Catherine Kilonzo, Ministry of Health, Kenya, Joy Gakenia Murangiri, Ministry of Health, Kenya, James Kiarie, Ministry of Health, Kenya, Jane Githuku, President Malaria Initiative Measure Malaria, Hellen Gatakaa, President Malaria Initiative Measure Malaria, Elvis Oyugi, Ministry of Health, Kenya, Dan Otieno, World Health Organization (WHO), Nairobi, Kenya, Fredrick Ouma Odhiambo, Ministry of Health, Kenya, Regina Kandie, Ministry of Health, Kenya, Ahmeddin Omar, Ministry of Health, Kenya, Alfred Oginga, County Government of Kisumu, Department of Health Services, Kisumu, Kenya, Robert Mwaganu, Ministry of Health, Kenya, Erolls Cheruiyot Sigei, Kenya Medical Training College (KMTC), Nairobi, David Gathara, KEMRI Wellcome Research Programme, Nairobi, Kenya, Edward Mberu Kamau, Special Programme for Research and Training in Tropical Diseases (TDR), World Health Organization, Geneva, Switzerland, Anne-Beatrice Kihara, University of Nairobi Department of Obstetrics and Gynecology, Kenya , International Federation of Gynecology and Obstetrics (FIGO) and Rose Jepchumba Kosgei, University of Nairobi Department of Obstetrics and Gynecology, Kenya.

Corresponding author: Catherine Kilonzo, National Malaria Control Program, Ministry of Health. Email: cmkilonzo@gmail.com

VECTOR CONTROL INTERVENTIONS TOWARDS ELIMINATION OF MALARIA IN 4 SELECTED COUNTIES, KENYA, 2023

C. Kilonzo, J. G. Murangiri, J. Kiarie, J. Githuku, H. Gatakaa, E. Oyugi, D. Otieno, F. O Odhiambo, R. Kandie, A. Omar, A. Oginga, R. Mwaganu, E. C. Sigei, D. Gathara, E. M. Kamau, A. B. Kihara, and R. J. Kosgei

ABSTRACT

Objectives: The objective of the present study was to assess the capacity to implement malaria vector control interventions in four counties, in Kenya, earmarked for elimination. Design: This was a retrospective cross-sectional study design that used routinely collected malaria program data using a tool adopted by National Malaria Control Program and modified to fit the country's context, District-Level Readiness for Elimination of Malaria Tool.
Setting: All the sub-counties constituting the four counties (Kirinyaga, Nyandarua, Laikipia and Nyeri).
Subjects: County and sub county health management teams.
Intervention: Implementation of vector control strategies targeted for malaria elimination in the four study counties.
Main outcome measures: County and sub-county health management teams' readiness to deploy vector control strategies in the four study counties.
Results: Out of 21 sub-counties, 11(52%) implemented vector control interventions for malaria vector control. Kirinyaga County implemented malaria vector control strategies: proactive indoor residual spraying, mass net distribution campaign, continuous or targeted distribution of insecticide treated nets in 3 sub-counties and larval source management in two sub-counties. Five

of 11 (45%) sub-counties conducted mapping of vector breeding habitats and 1(4.8%) conducted malaria vector entomological surveillance.
Conclusion: **In conclusion, the four counties targeted for malaria elimination lacked adequate capacity to implement malaria vector control interventions owing to their having limited resources to implement malaria vector control interventions. To achieve and maintain malaria elimination in the four counties there is an urgent need to mobilize adequate resources for conducting malaria vector control interventions.**

INTRODUCTION

Elimination of malaria strategies include surveillance and response, case management, vector control strategies and entomological surveillance. Since 2000, 21 countries have eliminated malaria and 15 have been certified malaria-free by WHO with elimination of indigenous malaria in the related countries for three years (1). A key goal of the World Health Organization (WHO) Global technical strategy for malaria 2016–2030 is to see malaria eliminated in at least 30 countries by 2030. Globally in 2021 there were 247 million cases reported in endemic malaria zones, 619 000 malaria deaths worldwide of which (234 million) 95% of malaria cases and 96% of malaria deaths reported in Africa. The Roll Back Malaria (RBM) partnership in Africa facilitates malaria elimination through increasing resources and awareness and addressing malaria regionally(2).

Malaria in Kenya is estimated at 3.5 million new clinical cases and 10,700 deaths occur with the highest risk in Western Kenya. Activities conducted towards elimination include surveillance and response, prevention strategies, case management, transmission reduction research and diagnostic advancements[i]. The four Counties Laikipia, Nyeri, Kirinyaga and Nyandarua counties are low risk zones and on the trajectory for malaria elimination.

Malaria epidemics are increasing in East Africa since the 1980s, coincident with rising temperature and widening climate variability. A projected 1–3.5 °C rise in average global temperatures by 2100 could exacerbate the epidemics by modifying disease transmission thresholds. There is need for continuous entomological surveillance which monitors disease vector species, their population dynamics, as well as behavioural traits that impact disease transmission and intervention effectiveness over time and space (3).

Eco-friendly and effective control of the anopheles' malaria mosquito and its life cycle crucial to malaria elimination. However, obstacles limiting effective vector control includes variation in mosquito behaviour, development of insecticide resistance, presence of behavioural avoidance, high vector biodiversity, competitive and food web interactions, lack of insights on mosquito dispersal and mating behaviour, and the impact of environmental changes on mosquito ecological traits. In the Kenyan National malaria programs vector control includes: indoor residual spraying (IRS), mass distribution and address of vulnerable groups with long-lasting insecticidal nets (LLINs), larva source management (LSM) and having a multidisciplinary team with parasitologists, tropical medicine, ecology, entomology, and ecotoxicology team (4).This paper aimed to assess the vector control interventions towards elimination of malaria in the 4 Kenya Counties and related Sub-Counties.

METHODOLOGY

Study design

The study design was a retrospective cross-sectional study using routinely collected program data collected during a survey done in January 2023

Study site

The study sites were the four counties earmarked for elimination of malaria. The counties include Laikipia, Nyeri, Kirinyaga and Nyandarua. The counties are located in the central highlands of Kenya. The four counties have a total of 21 sub counties: Laikipia, Kirinyaga, Nyeri and Nyandarua counties have 3, 5, 8 and 3 sub-counties respectively as shown in Table 1 (12–15). The climatic conditions in the central highlands where these counties are located are characterized by the low temperatures. The low temperatures do not favour development of mosquitoes since they don't allow completion of the sporogonic cycle of the malaria parasite in the vector.

Table 1
Sub counties within the four counties targeted for malaria elimination, Kenya, 2023

Sub-counites in the four selected counties

	County	Sub-county
1)	Laikipia	Laikipia East, Laikipia West and Laikipia North
2)	Nyeri	Kieni East, Kieni West, Mathira East, Mathira West, Nyeri Central, Mukurweini, Tetu and Othaya
3)	Kirinyaga	Kirinyaga East, Kirinyaga West, Mwea East, Mwea West and Kirinyaga Central
4)	Nyandarua	Ol'Kalou, Kinangop, Kipipiri, Ndaragwa and Ol'Joro Orok

The above table describes the sub counties within the four counties. Each county has a different number of sub counties.
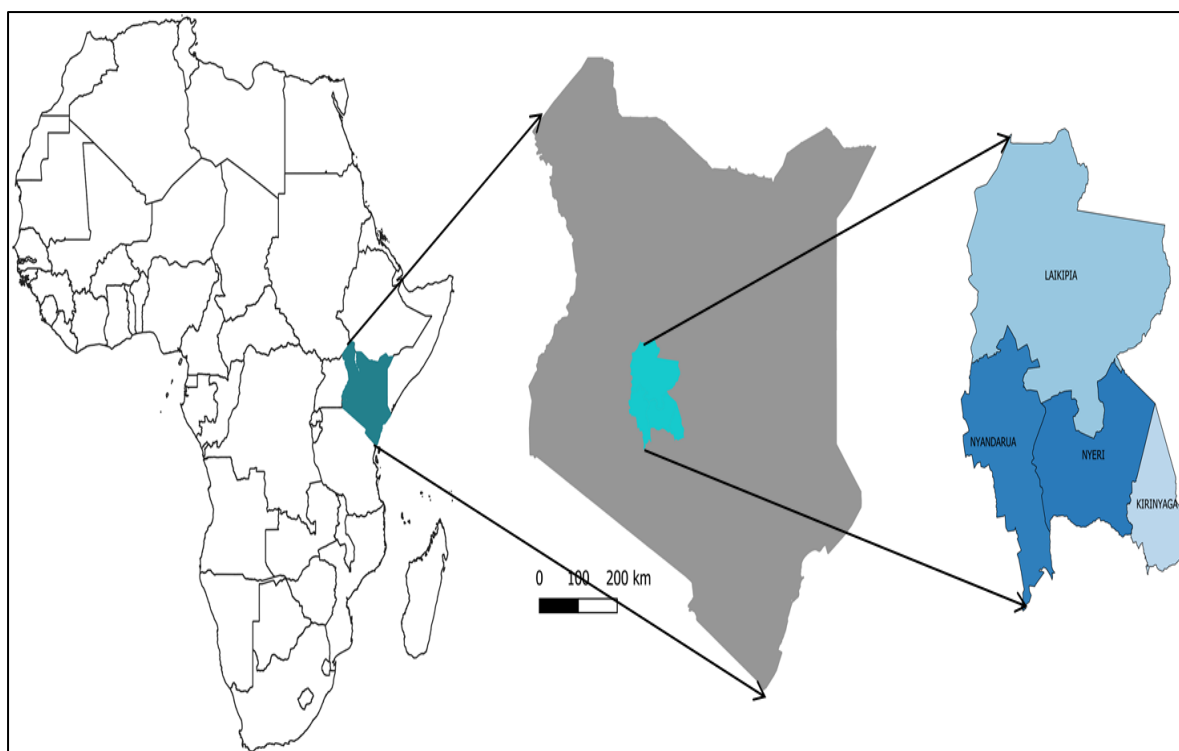
Figure 1: Map of Kenya Showing the Four Counties Kirinyaga, Laikipia, Nyeri and Nyandarua,2023

The above figure shows the location of Kenya in the African map, and the four counties targeted for malaria elimination in Kenya. The four counties are within the central region of Kenya where malaria prevalence is less than 1%.

Study Population.

All the County and Sub- County health management teams in the four counties targeted for malaria elimination provided responses to the various domains assessed.

The county and sub county teams included key coordinators and technical staff in malaria related activities. The study excluded executive members of the county.

Data collection instruments

The health facility assessment data abstracted from the records is collected as part of routine assessments by National Malaria Control Program (NMCP) using the District-Level Readiness for Elimination of Malaria Tool (DREAM-IT) tool that contains structured checklists. Within the domain on vector elimination there were two questions that looked at whether a Sub- County undertook malaria vector control interventions and whether the Sub- County had conducted entomological surveillance in the past 12 months.

Data management and Analysis

Data from the questionnaires as per the checklists were captured electronically using an electronic application in a tablet. Routinely collected program data was analyzed retrospectively. The quantitative data was downloaded from the tablets into Microsoft Excel spreadsheets (Microsoft version 2010) for data management and statistical analysis. Data management included the following: data cleaning, sorting, and also check for consistency, accuracy and completeness of the data. Quantitative data was summarized descriptively using absolute numbers and proportions and reported per objective using tables and graphs.

Ethical considerations

Ethical approval to carry out the research was granted by the Maseno University Scientific and Ethics Review Committee (MUSERC), number MUSERC/01234/23. Permission to

use the data for this study was granted by the Kenya Malaria Control Program.

RESULTS

From the baseline assessment, 11 (52%) of the 21 sub-counties assessed conducted vector control intervention for malaria. Only Kirinyaga County implemented several vector control strategies proactive indoor residual spraying in two sub-counties (Kirinyaga East, Mwea West), mass net distribution campaign in Kirinyaga South and Mwea West sub-counties, continuous or targeted distribution of ITNs in 3 sub-counties (Kirinyaga South, Kirinyaga East, and Kirinyaga Central) Larval source management was conducted in Kirinyaga Central sub-county.

Five of 11 (45%) sub-counties implementing malaria vector control interventions conducted mapping of the vector breeding habitats; three out of four sub-counties in Nyeri and one each in Nyandarua and Kirinyaga Counties.

Only one sub-county in Kirinyaga County conducted entomological surveillance in the 12 months preceding the assessment. The activities included routine sentinel site surveys, foci investigations, and survey to collect baseline data for planning.

Overall, in all the 21 sub-counties there was inadequate skilled human resource, especially entomologists and lack of a focal person for vector surveillance at sub-county level.
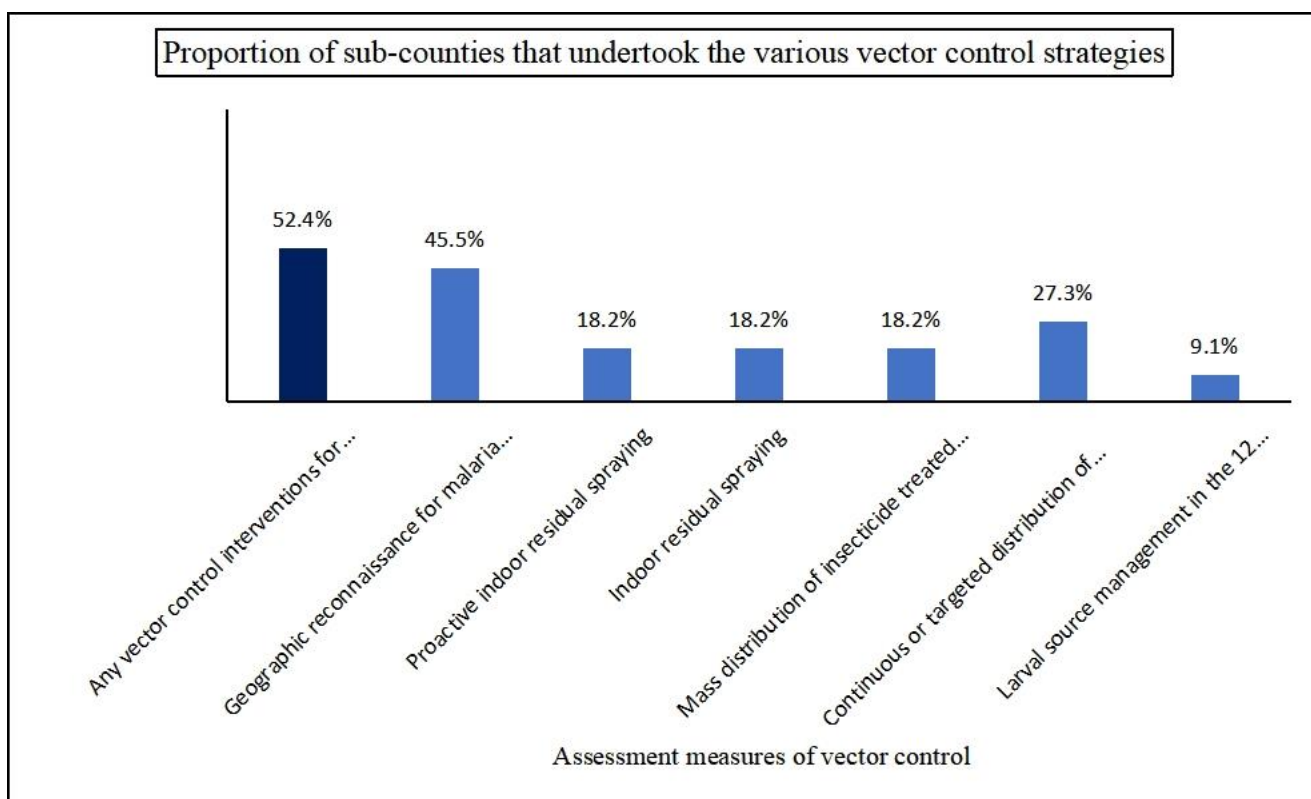

Figure 2: Sub-counties implementing the various vector control strategies in counties targeted for malaria elimination

DISCUSSION

From the baseline assessment conducted in four selected counties to assess the vector control interventions towards elimination of malaria in the 4 Kenyan Counties and related Sub-Counties. From the assessment, Kirinyaga county was the only county among the four targeted for malaria elimination that deployed several vector control interventions. These included LLINs distribution, LSM, proactive IRS and entomological surveillance. Entomological surveillance included routine sentinel site surveys, foci investigations, and survey to collect baseline data for planning.

In Kenya, malaria transmission is heterogenous and is stratified into epidemiological zones to include areas of high transmission to areas of low transmission. Malaria control interventions are targeted and implemented according to the epidemiological zones with more interventions in the high burden zones. There has been limited routine entomological surveillance and mapping of vectors in malaria elimination counties.

In malaria elimination settings, vector control interventions, including entomological surveillance will identify potential malaria transmission hotspots and continued monitoring of receptivity of areas within these counties to prevent re-establishment. Mwea irrigation settlement scheme is in two sub-counties in Kirinyaga county hence the deployment of vector control interventions. The county also received support from several implementing partners unlike the other 3 counties.

Notably, lack of entomologist and entomological surveillance training at the county and sub county level was also an important gap. In a study conducted in Madagascar there were also key gaps in vector control(5). To eliminate malaria, programmes need to concentrate on identification and elimination of foci of infections through both passive and active methods of case detection(2). Therefore, the need to capacity build on entomological surveillance.

CONCLUSION AND RECOMMENDATION

In conclusion, the four counties selected for malaria elimination have limited resources to implement vector control interventions and to achieve and maintain malaria elimination there will be need to combine other malaria control interventions and targeted vector control. To achieve this resource mobilization to conduct a baseline entomological surveillance to map out areas with high receptivity will be important.

Limitations.

The counties assessed are in the low transmission epidemic zone. National Malaria Control Program implements vector control interventions mainly in the high transmission epidemic zone.

REFERENCES

1.	World Health Organization. Zeroing in on malaria elimination: Final report of the E-2020 initiative. WHO Website [Internet]. 2021;1–20. Available from: https://apps.who.int/iris/handle/10665/340881

2.	Moonen B, Cohen JM, Snow RW, Slutsker L, Drakeley C, Smith DL, et al. Operational strategies to achieve and maintain malaria elimination. Lancet (London, England). 2010 Nov;376(9752):1592–603.

3.	Ávila MI, Vajda ÉA, Jeffrey Gutiérrez E, Gibson D, Renteria MM, Presley N, et al. Entomological Surveillance Planning Tool (ESPT)-generated actionable evidence on human and vector behaviours optimizes present interventions and reduces exposure to Anopheles vectors in two communities of Guna Yala, Panamá. Malar J [Internet]. 2023;22(1):1–11. Available from: https://doi.org/10.1186/s12936-023-04453-1

4.	Benelli G, Beier JC. Current vector control challenges in the fight against malaria. Acta Trop. 2017 Oct;174:91–6.

5. Favero R, Rabozakandraina O, Ramamonjisoa S, Rakotovao JP. Malaria Elimination Readiness in Selected Districts of Madagascar: A Mixed-Methods Assessment. Available from: www.mcsprogram.org

---

[i] CDC Malaria activities in Kenya, https://www.cdc.gov/malaria/malaria_worldwide/cdc_activities/kenya.html#:~:text=In%20Kenya%2C%20there%20are%20an,of%20Health%20to%20fight%20malaria (cited 31/8/2023 12.10pm)