

RESEARCH REPORT

Malaria Incidence in Zambia, 2013 to 2015: Observations from the Health Management Information System

AB Inambao^{1,4}, R Kumar², B Hamainza³, M Makasa⁴, CF Nielsen⁵

1. Zambia Field Epidemiology Training Program, Ministry of Health, Lusaka, Zambia
2. ASPPH/CDC Allan Rosenfield Global Health Fellow
3. National Malaria Control Center, Lusaka, Zambia
4. University of Zambia, Lusaka, Zambia
5. United States Centers for Disease Control and Prevention, President's Malaria Initiative, Zambia

Correspondence: Akatama Biggie Inambao (ab_inambao@yahoo.co.uk)

Citation style for this article:

Inambao AB, Kumar R, Hamainza B, Makasa M, Nielsen CF. Malaria Incidence in Zambia, 2013 to 2015: Observations from the Health Management Information System. Health Press Zambia Bull. 2017;1(3);[inclusive page numbers].

Malaria is a major cause of morbidity and mortality in Zambia, particularly in highly endemic areas and among pregnant women and children under 5 years. In 2014, 5.8 million cases were reported through the National Health Management Information System (HMIS). We seek to assess the current trends in malaria incidence, and assist policy makers in decision-making around malaria prevention and treatment priorities.

We extracted national and provincial data on malaria cases (clinical and laboratory-confirmed) reported in HMIS from 2013-2015. We calculated overall and age group-specific (under 5 years and 5 years old and above) malaria incidence using extrapolated census data, and calculated the proportion of cases that were laboratory-confirmed by rapid diagnostic test or microscopy.

National malaria incidence was 386/1000 persons in 2013, 409/1000 in 2014, and 335/1000 in 2015. North-western Province recorded highest total incidence, ranging from 867/1000 in 2013 to 847/1000 in 2015. In 2013, 51% of cases were laboratory-confirmed; however, this increased to 80% of malaria cases by 2015. The incidence of laboratory-confirmed malaria among

pregnant women increased from 49/1000 in 2013 to 64/1000 in 2015. The incidence in pregnancy was highest in Luapula (131/1000 in 2013, 207/1000 in 2014 and 177/1000 in 2015). For three years, malaria incidence was higher among under 5 children (756/1000) compared to 5 years and older (275/1000).

Malaria incidence in Zambia has substantial variation by province and age-group, and possible increases in pregnant women. This study identified high incidence in North-western and Luapula Provinces as well as pregnant women and children under five. These provinces and risk groups should be prioritized for malaria prevention and control programs.

Introduction

Malaria is a major cause of morbidity and mortality in Zambia, particularly in highly endemic areas and among pregnant women and children under 5 years [1]. In 2014, 5.8 million malaria cases were reported through

routinely collected data in the National Health Management Information System (HMIS) [2].

Reducing the incidence of malaria is a national priority that requires a focused, comprehensive, and consistent approach in order to achieve the vision of “a malaria-free Zambia by 2030”, as stated in the 2011-2016 strategic plan of the Zambian National Malaria Control Programme (NMCP) [1]. As part of Zambia’s National Malaria Elimination Strategy, several interventions are implemented to reduce malaria; including universal insecticide treated bed-net (ITN) coverage and indoor residual spraying (IRS) in targeted areas. The plan also includes strategies to: improve malaria case management; improve diagnostic testing capacity and quality, increase coverage of three doses of sulfadoxine - pyrimethamine (SP) for intermittent preventive treatment in pregnancy (IPTp), establish a robust surveillance system, and establish a monitoring and evaluation framework [2].

Malaria research in Zambia has primarily focused on specific interventions and population sub-groups. Phiri et al, 2015 concluded that Indoor residual spraying was associated with reduced malaria incidence in Kaoma district in areas where it was implemented [25]. According to a study

conducted in Macha, Norris et al, 2011 concluded that Proper LLIN care was a strong determinant of LLIN efficacy, indicating that education on the importance of LLIN use and care is key when distributing nets [26]. In a study conducted in Mansa by Tan et al, 2014, they found 26% failure rate of sulphadoxine-pyrimethamine (SP) giving the moderate prevalence of the quintuple mutant haplotype. They indicated that, despite the presence of resistance, SP retained some efficacy in clearing parasites in pregnant women, and may remain a viable option for IPTp in Zambia [27]. Chaponda et al, 2015 investigated the prevalence and the predictors of malaria infection among pregnant women residing in one rural district in northern Zambia. They concluded that the high burden of malaria detected by Polymerase Chain Reaction (PCR) in pregnant women was suggestive of a limited effect of past prevention efforts in this population [3]. To sustainably reduce this burden of malaria, they suggest strengthening existing interventions, and shifting approaches towards targeting of pregnant women and other high-risk groups [3]. Chanda et al, 2012 assessed the status of Zambian vector control implementing policies and strategies and concluded that solid, consistent, and coordinated policies,

strategies, and guidelines exist for malaria vector control [4]. Bennett et al, 2014 advocated for increased evaluation of national malaria control programs (and other national public health interventions) using routine data [5]. However, more research and surveillance is needed to improve the understanding of the overall epidemiology of malaria in Zambia.

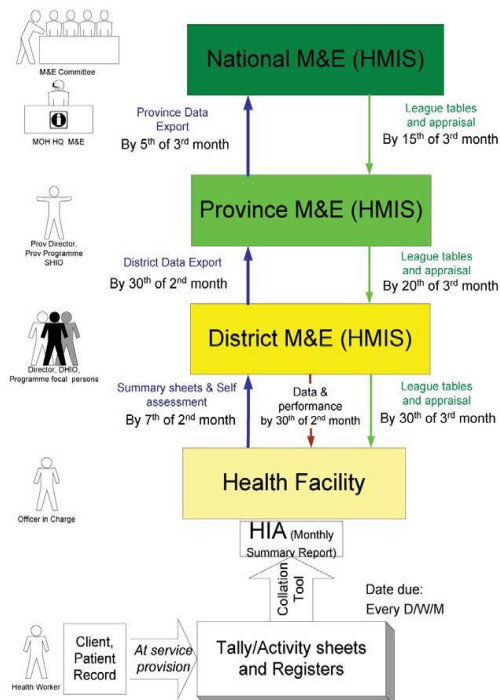


Figure 1 Movement of HMIS data

Understanding incidence trends across the nation is critical to aiding the NMCP. As such, we describe national and provincial malaria incidence for 2013-2015, highlighting vulnerable populations, and comparing proportions of laboratory-confirmed malaria cases reported from Zambia’s ten provinces. Our intent is to

assess the current trends in malaria incidence and assist policy makers in decision-making around malaria prevention and treatment priorities.

Method

We conducted a descriptive epidemiological analysis of secondary data for all ten provinces of Zambia, i.e. Central, Copperbelt, Eastern, Southern, Luapula, Lusaka, Muchinga, North-western, Western and Northern Provinces.

We extracted provincial data on all malaria cases (clinical and laboratory-confirmed) reported in the Health Management Information System (HMIS) from 2013-2015. HMIS is a routine web-based health information system which was established in 1996 [2]. Its aim is to supply each level of the health sector (facility, district, provincial-level, and national-level) with necessary information in a timely and accurate manner to support informed decision-making. The HMIS covers routine service activities and integrates epidemiological surveillance in every facility within the country (Figure 1). HMIS variables of interest included total reported malaria cases, laboratory confirmed malaria cases, and age group-specific rates of malaria incidence in each province.

The Central Statistics Office (CSO) provide catchment population estimates for each

province based on extrapolated 2010 census data: children under 5 years account for 20%, persons 5 years old and above account for 80%, and pregnant women account for 5.4% of the total provincial population [6].

We calculated overall and age group-specific (under 5 years, and 5 years old and above) malaria incidence using the estimated provincial catchment populations as denominators.

Table 1 Malaria Incidence per 1000 Persons (Both Clinical and Laboratory Confirmed) by Age Group in Zambia, 2013 – 2015

Year	Age						Malaria in Pregnancy			Malaria Incidence		
	<5 years			≥5 years			Total	Lab-Conf	% lab-conf	Total	Lab-Conf	% lab-conf
	Total	Lab-Conf	% lab-conf	Total	Lab-Conf	% lab-conf						
2013	824	410	50	271	133	49	90	45	50	386	191	49
2014	808	538	67	302	201	67	103	69	67	409	272	67
2015	643	518	81	252	203	81	83	64	77	335	269	80
3 yrs	756	495	65	275	180	65	92	60	65	376	245	65

Source: HMIS, 2013-2015

Expected pregnancies accounted for 5.4% of the annual total population and were used as a denominator when calculating incidence of pregnant women at risk of getting malaria infection at a given time. Next, we calculated the proportion of reported cases that were laboratory-confirmed by rapid diagnostic test or microscopy. All collected data were checked, cleaned and entered into a computer using Epi-Info software version 7 [24]. Descriptive statistics were used to compare differences in incidence proportions among age groups, place and time period. We also compared our findings with the findings from the Zambia’s Malaria Indicator Survey (MIS) of 2015 which is a comprehensive, nationally

representative household survey designed to measure progress toward achieving the goals and targets set forth in the National Malaria Strategic Plan 2011–2015 [9].

Ethical Consideration

This is surveillance and program evaluation activity, not human subject research. Only secondary data without personal identification information was used. Permission to conduct the study and use of the malaria morbidity data was obtained from the National Malaria Control Program of the Ministry of Health (MoH). All data extracted were confidentially stored at the end of the study.

Results

Overall, malaria incidence in Zambia was 386 per 1000 in 2013, 409/1000 in 2014, and 335/1000 persons in 2015, with a three year average of 376/1000. Incidence was higher in persons under 5 years age group compared to persons aged 5 years and above. Incidence of laboratory confirmed malaria among pregnant women was 45/1000 in 2013, 69/1000 in 2014, and 64/1000 in 2015. Incidence of laboratory confirmed malaria in pregnancy was 92/1000 with an average of 65% of cases laboratory confirmed over three-year period, 2013-2015 (Table 1). Nationally, percentage of cases that were lab

confirmed increased from an average of 49% in 2013 to 80% in 2015 (Table 1).

Regionally, North-western Province recorded the highest malaria incidence in all three years, with 867/1000 in 2013, 950/1000 in 2014, and 847/1000 persons in 2015, followed by Luapula and Muchinga Provinces. The lowest incidence occurred in Southern Province with 65/1000 in 2013, 100/1000 in 2014, and 26/1000 persons per year in 2015, followed by Lusaka Province (Figure 2).

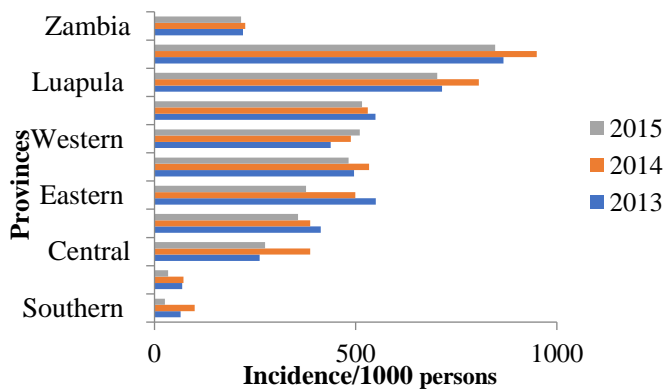


Figure 2 Total Malaria Incidence (Clinical and Laboratory Confirmed) by Province in Zambia, 2013 to 2015

The proportion of cases that were laboratory-confirmed improved over time in all ten provinces. Eighty percent of reported malaria cases were confirmed nationally in 2015, compared with 51% in 2013. The percentage of confirmed malaria ranged among the provinces: from the lowest with only 35% confirmation in Western and Lusaka Provinces in 2013, to 92% in Southern Province in 2015 (Figure 3). During 2013-

2015, total malaria incidence was higher among children under 5 years (756/1000) compared to persons aged 5 years and above (275/1000 persons) across all the ten provinces.

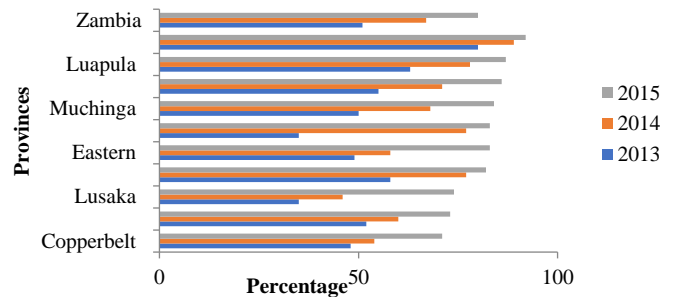


Figure 3 Percentage of Laboratory (RDT/Microscopy) Confirmed Malaria by Province, Zambia, 2013 To 2015

North-western Province recorded the highest malaria incidence among the under 5 age group (1658/1000), followed by Luapula (1600/1000) and Northern Provinces (931/1000) over the 3-year period (Figure 4).

Discussion

This study has important findings regarding the burden of malaria in Zambia. First, the overall incidence of malaria in Zambia increased by 6% between 2013 and 2014, and then decreased by 18% between 2014 and 2015, resulting in an overall decrease of 12% for the 2013-2015 time periods. Notably, the overall incidence is not representative of trends within provinces: substantial variations exist. While a similar increase in incidence from 2013 to 2014 and then drop in 2015 was found in six provinces (Central,

Luapula, Northern, North-western, Lusaka, and Southern), a two-year drop in incidence was found in Copperbelt, Eastern, and Muchinga Provinces. In contrast, a two-year increase in malaria incidence was seen in Western Province. The type of regional variation is seemingly limited to geographic or ecologic influences from local to the national level, implying that strategies put in place were affected differently regionally over the 3-year period.

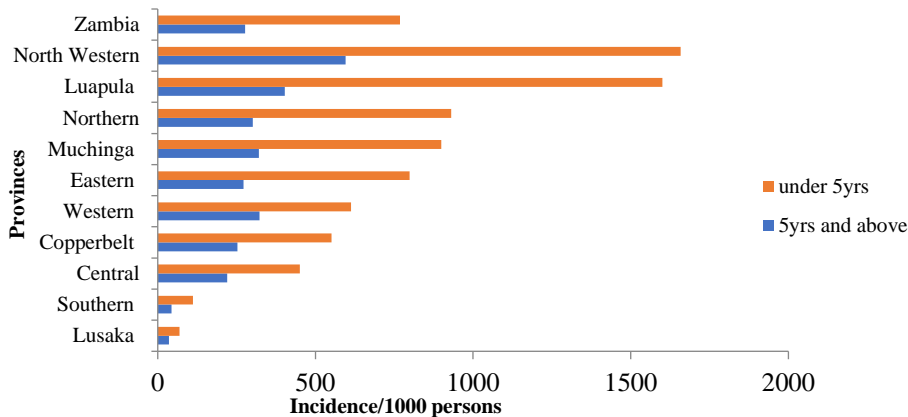


Figure 4 Total Malaria incidence by Age Group by Province over 3 Years, Zambia, 2013 – 2015

Regionally, North-western, followed by Luapula and Muchinga Provinces are at a higher risk of malaria. North-western Province had the highest incidence of malaria during 2013 through 2015 compared to other provinces in Zambia. Suffice to mention is that the proportion of cases that were laboratory confirmed was lowest in North-western province compared to Luapula and Muchinga provinces despite a steady increase recorded across provinces

during 2013 to 2015 (Figure3). However, despite having the highest malaria incidence rates overtime, the province recorded a decrease in incidence by 25% in 2015 compared to 2014 (Figure 2). On the other hand, North-western had the highest incidence of malaria in children under 5 compared to other provinces during 2013 to 2015 (Figure 4). Still, these findings indicate a need for concerted efforts to fight the disease in line with the national strategic

goal of the malaria control program. While on their way to achieving the strategic framework laid out by the NMCP, this

province still requires the involvement of various stakeholders in addition to the MoH, in order to establish effective vector control [7]. Another key finding is that all the ten provinces recorded higher incidence of malaria among children under the age of 5 years compared to persons aged 5 years and above. The highest 3-year incidence in the under 5-year age group occurred in North-western Province followed by Luapula and Northern Provinces. Despite the increase in

malaria disease burden among children under the age of 5 years (as compared to adults), the Ministry of Health with support from partners have through the successive National Malaria Strategic plans been providing free ITNs to the vulnerable population groups which include children under-five years of age to prevent and control the spread of malaria regionally. The malaria strategic plan (NMSP 2011-2016) is to provide, a comprehensive strategic framework for the fight against malaria that contributes to the attainment of the national vision of “a malaria-free Zambia by 2030” [2]. The ITN policy initially targeted young children and pregnant women but has since been extended to cover all age groups through mass distribution campaigns and routine distribution to pregnant women during antenatal care (ANC) clinics so as to increase in ITN ownership and utilization. However, persistently high levels of malaria in Luapula and North-western Provinces may indicate that the existing malaria preventive and control strategies put in place may not have yielded desired results. The deployment of an effective and evidence-based malaria vector control requires locally informed decisions because the epidemiology of the disease varies at a small

scale, suggesting the need for precise targeting [8]. The core interventions can be supplemented in specific locations, by larval source management strategies i.e. larviciding or environmental management [13-17]. As such, we suggest that an operational research study to determine risk factors contributing to increased malaria incidence be undertaken in Luapula and North-western Provinces of Zambia. In comparison to the Zambia’s Malaria Indicator Survey (MIS) of 2015 [9], Luapula reported the highest level of malaria prevalence, with 32.5% of children’s testing slides positive. Muchinga, Northern, and North-western Provinces reported the next highest levels of slide prevalence with 31.4%, 27.6%, and 22.6%, respectively. Lusaka and Southern Provinces reported the lowest levels of slide-positive children with less than 3% positivity. MIS of 2015 indicates that over time, North-western Province has reported a large increase in slide prevalence, from 2012 to 2015 [9]. This finding provides an epidemiologic picture similar to our findings during our investigation period. Additionally, our findings are consistent with some malaria research in Zambia and other sub-Saharan countries, which consistently report higher incidence of malaria among young children

(as compared to adults), and thus there is a need for malaria prevention interventions targeting this vulnerable group [10]. One potential option for achieving improvements in childhood morbidity is by combining ITNs and IRS to improve protection offered by IRS or ITNs alone [11, 12]. Pregnant women are also particularly at risk of malaria, partially due to lowered immunity during pregnancy [18]. Additionally, malaria can have particularly serious health consequences for both pregnant women and their unborn children [3, 19, 20]. As such, the Zambia's MoH has routinely distributed ITNs and provided Intermittent Preventive Treatment in pregnancy (IPTp) for malaria prevention in order to reduce malaria disease burden among pregnant women [18]. This however, does not necessarily mean that malaria incidence among this sub-group will not rise again, because Zambia recorded an increase in incidence of malaria in pregnancy from 90 to 103 per 1000 (from 2013 to 2014) before dropping to 83/1000 in 2015. This finding highlights the need for continued vigilance on protecting pregnant women from malaria, particularly in places with highest incidence, including Luapula, North-western, and Northern Provinces. One of the most definitive findings of this study is the increase in laboratory-confirmed

malaria from 2013 to 2015. Nationally, over three-quarters of recorded malaria cases were laboratory-confirmed in 2015, while over half of the cases were laboratory-confirmed in 2013 and 2014. All ten provinces in Zambia had a consistent proportional increase of malaria cases that were laboratory-confirmed over time. With the exception of Copperbelt, Lusaka and North-western Provinces, all other provinces in 2015 recorded >80% of cases confirmed by laboratory test in 2015. The percent confirmed ranged from 35% in Western and Lusaka Provinces in 2013 to 92% in Southern Province in 2015. An increasing proportion of reported malaria cases with laboratory confirmation signifies improved adherence to diagnostic and treatment guidelines of malaria, improved case management, and stronger surveillance. At present, however, some health facilities are still reporting on clinical malaria cases contrary to the diagnostic and treatment guidelines, possibly due to difficulty in obtaining prompt laboratory diagnosis, or inefficient documentation and record keeping of malaria data during period under review. This implies that total malaria being reported may be misclassified [21]. Over-diagnosis can be considerable and contributes to misuse of anti-malarial drugs,

which may yield anti-malarial drug resistance in the general population overtime [21]. Some provinces with higher malaria incidences rates may have less laboratory capacity. As such, continued efforts should be made to ensure that health facilities in the provinces have the tools and skills needed to both confirm malaria diagnosis, and to adhere to diagnostic and treatment guidelines. This will minimize reporting of presumptive clinical malaria cases. Enhanced data audit and verification at both health facility and district levels will further ensure validity of data before being submitted onward to the central reporting system. There are limitations to this study and its findings. This study is ecological, and we could not confirm whether the trends observed represent real changes in malaria incidence versus artificial changes due to reporting. Another limitation is that the HMIS does not disaggregate malaria data by sex, which limited our ability to determine malaria incidence by sex as well as other potential risk factors.

In spite of these limitations, it is clear that malaria incidence in Zambia has substantial variation by province and age group, and possible increases in pregnant women. Continued efforts are needed to achieve the vision of “a malaria-free Zambia by 2030”

[2]. This study has identified areas needed for improvement, particularly addressing provinces with high incidence such as North-western and Luapula Provinces, where these findings present an epidemiological picture similar and largely consistent with the results obtained during the Malaria Indicator Survey for 2015 [9]. Future studies should look at seasonal variation of malaria incidence which would require individual-level data that is not available in HMIS. The MoH and partners should rigorously monitor and evaluate the interventions being implemented, and compare their programmatic data to HMIS, in order to ensure that the malaria elimination strategies are well-targeted and coordinated so that substantial results are achieved.

Acknowledgements

This work was funded by the United States Centers for Disease Control and Prevention and the US President’s Malaria Initiative. The author acknowledges them with gratitude for supporting and funding the manuscript writing workshop on behalf of the Zambian Field Epidemiology Training Program (FETP). We also acknowledge the role the Ministry of Health is undertaking in coordinating, supporting and ensuring that FETP becomes a success in Zambia. We

would like to thank the following: Dorothy Southern, for providing mentorship and technical skills during training; Nicole Bellows, for providing guidance and mentorship towards the production of this document and Dr. Henry K. Baggett, for reviewing and providing technical advice towards the production of this document.

This publication was supported by Cooperative Agreement Number U36OE000002 from the Centers for Disease Control and Prevention and the Association of Schools and Programs of Public Health. The findings and conclusions of this publication do not necessarily represent the official views of CDC or ASPPH.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

Extracted the data: AI, Analyzed the data: AI, RK. Wrote the paper: AI, RK, BH, MM, CFN. All authors read and approved the final manuscript.

References

1. Zambia Ministry of Health. National Malaria Strategic Plan 2011– 2015. Ministry of Health, Zambia. 2011
2. Zambia Ministry of Health. Lusaka. Health Management Information System (HMIS). Ministry of Health. 2015.
3. Chaponda EB, Chandramohan D, Michelo C, Mharakurwa S, Chipeta J, Chico RM. High burden of malaria infection in pregnant women in a rural district of Zambia: a cross-sectional study. *Malaria journal*. 2015; 14(1):1.

4. Chanda E, Coleman M, Kleinschmidt I, Hemingway J, Hamainza B, Masaninga F, et al. Impact assessment of malaria vector control using routine surveillance data in Zambia: implications for monitoring and evaluation. *Malaria journal*. 2012; 11:437.
5. Bennett A, Yukich J, Miller JM, Vounatsou P, Hamainza B, Ingwe MM, et al. A methodological framework for the improved use of routine health system data to evaluate national malaria control programs: evidence from Zambia. *Population health metrics*. 2014; 12(1):1.
6. Zambia Central Statistical Office. Population and demographic projections. Lusaka, Zambia. 2013-2035 (2013).
7. World Health Organization. Global strategic framework for integrated vector management. 2004.
8. Van den Berg H, Takken W. Viewpoint: A framework for decision making in integrated vector management to prevent disease. *Tropical Medicine & International Health*. 2007; 12(10):1230-8.
9. Ministry of Health: Ministry of Health CSO, PATH Malaria Control and Evaluation partnership in Africa (MACEPA). Lusaka. Zambia National Malaria Indicator Survey 2015. The United States President's Malaria Initiative, the World Bank and World Health Organization. 2015(2016):39.
10. Fullman N, Burstein R, Lim SS, Medlin C, Gakidou E. Nets, spray or both? The effectiveness of insecticide-treated nets and indoor residual spraying in reducing malaria morbidity and child mortality in sub-Saharan Africa. *Malaria journal*. 2013; 12(1):1.
11. West PA, Protopopoff N, Wright A, Kivaju Z, Tigererwa R, Mosha FW, et al. Enhanced protection against malaria by indoor residual spraying in addition to insecticide treated nets: is it dependent on transmission intensity or net usage? *PloS one*. 2015; 10(3):5661.
12. Utzinger J, Tozan Y, Singer BH. Efficacy and cost effectiveness of environmental management for malaria control. *Tropical Medicine & International Health*. 2001; 6(9):677-87.
13. Killeen GF, Knols BG, Fillinger U, Beier JC, Gouagna LC. Interdisciplinary malaria vector research and training for Africa. *Trends Parasitol*. 2002; 18(10):433-4.
14. Utzinger J, Tozan Y, Doumani F, Singer BH. The economic payoffs of integrated malaria control in the Zambian copperbelt between 1930 and 1950. *Trop Med Int Health*. 2002; 7(8):657-77.
15. Keiser J, Singer BH, Utzinger J. Reducing the burden of malaria in different eco-epidemiological settings with environmental management: a systematic review. *Lancet Infect Dis*. 2005;5(11):695-708.
16. Townson H, Nathan MB, Zaim M, Guillet P, Manga L, Bos R, et al. Exploiting the potential of vector control for disease prevention. *Bull World Health Organ*. 2005; 83(12): 942-7.
17. World Health Organization. Guidelines for the treatment of malaria. 2015. Geneva, Switzerland: World Health Organization, Rev. 2010; 1(2).

- 18.Senga EL, Harper G, Koshy G, Kazembe PN, Brabin BJ. Reduced risk for placental malaria in iron deficient women. *Malaria journal*. 2011; 10:47.
- 19.Ministry of Health, Lusaka, Zambia. Guidelines for the diagnosis and treatment of malaria in Zambia. Ministry of Health. 2014.
- 20.The United States Centres for Disease Control and Prevention. Treatment of malaria (guidelines for clinicians). 2011.
- 21.Oliver M, Develoux M, Chegou Abari A, Loutan L. Presumptive diagnosis of malaria results in a significant risk of mistreatment of children in urban Sahel. *Transactions of the Royal Society of Tropical Medicine and Hygiene*. 1991; 85(6):729-30.
- 22.Campbell CC, Steketee RW. Malaria in Africa can be eliminated. *Am J Trop Med Hyg*. 2011;85(4):584–585.
- 23.USAID | DELIVER PROJECT, Task Order 3. 2011. Digging into Malaria Data: Comparing HMIS and LMIS Data to Improve Program Management in Zambia. Arlington, Va.: USAID | DELIVER PROJECT, Task Order 3.
- 24.Burton AH, Dean JA, Dean AG. Software for data management and analysis in epidemiology. In *World health forum 1990* (Vol. 11, No. 1, pp. 75-77).
- 25.Phiri E, Baboo KS, Miller J. Effect of Indoor Residual Spraying on the Incidence of Malaria in Kaoma District of Western Zambia. *Medical Journal of Zambia*. 2015;42(4):150-8.
- 26.Norris, Laura C., and Douglas E. Norris. "Efficacy of long-lasting insecticidal nets in use in Macha, Zambia, against the local *Anopheles arabiensis* population." *Malaria journal* 10.1 (2011): 254.
- 27.Tan KR, Katalenich BL, Mace KE, Nambozi M, Taylor SM, Meshnick SR, Wiegand RE, Chalwe V, Filler SJ, Kamuliwo M, Craig AS. Efficacy of sulphadoxine-pyrimethamine for intermittent preventive treatment of malaria in pregnancy, Mansa, Zambia. *Malaria journal*. 2014 Jun 9;13(1):227.