Original Article

PREVALENCE AND RISK FACTORS OF MALARIA AMONG INTERNALLY DISPLACED PERSON IN TENT CITY OF HYDERABAD, SINDH

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Abstract:

Background: Flooding is associated with increased malaria transmission in many regions worldwide. However, there is a lack of comprehensive studies that specifically investigate the seroprevalence and determinants of malaria subtypes among flood-affected internally displaced population (IDPs) in Sindh, Pakistan. The objectives of this study were to determine the prevalence of malarial types and risk factors associated with them.

Material and Methods: A cross-sectional study was conducted on the IDPs in Hyderabad, Sindh who were affected during August – October 2022 floods. A structured questionnaire was used to collect data about their demographic background, current signs and symptoms, and basic knowledge on malaria. Individuals with an axillary temperature > 100ºF and myalgia at the time of data collection were included in the study and after seeking consent they were assigned to either Rapid Diagnostic Testing (RDT) or Microscopy for malaria. Data was entered, described and analyzed using Stata v. 16.0.

Results: Out of all registered IDPs [N= 4980], almost half of them [n=2640; 53%] who were found to be suffering from fever, were included in the study [age range= 1 day to 96 years]. Total prevalence of malaria patient positive was found to be 13.41%; 1.7% affected by Plasmodium Falciparum and 11.7% by Plasmodium Vivax. Gender, age and pregnancy were found significantly associated with malaria [$p \leq 0.05$].

Conclusion: This study offers a thorough analysis of the demographics, diagnosis, and prevalence of malaria in a IDPs in Sindh due to flood. The results underline the necessity of specialized healthcare interventions that take gender, age, and pregnancy status into account.

Keywords: Malaria, Plasmodium, Disease Outbreak, Flood

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INTRODUCTION

World Health Organization (WHO) reported that among the seven Eastern Mediterranean countries, Pakistan responsible for 98% of burden of malaria in this region. The statistics showed that approximately 217 million Pakistani is at intermediate risk of malaria, 63 million are at high risks with 0.47 million malaria infections and 800 fatalities reported in 2020.[1] Malaria is endemic in many parts of Pakistan, with significant variations in transmission intensity across the country. Sindh, located in the southern region of Pakistan, has historically been prone to malaria outbreaks primarily due to its tropical and subtropical climate, suitable breeding grounds for mosquito vectors, and a lack of adequate healthcare infrastructure in rural areas.[2] The

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province consistently ranks among the regions with high malaria burden in Pakistan.

Pakistan has witnessed its worst humanitarian crisis of a decade, resulting in torrential rains and the most devastating flash floods. In the last 73 years of Pakistan's history, this was the most widespread flooding that brought a lot of complications with it. This has left one-third of Pakistan's area under water and made it resemble a small ocean. Among the severely affected areas the provinces of Sindh and Baluchistan are at the top of the list. Approximately 6.4 million people are in dire need of immediate support. People are still forced to live under open skies in most parts of the country, waiting for relief goods and shelter.[3] Climate change has been perceived as on urgent global challenge, resulting in outbreak of many infectious diseases. Flooding events have been associated with increased malaria transmission in many regions worldwide.[4] The displacement of populations, disruption of healthcare services, and the creation of suitable breeding habitats for mosquito vectors in stagnant water can contribute to increased malaria risk among flood-affected communities. Seroprevalence studies play a crucial role in understanding the epidemiology of infectious diseases. They provide insights into past and current exposure to pathogens within a population. In the context of malaria, seroprevalence studies can help determine the extent of transmission, identify high-risk groups, and assess the effectiveness of control measures.[5] Despite the well-documented association between flooding and increased malaria risk, there is a lack of comprehensive studies that specifically investigate the seroprevalence and determinants of malaria subtypes among flood-affected IDPs in Sindh, Pakistan. This research aims to bridge this gap and provide valuable insights into malaria control and prevention strategies in similar disaster-prone regions. The positive and exact or near-to-exact determination of the prevalence of Plasmodium infection can likewise help increase malarial infection observation and its management to the flood affected in need of time.[6] Unfortunately, we do not have exact information and data regarding the prevalence of Plasmodium subtypes in internally displaced persons of Pakistan.[7] To plan for and carry out incorporated Malaria control intervention. The result of this study will affirm that Malaria disease in Pakistan changes with irregularity variety in the environment. The study aims to strengthen the health system and to help policymakers take proper intervention and manage malaria endemic with the best of their knowledge. The objectives of this study were to determine the prevalence of malarial types and risk factors involved among internally displaced persons of Sindh.

MATERIAL AND METHODS

A cross-sectional study was conducted on the internally displaced population group in Hyderabad, Sindh who were affected by rain and flood. Only those registered individuals residing in the Tent City during the period from August 2022 to October 2022 were eligible to participate in the study. A structured questionnaire was used that was adopted from previous study, to collect data about their demographic background, current signs and symptoms, and basic knowledge on Malaria.[8] Ethical approval was obtained from the Institutional Review Board of Health Services Academy (IRB-HSA).F.No.Fall/HAS/ MSPH-2021, dated 29th May 2023. Convenience sampling method was used to collect the data after explaining the purpose and objectives of the study and written informed consent was obtained from each participant. The clinical signs and symptoms of Malaria that were assessed included fever, chills, myalgia, vomiting headache and sweating. Individuals presenting with fever (axillary temperature > 100ºF) and myalgia at the time of data collection were included in the study and after seeking consent they were randomly assigned to either Rapid Diagnostic Testing (RDT) or Microscopy for malaria testing. The procedure involved pricking the participant's fingertip, collecting a blood sample, and using the RDT

kit to test for the presence of Malaria antigens *(Plasmodium vivax and Plasmodium falciparum).* The results were interpreted, distinguishing between positive and negative cases for both Malaria subtypes. Data was entered, described and analyzed using Stata v. 16.0. Prevalence of all individuals tested positive for Malaria using RDT and Microscopy was calculated. Prevalence of subtypes of malarial infection was also calculated and presented in frequency and percentages. For analysis all tested positive on both RDT and Microscopy were combined to assess the differences in independent variables including demographic variables, testing types, clinical signs and symptoms, and individual responses on questions related to malaria. For independent variables which were continuous in nature, student t-test was used, whereas, for categorical variables fisher exact chi-square test was used to calculate the p-values considering $p \leq 0.05$ as statistically significant. Significant differences were considered a p-value ≤0.05 and 95% confidence interval. Multivariate analysis was also done to calculate odds ratios (ORs) to assess the confounding association of independent variables with individuals tested positive for malaria.

RESULTS

Out of all registered and residing population in the Tent City of Hyderabad [N= 4980], almost half of the population [n=2640; 53%] were found suffering from fever (axillary temperature > 100ºF) and myalgia. The mean age of these individuals was found with 37.87±17.17 [range= 1 day to 96 years]. Majority of individuals were uneducated and had no formal education; only less than 2% had formal education of secondary and graduate level in all. Around 5% of all the women were found pregnant. Out of all study participants 28% underwent microscopy test and 72% underwent rapid diagnostic test (RDT) for malaria. The prevalence of individuals found positive for malaria in both RDT and Microscopy groups was found as 13.41%. Their demographic details in different categories are given on table- 1.

Table 1: Demographic details of the study participants (n=2640) residing in Tent City of Hyderabad

Gender		
	(n=2640)	**(%)**
Female	828	31.4
Male	1812	68.6
Educational level		
Un-educated	2477	93.8
Educated	163	6.2
Categories	**(n=2640)**	**(%)**
Age groups		
0 – 29 years	867	32.8
30 – 44 years	863	32.7
45 – 96 years	910	34.5
Pregnant women (n=828)		
Yes	45	5.4
No	783	94.6
Religious belief		
Muslim	2436	92.3
Non-Muslim	204	7.7
Use Mosquito Nets		
Yes	2210	83.7
No	430	16.3
Heard of Malaria		
Yes	2001	75.8
No	639	24.2
Malarial Test Types		
RDT	1900	72.0
Microscopy	740	28.0
Test Result		
Positive	354	13.4
Negative	2286	86.6

Table-2 presents the detailed description of participants who were found positive with Plasmodium Falciparum and Plasmodium Vivax types of malaria. Only 12.4% [n=44] were found affected by *Plasmodium Falciparum* in comparison to *Plasmodium Vivax* who were 87.6% [n=310] out of all

malaria positive individuals. The overall population affected by *P. Falciparum* was 1.7% and those affected *by P. Vivax* was 11.7%. However, there was no statistical difference [p > 0.05] with respect to demographic variables (age, gender, and religious belief), pregnancy status, signs, symptoms and use of mosquito nets between individuals affected by *P. Vivax or P. Falciparum.* Yet the results show that not a single pregnant woman was affected by P. Falciparum and only 10 out of 80 pregnant women were affected by *P. Vivax.*

Table 2: Detailed background of individuals tested positive for Malaria (n=354)

P. Vivax (%) n= 310		**P. Falciparum (%) n= 44**
Gender		
Female	69 (22.3%)	11 (25.0%)
Male	241 (77.7%)	33 (75.0%)
Educational level		
Un-educated	286 (92.2%)	43 (97.7%)
Educated	24 (7.8%)	1 (2.3%)
Categories	**P. Vivax (%) n= 310**	**P. Falciparum (%) n= 44**
Age groups		
0 – 29 years	124 (40.0%)	24 (54.5%)
30 – 44 years	86 (27.7%)	11 (25.0%)
45 – 96 years	100 (32.2%)	9 (20.5%)
Pregnant women (n=80)		
Yes	10 (14.5%)	0 (0.0%)
No	59 (85.5%)	11 (100.0%)
Religious belief		
Muslim	288 (92.9%)	41 (93.2%)
Non-Muslim	22 (7.1%)	3 (6.8%)
Have you ever heard of Malaria?		
Yes	216 (69.7%)	25 (56.8%)
No	94 (30.3%)	19 (43.1%)
Do you have rigors or chills?		
Yes	291 (93.8%)	44 (100.0%)
No	19 (6.1%)	0 (0.0%)
Do you have vomiting?		
Yes	295 (95.1%)	42 (95.5%)
No	15 (4.8%)	2 (4.5%)
Do you have headache?		
Yes	221 (71.2%)	30 (68.2%)
No	89 (28.7%)	14 (31.8%)
Do you have sweating?		
Yes	71 (22.9%)	7 (15.9%)
No	239 (77.1%)	37 (84.1%)
Do you use Mosquito Net		
Yes	263 (84.8%)	38 (86.4%)
No	47 (15.2%)	6 (13.6%)
Test Type		
Microscopy	70 (22.6%)	2 (4.5%)
RDT	240 (77.4%)	42 (95.5%)

Table 3: Factors found associated with Malarial Infection (Negative=0, Positive=1) of the study participants (n=2640) residing in Tent City, Hyderabad

	Un-Adj. ORs	p-value (95% CI)	Adj. ORs	p-value (95% CI)
Gender				
Female	Ref.	--	Ref.	--
Male	1.66	**0.000** [1.279 – 2.168]	6.39	**0.000** [2.666 – 15.382]
Age groups				
0 – 29 years	Ref.	--	Ref.	--
30 – 44 years	0.61	**0.001** [0.467 – 0.810]	0.63	**0.002** [0.480 – 0.846]
45 – 96 years	0.66	**0.002** [0.506 – 0.863]	0.71	**0.019** [0.544 – 0.946]
Education				
Educated	Ref.	--	--	--
Uneducated	1.20	0.296 [0.847 – 1.722]	--	--
Pregnancy status				
Yes	0.68	**0.002** [0.539 – 0.874]	3.22	**0.002** [1.512 – 6.873]
No	Ref.	--	Ref.	--
Use Mosquito Net				
Yes	1.12	0.471 [0.820 – 1.532]	--	--
No	Ref.	--	--	--
Heard about Malaria				
Yes	0.63	**0.000** [0.499 – 0.813]	0.70	**0.007** [0.542 – 0.909]
No	Ref.	--	Ref.	--
Rigors/ Chills				
Yes	0.89	0.679 [0.545 – 1.483]	--	--
No	Ref.	--	--	--
Vomiting				
Yes	0.84	0.521 [0.495 – 1.427]	--	--
No	Ref.	--	--	--
Headache				
Yes	0.61	**0.000** [0.481 – 0.795]	0.71	**0.012** [0.545 – 0.928]
No	Ref.	--	Ref.	--
Sweating				
Yes	1.34	**0.036** [1.019 – 1.762]	1.35	**0.033** [1.024 – 1.785]
No	Ref.	--	Ref.	--

In binary logistic regression one category of each variable is set as the reference group (Ref.) so that all other categories are compared relative to it. For category one female is taken as the reference because: It is often the larger or more stable group in population surveys. epidemiologically, males often have higher outdoor exposure so hypothesized higher risk, It provides a baseline to see how much males are to be infected compared to females. For second category age group of 0-29 years as reference it is usually the largest age category in disaster-affected populations. It represents the youngest and potentially least exposed baseline group. Older age groups may have different exposure levels, immunity, or comorbidity. For third category reference educated individuals are used as reference because, they are assumed to have greater awareness of malaria prevention, hygiene, and health-seeking behavior. uneducated individuals are compared relative to this

baseline of awareness. Use of mosquito nets is taken "No" as reference because the absence of preventive measure ("No net") serves as baseline. Using a net ("Yes") is expected to reduce risk. Individuals with less knowledge are baseline. Comparison checks whether awareness affects infection risk. Or not. pregnancy status "No" is taken as reference non to pregnant individuals form baseline. Because pregnant women are a biologically vulnerable group. Symptoms (vomiting, headaches, sweating, chills) "No" as Reference is a Logical baseline: absence of symptom. Interpretation of Unadjusted Odds Ratios (UOR) Unadjusted Odds Ratio shows the association between one variable and malaria infection, without controlling for other variables

Table-3 presents the factors associated with the test positive malaria (including both caused by *P. Falciparum* and *P. Vivax)* with reference to individuals found negative. Gender, age and pregnancy were found significantly associated with malaria. Those who had already heard about malaria were also found associated with malarial positivity. Furthermore, out of all current symptoms, only headache and sweating were found associated with malaria. While adjusting for these factors, pregnancy was found to be more than 3-times [adj. OR= 3.22] likely to be associated with malaria than no pregnancy and males were found more than 6-times [adj. OR= 6.39] likely to be affected than females [95% CI= 2.666 – 15.382]. The link test revealed no problem with our specification [_hat= 0.003; hatsq= 0.106]. The overall Hosmer and Lemeshow's goodness-of-fit (GoF) test result also showed that the model fitted well [Pearson's chi-2 (52) = 57.97; p > 0.05].

DISCUSSION

Malaria remains a critical public health concern globally, particularly in regions which are vulnerable to environmental disasters such as flooding resulting in potential global health emergency, endangering human health and well-being for many years.[9] Many studies have been conducted globally to assess the impact of climate change on malaria; however, the uncertainty among the results persists with wider variation. It has been claimed that due to extremely high temperatures followed by floods due to climate change, certain vector such as Anopheles calcifies has been wiped off from Pakistan and has been replaced by a harmless mosquito known as Anopheles pulcherrimus, particularly in Sindh.[10] This change in trends of mosquitos due to climate change and flood urged us to analyze the data regarding plasmodium species and whether they have been affected by climate change and flood or not. Therefore, we aimed to examine the situation pertinent to malaria immediately after the flood that occurred in Pakistan in 2019 where Sindh province was massively affected and more than 10 thousand flood effete were suspected of being affected by Malarial infection. Understanding the seasonality of malaria parasitemia is crucial for planning and implementing effective malaria control interventions.[11] The findings of this study support the belief that seasonal climate change has caused fluctuations in malaria parasitemia in displaced populations. By observing the peak prevalence and density of *Plasmodium vivax* throughout the post-monsoon season (August to October), we were able to identify new seasonal trends in this study. Because of climatic change and the higher levels of gametocytemia produced by *Plasmodium Vivax* during the monsoon, there has been a seasonal shift in *Plasmodium Vivax* dominance and suppression of *Plasmodium Falciparum*. This seasonal change extended the summer and boosted the breeding habitat for mosquitoes, which in turn promoted the late summer spike of malaria.[12,13] The prevalence of malaria by species in our study was found as 11.7% for *Plasmodium vivax* and 1.67% for *Plasmodium falciparum*. The lowest prevalence of *Plasmodium vivax* is so far reported by Naqvi et al which was 8.38% in 2021.[7] Whereas the highest so far has been reported is by Khan et al which is 26.3% in 2019.[14] Our result is somewhere in between these two reported

prevalences. Similarly, Ullah et al in 2019 found out that the prevalence of Malaria resulting from *P. Falciparum* is much lower which is only 1.2% and our result is in line with it.[15] The highest prevalence of *P. Falciparum* was reported as 2.5% by Ajmal and Rehan in 2019.[16] Thus, we found no conflict with the existing reports; and therefore, safely claim that this could be because of the flood's altered temperature and humidity levels. Malaria in pregnancy is a threat to the normal delivery and is considered a major public health problem. Out of global pregnancies, 9.1% of pregnant women are at risk of malaria only in Eastern Mediterranean Region (EMRO). [17,18] Luckily, our study found only 45 pregnant women residing in this high risk flooded area. However, 10 of these pregnant women were found infected with malaria in our study. Although this number looks very small but this accounted for almost a quarter (22%) of all these pregnant women. This result is not so satisfactory because even in an African region like Ethiopia where around 14% of the pregnant women were malarial positive, even when these women were found residing near stagnant water.[19] On the contrary, our study data was collected immediately after flood occurred where water was still flowing and not stagnant. Other studies have also shown that susceptibility to malaria particularly in area where people reside in close vicinity to stagnant water.[20,21] Comparing our result with other local studies, a prevalence of 1.43% was observed by Qureshi et al, 2021,[22] and 7.54 % as reported by Afridi 2019. [23] Only one study shows a very high prevalence of malaria which is 42% in pregnant women.[24]. The discovery of malaria in pregnant women emphasizes the need for early identification and prenatal screening. According to our results, it was found crucial to provide rest of the 75% of pregnant women who were still malaria negative the preventive services like bed nets, and repellents etc. to keep them safe until their delivery or re-mobilize them to places away from the area before the flood water would get stagnated. With respect to the demographic variables of the study participants there were no significant differences found between those affected by *P. Falciparum* or *P. Vivax*. This finding was in conflict with the African regional data where early childhood age and pregnancy were the significant variables particularly related to *P. Falciparum* as compared to *P. Vivax*.[25,19] There may be a slight idea of the observation that more than 50% of participants belonged to younger age group who were found affected by *P. Falciparum.* However, this difference was not statistically significant. Moreover, when malaria caused by both species were combined and analyzed in our study, it was observed that increasing age was significantly associated with malaria. On the other hand, not a single pregnant woman was found affected *by P. Falciparum;* all were affected by *P. Vivax*, and therefore, the odds ratio remained unidentified. The preponderance of *P. Vivax* in expectant women emphasizes the necessity for precise species identification to direct suitable therapy. It is known that pregnant women are three times more likely to suffer from malaria as compared to women who are not pregnant.[25] Our study showed an adjusted odds ratio of 3.22 which is in line with this study. Furthermore, our multivariate analysis showed that males are 6 times more vulnerable to be affected by malarial infection than females. Typically, only high fever, myalgia and chills / rigors are found as classic signs and symptoms associated with malaria but in our study, factors found significantly associated with malaria were sweating and headache. This emphasizes how crucial it is to include malaria in the differential diagnosis. For problems to be avoided and the right therapy to be started, a prompt and correct diagnosis is essential. One important finding in our study which needs to be highlighted was that the participants who had already heard of malaria were 37% less likely to suffer from malaria. Malaria preventive programs may take leverage from this crucial finding and target towards increasing the awareness regarding malaria particularly in communities and areas effected by such disasters caused by climate change. This study offers a thorough analysis

of the demographics, diagnosis, and prevalence of malaria in a population that has been relocated (IDPs) within its limitations. The results underline the necessity of specialized healthcare interventions that take gender, age, and pregnancy status into account. The study also emphasizes the significance of precise species identification and the frequency of traditional malaria symptoms in the populace. However, the results being based on a cross-section of a limited population group of only those residing in the tents, they may not be enough to extrapolate the findings in the entire population. But based on the cross-sectional investigation, we may strive towards more effective malaria control and improved health outcomes in vulnerable groups by addressing these issues in order to lessen the impact of malaria in vulnerable areas. More longitudinal data may be required once an appropriate public health initiative has taken place focusing on population-based prevention programs towards malaria particularly in the seasons during which the population is most vulnerable.

CONCLUSION

This study identified a notable malaria burden (13.41%) among internally displaced persons (IDPs) affected by floods in Sindh and reported predominant species was *Plasmodium Vivax*. The association of age, gender, pregnancy and previous knowledge about malaria highly draw attention towards the need for targeted and inclusive healthcare strategies including preventive measures, early diagnosis, treatment approaches and syndromic surveillance to improve health outcomes.

CONFLICT OF INTEREST

None

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None

AUTHOR'S CONTRIBUTION

MAK: Conception of Idea, Data collection, data entry and cleaning, write-up

AQ: Data Analyses, interpretation, write-up and final review

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