Research Article

The influence of seasonal variations on malaria prevalence in Mount Cameroon Region: A review.

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Abstract

Malaria is Cameroon's most serious and complex public health problem. Its transmission is usually associated with topography, climate and socio-economic conditions. The problem of the disease is aggravated by changing climate, poverty, and lack of efficient controlling mechanisms. Also, the emergence of new parasite strains, expansion of host range due to human population growth and movement, land use change, increasing vectorial capacity, and deteriorating public health infrastructures contribute to the spread of the disease. Due to climate and ecological diversity, there is apparent variation and instability in the epidemiology of its transmission and prevalence. All age groups are particularly vulnerable to even mild malaria during epidemics. The challenges posed by seasonal changes on malaria prevalence urgently demand re-visiting control measures and policy of urban planning. This paper reviews previous studies on seasonal variations and the prevalence of malaria in Mount Cameroon Region. Generally, seasonal changes from these studies are highly linked to malaria prevalence in the region. We also present in this review new measures that need to be taken to harness existing malaria control measures and evade possible malaria epidemics in the region and Cameroon as a whole. We proposed future studies which involve monitoring and modeling the influence of climate change and land use changes on the malariology indices in the Mount Cameroon Region.

Key words: malaria, prevalence, seasonal variations

Résumé

Le paludisme est un problème de santé publique majeur au Cameroun. Sa transmission est généralement associée aux conditions topographiques, climatiques et socio-économiques. Il est exacerbé par le changement climatique, la pauvreté et l'absence de méthodes de contrôle efficaces. En outre, l'émergence de nouvelles souches de parasites, l'expansion de la gamme d'hôtes du aux mouvements et a la croissance des populations, le changement des méthodes d'utilisation des terres, l'augmentation de la capacité vectorielle, ainsi que la détérioration des infrastructures de santé publique contribuent à la propagation de la maladie. En raison du climat et de la diversité écologique, il existe une variation apparente et une instabilité dans l'épidémiologie de sa transmission et de sa prévalence. De ce fait, tous les groupes d'âge sont particulièrement vulnérables au paludisme -même léger- pendant les épidémies. Les défis posés par les variations saisonnières de la prévalence de la maladie recommandent une revue des mesures de contrôle et de la politique de planification urbaine. Cet article passe en revue les études antérieures traitant des changements saisonniers et la prévalence du paludisme dans la région du Mont Cameroun. Dans l'ensemble, ces études révèlent un lien de cause à effet entre les changements saisonniers et la prévalence du paludisme dans cette région. Cette revue présente également de nouvelles mesures qui doivent être prises afin de compléter ou de mieux exploiter celles déjà existantes pour une lutte plus efficace contre le paludisme et la prévention d'éventuelles épidémies dans la région en particulier et au Cameroun en général. En conclusion, mention est faite des études ultérieures traitant de la surveillance, de la modélisation de l'influence des changements climatique et d'utilisation des terres sur les indices paludiques dans la région du Mont Cameroun.

Mots Cle: paludisme, prévalence, variations saisonières

Introduction

Malaria is an ancient scourge, but remains a major public health problem in Cameroon and the first cause of death from infectious diseases worldwide. It accounts for over 40-45% of medical consultations, 57% of hospitalization days and 26% of sick leave annually (Global Envision, 2005). The WHO (2010) estimated about 225 million cases and 800,000 deaths in 2009. Five apicomplexan parasites of the genus Plasmodium are now known to be human-pathogenic species (i.e. P. falciparum, P. malariae, P. ovale, P. vivax, and P. knowlesi). In Mount Cameroon region malaria parasite species initially thought to be non-existent or refractory by Duffy negative individuals has been found to asymptomatically infect healthy adults (Fru-Cho et al., Manuscript in preparation) who are both Duffy negative and positive. Despite efforts to curb malaria transmission, the disease persists.

Malaria is transmitted from man to man in the region by the female anopheles of the Anopheles gambiae complex which is the major vector of the disease. These vectors in sub-Saharan Africa generally exhibit high inoculation rates and are remarkable for their wide range of geographical and ecological conditions (Wanji S. and Tanga M. C., 2003). They equally appear to be very flexible, in exploiting both new man-made environments and adapting to malaria control activities.

Changes in temperature (14-18 oC at the lower and 35-40 oC at the upper end of the range) can affect the development and survival of malaria parasites and the mosquitoes that carry them (Watts et al., 1987; Wanji et al, 2003; Wandiga et al., 2006; Afrane et al., 2011). Malaria flourishes in warm, humid environments, so surface temperature and rainfall are the two most important natural factors that influence where it will strike and how quickly it is likely to spread. Mt. Cameroon region covers all the rural, semi-urban, and urban areas on its eastern and western slope. The mountain starts at an altitude of 50 m from the coast as a sedimentary plain that extends from Limbe to Mutengene and Tiko. From Mutengene, the terrain gradually elevates to an altitude of 800-1200 m in Buea town. Hydrologically, some 20 streams are of prime importance and empty into the Atlantic Ocean (Wanji et al., 2012). In this forested area of Southern Cameroon, the equatorial climate has been modified by the double influence of the ocean and the mountain. The temperatures are lower than in the other areas of the southern part of the country: the mean values of the minimum temperatures are 20 oC in December and 18 oC in August; the mean values of the maximum temperatures are 35 oC in August and 30 oC in March. From Mutengene, the terrain gradually elevates to an altitude of 800-1200 m in Buea town (Wanji et al., 2012). Seasons in Mt. Cameroon region has become quite variable in the last 6 years as demonstrated in our review and this has significantly influenced malaria prevalence (Nkuo-Akenji et al., 2005).

Seasons and malaria prevalence in the Mount Cameroon region

Seasons are critical for reproduction of both the malaria parasite and the vectors that transmit it. Seasonal malaria variations may come about as the result of many factors, including periodic heightened host susceptibility resulting from stressors due to the prevailing climatic condition (Koelle et al., 2005), changes in contact rates resulting from school terms where children are most affected, (Fine and Clarkson, 1982) and changes in pathogen transmission rates resulting from climate variation (Spira, 1981). Temperature, which is the main climate change driver, can affect disease by altering the susceptibility of hosts, the virulence of pathogens and the growth rates of both hosts and pathogens, which can in turn influence host pathology and disease emergence (Cairns et al., 2005; Raffel et al., 2006). Temperature data from the CDC meteorological stations in three areas in Mt. Cameroon Region showed increasing linear trends from 1984 to 2011 (Ayonghe and others, unpublished data).

The seasons in the Mount Cameroon area have become quite variable from what was observed a decade ago when there was a steady pattern with the dry season running from mid November to mid March and the rainy season from mid March to mid November. Several studies within and out of Mount Cameroon region have shown that there is a strong positive correlation between

malaria prevalence and seasons with an increase in prevalence during the rainy season and a decrease during the dry season (Nkuo-Akenji et al., 2002, Nkuo-Akenji et al., 2005, & 2006; Wanji et al., 2003; Tanga et al., 2010; Kimbi et al., 2005 & 2006; Bigoga et al., 2007; Anong and Ambe, Manuscript in preparation). Data from Mt Cameroon Region suggest that the amount of rainfall decreased in 2008 relative to 2002 (Nkuo-Akenji et al., 2005; Anong and Ambe, Manuscript in preparation). However, there was a positive correlation between the amount of rainfall and malaria prevalence within the respective years, albeit higher in the rainy compared with the dry season (Nkuo-Akenji et al., 2005) ; Anong and Ambe, Manuscript in preparation). Gametocytes are the sexual stages of the parasite and are critical for disease transmission. The prevalence of asexual and sexual parasites in peripheral circulation was also shown to closely follow the rainfall pattern, with the highest prevalence recorded in the rainy months (July through October) (Akenji et al., 2007).

Plasmodiun falciparum genetic diversity and malaria in the Mt. Cameroon area

P. falciparum strains have been linked to almost every malaria hospitalisation in the region; three infecting falciparum genotypes have been found in the sub-region by different research groups. (Kimbi et al., 2004; Anong et al., 2010; Wanji et al., 2012). All of these studies focused on genetic variants of the MSP1 block 2 allele and reported K1, Mad20, and RO33 strains to cause disease, either singly or in combination. Basic questions such as the genetic relatedness between isolates within a region, and relatedness of disease-causing isolates and how these isolates change with time in a population thus influencing levels of immunity have not been addressed, mainly due to technical limitations. Rising temperatures have been shown to influence both the growth of pathogens as well as their vectors (Spira, 1981). Therefore, the changing climate in Mt. Cameroon region (Nkuo-Akenji et al, 2005; Anong and Ambe, manuscript in preparation; Ayonghe and others, unpublished data) can induce mutations even in the parasite and create novel parasite or resistant strains which can be more virulent in susceptible individuals and cause local epidemics.

Vector capacity/abundance and malaria prevalence in the Mount Cameroon area

The abundance of the malaria vectors in the region is very much related to altitude and no vectors have been found 1200 m above sea level (asl) (Bigoga et al., 2007; Tanga et al., 2010). Malaria vectors, which include An. Gambiae, An. Fenestus, An. Nili (Wanji et al., 2003; Bigoga et al., 2007), An. Hancocki, and An. Moucheti (Wanji et al., 2003), have been captured at a few study sites in Mount Cameroon region and were shown to have high man-biting rates or entomological inoculation rates (EIR), high sporozoite rates and many were documented to transmit malaria. In Ethiopia, malaria prevalence has been documented in two highland areas respectively at 2100 m and 2280 m asl (Tesfaye et al., 2011) while in some in the highlands of Kenya, it has been shown that malaria vectors had been flourishing at altitudes 1720-1921 m asl for over a decade (Afrane et al., 2011). Notwithstanding, it was not clear whether these cases were introduced from the nearby lowland or resulted from local transmission since no record of mosquito vectors on the highlands was in existence. Interestingly, analyses of species composition have shown that the proportion of An. arabiensis in these highland sites was characterized by a significant increase from < 1% in 2003 to 16% in 2010. This clearly shows that the parasites have been introduced in the highlands and are surviving and multiplying at heights close to 2000 m asl. There is evidence of An. arabiensis in the south of Cameroon (Fontenille D. and Simard F. (2004) and one cannot exclude the possibility of these species moving to other parts of the country.

Perspectives

Many policy makers are not familiar with the link between deforestation, climate change and their effect on malaria transmission. Forests have been shown to stabilize local temperatures and this can annul the effects of climate variability that is related to malaria epidemics in the highlands. Forests are carbon sinks as they absorb CO2 and

sequester it. Deforestation accounts for nearly 20% of global annual carbon emissions. Thus this phenomenon is closely linked to global warming and subsequent increased spread of malaria in the highlands. Variability in temperature as a result of environmental changes has the potential to affect the vector and their parasites as well as the transmission of many parasite borne diseases including malaria.

It is imperative to understand that due to changing vectorial capacity, rising temperatures, and more frequent rainfall in Mount Cameroon region, the malaria parasites could be equally mutating at very high frequencies. Therefore, it is important to identify new genetic variants and/or new Plasmodium species in the region that could cause local epidemics to occur once they are transmitted to susceptible human hosts. Although there are several studies which indicate that seasonal variations affect malaria prevalence (Nkuo-Akenji et al., 2002, Nkuo-Akenji et al., 2005, & 2006; Wanji et al., 2003; Tanga et al., 2010; Kimbi et al., 2005 & 2006; Bigoga et al., 2007; Anong and Ambe, manuscript in preparation), the issue of land-use changes that undoubtedly contributes significantly to the changing climatic conditions has not been adequately addressed in the Mount Cameroon region. A clear understanding of the changing landscape and its contributing factors on the prevalence of malaria in Mount Cameroon region will be critical in modeling malaria incidents in the region to avoid epidemics from occurring in the region as a result of the changing climatic conditions. Therefore, our proposed study investigating parasite genetic diversity in relation to malaria endemicity and disease at different altitudes of the Mount Cameroon region and how these may change with time in various settlements of the Mount Cameroon region due to changes in climatic conditions and the relative abundance of the mosquito vector will be very valuable in designing and implementing future malaria control stratefies.

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