of maternal malaria infection in all pregnant women to be 26%.[24]

In the present study, malaria infection was not associated with income. Few studies have explored the relationship between malaria incidence and income. Whereas one large multicountry study found little difference in the incidence of fever (used as a proxy for malaria) across groups of different socioeconomic status, a few country-specific studies have shown that malaria prevalence is substantially higher among the poorest.[25] The results of the present study may also be explained by the lack of controlling of several factors that are highly correlated with poverty (e.g. type of housing, cattle and land ownership).

The analysis did not show an association between parity and malaria infection which is consistent with some studies.[26–29] However, other studies demonstrate that in areas with high transmission, where the level of acquired pregnancy immunity against malaria is expected to be pronounced, primigravidae are at higher risk of malaria infection compared with multigravidae.[7–9,30]

In contrast to other studies, we observed no association between income and practices of malaria risk reduction.[20] This result may be explained as the working respondents had low-status jobs. Income as such, does not guarantee better socioeconomic status nor is it equal to the earning of a regular income or disposing of cash. Working women may well be remunerated in food, goods or services or they may hand over the money earned to another member of the household who decides how the cash is spent.

We found a strong and statistically significant association between school attendance and ITN ownership, and between school attendance and seeking out diagnosis and treatment. Furthermore, we observed a borderline association between school attendance and IPTp use. Other studies have demonstrated a relationship between educational attainment and malaria perceptions and practice.[31] Interestingly, the present study showed a significant association between school attendance and preventive and curative behaviour although the educational attainment of the respondents was not very advanced.[32]

No association was found between malaria risk reduction practices and malaria infection. IPTp consumption and ITN ownership did not seem to provide protection from malaria. This may be explained by the limited number of respondents who reported using IPTp and/or owning an ITN and the small number of women with malaria. Other explanations include incorrect drug dosage, poor quality of drugs or incorrect drug use. Owners of ITNs may not have used the net consistently and/or properly (too many people sleeping under the net or people sleeping too close to the net) or the net may have been damaged. In relation to educational attainment and malaria infection status, it is interesting to note that the results of the present study are not supported by other studies, which have shown that educational attainment has a beneficial effect on malaria burden.[33–35]

Limitations

The study had several limitations. First, women were enrolled early in the transmission season, i.e. at a time where parasitaemia rates are low. In addition, we did not know the incidence

Table 2. Relationship between use of malaria risk reduction measures (MRRM) and school attendance among 220 resettled pregnant women in South Sudan

	Bivariate analysis			Multivariate analysis		
	OR	(95% CI)	p value	OR	(95% CI)	p value
ITN ownership						
School attendance	6.54	(2.66–16.09)	<0.001	6.52	(2.37–17.94)	0.001
No school attendance	1			1		
IPTp use						
School attendance	0.36	(0.14–0.92)	0.027	0.37	(0.13–1.06)	NS
No school attendance	1			1		
Diagnosis and treatment						
School attendance	3.95	(1.67–9.35)	<0.001	3.20	(1.26–8.16)	0.015
No school attendance	1			1		
Use at least one MRRM						
School attendance	4.88	(2.34–10.16)	<0.001	4.37	(1.99–9.59)	<0.001
No school attendance	1			1		
Use more than two MRRMs						
School attendance	4.91	(1.66–14.51)	0.002	5.39	(1.55–18.72)	0.008
No school attendance	1			1		

IPTp: intermittent presumptive treatment of malaria in pregnancy; ITN: insecticide-treated net; NS: not significant.

or the prevalence of infection. Other studies conducted in areas with endemic seasonal malaria have shown important variations in transmission intensity.[14] Had we enrolled women at the peak of the malaria transmission season, the results could have been more easily compared with other observations reported from similar studies. The study was conducted in a rural area with access to ANC. In areas without access to ANC, the burden of malaria may be higher and this result may be an underestimation of the true burden of malaria in pregnancy in rural South Sudan. For logistical reasons, the OptiMAL rapid test was used to measure parasitaemia. Although the sensitivity and specificity of the OptiMAL test have been reported as high,[36] a more sensitive tool such as PCR could potentially have detected malaria parasites in a higher number of women. No other recognized standard test was used as a comparison with the OptiMAL test results. The study did not look at respondents' sources of health information on MRRMs during displacement or/and upon return. Yet respondents' access to such information plays an important role in their level of awareness of exposure to malaria and use of MRRMs.

Conclusions

This study suggests that resettled women who attended school were significantly more likely to own an ITN, to seek out diagnosis and treatment and to use several measures for malaria risk reduction. This may serve to illustrate that school attendance plays an important role in determining vulnerability to malaria. A person's attitude and behaviour when exposed to malaria infection are at least as important as or even more important than the exposure alone. Exposure to malaria infection does not automatically translate into actual malaria infection—at least not as long as one is aware of the increased exposure and capable of using MRRMs.

Based on the findings in the present study, we suggest improving information, education and communication about malaria prevention and control as these all play a pivotal role in increasing the use of MRRMs and improving their appropriate use.

Authors' contributions: BGK and TD conceived and designed the study; BGK collected the data; TD and BGK conducted the literature search; TD, DM and BGK analysed and interpreted the data and wrote the manuscript; TD critically revised the manuscript. All authors read and approved the final manuscript. TD is guarantor of the paper.

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