The influence of social factors towards resurgent Malaria and its mitigation using Sri Lanka as a case-study

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Abstract

Social factors of malaria were examined using the case-study of malaria incidence in Sri Lanka. Sri Lanka has currently achieved eradication of malaria but as it is a small island, developing country, it is vulnerable to climate change threats. Therefore the social influences, host immunity, anti-malarial resistance, prosperity and travel, were investigated with particular reference to potential climate change-induced malaria. Development of immunity depends on the intensity and stability of transmission within the region. Although Sri Lanka recently eradicated malaria, it was previously considered a region of low to moderate transmission, with most individual inoculation resulting in infection and disease at all ages. Self-medication when unrequired is particularly significant in contributing to the global issue of anti-malarial resistance. Despite known drug resistance, distribution continues to be widespread due to low over-the-counter cost and rapid relief of symptoms. Poverty promotes transmission of malaria and in turn malaria impedes economic growth. Malaria imposes economic loss beyond direct medical costs and associated effects to macroeconomic costs by impacts on worker productivity, school children performance, etc. However improved economic growth is insufficient to eradicate malaria e.g. Oman. Air travel is a vital factor in malaria transmission due to conveyance of asymptomatic carriers from endemic to non-endemic countries, leading to outbreaks of epidemic malaria. Incidence of imported malaria has been observed mainly due to lapse or absence of prophylaxis. The management of malaria was examined under the categories of public healthcare services and mitigation measures. Mitigation measures were evaluated in relation to social factors, to determine their efficacy in the event of resurgent malaria. Mitigation techniques of prominence were anti-malarial therapy, Indoor Residual Spraying, Insecticide Treated Nets and Long Lasting Insecticide Treated Nets and lastly environmental management. Malaria is borne out of multiple risks; both environmental (i.e. climate change and environmental degradation) and social (i.e. anti-malarial resistance, migration and poverty). As observed in Sri Lanka, strong political commitment in prioritising malaria control with sustained resource allocation is vital to eliminate malaria. A multi-measure approach cross cutting public health care services and malaria interventions has proven effective despite some evident climate change impacts.
1. **Introduction**

Impacts of climate change will provide suitable conditions for transmission is supported by the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (2007). Contradictory arguments were presented regarding climate change induced malaria, whether it will extend regions of endemic malaria or a general increase of global incidence. It is predicted climate change will extend regions of endemic malaria by impacting regions of malaria; 1) limited by low temperatures, or 2) of stable transmission, and where malaria has been 3) eradicated but the vector continues to be present (van Lieshout et al., 2004). Vectors of malaria are the *Anopheles* species of mosquito. In Sri Lanka the primary *Anopheline* species is *Anopheles culicifacies*. However less important species; *A. subpictus, A. vagus, A. petiataenius, A. varuna*, support transmission at a low level (Konradsen et al., 2000). In Sri Lanka, it is predominantly *P. vivax* malaria, with *P. falciparum* cases fallen from 29% to 2% (2000-2010) (WHO World Malaria Report 2011).

2. **Social and economic context of Malaria in Sri Lanka**

Sri Lanka has been subjected to 100 years of control efforts (1911-2011) from the first Anti Malaria Campaign. The current pre-elimination stage of Sri Lanka has overall been achieved due to actively following up suspected cases (leading to a high annual blood examination rate) (WHO World Malaria Report 2011).

2.0 **Public healthcare**

In Sri Lanka health services regarding malaria were run as a vertical campaign until 1989. Decentralisation of control activities was crucial to efficacy due to ownership of the district malaria programme by provincial health authorities (Fernando and Warusavithana, 2011). This transition was embodied by; regular household visits by field Public Health Inspectors, guidance by Regional Medical Officers, a stronger monitoring system and capacity building of technical officers (Fernando and Warusavithana, 2011). In general, health services are almost unique among developing countries because a pro-poor benefit environment has been achieved (McIntyre, 2006).

2.1. **Control of Malaria**

The success of the first National Strategic Plan (NSP) for malaria control (2005-2009) led to the objective of eradication within some parts of the country in the second NSP (2008-2012). In the new millennium, successes of the national Anti Malaria Campaign included; avoidance of chloroquine resistance by *P. vivax* and *P. falciparum*, strategic technical contribution, Mobile Malaria Clinics, Rapid Diagnostic Test and Long Lasting Insecticidal Nets (LLINs). Strategic technical contribution is residual spraying programmes being led by evidence-based decision making (Fernando and Warusavithana, 2011). Mobile Malaria Clinics allowed treatment of asymptomatic parasitaemia cases which would otherwise have gone undetected (Fernando and Warusavithana, 2011). Introduction of Rapid Diagnostic Test allowed Plasmodia species differentiation aiding treatment. Formalising use of LLINs as a control tool and its subsequent distribution significantly decreased malaria incidence (Fernando and Warusavithana, 2011).

3. **Social influences of Malaria**

3.1. **Host immunity**
In regions of low to moderate transmission, as in Sri Lanka, immunity is low and most individual inoculation results in infection and disease at all ages (Alles et al., 1998). It is dependent on the intensity and stability of transmission within the respective region. Acquired human immunity is developed with increasing age due to number of years of chronic exposure (Mendez et al., 2000). This high clinical tolerance allows no case fatalities after 10 – 15 years of age (Alles et al., 1998). Critically it can be lost within a year in the absence of reinfection, such as during periods of schooling or employment abroad.

3.2. Anti-malarial resistance

Multiple drug resistance, but most significantly chloroquine, has contributed to resurgent malaria. Despite resistance, distribution of these drugs continues to be widespread in the tropics, due to its low over the counter cost and rapid relief of symptoms. Critically, asymptomatic parasitaemia remains acting as a source of infection for Anopheline mosquitoes. In Sri Lanka *P. falciparum* resistance was first observed in 1983 with 4,500 cases (Fernando and Warusavithana, 2011). Furthermore remnant chloroquine inhibits its treatment for *P. vivax* malaria and thereby *P. vivax* resistance to chloroquine is growing globally.

3.3. Prosperity

Poverty promotes transmission of malaria while it simultaneously impedes economic growth. In countries with *P. falciparum* malaria GDP is decreased by 1.3% due to long term cognitive effects (Sachs and Malaney, 2002). Malaria imposes economic loss beyond direct medical costs and associated effects to macroeconomic costs. These include impacts on worker productivity, savings and investment, etc. In parasitaemic children performance of fine motor functions is impaired (Sachs and Malaney, 2002). Low birth weight babies, due to malaria induced anaemia, are two to four times more likely to experience failure in school. In addition, school absenteeism due to infection is suggested to increase failure rates, repetition of school years and dropout rates (Sachs and Malaney, 2002). However improved economic growth is insufficient to eradicate malaria e.g. Oman and the United Arab Emirates (Mendez et al., 2000).

3.4. Travel

Air travel allows conveyance of asymptomatic carriers from endemic to non-endemic countries, and if female *Anopheles* is present this leads to outbreaks of epidemic malaria. Imported malaria has been observed in Sri Lanka, Australia, Europe, and the United States, mainly due to lapse or absence of prophylaxis (Shiff, 2002). Therefore with expected 4-5% growth of the global airline industry in the next 10-15 years this will substantially increase.

4. Mitigation

As an anti-malarial, Artemisin-based Combination Therapy (ACT) is currently most effective. Fixed combination and multiple drug therapies (hinder resistance to individual components) maximises therapeutic lives of remaining effective drugs (WHO, 2001). In Sri Lanka ACT (arthemer+lumefantrine) was adopted as a national policy in 2008 (Fernando and Warusavithana, 2011).

The intradomicile application of residual insecticides is based on feeding and resting habits of most *Anopheles* species. Evidence dictates this is the best available means of mitigation of resurgent malaria (as observed in Asia and the Americas) (Baird, 2000). Synthetic pyrethroid insecticides are stable and effective over long periods, are impregnated into mosquito nets (Shiff, 2002). Higher mosquito mortality is observed in rooms with ITNs due to accumulated dosages from probing nets on entry and exit (Shiff, 2002). ITNs reduce malaria incidence by 39-62% and child mortality by 14-29% (Okomu and Moore, 2011). ITNs are proven to be effective despite nets being torn, improperly tucked in, etc. (Shiff, 2002). Its capacity is equal to IRS (Shiff, 2002). Re-impregnation of the residual
insecticide is required to avoid loss of function as a vector control agent. A substantial reduction of transmission is achieved by extensive coverage and requires the compliance of a well-informed and committed community (Shiff, 2002).

Environmental management is direct intervention in the mosquito life cycle by the removal of breeding sites, via spreading oils or source reduction. Source reduction is viewed as an impractical control effort due to the opportunistic capacity of Anopheles species to breed in a range of situations (Shiff, 2002). These methods need to be tailored to the particular species of malaria transmission (Shiff, 2002). The use of larvivorous fish or polystyrene beads reduces the survival of larvae and pupae of species found in swamps, ponds and drainage (Shiff, 2002).

5. Added value to Integrative Risk Management

Malaria is borne out of multiple risks; anti-malarial resistance, climate change, social migration and unrest, environmental degradation and finally poverty. Therefore an integrative risk management approach is required. Risk is eliminated by source reduction. Risk reduction is implemented via IRS, ITNs and LLINs. Emergency management by 1) Monitoring factors of ecological transmission and implementation of a potential early warning system 2) Enhanced parasitological surveillance. Self-responsibility lies in seeking treatment at the onset of symptoms and if within high transmission zones ensuring regular check-ups. Malaria itself has multiple risks; direct human impacts (morbidity and mortality) and secondary social and economic costs. The basis of my review is a multidisciplinary approach since it examines malaria in environmental, economic and social perspectives (Section 2 and 3). Added value is presented in the need for; awareness of macroeconomic costs, and consumer compliance in receiving health services and mitigative control of malaria. In Sri Lanka the success of a multi stakeholder approach is evident in the decentralisation of the Anti Malaria Campaign. Also instrumental were funds received from multilateral agencies and continuous technical support and capacity building from the World Health Organisation (Fernando and Warusavithana, 2011).

6. Conclusions

It was found climate change and travel respectively fulfils two components of endemic malaria; ‘suitable climate for the sporogony cycle’ and ‘infected individuals with gametocytes in their blood as source of infection for vectors’. However the third component of ‘suitable mosquito vectors in sufficient numbers to maintain transmission’ is negligible – it is the length of mosquito survival which is required for efficient transmission (Shiff, 2002).

An effective combination of mitigation techniques is; coupling insecticide treated nets (preferably LLINs) with IRS, rotational outdoor residual spraying (using complementary but divergent insecticides) and use of ACT. Strong political commitment, to prioritising control of malaria, allowed for sustained resource allocation. Evidence-based policy making enabled a reactive control policy (effective at district level) which was implemented by expertise in numbers. Highly trained and committed staff meant enhanced parasitological surveillance and diagnosis. Overall Sri Lanka implemented a specialised multi-measure approach targeted to its characteristics of transmission of malaria.

Acknowledgements

I am grateful to Professor C. Black, my former supervisor at the (School of Biosciences) University of Nottingham for his extensive support and encouragement when I initially compiled this study. I am thankful for the guidance provided by, my mentor at the Institution of Environmental Sciences Dr M Everard and my current supervisor, Professor SSL Hettiarachchi who has supported me as I have continued to develop this study.

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