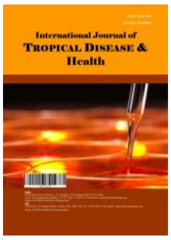

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Malaria Transmission and Asymptomatic Malaria during Rainy Season among Nomads, North-eastern Nigeria

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Author's contribution

The sole author designed, analyzed, interpreted and prepared the manuscript.

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ABSTRACT

Aim: To determine the point prevalence of malaria infection and asymptomatic malaria during rainy season among some nomads of North Eastern Nigeria.

Study Design: A cross sectional observational study.

Place and Duration of Study: The study was conducted across 11 randomly selected nomads' camps around the Rivers Gongola and Benue basins spread over 3 Local Government Areas of Southern Adamawa State of North Eastern Nigeria. Data was collected during rainy season between July and September, 2016.

Methodology: Fifty-five randomly selected households (5 from each camp) were covered in the survey. One hundred and ninety two (192) consenting participants aged between 1 and 79 years (inclusive) were involved in the survey. Structured questionnaires were administered (care givers consented and responded on behalf of children) and blood samples collected. Blood samples were examined for malaria parasite using a microscopes and results of both survey and microscopy analysed.

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Results: Overall malaria parasite prevalence was 87.5% and mean parasite density was 36,168 parasites per µl of blood. Thirty five (18.2%) of participant were of low parasite density, 35.5% were of moderate parasite density while 32.8% were of high parasite density. More than half (53%) of the malaria positive participants did not experience febrile symptoms within one month prior to the survey and were therefore asymptomatic. Tendency of manifestation of symptoms significantly increased with parasite density and decreased with age. The use of preventive measures against mosquito bite was 7.7% and only 16.1% of participants used antimalarial medicines or sought medical attention during their most recent fever episode.

Conclusion: The high prevalence of asymptomatic carriers with high parasite densities and abysmally low usage of preventive and curative measures among the study population represents an ideal condition for effective malaria transmission which is unlikely to abate unless control measures are intensified.

Keywords: Malaria parasite transmission; asymptomatic malaria; parasite density; nomadic fulani.

1. INTRODUCTION

Malaria remains one of the most dreaded public health problems worldwide causing a death toll of 627000 in 2020 up from 558,000 in 2019 [1] and a loss of enormous economic resources which has been estimated at 12 billion USD annually in terms of direct cost and multiples of it in terms of loss in economic growth [2]. About 95% of malaria burden is borne by Sub-Saharan Africa [3,4]. With renewed control efforts, malaria incidence, prevalence and mortality were declining globally prior to the COVID-19 pandemic [1]. However, there is considerable disparity in the decline among and within countries [5,6]. While the estimated prevalence of malaria in Nigeria is below 31.4% [1], many localized studies have reported prevalence of between 50 - 80 percent in some foci [7-10]. In highly endemic areas, malaria prevalence could exceed 90% during peak transmission periods [11]. During high transmission, individuals in malaria endemic regions often harbor high number of parasites - exceeding 100,000 parasites/ul of blood [12]. Although parasitaemia has been found to positively correlate with severity of illness, repeated exposure to infection appear to gradually enhance mechanisms to limit the inflammatory response associated with febrile illness and hence large proportion of infected individuals remain asymptomatic carriers [13,14].

There is an estimated 35 million Fulani nomads spread across West and Central African countries [15]. Nigeria hosts a considerable proportion of the nomadic Fulani population in West Africa. It is estimated that there are about 15.3 million Fulani pastoralist in Nigeria and a considerable number of them are nomads [16,17]. Nomad groups usually have defined and fairly consistent pattern of migration following an annual cycle. Although most of their camps during their migration cycle are located in close vicinity to local sedentary communities, their culture and life style significantly differ from these neighboring sedentary communities [18].

Fulani nomads are by their life style more exposed to infectious diseases including malaria than sedentary populations. Although appearing generally healthier their sedentary rural neighbours, they seldom benefit from interventional programmes of the conventional health system [19].

In Nigeria, nomads inhabiting the Gongola-Benue basins in Adamawa State live in highly malaria endemic region and prevalence of about 37% has been reported even during the dry season [18,20]. Nomadic Fulani have for long held the belief that malaria which is locally identified as *Pabboje* is an inherent illness of the Fulani and does not need to be treated since it “visits for a while and goes away”. It is believed that modern antimalarial treatment may aggravate subsequent malaria episodes [18]. The complacency which nomadic Fulani adopts in coping with malaria and anecdotal data suggest that nomads could harbor substantial malaria parasite burden while remaining asymptomatic. That, coupled with their reduced access to intervention services, positions the Nigerian nomadic Fulani as reservoirs of malaria infection with the potential of upsetting current control and elimination efforts. Determining the magnitude of this concealed prevalence among the nomads is important in highlighting the need for targeted interventions. We report here the point prevalence of malaria infection and asymptomatic malaria during rainy season (between July and September, 2016) among the nomads of north western Adamawa State of North eastern Nigeria.

2. MATERIALS AND METHODS

2.1 Study Area

The study was conducted in 11 nomadic Fulani camps spread across three Local Government areas in the Southwestern part of Adamawa State, namely; Demsa, Numan and Mayo Belwa Local government areas. These Local Government Areas are located between latitudes 8.400N - 9.500N and longitudes 11.50S - 12.35S. Along the border of the Local government areas (Demsa and Numan) is a confluence of two important rivers - Gongola and Benue. The basins of these two rivers attract substantial economic activities including fishing, cropping and animal grazing. Nomadic Fulani pastoralists traditionally congregate along the river basin as soon as crops are harvested around December. A proportion of the nomads occupy parcels of uncultivated the hilly parts of the basin during the rainy season. Although the 2013 malaria epidemiological guide reported Adamawa State malaria risk model as mesoendemic [21], the Upper Benue Basin (also within Adamawa) is hyperendemic and a 2020 under-five malaria risk modeling report has designated it among the high malaria “hotspots” [22]. Moreover, nomadic Fulani pastoralist in the Benue Basin have been known to be highly exposed and harbor high malaria infection rates [23]

2.2 Study Design

A cross sectional survey design was conducted during the months of July and September targeting nomads who spend the rainy season in the study area.

2.3 Sampling

Eleven camps were randomly selected from a list forty camps earlier identified for an interventional study by means of folded papers. Six (Anini, Chore, Dudel, Dwam, Marawo and Kadel) camps from the cluster of camps in Demsa and Numan LGAs and 5 (Korawa-Maccido, Korawa-Umaru, Korawa-Burti, Korawa-Ahmadu and Liringo) camps from the Mayo Belwa LGA cluster. From each camp, 5 households were randomly selected and all consenting members of the household who were 1 year or older were included in the study. In addition to children less than 1 year old, severely ill household members were also excluded from the study.

2.4 Data Collection

Structured questionnaires designed for oral interviews were administered for each participant either directly or through a child minder (in the case of children). The questionnaire was designed to collect demographic data, clinical manifestation of malaria, medicine usage (anti malaria medicine use was defined by either taking a prescription from a health personnel or use of any of the approved antimalarial medicines since they are easily recognizable) and use of barriers against mosquito bite (use of protective barrier was defined by use of insecticide, insect repellant or mosquito net). A section on blood collection and examination has been included in each questionnaire. The section was used to document results of microscopy for malaria parasite.

Blood sample collection was done concurrently with the interview. For each participant, a sterile lancet was used for blood collection. The lancet was opened by the collector (a research team member) and witnessed by the participant or community members (for children). The lancet was used to prick the ball of the finger after gently massaging and disinfecting the area with ethanol-soaked cotton wool. By squeezing the finger for free flow of blood, a drop of blood is collected on clean grease –free slide. The edge of another slide was used to make a thick smear and allowed to dry for laboratory staining and microcopy. Finally, the pricked area was cleaned with dry cotton wool.

2.5 Microscopy for Malaria Parasite

Microscopy and parasite estimation were done as described by WHO and Adu-Gyasi and colleagues [24,25]. The slides containing the thick smears were brought to the laboratory and stained using 10% Giemsa stain. The slides were allowed to dry and observed under X100, oil immersion objective of a light microscope. The number of asexual stage of parasites seen per oil immersion field and the number of white blood cells (WBCs) were also counted for the same field. Counting continued until 100 parasites or 200 WBCs was counted and when less than10 parasites were found after counting, counting continued until 500 WBCs were counted. As many as 100 oil immersion fields were viewed without identifying a malaria parasite before a slide is regarded negative. Microscopy of slides was validated by a reference microscopist in Yola Specialist Hospital.

2.6 Parasite Density Estimation

Numbers of parasite and WBCs seen were recorded and entered into EpiInfo along with the rest of the data. Parasite densities per micro liter (μl) were subsequently computed in SPSS 20 as follows:

Parasite density per μl= (Number of parasite x 8000)/(Number of WBC)

Where 8000 is the assumed number of WBC per μl of blood.

Parasite densities across all the malaria positive participants were classified into three levels fairly corresponding to classification by Kotepui and colleagues [26]. Participants whose slides had 1 – 3999 parasites per μl were classified as low parasite density, 4000 – 24999 parasites per μl classified as moderate parasite density while 25000 or more parasites per μl were classified as high parasite density. Those with 0 parasites per 100 oil immersion field were classified as not infected.

2.7 Data Entry and Analysis

All data were entered into EpiInfo 6 and transferred into SPSS 16 for analysis. Frequencies and percentages were used to compute prevalence and proportions. Association between febrile symptoms and parasite densities was explored and significance tested by Chi Square at 95% confidence level. Similarly, Associations between asymptomatic infection (those who did not report having fever in the last one month) and other demographic variables were explored and significance tested at 95% confidence level using chi square.

3. RESULTS AND DISCUSSION

3.1 Demographic Characteristics and Malaria Parasite Infection

One hundred and ninety two participants comprising of 131 males and 61 females took part in the study. Table 1 shows the demographic characteristics of the participants and their malaria infection status. The participants belong to two major clans of nomadic Fulani frequently camping around the study area – the Kiri clan made up 58.9% of the participants while the remaining 41.1% were made up of Fulani from the Goriji clan. Malaria parasite count on thick blood smears from the participants showed that 24 (12.5%) of the participants were not infected while the remaining 168 (87.5%) were infected with varying densities of malaria parasite. Estimation of levels of parasitaemia showed that 18.2% of participants were of low parasite density (1-3999 parasites per μl) category, 35.5% were of moderate parasite density (4000 – 24999 parasites per μl) while 32.8% were in the high parasite density (>24999 parasites per μl) category. The mean parasite density among the malaria positive participants was 36168 parasites per μl of blood.

Table 1. Demographic characteristics and malaria infection status of participants

Variables	Number in sample (N=192)	Percentage
Sex		
Males	131	68.2
Females	61	31.8
Clan		
Kiri	113	58.9
Goriji	79	41.1
Age group		
<5 years	25	13.0
5 – 14 years	93	48.4
15 – 29 years	26	13.5
30 – 44 years	27	14.1
45 – 59 years	16	8.3
60 years and above	5	2.6
Malaria infection status		
Not infected	24	12.5
Low parasite density	35	18.2
Moderate parasite density	70	36.5
High Parasite density	63	32.8

3.2 Parasite Density and Manifestation of Symptoms

Table 2 shows the distribution of infection and parasite densities among participants with recent (within one month) febrile symptoms and those without. Most (56.8%) of the participants (infected and non-infected) did not experience febrile symptoms within one month prior to the date of collection of blood sample. Proportions of participants with febrile symptoms were similar among non-infected (16.7%) and those infected with low parasite density (17.1%). Febrile symptoms experience showed significant association with parasite density at p=0.001. More than half of the participants with moderate parasite density (51.4%) and high parasite density (58.7%) had recent febrile symptoms. Symptoms most frequently reported includes hot-body (71 cases) followed by headache (66 case). Least frequently reported symptoms were diarrhea (4 cases), cough (3 cases) and chest pain (2 cases) which were all categorized as "other" symptoms. Majority (109) of participants reported experiencing no symptoms in the last one month prior to data collection (Fig. 1).

3.3 Manifestation of Symptoms Febrile Symptoms, Demographic Characteristics and use of Control Measures

Among the 168 malaria positive participants, proportion of those who were asymptomatic vary significantly with age group but insignificantly with sex, clan, antimalarial medicine use and use of protective barriers against mosquito bite at p=.05 (Table 3). Sixty four (57.1%) of malaria positive males were asymptomatic while 25 (44.6%) of females were asymptomatic. However, Chi-square test showed that the difference in the proportion of asymptomatic participants between to two genders was not statistically significant at 95% confidence level. Use of preventive measures against mosquito bite and use of antimalaria medicine during the most recent fever episode were 7.7% and 16.1% respectively among the participants. Manifestation of febrile symptoms did not significantly differ between those who use protective barriers against mosquito bite and those who do not neither did it differ between those who between took antimalarial medicines and those who did not.

Table 2. Distribution of malaria parasite densities among symptomatic and asymptomatic participants

Malaria infection status (N)	Recent (within one month) febrile symptom	
	Symptomatic (%)	**Asymptomatic (%)**
Not infected (24)	4 (16.7)	20 (83.3)
Low parasite density (35)	6 (17.1)	29 (82.9)
Moderate parasite density (70)	36 (51.4)	34 (48.6)
High Parasite density (63)	37 (58.7)	26 (42.3)
Total	**83 (43.2)**	**109 (56.8)**

X^2=24.2691,df=3, p<0.001

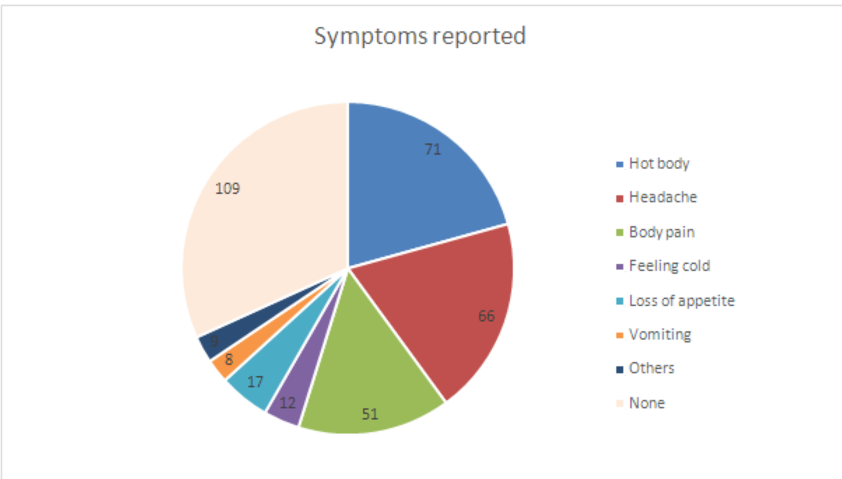

Fig. 1. Symptoms (in including "no symptoms") as reported by participants

Table 3. Comparison of symptomatic (N=79) and asymptomatic (N=89) malaria positive participants by demographic characteristics, antimalarial use and use of barriers against mosquito bite

Demographic characteristics, antimalarial use and use of barriers against mosquito bite (N)	Recent (within one month) febrile symptoms		
	Symptomatic (%)	Asymptomatic (%)	p-value
Sex			0.086
Male (112)	48 (42.9)	64 (57.1)	
Female (56)	31 (55.4)	25 (44.6)	
Clan			0.084
Kiri (109)	56 (51.4)	53 (48.6)	
Goriji (59)	23 (39.0)	36 (61.0)	
Age group			**>0.001****
<5years (21)	18 (85.7)	3 (14.3)	
5-14 years (84)	45 (53.6)	39 (46.4)	
15 – 29 years (24)	7 (29.2)	17 (70.8)	
30 – 44 years (24)	6 (25.0%)	18 (75.0%)	
45 years and above (15)	3 (20.0)	12 (80.0)	
Antimalarial medicine use			0.224
Yes (27)	15 (55.6)	12 (44.4)	
No (141)	64 (45.4)	77 (54.6)	
Use of barriers against mosquito bite			0.590
Yes (13)	6 (46.2)	7 (53.8)	
No (155)	73 (47.1)	82 (52.9)	

***Significant at P=0.01*

3.4 Discussion

We conducted a cross sectional survey to determine the point prevalence of asymptomatic malaria and its relationship with other relatable factors among the Fulani nomads who inhabit some of the less swampy uncultivated parcels of land around the basins of Rivers Benue and Gongola in South Western part of Adamawa State during the rainy season.

The results showed high prevalence (87%) of malaria infection during the rainy season which corresponds to season of high transmission similar to what has been reported in other studies in some parts of Nigeria [10,11].This high prevalence of infection was expectedly, complemented by high parasite densities, agreeing with findings from other similar studies [27,28]. Average parasite density among the malaria positive participants 36361/ul.

Considering those who were malaria parasite positive, there were more asymptomatic participants (53%) than the symptomatic ones (47%). This confirms high prevalence of asymptomatic malaria infection among the study population similar to what is being reported in many malaria hyper-endemic settings [29-31].

Although there appears to be no clear-cut threshold of parasite density that corresponds to febrile attacks, the likelihood of experiencing fever symptoms increased significantly with increasing parasite density. This finding is consistent with a number of studies reporting significant relationship between fever-risk and parasite density, among other variables [32,33].

The proportions of participants who reported recent febrile symptoms were similar among non-infected (16.7%) and those infected with low parasite density (17.1%) suggesting that, at low densities, parasitaemia might not have played a role in eliciting fever symptoms in the study area. Similar finding was reported in a study in West Bengal where none of the malaria positive participants with parasite densities up to 12,800 parasites per µl exhibited symptoms of malaria [34]. Expectedly, significantly more of the participants with higher parasite densities (>3999) experienced recent febrile illness but even in those categories, a considerably large proportion (45%) of them was also asymptomatic. This is indicative of the existence of effective transmission in the study population even among apparently healthy individuals.

Similar to earlier reported findings from the same study area [18], the use of preventive barriers against mosquito bites and the use of antimalarial medicines were as low as 7.7% and 16.1% respectively. Lower usage of preventive measure ensures exposure to malaria infection and hence transmission. Furthermore, the abysmally low antimalarial usage among both symptomatic and asymptomatic malaria positive participants during their last fever episode suggests that transmission could perpetuate uninterrupted.

When five socio- demographic attributes including sex, clan, age, use of antimalarial medicine and use of protective barriers against mosquito bite were explored for association with manifestation of symptoms among the malaria positive participants; it was found that only age showed significant association with manifestation of symptoms. More than 85% of malaria positive children younger than five years have experienced recent febrile symptoms while 53% of malaria positive participants within the age bracket of 5-14 years (inclusive) had recent symptoms and as few as 20% of malaria positive participants who were 45 years or older experienced recent febrile symptoms. This finding corroborates the much reported age (hence exposure)-dependent acquired immunity among malaria endemic populations [35-37].

4. CONCLUSION

The prevalence of malaria parasitaemia is high in the study area with most of the study participants hosting thousands of parasites per µl of blood. However, in most cases, clinical symptoms do not manifest. This veiled parasitaemia is more common among the older members of the population than in the younger ones apparently because of the relative immunity acquired by the older ones through repeated exposure. The use of preventive measures against mosquito bites and antimalarial medicines are abysmally low among the study population. The scenario represents an ideal condition for effective malaria transmission which is unlikely to abate unless control measures are intensified. We therefore recommend the application of tailor-made control strategies to this population with exceptional lifestyle.

ETHICAL APPROVAL AND CONSENT

Ethical approval was obtained from Adamawa State Ministry of Health via a letter referenced S/MOH/1131/1/06. Nomad community leaders at various levels were approached and their consent to work among their community members obtained. Informed consent was obtained from each adult participant and from child minders (in the case of children). Standard aseptic techniques were strictly adhered to during sample collection and data obtained were handled confidentially. Field team included a health personnel who managed minor illnesses using essential medicines in the team's kit. Cases were referred to the health facility when necessary.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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