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# MALARIA INCIDENCE IN REFUGEE DOMINATED HUMANITARIAN EMERGENCY SETTINGS IN AFRICA AND SOUTH-EAST ASIA, 1980-2022

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**ABSTRACT:** Malaria imparts significant public health concern in humanitarian emergency settings in endemic areas from a relatively more compromised and flaccid disease surveillance and monitoring practice compared to that in peace time situation. Incurring a chronically high malaria case morbidity and mortality Africa and south-east Asia additionally suffer from human caused conflict and war led population migration and displacement crises intermittently to exacerbate malaria burden in the two regions. The patterns and trends in the transmission dynamics of malaria infections in peace time and plain areas is considered to be complicated with in-country as well as cross-border human movement to and from the endemic and/or non-endemic territories. This ends in with developing imported or introduced plasmodial infections in an area that stands as the key challenge for controlling or eliminating malaria there. Then exploring malaria situation and experiences in some key refugee camps in Africa and south-east Asia in this review paper has helped us add new experiences and ideas of fighting malaria to the existing data base of the disease. The acute and unstable humanitarian settings in malaria endemic areas intrigue the disease transmission dynamics and the toll with greater fluctuation in terms of case morbidity and mortality compared with that in chronic and unstable humanitarian emergency situations. This and other overviews here will definitely better guide malaria elimination efforts, especially in humanitarian emergencies in the two endemic regions in an integrated and comprehensive way.

***Key words****: Malaria incidence, refugee, humanitarian emergency settings, Africa and south-east Asia*

## INTRODUCTION

Malaria is a plasmodial infectious disease borne by female anopheline mosquitoes causing significant loss to human lives and properties in tropical and subtropical regions. Its occurrence during humanitarian emergencies in

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refugee camps within a greater peace time endemic area adds to the overall case morbidity and mortality in a malaria endemic region (United Nations High Commission for Refugees, UNHCR, 2018). In 2022, globally there were an estimated 249 million malaria cases and 6, 08000 deaths with the majority in Africa followed by Asia (WHO, 2023). Human movement is a major contributor to changes in malaria transmission within and between countries through circulation between endemic areas, reintroduction to formerly endemic regions and introduction to new areas (Pindolia *et. al*, 2013). Surveillance for malaria in mobile and migrant populations is more challenging than in static populations and their contribution to disease burden may be under-recognized. Accordingly, understanding malaria transmission dynamics in both peacetime and humanitarian settings in endemic regions is key to run an effective surveillance addressing local, national, regional, and global threats of eliminating the disease. But tracking malaria situation in emergency settings including refugee dominating areas obviously turns difficult that requires extra ordinary surveillance in a rather new environmental, political, social, cultural and demographic contexts. This also causes conducting malaria research difficult over there that the documentation of the latter could also be under performed. Nonetheless, for a malaria free world, this is vital to ensure that the international community's effort of eliminating malaria sustains without its resurgence, reintroduction, or recurrence anytime in any place of interest. Eventually, to grasp an oversight on malaria transmission dynamics and the disease burden in extra ordinary situations of refugee crisis in endemic regions guided this literature review in a systematic, mutually supportive, coherent, adherent, consistent, and a critical methodology as follows.

## MATERIAL AND METHODS

The answer to the inquisitive issues in the preceding section required understanding an integrated and updated version of malaria transmission dynamics in humanitarian emergency settings in the malaria endemic regions on earth. Then a diverse range of works on distribution of malaria incidences and their associations (risks) in mostly refugee crisis areas has been reviewed from the relevant instances, settings, and accounts. More precisely, malaria situation in various humanitarian emergency settings reported in literary sources-offline (books, papers, etc.) as well as online (Google scholar) were consulted in some epidemiological viewpoints in terms of malaria cases and their relationships (risks). In the pursuit of the literature, at first, the national relevance and implications of malaria elimination in some major African and south-east Asian countries have been focused whilst the trans-border transmission factors of malaria incidences are intermingled within a greater

cross border setting in the regions. The new malaria situation in emergency settings from humanitarian crisis was explored in light of relevant studies, methodological contexts, and settings. This has contributed to the reorganization of key findings in malaria transmission dynamics in the explored extra ordinary situations described in the following section.

## RESULTS AND DISCUSSION

*Malaria occurrence in humanitarian emergency settings in major WHO regions:* Humanitarian crisis in malaria prone area ends in with enhanced morbidity and mortality from weak malaria surveillance, e.g. Refugee camps in Burundi experienced an increase in malaria cases from 0.2 million in 1984 to more than 3 million in 2000. Refugee camps in Afghanistan counted the annual malaria incidence from 0.3 million in 1970 to 3 million in 1990 with 20 percent of the total malaria infections from *P. falciparum* that crossed to northern border of Tajikistan. Democratic Republic of Congo, DRC refugee settings faced three-fold increase in malaria mortality in 2000 against a long day violence in the region (Anderson *et al.*, 2011, Coldiron *et al.*, 2017, Nafo-Traore and Nabarro, 2005, Pindolia *et al.*, 2013, Rowland and Nosten, 2001). Most global malaria cases and deaths occur in WHO African region for decades. Many territories in the region suffer from intermittent political and socio-economic conflicts and unrest leading to forced population movement and displacement during refugee crises. Malaria morbidity in this region increased to 232 in 2020 from 222 per 1000 population at risk due apparently to COVID-19 related disruptions to health services (WHO, 2021). The Region incurred 94% of malaria cases (233 million) and 95% (580 000) of malaria deaths globally in 2022. Children under 0-5 year range accounted for about 80% of all malaria deaths in the Region (WHO, 2023). Between 2000 and 2009, Madagascar, Eritrea, Rwanda, Zambia could decrease malaria burden by 50% through extensive control efforts with high national priority. Addressing chronic refugee problem among others, Rwanda availed 74% lower rate of confirmed malaria cases between 2005 and 2010 and microscopy positive rate decreased by 26% to count 9%. Besides, both the rate of hospital admission for malaria and deaths from malaria went down to 65% and 55% respectively. Many countries of Africa, like Tanzania, have experienced significant progress in combating malaria in the last decade by strengthening malaria control strategies and measures with high importance on microscopy and rapid diagnostic tests, and large scale coverage of insecticidal nets. A malaria outbreak in 2017 at a refugee camp of Kalobeyei refugee complex in Turkana county of north-western Kenya killed 4 people. There were 200 malaria case incidences per week in the camp that lacked in with adequate health facilities, drugs, diagnostic kits, and trained health workers to treat the

disease properly (Halake, 2017). On plasmodial species identity, most of the infections were *P. falciparum* followed by *P. malariae* and *P. vivax*.

WHO south-east Asia region incurred around 24 million of confirmed malaria cases in 2010 that declined to 5 million in 2021. The region also experienced chronic refugee led humanitarian emergencies, like the Afghan and Khmers, Karens, and the Rohingyas since 1970s. India alone accounted 66% and 83% of the cases in respectively 2010 and 2021 though the country could reduce 28% of case incidences between 2000 and 2010. Most of the 2426 cases of malaria mortality from a total of 8 countries in the region was reported from India in 2010. By 2012, Democratic People's Republic of Korea and Sri Lanka were in elimination phase. Nepal, Bhutan, India, Bangladesh, Myanmar, the Democratic Republic of Timor-Leste, Indonesia, and Thailand were in the control phase (Autino *et al.*, 2012). While malaria endemic countries are usually afflicted with health and humanitarian emergencies time and again, WHO (2022) in 2021 found an estimated 268 million people to incur humanitarian emergencies that was 301 million in 2020. Such humanitarian emergencies are mostly contributed by conflicts, flooding, and famine being compounded in many occasions by disease outbreaks. Myanmar in 2021 was spotted as one of most affected countries in conflicts and terrors.

However, in all WHO malaria regions, the emergence of humanitarian crisis situation posed new complications that caused uncontrolled disease outbreak and further deteriorated the achievement of the malaria elimination targets in the greater area of both host and neighboring territories. In each instance, eliminating malaria in a country potentially relies on the proper evaluation of the disease factors in different contexts of host, vectors, geography, climates, and the local, national, and global interventions. The endemic areas for malaria, thus potentially offer the concerns of reintroduction, importation, drug and insecticide resistance complications with the onset of extra ordinary situations. At this point, let's further explore the malaria situations in specific emergency settings in endemic areas.

*Malaria in acute and unstable refugee camps in endemic areas:* Research on current malaria situation in many refugee camps appears inadequate. A thorough search yet has found some published literature on malaria in complex emergency settings, e.g., southern Sudan in 1983-1999, Liberia in 1989-1999, Somalia in 1991-1999, Azerbaijan in 1993-1995, Thailand in 1980s, Iraq and southern Turkey in 1993-1997, and Pakistan in 1989-1999 (Najera *et al.* 1998, WHO, 1999). The studies focused on malaria epidemics, morbidity, and mortality cases in acute or unstable and post emergency or chronic stable conditions. The reports of the concerned relief agencies in addition to some manuals on guiding different malaria situations in some relief camps (Glass *et*

*al.,* 1980, Shears *et al.,* 1987, Meek, 1988, Lienhardt *et al.,* 1990, Rey *et al.,* 1996, Rab *et al.,* 2001) helped many studies in framing their analyses. The Afghan refugees in Pakistan and the Karen refugees in Thailand had to experience acute emergency situation before reaching to stable post emergency settings. They also suffered from the complications of the infectious and communicable diseases including malaria as the most threatening health concern in the camps that apparently contributed the existence of endemic malaria from trans-border movement of infected people fleeing chaotic situations in neighboring countries (Rowland and Nosten, 2001, Parker *et al.,* 2015). The same situation prevailed in the Karen refugee settings in Thailand. The study with Karen refugee camps included a prospective mass blood survey in a village on the Thailand-Myanmar border during 2011-2012 while citizenship issue appeared to be a significant risk factor for malaria so that the odds of malaria infections shot over eight times up of that for the Thai people. Malaria diagnosis by microscopy in the Karen refugee settings appeared less effective compared to molecular diagnosis assay of PCR whilst ratios of microscopy positive to PCR positive cases of *P. falciparum* and *P. vivax* stood 1/9 and 1/10 respectively. However, these and other refugee camps especially that of the sub-Saharan region have had multiple factors to cause malaria situation there more alarming. Some of the most evident factors are: around 90% of the global malaria morbidity and mortality incidences occur in Africa, location and condition in refugee camps support rapid expansion of the vector mosquitoes' population, children and women among the refugees are more susceptible to illness from malaria, existence of sub microscopic or asymptomatic infections, the ignorance of the refugees on malaria, nutrition, a kind of compromised immune system among the refugees leading to increased mortality (Landman, 2016). Such factors are more obvious and devastating in areas with complex settings where malaria has already been endemic or a common public health concern and the transmission trajectory of the disease takes new dynamics and implications beyond the peacetime settings. In such, the traditional health system, human factors and the total environment for both the vector and human host in peace time situation apparently fall into a quick shift towards a rapid deterioration in terms of the disease morbidity and mortality (Rowland and Nosten, 2001) in humanitarian emergencies in refugee camps. To add, Rowland and Nosten (2001) studied the complex emergency situations prevailing in refugee camps of the Pakistan-Afghanistan and Thailand-Myanmar border areas in context to malaria epidemiology, its control and implications under strategies for malaria elimination worldwide in 1990s. The studies were found helpful to device out effective malaria control strategies and case management as adapted into other similar settings with refugee crisis in different malaria endemic parts of the

world. One concern was that malaria mortality could rise to high and the epidemic form of the disease might have developed uncontrolled before health services become properly established in an emergency situation. Such issue could be addressed properly with the experiences gathered from a thorough malaria case-management approach in the long lasting refugee dominated area in a malaria endemic region. The study investigated malaria incidences and case management in the two refugee populations. Noticeably, the Afghan refugee camps over the border on Pakistan side were going through long-lasting emergencies with severe shortage of resources that were traced out to manage the risk of malaria spread. This latter was done through enhanced coverage of the insecticide treated nets and indoor residual sprays supported by higher proportions of malaria tests with microscopy and rapid diagnostic tests in the camps. On the other hand, the research on the Karen refugee camps was investigated by the Shoklo Malaria Research unit of the Welcome-Mahidol University-Oxford Tropical Research Program for some vital issues: multidrug resistance in malaria, new therapies and interventions for fighting severe malaria, and/or managing resistant malaria in the camp area. Apart from these issues of malaria epidemiology with shifting of peacetime settings into emergency situations, here is an effort to further discuss a number of prominent instances of malaria in the refugee camps in south-east Asian territories.

*Malaria in Afghan refugee settings:* Around three million Afghans crossed over the border and took shelter in the western border part of Pakistan being settled in more than two hundred camps after the Soviet invasion in 1979 (Rowland and Nosten, 2001). On the fall of the Soviet backed regime in the early 1990s, half of the refugees returned back into their country of origin while the rest one continued to live in the camps on the marginal land. Many camps were water logged, or near to rice cultivation wet land being prone to mosquito breeding sites. These Afghan refugees were non-immune on their arrival since there had been a successful malaria control program in Afghanistan before the war. This caused them to be infected by malaria in complex emergency situation in the camp areas and they faced a serious public health problem from malaria. Eventually, malaria took an epidemic form among the refugees in 1990 and 1, 50000 malaria cases per year were diagnosed by the health facilities under the UNHCR, Government of Pakistan, and NGOs. Of these cases, an estimated 30% was accounted for by *P. falciparum*, and the rest by *P. vivax*. Malaria transmission in Pakistan is seasonal with highest after the monsoon (July-August). The country falls under subtropical climate that comprises two peaks for *P. vivax* malaria in a year. The first is spring peak resulting from delayed attack or relapse and the second one is the summer peak. But *P. falciparum* malaria shows a single peak after the summer peak of the *P. vivax.* In addition,

malaria in Pakistan is reported to show long term periodic cycles that gave the last significant epidemic form in the middle of 1970s. The northern edge of the country experiences unstable range of *P. falciparum* malaria along with yearly fluctuation for climatic variation. The malaria transmission season in Pakistan was found to be prolonged due to increased down pour in autumn or temperature more than the average counts in November-December, a recent trend in the ambient climate of the country. Such risk factors are suggested to be addressed properly to bring success in malaria elimination in Pakistan. Besides, the common instances of chloroquine resistance across the country has compounded the malaria situation resulting in increased fatality of *P. falciparum* not only in Pakistan but Afghanistan and the neighboring Tajikistan also. On top of all, war, conflict, and population uprising are some other important factors to make the malaria situation worse in the region. Studies showed that most of the *P. falciparum* cases among the Afghan refugees in Pakistan are sensitive to sulfadoxine-pyrimethamine (S-P) though the *P. vivax* are still sensitive to chloroquine. But Afghan refugees are somehow accused of carrying malaria to their host country Pakistan reminding the fact that in many cases the refugees are treated as scapegoats. A significant number of relevant studies found that the Afghan refugees in the early 1980s became the target of malaria attack transmitted locally in Pakistan (Rowland and Nosten, 2001). It was conjectured that the zoo-prophylaxis measures (rearing domesticated mammals) among the poverty stricken refugees were not enough and exposure to infected mosquito bites were easily attainable in the emergency and complex situation in the camp areas. The preventive measures targeting the abatement of mosquito bites, say it chemoprophylaxis or zoo-prophylaxis were not easily accessible to them and thus the malaria transmission accelerated. In some development, the refugees in the camps were found to have domestic cattle with a possible vector diverting role to cause a little difference of malaria prevalence between the Afghan refugees and the local communities of Pakistan in the region. Besides, Insecticide treated bed nets and other materials were found to be remarkably used as preventive interventions for the Afghan refugees in Pakistan. Interestingly, in the refugee camps of Pakistan and Tanzania, ITNs were found to have better outcome and IRS worked better in post conflict situation in early 1990s (Rowland and Nosten, 2001). Still, malaria in Pakistan and its adjacent areas prevails with significant threat to the human life and properties (WHO, 2023).

*Malaria in Karen refugee settings:* Over 100000 (0.1 million) Karen, Karenni, and Mon ethnic minority lived in a series of refugee camps on the Thailand-Myanmar border (Rowland and Nosten, 2001). Symptomatic infections of malaria are common in all age groups in this endemic area. Malaria in the

camps in 1992, caused 15% of all deaths other than that from accidents with three case per person per year mostly (70%) by *Plasmodium falciparum* infections followed by *P. vivax,* (20%), and the rest (10%) by mixed infections of the two parasites. The spread of antimalarial resistance in the camp then was a concerning matter. As a result of reinforcing the intervention program in the camp area, the malaria burden fell dramatically during the period of 1995-2000. Interestingly, a higher susceptibility to malaria by the pregnant women and the children was noticed whilst malaria posed a less or minor threat in the camps since 2013 until the recent emergence of artemisinin combination therapy (ACT) resistant strain of *P. falciparum* in the Greater Mekong Sub-region (GMS) (*Background*) *Shoklo Malaria Research Unit*, 2002). On average, each child experienced 1/2 malaria infection round the year. *Plasmodium vivax* incidence was highest among the young while the *P. falciparum* infection prevailed most among the adults under 20-29 year of age. The infection was clustered in households like that of the Afghan refugees while the severity and mortality of the disease was higher in young age rather than older ages. The mixed infections entailed less severity compared to *P. falciparum* mono infections. The incidence of *P. vivax* in mixed infections in the population was deemed to have had a positive effect in reducing the severity of *P. falciparum* infections. However, by the late 1980s, in the camp areas, malaria caused the highest morbidity (45% of total tests) and mortality (15% of deaths) among the Karen refugees compared with other infectious diseases.

Additionally, malaria burden in pregnancy caused an estimated 1% death in the camp areas. Moreover, 1% death from cerebral malaria in pregnancy was estimated. This resulted in strengthening the combined health system in the camps targeting, especially the pregnancy cases that finally helped reduce the mortality burden. Anyway, the area of the Karen refugee camps was treated as unstable and of low malaria transmission area and the malaria surveillance data there gave a detailed picture of *P. falciparum* incidence in pregnancy for the first time. The malaria surveillance system there included both clinical symptom based and parasitological (microscopy and RDT) test based malaria treatment. Worth to note, an approach to investigating the validity of clinical symptom-based diagnosis in malaria cases in the Karen refugee camps, positive predictive value of such identification was found relatively weak, which revealed wrong in 51% cases on the best algorithm so that 30% non-malaria cases were misdiagnosed or wrongly spotted as malaria positive (Rowland and Nosten, 2001). Microscopy and RDT in such emergency situations were found to be correct malaria diagnostic tools. This finding went consistent with Imwong *et al.* (2015) that estimated prevalence of sub-microscopic reservoir of *Plasmodium* infections in three cross sectional surveys in three villages in western Cambodia,

four villages along the Thailand-Myanmar border, and four villages in south-east Vietnam through highly sensitive high blood volume quantitative real-time polymerase chain reaction method. All the villagers older than six months were invited in the trial as the study participants. The study estimated an overall prevalence of the sub-clinical (sub-patent or asymptomatic) malaria in the eleven villages as 4% by RDT, 5% by microscopy (blood smear), and 20% by high volume ultra-sensitive real time polymerase chain reaction. The infection rates of *P. falciparum, P. vivax,* and mixed infections read respectively 3%, 7%, and 1%. Of the positive cases, 8% contained low parasitemia that species identification could not be done.

The study did a multivariate regression assay and found the incidence of fever, male-sex, and age of 15 years or older to be associated independently with the malaria parasitemia in the study region. To add, a considerable volume of asymptomatic malaria was identified even in low transmission settings. But the implication with operating different types of diagnostic tools, i.e. RDT, Microscopy, and PCR could be an important factor to decide on the real prevalence status- asymptomatic or symptomatic in any population under any situation- peace time or emergency time (Imwong *et al.* 2015). Thus, maintaining some similarities vis a vis, malaria epidemiology of the Karen refugees in Thailand differed to some extent with that of Afghan refugees in Pakistan to the end of the 20th century. While the Afghan refugees experienced a malaria epidemic situation with huge loss to life and property nearly by ten years of their exodus into the host country Pakistan, the Karen refugees rather experienced a decline in both case incidence and death incidence by five years upon tolerating an initial rapid upsurge in malaria morbidity and mortality cases earlier to their arrival in the new residence in Thailand. In the Afghan refugee camps, *P. vivax* dominated whereas in Karen refugee camps, *P. falciparum* dominated over other malaria infections with developing high antimalarial resistance. Notwithstanding, in both settings, *P. vivax* was still sensitive to chloroquine in a different degree while the vector control approaches in Karen refugee settings differed in many ways with that of the Afghan refugees in Pakistan. Children of all ages, preferably those under five years in Afghan refugee settings suffered the disease burden more compared to that in Karen refugee settings. Both settings experienced alarming rates of malaria morbidity and mortality in younger children and the pregnant women until a successful anti-malarial program developed across different periods of time for the two refugee populations.

*Malaria among displaced Khmers on Thai-Cambodian border areas:* Meek (1988) confirmed an increase in malaria incidence from the immigration of infected people from higher incidence in thrush and bamboo made camps on the border of Thailand and Cambodia. The study camps, similar to Rohingya camps

on Myanmar-Bangladesh border were surrounded by hilly and forested zones, sheltered around 218000- 246000 displaced people of Khmers- the Cambodian people between 1983 and 1985. The camps were under emergency humanitarian situation whilst *Anopheles dirus* was the most dominating malaria vector against the use of mosquito nets and DDT in indoor residual sprays as control measures. Administering chloroquine and sulfadoxine-pyrimethamine, quinine and tetracycline being added by primaquine as treatment regimen for the disease was in the treatment segment. The study found *P. falciparum* and *P. vivax* as dominating infections against only one case of *P. malariae* while the incidences shot up significantly in rainy season between May and October. On age-sex breakdown, malaria incidences were spotted in all age groups, especially in children under 5 years, and other children and adults to confirm local or indigenous malaria transmission in the camps. Adults were attributed to maintain high immunity in the infections. However, in 1984-1985, the control measures and the treatment were considered to help reduce malaria mortality rate- a decline from 77 to 28 per 100000. The annual parasite rate in different zones in the total study area varied between < 180 and > 180 per 1000.

Malaria in pregnancy, however can lead to various complications of still birth, spontaneous abortion, and birth of premature babies while the symptomatic infections were significantly higher in adult males. On infection context, both cerebral (*P. falciparum* attack with unarousable coma) and uncomplicated malaria conditions were found too. Anyway, the surveillance (controlling factors) helped reduce malaria transmission while the movement to nearby forests or residences untreated with IRS or without cooking fire, appeared as some favoring factors in malaria transmission. The spread of malaria by the movement of infected people from higher malaria endemic areas to lower transmission areas is affected by the availability of vectors more than that by the parasites. This affirms mass treatment of the immigrants to kill gametocytes followed after greater coverage of vector control and protection from infected mosquito bites. Hence, the mixing of two people- the Thais and the Khmers in an area of transmission could have possibly helped exchange of parasites of different susceptibilities to worsen malaria situation in the two endemic countries.

*Malaria in Rohingya refugee camps in Bangladesh:* Bangladesh experienced less than one percent of the overall reported malaria cases in the WHO south-east Asia region in 2019 that was ten percent in 2008 (WHO, 2020). An epidemiological survey of malaria incidences and associations was done in the Rohingya refugee camps on the south-eastern border area of Bangladesh from 2017-2020 (Khan *et al.*, 2023). Following a mass ethnic conflict and carnage, more than 1.2 million Rohingya refugees migrated from Myanmar to Bangladesh

since after 25th August, 2017**.** Many of these came from malaria endemic regions of Myanmar that there was concern that they could bring with them a substantial burden of malaria infections. The area they migrated into in Bangladesh was also endemic for malaria with probability for local transmission in and around the camp areas. Unselected individuals, self-presenting to Primary Health Care Centers (PHCC) in one Kutupalong registered camp (KRC, population 18,223), and Nayapara mega camp **(**NMC, population 68,274) in the country's Cox's Bazar district, were tested for malaria using rapid diagnostic test (RDT) and/or light microscopy of peripheral blood as part of routine healthcare service.

Criteria for malaria testing were **tympanic temperature >37.5° C** and any **age** or **sex.** This passive case detection comprised 96% of tested individuals. An additional 4% of tested individuals were identified during door to door visits by the health workers using the same criteria. The tests were done in the concerned PHCC in a camp and the data were recorded and stored in malaria surveillance registers on paper followed by transferring into electronic database. Besides, data on age, sex, pregnancy, travel to forests in the previous 2 months, and use of bed nets of the suspects were analyzed. The overall average annual test positivity rate (TPR) was 0.05%. TPR was highest in people who had travelled to the forest in the previous 2 months, at 13.60%. Cases were clustered largely in male adults under 15-60 years. There were no cases among children under five or in pregnancy, and no deaths from malaria. *Plasmodium falciparum* mono infection accounted 53% (TPR 0.09%) whilst for *P. vivax* and mixed infections the counts stood, respectively 37% (TPR 0.06%) and 10% (TPR 0.02%). The API was 0.19 per 1000 population. TPR by RDT (0.25%) was higher compared to microscopy (0.04%, $p < 0.001$). TPR among people who slept under bed nets was 0%, all cases occurring in people who did not use bed nets, ($p = 0.01$). All malaria positive cases were treated with chloroquine plus primaquine for *P. vivax* and artemether-lumefantrine for *P. falciparum*. No cases presented twice that, to our knowledge, all were cured. Accordingly, malaria in Rohingya refugee camps on the trans-border area of Bangladesh-Myanmar appeared to be rare and mostly acquired by forest travelling adult males. This could not support the idea of importation of malaria from Myanmar by the Rohingyas in Bangladesh. Thus efforts to reduce malaria in the population seemed to be more logical and appropriate (Figure-1).

*Malaria in chronic and stable refugee settings in endemic areas: Malaria in refugee camps in Tanzania:* Burundi and Democratic Republic of Congo were victim to political crisis and conflicts that led around 400000 people to flee to western Tanzania and get sheltered in refugee camps there in 1998-2004. A rapid joint malaria screening survey in 1998 by UNHCR, WHO, and the

Tanzanian Government identified malaria as the leading cause of death among the children under 5 years in the camps (Ezard *et al.,* 2005). All age groups and the child bearing women were at high risk of sever malaria whilst malaria transmission was perennial despite being highest during and after the wet rainy season (May to October). Sulfadoxine-pyrimethamine in place of long practiced chloroquine was prescribed to treat uncomplicated malaria. In prevention component of the surveillance efforts, ITNs and IRS usage, and draining the standing water and killing the mosquito larvae in the camp areas were practiced on priority basis. Besides, on the back of standard entomological data periodic net retention was scaled up and improved. The study also reaffirmed the effectivity of malaria control activities in complex emergency situations in Chad and Tanzanian refugee camps adding a lot to the experiences of the concerned local and international bodies involved in combating malaria worldwide. Prompt application of RDT and using ACT revealed as the reliable approaches for dealing malaria case incidence in Chad refugee camps and many other similar emergencies (Ezard *et al.*, 2005). The interventions in dealing with malaria in the humanitarian situations in the two settings included the estimation of the real case incidence, rapid application of RDT kits, administering SP in uncomplicated and ACT in advanced stage cases, resorting ITNs, IRS, and establishing a functional malaria surveillance system in the complex settings from refugee crisis on top. Interestingly, Ezard also observed that the risk factors for malaria outbreak in emergency situations differ between plain and hilly areas. Land surface, forest cover, altitude, climatic region, humidity, rainfall, and availability of water reservoir- small or big can determine malaria vector bionomics and species diversity among others. Some high land areas flanked by high land forest in tropical climate region as in Khan *et al.* (2023) are considered hotspots for malaria endemicity. Such malaria endemicity, however could vary largely in mortality and morbidity on both intra and inter geo-climatic regional contexts. This turns evident in a wide range of humanitarian emergency settings- the Kiziba UNHCR refugee camps in Rwanda, Nyarugusu Refugee camp in Western Tanzania, Mahama Refugee camp in Rwanda, and the refugee camps in Chad (Ezard *et al.,* 2005, Rowland and Nosten, 2001). On the other hand, high malaria infections are recorded in Nyarugusu refugee camp in western Tanzania (Schug, 2019, 25 September). The refugees experienced malaria attack in their home country- Congo and bore the infection for long from a very poor coverage of the national health system to test, treat, and track the fatal disease. The shelters they enjoyed in the host country since 1996 have had surrounded by swampy fields offering suitable breeding places for the vector mosquitoes. The refugees used to sleep under bed nets of faulty types with big holes to maintain very poor protection against the infective mosquito bites in the camps. The case

incidence and death incidence of malaria amounted high in refugee children under 5 years. A comparative analysis of malaria incidence in Nyarugusu refugee camp in Tanzania with that of Khan *et al.* (2023) in the Rohingya camps in Bangladesh then appears important. This fits well in the contexts of concerned geography, demographics, and the interventions to better understand and build the epidemiology of the disease in similar settings against the prominence of common transmission factors in malaria endemic regions.

*Malaria in refugee camps in Chad:* Ethnic conflict, fights, and violence caused more than 200000 Sudanese of Western Darfur to flee and take shelter as refugees in 12 camps on the border area of Chad-Sudan in 2003 (Ezard *et al.*, 2005). Like that in the Rohingya camps, children and women constituted the major portion of the camp population. Malaria incidence in was reported to be unstable in different seasons similar to that of the Western Sudan, the refugees' place of origin. The wet season prevailed from June to October with 600 mm as maximum rainfall in a year. The majority of the host and refugee people were estimated to maintain little or no immunity to malaria that they fell into the risk of severe malaria infection and death. The population at risk were kept unaware and poorly intervened in transmission season during and after the onset of the rainy season. An initial assessment followed the influx off the refugees by WHO, UNHCR, and the Chad Government. The organizations jointly decided for a set of interventions including real case identification by RDTs, prompt treatment using ACT, deploying ITNs, and IRS etc. A deliberate application of these priorities contributed to a stable trend of malaria incidences in the refugees without any increase in morbidity and mortality rate to the end of 2004. Anyway, cautious use of ITNs and IRS were given the credit for this control of malaria transmission in Chad refugee camps in acute and unstable emergency in the greater African malaria region. Most of the refugee camps and settings in Africa have passed through a long history of humanitarian crises from the initial acute phase through the present stable post emergency situation. Thus, with time, the immediate acute and unstable emergency settings usually turns into post conflict or chronic emergency settings (stable) being adapted with the implications of the epidemiology of an infectious disease, here malaria within and without the camp areas. Eventually, malaria situation and its epidemiology can offer new ideas and avenues across maintaining similarities and dissimilarities to that in the initial acute and unstable emergency situations. A number of studies are available that show incidences of malaria in various African refugee camps under post emergency or stable humanitarian complex situation. Here this starts.

*Malaria in Mahama and Kiziba Refugee camps, Rwanda:* A model refugee camp was set in 2015 in Kirehe district of Rwanda as the erstwhile largest camp

in the country (Karema *et al.,* 2020). The camp hosted more than 54ooo people in a sector homing more than 23000 Rwandans. Malaria turned the leading cause of morbidity in the camp scoring a toll of 50% of all cases of morbidity from all infectious diseases in the past two years in the district. Besides ensuring the use of ITNs, the UNHCR and the Rwandan government jointly applied IRS extensively in the camp areas ending in with a significant reduction of both morbidity and mortality rates of the disease. Again, an active surveillance in Kiziba camp areas in Rwanda tested 4777 febrile residents for malaria by microscopy and RDT (Molnarova *et al.,* 2016). Of them 7.77% (371) showed malaria positive. Accordingly, the study showed a high land area (1950 meter above sea surface) to be inflicted with malaria transmission as a big public health concern. The study apprehended the difficulties in continuing traditional interventions leading to high land malaria with mild malaria symptomatology in Kiziba camps. This was also well grounded to be the result of uncaring diagnosis and treatment in many instances of the disease management (Oboth *et al.*, 2019).

With this, post emergency refugee settings have had suffered from humanitarian crisis for rather a longer time compared to that in acute and unstable emergency settings. Around 1.18 million refugees in a total 60 refugee sites in Burundi, Sudan, Tanzania, Chad, Cameroon, Kenya, Ethiopia, Thailand, and Uganda during 2006 to 2009 suffered from malaria with an average incidence of 50 cases per 1000 refugees in 2008-2009 (Anderson *et al.*, 2011). Tanzanian refugee sites incurred malaria incidence round the year with 399 confirmed cases out of 1000 refugees excluding the children under 5 year who showed an unusual malaria incidence of 728 confirmed cases out of 1000 malaria tests. The study found the highest mortality rate of 0.9 deaths per 1,000 refugees at sites in Sudan followed by refugee settings in Uganda and Tanzania (0.7 deaths per 1000 refugees apiece). An estimated 16% of malaria mortality were in refugee children under five years. Younger children in post emergency refugee settings are significantly vulnerable to malaria morbidity and mortality across the malaria endemic areas on earth. This is consistent with the experience of South Africa that hosted thousands of refugees from different countries of the greater sub-Saharan region of Africa. The refugees fled ethnic conflicts and took shelter to the refugee camps in Durban city of the KwaZulu-Natal province of South Africa since 1994. As they came from malaria endemic part of Africa, e.g., DRC, Burundi, Rwanda, and Zimbabwe, they were brought under malaria screening in 2012-2013. This helped check the threat of malaria outbreak for the refugees themselves and the host population of the country. Total 303 adult refugee participants in the city were surveyed for malaria in 2012-2013 that found most of the malaria incidences in South Africa was

imported through population migration in the form of refugee crisis (Tsoka-Gwegweni *et al.*, 2014). This postulated that in South Africa, the refugees were potentially immune to malaria and could have acted as the infection reservoir missing proper interventions. The city of Durban and its people could have had faced with malaria transmission threat for persistent refugee crisis in the country whilst 89% of the refugees incurred malaria positivity before their entry into the refugee camps. On spot screening, 3.8% in the camps, were found positive with RDT and 5.9% with Microscopy. All of the participants were under 19-64 years and *Plasmodium falciparum* was the dominant infection. Keeping aside, Africa stands as the home to all types of malaria case incidence, morbidity, and mortality comprising more than 90% of the global malaria burden (WHO, 2023). This has obviously led UNHCR (2019) to weigh most on maintaining anti-malaria program based on research, primary data, and case studies in sub-Saharan Africa. Given that 30% of the malaria burden in Africa belongs to its complex refugee settings reviewing the relevant studies in UNHCR refugee camps in Africa seems crucial for combating the disease in similar crisis driven areas on earth. The account of 7.77% malaria prevalence in the Kiziba, Rwanda was significantly higher than many other similar settings in Africa (Molnarova *et al.,* 2016) being consistent with Coldiron *et al.* (2017) that identified malaria as one of the major health problems in two refugee camps- Ayilo 1 and Ayilo 2 in Northern Uganda in 2015. Interesting that, the conflict ridden settings for refugees get aggravated from onset of infectious and communicable diseases that addressing the latter's potential threats in any trans-border areas with uncontrolled population migration and/or displacement in eliminating malaria turns further complicated. The crises from this migration problem vis- a- vis the refugees affect the cross border population that both pre and post crisis aftermaths of transmission of a communicable disease- here the malaria, pushes up the graph of concerned morbidity and mortality burden of the disease. Then some barriers- linguistic, cultural, and difficulties with accessibility to the mixed population on the border area appear in the path to meeting the elimination targets and goals (Shoklo Malaria Research Unit, SMRU, 2019).

In every instance, leaving malaria untreated among a displaced population at risk could be a major threat to anyone living or travelling to the endemic areas. SMRU (2019) advocated for proper surveillance on the transmission dynamics of malaria in the migrant populations and the populations under complex refugee crisis situation for combating malaria and checking its potential outbreak among any population at risk on the earth (Figure-2).

*Malaria surveillance in humanitarian emergency and/or peace time settings:* Most of the malaria endemic countries follow Test, Treat, and Track (T3) strategy

of WHO Global Malaria Program in malaria surveillance being launched since 2012. This was to combat malaria by ensuring that every malaria case is identified, treated and tracked in a malaria prone country (Oteng *et al.*, 2020). The vulnerable population groups and the selection of resources are then focused under a strong monitoring system to address the malaria risk. In addition, proper reporting and case management in all confirmed malaria incidences need to be on track to win the elimination targets and goals in national, regional, and global contexts (WHO, 2018) irrespective of the prevailing situations- peace time or humanitarian emergencies.

*Malaria screening in refugee camps is constrained by the poor in-camp environment:* Impoverished health care facilities and shabby public health hygiene in most refugee camps in malaria endemic areas seemingly offer dire situation to worsen malaria situation there. Africa origin refugees in Canada have had tested positive for malaria in many cases (Sullivan, 2000). The camps of the refugees are assumed to have rudimentary laboratory facilities to provide proper malaria test. The study found a Canadian doctor to confirm 240 refugees from a refugee camp in Burundi being tested for malaria upon their febrile condition. The screening accounted 5% test positivity for malaria. Testing or screening malaria in a refugee camp then revealed difficult against hard to cover normal health system in complex situation with poor living conditions. This supports many routs of malaria transmission for further complicating malaria situation in refugee camps. This also confirmed unreported malaria incidence as a common matter in the refugees of south-east Asian nations. In addition, the rate of malaria among the refugee camps in Burundi and the Central Congo was higher than that of many south-east Asian countries, like Vietnam, Laos, and Cambodia. The refugees of Laos, Cambodia and Vietnam in addition were found malaria positive in Canada where they arrived in early 1980 not in the camps where they lived for years. In either case, not for the medicines or pills, malaria treatment rather entailed higher portion of cost for diagnosis that could be a factor making malaria screening difficult in refugee camps in a malaria endemic zone. On a different note, elevated malaria risk revealed among occupational groups in areas of poor economy, like the traditional Jhum, slash and burn cultivators that Rohingya refugee settings in Bangladesh could be compared with the forest going people showing enhanced malaria case incidence (Galagan *et al.*, 2014, Khan *et al.*, 2023). This turns consistent with Ahmed *et al.* (2013), National Malaria Elimination Programme, NMEP (2019), and Shannon *et al.* (2016) implicating the abundance of diverse infective and/or infected mosquito bites for the persistence of malaria in and around refugee settings in endemic areas. M**alaria** in the Afghan, Karen, and Khmers, and various African refugees thus makes it clear that controlling malaria in the emergency and post

emergency humanitarian settings is one of the hardest public health challenges. The risk of epidemics of a vector borne infectious disease in malaria cases potentially generates the challenges to overcome directly in managing public health.

The disease needs to be dealt under rapidly changing and struggling health system against the threats of many other infectious diseases in a rather densely populated, unhygienic and environmental conditions suitable for the breeding and spread of the vector mosquitoes. Such settings usually claim for more answers, more solutions, and more avenues to be satisfied through multifaceted research studies on malaria and other infectious disease in the region as a whole. To add, malaria transmission dynamics in refugee settings evolves through acute and unstable to chronic and post conflict stable phase before the epidemic and devastating forms unless proper interventions for the disease are taken. The acute unstable settings obviously can change the malaria dynamics in parallel with socio-political development that the first protective and preventive measures need to be taken to avoid rapid deterioration of the vector borne disease. Nonetheless, a proper case diagnosis and understanding of the source of infection and the status of transmission in malaria incidences appear as the two most effective practices in a malaria programme. With such a view, the anti-malarial initiatives should be translated into operational research complemented with regular control program. Thus this findings in the Karen, Afghan, and Khmers, and all of the African refugees in malaria endemic zones are thought to continue to work a lot for simulating better effective case management in many other similar settings under acute or post emergencies. Despite difficulty with operational perspectives in the complex settings, proper understanding of the transmission factors including plasmodial species identity, real case definition, and demographics of the infections in any case study of malariometry should help us give better answers to many questions. This is needed for constructing malaria epidemiology of the disease in humanitarian crisis situations. The demographic stratification of malaria incidences in a setting then appears important in tracking transmission dynamics in the emergencies that undergo various changes unpredictably not in ecological aspect only, in the context of the ambient humanitarian crises there also. A properly functioning malaria surveillance then can integrate and craft evidence based malaria elimination efforts ensuring the best use of malaria resources in proper time and space. Such evidence base can help malaria experts to lead malaria reduction efforts further.

*Malaria prevention:* The use of bed nets, insecticidal bed nets (ITNs), Indoor Residual Spraying (IRS), coils, and spray of various ingredients including pyrethroids, organochlorine, carbamates and organophosphate appears effective

preventive measures in eliminating malaria in any situation (WHO, 2018). Though in some malaria prone areas resistance to pyrethroids has already developed, ITNs reportedly remain effective tool for malaria prevention. All in all, vector control is the most effective tool to fight malaria that advocacy for extended use of ITNs in all malaria risk areas under any situation tops all time preferably in refugee, internally displaced, or forcibly migrated human populations on earth (WHO, 2018). Distribution of ITNs is found to be taken as the most important immediate intervention approach in the refugee camps in Africa, Europe, and Asia by the respective governments and the NGOs especially during unstable emergency and stable chronic post emergency crisis situation there. Keeping align to this, the nomadic refugees who travel and migrate each spring from winter camps in the Punjab to high-altitude camps in tribal areas of the North West frontier province of Pakistan, experience their tent being sprayed as effective to check the spread of malaria outbreak there (Nafo-Traoré and Nabarro, 2005, Rowland and Nosten, 2011). However, the nomadic populations potentially transport malaria to unaffected places being unprotected by traditional house spray with residual insecticides through a hard to follow-up style. This needs their tents to be treated with adhesive formulations of insecticides, like the pyrethroids as effective mosquito repellent. Other such insecticides are permethrin or deltamethrin that could last for at least one year if used on the inner surface of the tents. In the settings of the refugees from war or conflict on trans-borders, insecticide treated bed nets (ITNs) are found to offer an attractive solution.

Thus using insecticidal bed nets as daily practice by the refugee populations guaranties the best preventive measure. Some ethno populations who are found to be unwilling to use bed nets however need undergo some motivation and awareness building campaigns to make themselves resort to the practice. That distributing ITNs to the refugees in the malaria prone areas at free of cost cannot ensure cent percent proper use of the preventive tools should also be resolved practically. Bearing a portion of the cost of the nets by the users during the campaign should bring better assurance of using the tools on their own awareness and concerns. This works better while the incident emergency situations are aligned with developing better livelihood and better social prospects for the vulnerable populations and ensuring malaria prevention program with effective use of ITNs or bed nets in the settings (Rowland and Nosten, 2001).

*Malaria diagnostic tests:* Prompt diagnosis and treatment can prevent a mild case of malaria from developing into severe disease and death. Fever is the first symptom of clinical diagnosis for malaria in a malaria endemic zone that all the febrile cases in malaria prone areas needs to be tested in time through rapid

diagnostic test and microscopy as soon as possible (WHO, 2018). For this, lack of awareness or poor access to health care providers for the febrile patients seemingly ends in with leaving significant number of cases under diagnosed and unreported in malaria surveillance in the extra ordinary humanitarian emergencies (WHO, 2013). To resolve such weakness in the national health system, enough malaria RDT and microscopy must be ensured carefully. Especially, the febrile patients under either situation must go through the screening techniques if the area belongs to malaria endemic zone under any situation as a whole (WHO, 2018).

*Implications of malaria elimination in humanitarian emergencies:* Malaria elimination efforts in endemic areas is seemingly linked with the relative social, cultural, political, and economic factors in the targeted populations. These factors jointly command the transmission dynamics of the disease. This aligns with peculiarities, if any in the nature of vectorial roles of the mosquitoes, parasitic roles of the plasmodial strains, and insecticide and drug resistance issues in the manifestation of malaria. Proper case diagnosis and treatment in endemic areas also appears integral to bringing an effective impediment in the disease spread and complication. Interestingly, malaria control and elimination in an area of interest is guided and supported by the World Health Organization's technical framework for all malaria endemic countries adopted in 2015 (WHO, 2016). This instrument asserts four targets to be achieved by 2030 based on the corresponding base line data of 2010: 1. To reduce malaria case incidence by at least 90% 2. To reduce malaria mortality rate by at least 90% 3. To eliminate malaria in at least 35 countries including Myanmar and Bangladesh 4. To prevent the resurgence of malaria in the countries declared malaria free. As an effort to follow-up the framework, WHO (2018) estimated among others India and 10 sub-Saharan countries to bear the toll of 70% of the global malaria case and death incidences in 2017. Besides, the experiences of the Roll Back Malaria (RBM) and WHO programme constituted 4 pillars to win before confirming proper malaria response by 2020, 2025, and 2030. These comprise galvanizing national and global political attention to reduce malaria mortality; using information in a way to driving impact in a country; establishing best global policies, guidance, and strategies applicable to all malaria endemic countries; and implementing a coordinated country response to malaria epidemics. This led towards unrolling a country driven approach- 'High burden to high impact' for the high burden malaria countries. In Mozambique, the programme was launched in 2018 (WHO, 2019). Cambodia, o**ne** GMSR country bearing high incidence of drug resistant *Plasmodium falciparum* strains experienced many containment efforts in 4/5 years back considering its high toll of drug resistance (WHO, 2019).

In WHO south-east Asian region, considering a large number of malaria incidence cases, especially on the Myanmar-Thailand border areas, many health posts with malaria diagnosis facilities are installed in several villages of the two countries. In 2013, a malaria research team in Pailin (a village where first instance of artisunate mono-therapy drug resistance was noticed) Referral Hospital in Western Cambodia found significant number of asymptomatic parasitemia in the villages of the country. Another GMSR country, Vietnam has had long history of fighting against malaria. Malaria in the country started to show a gradual increase in the incidence of artemisinin-resistant infections in its Binh Phuoc province after a long trend of substantial decline in the incidence cases until 2010. However, malaria burden in several endemic countries was disproportionate in 2017 whilst significant increase in case morbidity occurred among children under 5 year (WHO, 2019). Anyway, until 2018, most of the malaria morbidity in south-east Asia were attributed to India (58%), Indonesia (30%), and Myanmar (10%). Bangladesh appears to be vulnerable to malaria outbreak against a potentially poor and improper data driven interventions in its remote and hard to reach border areas with India and Myanmar in the region. The rate of progress in reducing malaria burden in south-east Asia has reportedly remained similar since 2014. Annual malaria incidence rate in the area was 57 per 1000 in 2014 while 71 per 1000 in 2010. To date, it is roaming round 57 with similar trend since 2014 (Daily Star, December 8, 2019, WHO, 2023). The country-led approach- “High burden to high impact” is getting momentum across many countries in Africa and south-east Asia aimed at pulling the global malaria response back on track and make progress towards achieving the GTS goals by 2030. The four founding pillars mentioned already for nationwide anti-malaria programme in an endemic country should be catalyzed by WHO. Besides, Roll Back Malaria partnership needs to be maintained to end malaria. Considering the trends of progress in fighting malaria across 2015-2018, attaining the targets in reducing both malaria case and death incidence globally by 2025 and so compared to the 2015 baseline could potentially be missed (WHO, 2019). Nonetheless, eliminating malaria at any level- local, national, regional, and global obviously depends on individual as well as integrated success in malaria fights. Such fights usually keep transcending the peculiarities of nature in terms of epidemics, geography, political setups, legal framework, and the resources allocated in the elimination efforts. The free flight of the anopheline mosquito vectors, human migration, trans-border activities, and the under-reporting of the real scenario of the epidemiological aspects of the disease incidence to the national and international malaria database stand as the key challenges of combatting malaria This underscores the need for addressing the basic epidemiology in any

given setting at any point of malaria control or elimination program for bringing success to an ongoing national malaria elimination program in a country afflicted with refugee or migrant crisis in an endemic region. Hopefully, many border sharing nations inflicted with such humanitarian crisis are making significant progress in responding to a potential malaria outbreak from the unexpected new situation and events.

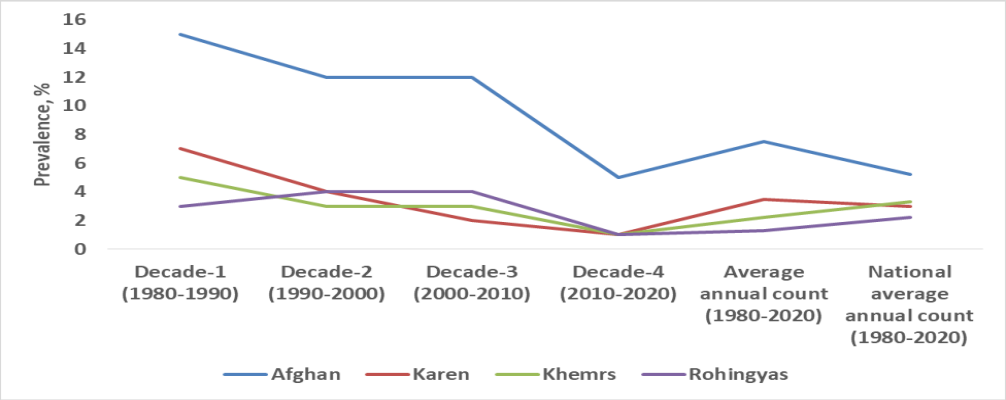


Fig.1. Malaria prevalence (%) in some unstable/acute humanitarian emergency settings in Asia in the last four decades (Adapted from Anderson *et al.*, 2011, Coldiron *et al.*, 2017, Khan *et al.*, 2023, Khan, 2024, Nafo-Traore and Nabarro, 2005, Pindolia *et al.*, 2013, Rowland and Nosten, 2001)

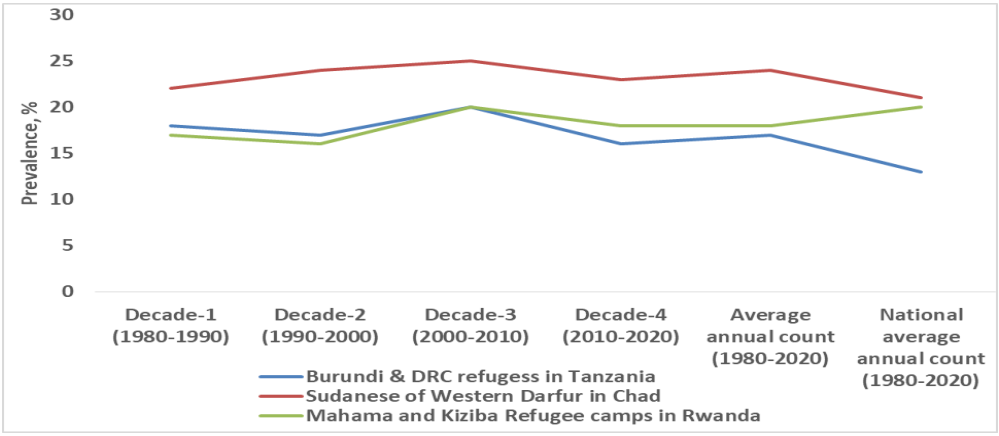


Fig. 2. Malaria prevalence (%) in some chronic/stable humanitarian emergency settings in Africa in the last four decades (Adapted from Anderson *et al.*, 2011, Coldiron *et al.*, 2017, Khan *et al.*, 2023, Khan, 2024, Nafo-Traore and Nabarro, 2005, Pindolia *et al.*, 2013, Rowland and Nosten, 2001)

*Conclusion and Recommendations:* This overview of malaria situation in humanitarian emergencies, mostly of the refugee camps evidentially gives some answers to many questions of the trends, patterns, and the implications of malaria transmission across a wide range extra ordinary complex situations in

Africa and south-east Asia. Any territory with such settings of diverse range of geography, topography, economy, culture, and political crisis led humanitarian crises claims for common strategic and technical arrangement in combatting the mosquito borne disease. The key interventions include mobilization of malaria resources in proper time and place, and operating rapid test, treat, and track in the new environment. This obviously helps a malaria risk country to respond with a design for eliminating malaria in either situation- peace time or emergency against a rapidly changing regional and world order. Any endemic country laden with population displacement issue must consider their peacetime experiences in fighting malaria in its complex humanitarian situations too. This will help reduce the morbidity and mortality burden of the disease either fully or partially. The result, nonetheless is relative of the incident political, cultural, and social issues whilst both experiences- peace time and emergency complement one another.

Also, the risks and implicating factors in malaria programme in trans-border settings within malaria endemic region evidentially depend on the relative status of endemicity of the places with 'source and sink' categories. This is added with the demographical and spatiotemporal characteristics of the population at risk on the back of their movement and life style episodes. As a result, the possible aggravating of malaria situation from amalgamation and overlapping of several neighboring trans-border populations in a malaria endemic country or region stands challenging for being assessed. Because, understanding the malaria risk factors either existing or emerged, anew in a new community is one of the key breakthroughs in eliminating the disease in an endemic area. With this, an attempt is here to explore the environmental, demographical, biological, and interventional factors and their implications in combating malaria in the greater Africa and south-east Asia region. Strengthening targeted deployment of malaria investment should be integral to strategic implementation programme on proper research and development. This rests on operating surveillance and interventions and cut the pathways in chronic malaria transmission in the crisis situation. Accordingly, attenuating malaria threats and tolls in humanitarian settings in the endemic areas and eliminating the disease on local, national, regional and global scales should focus more on the following issues:

Strengthening regular epidemiological monitoring and tracking of malaria incidences among the migrating populations of any destitute class- refugees or immigrants from humanitarian crises. Conducting malaria surveillance of prompt and early detection of new infections, either clinical or subclinical types is then imperative. Promoting case detection and checking for the emergence of any dominant strains and its potential resistance to antimalarial could give a significant result in reducing recurrence of the disease in an area of interest.

Mobilizing malaria resources in remote and hard to reach human settlements in and around trans-border areas during both peace and emergency time must be a priority intervention in fighting the disease. Accelerating community engagement programme, like education and building awareness campaigns on using bed nets and mosquito repellents in the emergency settings.

Reinforcing entomological control for *Anopheles* vector in all stages of fighting malaria. The local, rural, and urban agencies in such will succeed in treating the vectors' breeding places, using effective repellents and insecticides in malaria surveillance. Better tailoring malaria interventions through striking proper investment in research, development, and innovation in addressing study findings on mosquito bionomics, drug resistance patterns and habitat preferences. For this, funding cutting-edge technologies of genetic modification of mosquitoes in malaria transmissions in endemic areas is important. Building more roads, clinics, schools, industries, and other infrastructure in malaria risk areas in the two regions and facilitating the mobilization of malaria resources there will further accelerate the elimination efforts.

Organizing for conducting collaborative malaria surveillance programme on regional and international scales till the achievement of the concerned malaria elimination goals. In this respect, pursuing the Global Strategic Techniques for Malaria (2016-2030) towards ensuring zero malaria transmission risk mostly in trans-border areas of two or more neighbouring countries will be a guaranty for stopping the buildup of human reservoir or reconstruction of new transmission routs from human migration or refugee crises.

All in all, malaria transmission in humanitarian emergencies is benefitted from a diverse range of factors through peculiar environment, vector bionomics, host experiences, and socio-cultural as well as political implications in dealing with the disease. In such, for winning the goal of total elimination of the mosquito borne infection globally by 2050, a lot of efforts yet to deploy, not should we remain complacent with a rather stellar progress in anti-malaria efforts in the near past, especially in many south-east settings. Intermittent up-urging of malaria burden in the extra ordinary situation in refugee camps must be taken seriously under an overall malaria combatting struggle. Keeping aside, stray malaria outbreaks in clustered spots of forest dominating areas are not uncommon. Then the appreciation of the aforementioned recommendations needs more investment, more innovation, and the joined engagement of all stakeholders- government and nongovernment to eradicate malaria as the ultimate goal.

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