A literature review about the impact of climate change on malaria in South Sudan

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Abstract

Mortality from malaria remains high in Africa despite constant efforts to combat the disease. By the end of 2018, fatalities were estimated to be 380,000 per year. This literature review covers papers on the management of malaria and the impact of climate change on the disease in South Sudan.

PubMed and the South Sudan Medical Journal website were searched using the MeSH terms (Medical Subject Headings): malaria, prevalence, epidemiology, diagnosis, medication, prevention, strategies, policies, South Sudan, chemoprophylaxis, immunity. Fifteen studies were included in the final review. Information was extracted on climate change, mosquito activity and management of malaria. Seeking improvements in the treatment and prevention of malaria is an on-going task. New strategies are needed aimed at tackling climate change and the elimination of the disease.

Introduction

PubMed was searched using the MeSH terms of malaria or prevalence or diagnosis or medication or prevention or strategies or policies or South Sudan or chemoprophylaxis or immunity or humans. Filters were on humans, free full text, in English, up to five years old, clinical studies and trials, journals, multicentre studies, observational studies. The MeSH terms were also used as keywords to search the South Sudan Medical Journal. Searches were also performed on some of the references of the primary research studies. Fifteen studies were included in the review, based on the keywords and the topics.

The impact of malaria

Malaria is a heavy burden on health systems particularly in parts of Africa and Asia.[1] In 2018, malaria cases were estimated at 228 million worldwide, with 93% in Africa. P. falciparum causes 99.7% of infections in Africa, 50% in South East Asia, 71% in the Eastern Mediterranean and 65% in the Western Pacific.[2]

Malaria affects particularly children and pregnant women. In countries with a moderate or high burden of malaria, anaemia is found in 61% of children aged under five years.[2] It is a frequent reason for school absenteeism. Expectant mothers may have asymptomatic infections, with parasites sequestered in the placenta.[2] Malaria in pregnancy can result in premature birth, low birth weight and death of new-borns. Among the survivors there is a risk of damage to physical and cognitive development.[2]

Malaria and climate change in South Sudan

In South Sudan, malaria is the leading cause of illness and mortality, accounting for 70% of the weekly reported deaths in 2017.[3] Malaria is endemic in 95% of South Sudan. It occurs throughout the year and is worse during the rainy season. The Malaria Consortium in 2019 reported that malaria was responsible for 20 to 30% of health facility visits, 30% of admissions and was a leading cause of mortality.[4]

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Climate change leads to inconsistent patterns of rains. High rainfall often results in severe flooding in parts of Equatoria, Upper Nile and the Bahr el Ghazal regions. This causes serious damage to housing and crops. The floodwaters are good breeding grounds for mosquitoes, leading to the higher transmission of malaria and other communicable diseases like cholera, typhoid and dysentery.[5]

In August 2019 OCHA[6] reported that, as the rains intensified, cases of malaria increased leading to high rates of illness and death, especially among children. Malaria accounted for 68% of the disease reported in health facilities, and 72% of deaths in the under five-year olds.[6] Additionally, cases of malaria were noted to have increased from 2013-2017 in 19 counties across the country. Other challenges in diagnosis, treatment and prevention measures were identified: the absence of antimalaria drugs causing people to resort to the use of herbal medicines, conflicts, few health workers and poor road conditions.[6]

Health care models for malaria

The Integrated Primary Health Care (iPHC) Model proposed by Joseph and Hakim[7] shows how malaria treatment and other healthcare services can reach rural areas where 95% of the population resides. This health model combines five aspects: Public Heath, Clinical Services, Universal Registration, Physical Building and Training.

Public health service provision requires collaboration with the local administrative structures, chiefs, community leaders, non-governmental organisations and other organisations tackling malaria.[7] Strategies are needed for malaria control, especially during the flooding seasons, for example, by digging drains in community areas to avoid stagnant water and so the breeding of mosquitoes, and spraying residual water.

Laboratory facilities at Primary Health Care Centres (PHCC) are essential to provide accurate diagnosis before starting appropriate antimalarial treatment.[7] Training allows the PHCCs to be run by health workers such as laboratory assistants, nurses, and clinical officers, so that patients attending in a critical condition can be treated better and a referral system set up.[7]

An efficient medical records system facilitates monitoring and surveillance of malaria.

Mosquito activities and climate change

Beck-Johnson et al[8] noted that rising temperatures and other changes in climate have an impact on vectors and may lead to an increase of some diseases. The developmental stages of the plasmodium parasites and the adult mosquito are temperature dependent. Existing mosquito control measures need to be re-assessed.

The variations in the local climate of the regions in South Sudan affect the epidemiology of diseases. South Sudan has two different climate conditions, a hot semi-arid climate and a tropical climate.

Mukhtar et al[9] indicate that the weather and rainfall do influence malaria, as the disease was noted to be more prevalent in Central Equatoria State region where it is tropical, a more favourable climate for mosquitoes than it is in the Western Bahrghazel region.[9]

They modelled the population dynamics of Anopheles gambiae mosquitoes in relation to rainfall and temperature, using data from these two distinct climatic regions of South Sudan and proposed likely values for R0, the basic reproduction number, under different climatic conditions. Existing malaria control strategies and health service provision are based on historic climate patterns, but such modelling is now needed to inform future, climate change resilient strategies and provision.

Also, low, or heavy rainfalls were shown to reduce the number of immature mosquitoes still developing from the eggs, larvae, and pupae. Suitable measures should consider the local climate of the area.[9] Hence, understanding climate change informs on the transmission of malaria. A deeper understanding of climate change may lead to more knowledge on how mosquitoes behave, subsequently how malaria is transmitted. This in turn helps the design of effective interventions.[9]

Other methods that are available include the linear regression (LR) method by Benedette et al[10], who evaluated a novel method for detecting exceptional increases in case numbers in the absence of useful historical records, using only eight weeks of current data.[10] This method may be useful in South Sudan where reliable historical records may not exist, and historical records may not be a guide to future disease incidence due to climate change and variation in the occurrence of malaria.[10] Better ways of recording and storing data are needed, in order to assess and interpret disease occurrence; this can also aid in observing the changes in disease patterns that are influenced by climate change.

The management of malaria in South Sudan

Mosquito nets are commonly used for the prevention of malaria in South Sudan. A 2017 malaria survey by the Ministry of Health and the National Malaria Control programme reported that the percentage of households owning at least one mosquito net was 79% in urban areas and 61% in rural areas.[11] The highest coverage of households using Insecticide Treated Nets (ITNs) was in Central Equatoria, where two persons share one mosquito net in 45% of the households. Despite the use of ITNs being high, there is a slight decrease from 66% in 2013 to 63% in 2017.[11] Although the household

ownership of at least one mosquito net is high in the areas for the Protection of Civilians (PoC), only 15% of PoC households and 6% of IDP households have an ITN for every two household members.[11]

The treatment of malaria varies depending on the level of complication presented. Azairwe and Achan in 2011 [12] described the treatment of uncomplicated malaria in South Sudan - which should be treated immediately to prevent progression to severe, potentially fatal, disease. Azairwe and Achan's paper[12] also dealt with treatment failure arising from drug-resistance, non-adherence or use of substandard medicines.[12]

The existence of current recommended treatments for malaria does not guarantee future success. Parasites have developed resistance to currently available drugs, which may worsen with time.[2] Further changes in climate may result in an increase in the number of malaria-transmitting mosquitoes.[13] Thus new strategies should be considered, for example, the RTS, S vaccine being piloted in Kenya, Ghana, and Malawi, which provides partial protection for young children against P. falciparum.[14] There has been a reduction by 29% of severe malaria in the children in the age range 5-17 months, who were given 4 doses of the RTS, S vaccines. Among these children, the vaccine prevented approximately 4 out of 10 (39%) malaria cases over 4 years of follow-up. Admission rate due to severe malaria also declined. This vaccine has been incorporated in the routine immunisation programme, in the countries conducting the pilot.[15] Once the pilot programme is complete, introducing it into South Sudan may play a great role by contributing to the in reduction of malaria morbidity and mortality.

Conclusion

To reduce the occurrence and stop the spread of malaria in South Sudan, new strategies that consider climate change as a major factor need to be considered. It is necessary to understand the climate where malaria thrives, by adapting methods that control the vector in addition to continuing appropriate use of anti-malarial drugs and close monitoring of the health system.

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