Research & Reviews: Research Journal of Biology e-ISSN:2322-0066

Malaria Risk Factors and Intervention Policies in Democratic Republic of Congo

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Review Article

Received date: 23/01/2018
Accepted date: 06/02/2018
Published date: 14/02/2018

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Keywords: Democratic Republic of Congo, Intervention policies, Malaria, Risk factors.

ABSTRACT

Malaria is one of leading causes of morbidity and of mortality in Democratic Republic of Congo (DRC). Population displacement, poor access to healthcare services and environmental factors such as warm and humid climate, variation of temperature, rainfall, vegetation nearby (providing shade for mosquitoes), harsh, and presence of Anopheles mosquitoes are risk factors permitting malaria transmission in DRC. The interventions policies are combined within: (1) insecticide-treated mosquitoes nets (ITNs) or long-lasting insecticidal nets (LLINs) are distributed through mass campaigns to all age groups free of charge; (2) the use of Indoor Residual Spraying (IRS) is recommended by National Malaria Control Program (NMCP) as long as IRS does not contain dichlorodiphenyltrichloroethane (DDT); (3) intermittent preventive treatment in pregnancy (IPTp) is used to prevent malaria during pregnancy; (4) every patient should get diagnostic test and the test is free of charge in public sectors; rapid diagnostic test (RDT) is used at community level; (5) Artemisinin-based Combination Therapy (ACT) is applied for treatment of plasmodium falciparum and quinine, artemether intramuscular (IM) or artesunate suppositories are prescribed for pre-referral treatment; (6) cases reporting from private sector and from active case detection (ACD) at community level are mandatory; (8) and the use of the larval control is recommended. This article aims at presenting malaria risk factors and intervention policies in DRC.

INTRODUCTION

Malaria is a public health concern threatening at least half of the world's population and is one of top causes of death worldwide. In 2015, World Health Organization (WHO) reported that approximately 212 million malaria cases and 429 000 people nearly died from malaria. WHO African Region is the most affected [1]. Democratic Republic of Congo (DRC) is one of the most affected countries by malaria in WHO African Region. In DRC, WHO reported that malaria killed at least 39,054 people in 2015 and 19% were children under five [2,3]. The figure of deaths grew from 3,856 to 39,054 between 2000 and 2015, while according to Ilunga-Ilunga, et al. an estimated number of world malaria deaths has been decreasing (from 655,000 to 429 000 between 2010 and 2015) [4]. Currently, at least 75 million of Congolese (97%) are living in the areas where the transmission of malaria is intense [2]. Malaria is a vector-born disease. Malaria is caused by the protozoan parasite plasmodium transmitted mostly to human body through bites of infected Anopheles mosquitoes [5]. The main vectors in DRC are called *A. gambiae* and *A. funestus*. Three species are mainly identified transmitting malaria in DRC, namely plasmodium falciparum, ovale, and malariae [6]. The plasmodium falciparum is the major cause of malaria mortality and morbidity in DRC [7]. The plasmodium falciparum is especially known for causing severe malaria [8,9]. In DRC, malaria severity is common in all groups of age and is mostly observed among children [10].

DRC has an environment that is favorable to development of vectors, e.g. warm and humid climate, vegetation providing shade for mosquitoes, etc. Additionally, health services are featured by poor service delivery and poor accessibility, which increases malaria

burden. This article tends to present malaria risk factors and intervention policies and strategies applied for rolling back malaria in DRC.

Malaria Risk Factors

When experiencing population movement, population either moves with their health status background or they compromise with health status at the hosting destination. Population movement including displacement was examined to be a risk factor that increases malaria epidemics due to influx of non-immune population displacing from regions of malaria free transmission to highly endemic regions [11]. Additionally, population displacement was examined to be a risk factor that affects malaria transmission [12]. In DRC, NMCP reported that the country faces challenge that comprises huge number of displaced and refugee population. The population displacement becomes one of the major risk factors exposing to contracting diseases, especially malaria in DRC. The northern and eastern DRC regions are mostly facing population movement due to civil war. Eastern DRC regions, the North Kivu and the South Kivu provinces are typical examples of population displacement. A study conducted in Walikale, North Kivu province, by Carrión Martín et al. analyzing the impact of the continuing conflicts and displacements on the population, shows that mortality among less than five was examined above threshold. The most reason of death was related to malaria fever [13].

Malaria is a burden disease in DRC due to the impact of financial cost, mortality and morbidity on the population of DRC. Number of cases and deaths related to malaria are rising in DRC **(Table 1)**. Additionally, malaria treatment cost was analyzed impoverishing already poor population of DRC, for instance when it comes to finance costs of malaria severity. The healthcare services are largely financed by out-of-pocket payment and this system engages a very exorbitant cost, which refrains or delays population access to healthcare services [14]. Delays in access to effective treatment increase chances of morbidity and mortality. Considering the case of severity, in Kinshasa, the Capital city of DRC, malaria severity was associated with kidney diseases, anemia, cerebral malaria and Blackwater fever in children under 5 [15]. Parents of these children were reported to have difficulty in paying hospital fees. The health system in DRC is generally characterized by hardship emanating from health financing system causing barrier for many Congolese to have access to healthcare services. Initially, it was presumed that around 80% of cases and deaths did not only happen at domicile but was not reported [3]. The current figure is not available, however many Congolese may have not been accessing to needed healthcare services.

Areas where the climate is humid and hot are favorable for the development of Anopheles mosquitoes and auspicious for the malaria infection [16]. Anopheles mosquitoes grow well in areas with warm temperatures, humid conditions, and high rainfalls [17-19]. According to the climate-based distribution model of malaria transmission in Sub-Saharan Africa, the temperature below 18°C was proved inconvenient for malaria transmission while above 22°C was said to be convenient for stable malaria transmission [20]. Additionally, a study conducted by Okuneye et al. in KwaZulu-Natal province, South Africa, reveals that malaria illness increases with increasing mean monthly temperature (17 to 25°C) and rainfall (32 to 110 mm), and malaria illness decreases with decreasing mean monthly temperature and rainfall values [21].

Table 1. Number of (presumed and confirmed) and death reported in health facility (excluding community).

Year	Cases	Deaths
2000	9,64,623	3,856
2005	63,34,608	15,322
2010	92,52,959	23,476
2011	94,42,144	23,748
2012	91,28,398	21,601
2013	1,13,63,817	30,918
2014	99,68,983	25,502
2015	1,16,27,473	39,054
Data source: WHO World Malaria Report 2016		

In DRC, the mean annual temperatures of DRC in every 4 geographical areas were above the threshold climate-based distribution model of malaria transmission in Sub-Saharan Africa. In fact, malaria transmission occurs permanently and intensely in DRC **(Table 2)**. However childhood acquisition of clinical immunity before the fifth birthday is possible in equatorial facies (central African forest and post forest savannas), tropical facies (African humid savanna), corresponding to equatorial areas and savannah respectively. Childhood acquisition of clinical immunity may happen in the large rivers shores and extended swamps depending on epidemiological faces. There are regions where the acquisition of clinical immunity is rare. In these areas, malaria is highly threatening and is severe due to lack of early clinical immunity acquisition. These areas are probably eastern mountain regions and are corresponding to the mountain faces. The common feature of these regions is that they are marked by intense seasonality. Malaria seasonality is observed in most of areas of the country and transmission occur the maximum during and just after the

rainy season [3]. The seasonality is intense in eastern and south regions of DRC, where the raining season takes almost from the end of September to May.

Table 2. Ecological areas and seasonality/ hazards and vectors.

Areas	Seasonality and other hazards	Vectors
Coastal areas: In the short shoreline superintending the Atlantic Ocean	Rainfall drops below 800- 1,000 mm per year, temperature (e.g. Banana 21 -27 °C) varies with sea temperature (high in the summer months, while it becomes a bit cool in winter, dropping to 22 °C in July and August), harbors, etc.	*A. melas*
Equatorial areas: (a)Flooded and marshy forest zone; (b) Central Basin; (c) suborophiles forest zone; (d)forest parks transition zone	Equatorial climate (hot and humid all the year round with no dry season), temperature e.g. 19.5 -30 °C in Kisangani, rainfall (all the year round) 1600 mm, marshy forest, vegetation (forest as shade for vectors), etc.	a) Flooded and marshy forest zone, vectors are *A. moucheti*; b) Central Basin zone, vectors are *A. moucheti* and *A. funestus* and *A. gambiae* s.l; c) suborophiles forest zone, vectors are *A. funestus* and *A. gambiae*; and d) forest parks transition zone, vectors are *A. funestus, A. moucheti*. and *A. gambiae s.l.*
Savannah: a) savannah North zones, b) savannah oriental zone that lies along Rwanda-Burundi eastern border below 1500 meters Above Sea Level (mASL) and take two small areas north and south of lake Edward; c) savannah south zone	Tropical climate, temperature (20-31 °C in Gemena with variation at greater extent and 21-30 °C in Kinshasa with a high and fairly stable temperature throughout the year), rain falls between 1400 and 1800 mmm per year, vegetation as shade for vectors, etc.	a) Savannah Northern zone, vectors : *A. funestus, A. gambiae s.l.* and *A. moucheti*; b) savannah oriental zone, vectors are *A. funestus* and *A. gambiae s.l; c)* savannah south zone, vectors are *A. funestus* and *A. gambiae s.l.*south , *A. funestus* and *A. gambiae s.l.*
High areas and eastern mountane: a) Sub mountane transition zones (1000-1200 mASL) + western foothills of the eastern mountains and Haut Katanga highlands b) Katangais highlands zone, C) Eastern mountains zone with 1750mASL	Malaria seasonality: in most of areas of the country, transmission reaches the peak during and just after the rainy season and malaria seasonality is intense in eastern and south regions of DRC, where the raining seasons takes almost from the end of September to May [3]; lack of clinical immunity that can lead to malaria severity in all groups of age	a) Sub mountane transition zones, Haut Katanga highlands, lakes Tanganyika and Moero and borders South-West Katanga; vectors are *A. gambiae s.l., A.* funestus. *A. nili* Theobald and *A. pharoensis*); b) Katangais highlands zone, vectors are *A. funestus, A. gambiae* s.l., *A. nili* , and *A. gambiae*; C) Eastern mountains zone, Vectors are *A. gambiae garhhami* , *A. christyi, A. funestus* and *A. gambiae*
Large rivers shores and extended swamps zone	Seasonality depends on the regions; others hazards are marshes, swamps, harbors	*A. moucheti.*
Source: Ministry of Planning and Monitoring Implementation of the Revolution of Modernity (MPMIRM), Ministry of Public Health (MoPH) and ICF International, (2014) and complementary elements available on https://www.climatestotravel.com/climate/democratic-republic-congo		

The environmental risk factors are summarized in three epidemiological facies based on eco-faciae strata used across Francophone Africa countries [22]. These three epidemiological facies are summarized, according to (MPMIRM, MoPH and ICF International) as follows [23]:

- Equatorial facies (central African forest and post forest savannas) where the transmission is intense and permanent; in these facies an individual can receive, per year, a number of bites by infected mosquitoes equals to 1000 resulting in childhood acquisition of clinical immunity before the fifth birthday; the most common vectors in the zone are *A. gambiae, A. funestus, A. nili and A. moucheri*. In children under 5, 30 to 50% of fevers are caused by malaria. The morbidity spreads all over the year. Severe forms of malaria are common in young children and mostly in neurological, and are diagnosed among children under five years old than adults.

- Tropical facies (African humid savanna) where the transmission depends on seasons e.g. during the long rain lasting for 5-8 months and where people might receive between 60-400 bites by infected mosquitoes per person and per year. However the transmission still results in clinical immunity in childhood. The most common vectors in this zone are *A. gambiae, A. arabiensis, A. funestus* and *A. nili*. Childhood acquisition of clinical immunity appears later, around the age of 10 years. Illness predominates in the raining seasons; severe forms of malaria are observed until older age. Ninety-seven percent (97%) of the Congolese population are exposed to these two facies.
- Mountain faces (between an altitude of 1000 and 1500mASL) where transmission takes very short period, there may even be a year without transmission however infection-immunity is acquired much later in life or may not be complete resulting in severe malaria in all age groups. Mostly found vectors are *A. arabiensis* in highland and mountain; *A. funestus* usually in poorly drained depressions. Mountain faces are marked by absence of infection-immunity therefore malaria severities are recurrent in the whole population (adults and children) in the form of acute annual recrudescence (pseudo-epidemic aspect). 3% of the population of DRC is exposed to mountain faces, mainly in the provinces of North Kivu and South Kivu.

Intervention Policies and Strategies

DRC needs a very rigorous policy of intervention, for the country is among world top malaria countries. The MoPH of DRC controls malaria through NMCP aiming at developing policies and strategies for monitoring, treating and preventing or surveilling malaria. The intervention concerns ITNs/ LLINs, IRS, larval control, treatment and surveillance **(Table 3)**. DRC faces some challenges to conduct duly its health policy. Among these challenges are problem related to population displacement. The population is at frequent displacement due to the instability of the country resulting to humanitarians' catastrophe. The health system financing is largely supported by external donors who come in for humanitarians' purpose. These humanitarians' agencies are from varied countries coming with their own skills of health system management and are dispatched in health zones across DRC. Matching government plan and strategies with partners plan becomes issue in the leaderships of health system management in terms of coordination and implementation of government plan and strategies.

Table 3. Intervention policies and approaches in DRC.

Intervention	Policy	Yes/No	Year of Adoption
Insecticide-treated mosquitos nets	ITNs/ LLINs are distributed free of charge	Yes	2008
	ITNs/ LLINs are distributed to all age groups	Yes	2008
	ITNs/ LLINs distributed through mass campaigns to all age groups	Yes	(-)
Indoor residual spraying	IRS is recommended by malaria control program	Yes	2007
	DDT is used for IRS	No	(-)
Chemoprevention	IPTp used to prevent malaria during pregnancy	Yes	2004
	Seasonal malaria chemoprevention (SMC or IPTc) is used	No	(-)
Larval control	Use of larval control recommended	Yes	1998
Testing	Patients of all ages should get diagnostic test	Yes	2010
	Malaria diagnosis is free of charge in the public sector	Yes	2010
	RDTs used at community level	Yes	(-)
	glucose-6-phosphate dehydrogenase (G6PD) test is recommended before treatment with primaquine	No	(-)

Treatment	ACT for treatment of *Plasmodium falciparum*	Yes	2005
	Pre-referral treatment with quinine or artemether IM or artesunate suppositories	Yes	(-)
	Single dose of primaquine is used as gametocidal medicine for *P. falciparum*	No	(-)
	Primaquine is used for radical treatment of *Plasmodium vivax* cases	No	(-)
	Directly observed treatment with primaquine is undertaken	No	2010
Surveillance	ACD for case investigation (reactive)	(-)	(-)
	ACD of febrile cases at community level (pro-active)	Yes	2010
	Mass screening is undertaken	No	(-)
	Uncomplicated *P. falciparum* cases routinely admitted	No	(-)
	Uncomplicated *P. vivax* cases routinely admitted	No	(-)
	Foci and case investigation undertaken	(-)	(-)
	Case reporting from private sector is mandatory	Yes	2005
Source: adapted from (WHO, 2016); Legend :(-), no information			

Key Control Intervention

Malaria prevention is aiming at reducing the contact between mosquitoes and human hosts through controlling vectors. The use of Indoor Residual Spraying (IRS) and Long-lasting insecticidal nets (LLINs) is top successful malaria program intervention and control [24]. LLINs play important role in reducing contact between vector and human body and are proven for killing mosquitoes. By killing mosquitoes, LLINs reduce the risk of infection in the community levels [25]. DRC has an agenda of reducing malaria burden by applying largely LLINs/ITNs. In accordance with WHO to achieve universal coverage of LLINs, DRC has adopted through NMCP, a mass distribution campaign free of charge policy every three years. LLINs ITNs are distributed through two distinct strategies namely fixed and door to door strategies.

Fixed Strategy of LLINs /ITNs Distribution

Health workers or volunteers who have been trained are selected from the community base; their duty is to count members of a household. The identified are given a coupon or voucher to be exchanged with LLINs/INTs on the due date of the distribution. These workers mobilize the community and campaign about the malaria prevention model, using the physical barrier, the LLINs/INTs. The campaigners pass sufficient information to community about the importance of net use. On the voucher or the coupon is marked the distribution schedule, date and avenue. Place is a “fixed site”, for example a public place such as national stadium, or most importantly an open public area closer to a health facility. In accordance with WHO guidelines the distribution operation is conducted as follow: one net to household of one to two members, two nets to a household of three to five members, three to that six to eight, and four to a household of greater than nine; one net per bed or sleeping space through mass campaign for hospitals and bordering schools [26].

Door to door strategy of distribution

In this strategy the health volunteers pass door-to-door recording the need of the mosquito net. The operation of prior counting household members goes the same way as in the “fixed site” strategy of LLINs /ITNs distribution, except for this time LLINs/ITNs are delivered at door.

Routine distribution strategy

To make stronger coverage of LLINs/ITNs the National Strategy adds the strategy of distributing across routine Antenatal care (ANC) and pre-school clinics. The pregnant woman receives the ITNs/LLINs during the first visit, and each child receives net after completing the vaccination series generally conducted at nine moths with meals vaccination. In 2014, 5.5 million LLINs were distributed in Province Orientale, 4.1 million in Kinshasa (MPMIRM, MPH and ICF International, 2014); and 56% of children slept under ITNs, so far 57 million LLINs have been distributed across the DRC [27,28].

CONCLUSION

So far, the country receives support from donors to finance health system. The internal financial resources are not sufficient to carry out entire health spending. Level and quality of services needed are not satisfied for the lack of enough resources mobilization to cover and to reduce malaria burden. A very strong response to health system financing is locally needed for a sustainable health service delivery. Majority areas of the countries are landlocked, with little access making difficult to supply products and medicines in all the remote areas. The efforts of building capacity including roads, transportations are needed to smooth chain supply. Readiness and preparedness to public health emergencies, rapid response, strengthening surveillance, and promoting workforce development and staff expertise are also needed to tackle malaria endemic. Environmental risk factors are the most cause of malaria burden. An efface intervention strategy to apply is usage of Indoor Residual Spraying (IRS) and LLINs/ITNs. Increasing public awareness and knowledge by explaining public health concern of malaria and mode of protection are important. The implications of mass media, schools, community etc. are the ways to mobilize public.

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