Research Article

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Indoor and Outdoor House Inspection Coupled with Community Mobilization Impact on Decreased Aedes *Aegypti* Entomological Indices during Chikngunya-Dengue Outbreak Containment in Affected Localities of Kassala and Red Sea States, 2018-2019

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Abstract
Aedes aegypti is an important vector for dengue virus infection. Apart from dengue virus, Aedes aegypti is also the vector for transmission of other viruses presenting serious public health threats: chikungunya, and yellow fever. The present paper aimed to assess the impact of indoor and outdoor house inspection coupled with community mobilization on decreased Aedes aegypti entomological indices during Chikungunya-Dengue Outbreak containment in affected Localities of Kassala and Red Sea States, 2018-2019. The survey was conducted in Kassala and Red Sea State during outbreak of chikungunya and dengue. The survey was performed in the affected localities by dividing the localities into seven-day blocks from Saturday to Friday. All dwellings of each block were thoroughly checked by health promoters on the specific day. The sufficient numbers of promoters were available to cover all the houses in the affected areas. The study revealed that the reduction in house index from baseline in Kassala state was reduced by 90.4% in week 7. While the House index was reduced from baseline in Red Sea Sate by 87.1% in week 14. For container index it was reduced by 89.6% in Kassala State in week 7 compared to 89.0% in Red Sea State in week 14. The study concluded that indoor and outdoor inspection coupled with community mobilization has impact on reduced of Aedes aegypti indices mainly house index and container index.

Keywords: Kassala State, Red Sea State, *Aedes Aegypti*, Chikungunya-Dengue Outbreak

Introduction
Chikungunya fever is caused by an arbovirus belonging to the *Alphavirus* genus of the *Togaviridae* family, first isolated in the Newala district of Tanzania in 1952–1953 [1]. CHIKV is transmitted to humans by the bite of *Aedes* spp. (i.e. *Aedes aegypti* and *Aedes albopictus*) mosquitoes. In western and central Africa, CHIKV is maintained in a sylvatic cycle involving non-human primates and forest-dwelling *Aedes* spp. mosquitoes. In Asia, the predominant vector is the urban, peri-domestic, anthropophilic, *Aedes aegypti*

mosquito, which is responsible for large-scale outbreaks characterized by long inter-epidemic periods which may last several decades [2]. Dengue is caused by an arbovirus belonging to the *Flavivirus* genus of the *Flaviviridae* family. There are four DENV strains, referred to as DENV1–4 serotypes. Clinical manifestations range from mild cases of dengue fever to severe cases of dengue hemorrhagic fever and/or dengue shock syndrome. The main vector of DENV is *Aedes aegypti*, but the infection may be transmitted also by *Aedes albopictus*. In the past 50 years, the incidence of dengue increased 30-fold, and nowadays it is the most rapidly spreading mosquito-borne viral disease worldwide, accounting for an estimated 50–100 million infections occurring every year [3]. The global distribution of *Aedes* spp and DENV serotypes; all the four DENV serotypes have been circulating at some point in time in virtually all the affected continents [3,4]. The main goals of *A. aegypti* surveillance methods are baseline infestation survey, control program monitoring low infestation levels [<5% house index (HI)], control program monitoring with □5% HI level, surveillance against reinfestation, verification of eradication, and evaluation of control methods [5]. Several indices have been used to monitor *A. aegypti* populations for dengue virus transmission. Those related to immature populations are the HI, i.e., the percentage of house infested with larvae or pupae; the container index (CI), i.e., the percentage of water-holding containers infested with larvae or pupae; and Breteau index (BI), i.e., the number of positive containers per 100 houses inspected. When using the HI or the BI, the definition of a house should be one unit of accommodation and the surrounding premises with respective of the number of people residing therein [6]. Red Sea state is one of the important State in Sudan because of its geographical location as an airport, it has been exposed to several outbreaks of dengue fever (DF) and Dengue hemorrhagic fever (DHF) [7]. Three serotypes of the virus (DENV1, DENV2 and DEN3) are known to circulate, and infestations of *Aedes aegypti*, the mosquito vector, have been documented in the area previously; this is associated with lack of drinking-water and consequent water storage habits of the local community [8-10]. While Chikungunya virus was first appeared in Jabait city, Swakin and Port Sudan City respectively and also seem to be exported to neighboring State of Kassala during August 2018. There is a need to promote vector control activities and linked with surveillance to incorporated in the response plan. Operational outcomes in terms of evaluation of vector control interventions and the monitoring of the course of the outbreak need to be assessed. The present study aimed to assess the significance of indoor and outdoor inspection coupled with community mobilization on decreased *Aedes aegypti* entomological indices during Chikungunya-Dengue outbreak containment in affected Localities of Kassala and Red Sea States, 2018-2019.

Materials and Methods

Study Design

The study was served as a descriptive cross sectional study.

Study Area

Kassala state is bordered by Eritrea from the east, Red Sea and River Nile States from the north, Gezira State from the west and Gaderef State from the south. Kassala state has a total population of 1.5 million (4.6% of total Sudan population) about 20 % (300,000) of them live in Kassala town, the state capital. Kassala is about 650 kilometers from Khartoum. Temperatures do not vary greatly with the season. Throughout the year, it is generally hot with a brief mild winter period between December and February. The heat can reach 45-50 Celsius at times, especially between March and June. Rainy season starts in July and ends in September/October. Port Sudan city is one of the important cities in Sudan due to its location as an airport of Sudan. Port Sudan has a hot desert climate with extremely hot summers and moderately hot winters, requiring the acquisition of fresh water from Wadi Arba'at in the Red Sea Hills and from salt-evaporating pans. Temperatures can easily exceed 30 °C (86 °F) in winter and 45 °C (113 °F) in summer. Over 90% of the annual rainfall falls between October and January, mostly in November, with the wettest month on record being November 1947 with 182 millimeters, whilst the wettest year was from July 1923 to June 1924 with 231 millimeters. Average annual rainfall is 76 millimeters, and no rainfall occurred between January 1983 and June 1984. The average temperature is 28.4 °C (83.1 °F) [11].

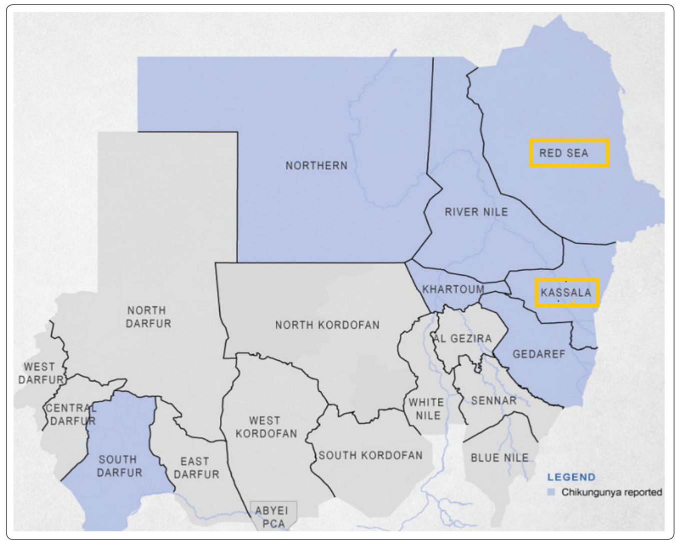

Figure 1: Map of the study states

Vector Surveillance and Control

Entomological Surveillance

The inspection of indoor and outdoor inspection of *Aedes aegypti* breeding sites were daily implemented to covered inspection of indoor and outdoor houses of affected localities in the two targeted states. The inspection was done by trained health promoters targeting all water containers inside and out of houses that potentially harbor *Aedes* mosquitoes. All work was performed in the affected localities by dividing the localities into seven-day blocks from Saturday to Friday. All dwellings of each block were thoroughly checked by health promoters on the specific day. The sufficient numbers of promoters were available to cover all the houses in the affected areas. However, the 7-days for every bloc were recommended based on the life cycle of mosquitoes as it usually takes between 7 and 10 days to emerge from eggs to adult. The weekly calculation on density parameters of *Aedes aegypti* in relation to the human population density will be produced by the senior entomologist. The entomological indices included; HI = percentage of houses or premises positive for *Aedes* aquatic stages; Container index (CI) = percentage of water containers positive for *Aedes* aquatic stages. Depends on the result of the preliminary survey, a systematic of vector control interventions were selected to work effectively against the dengue vector *Aedes aegypti*.

Vector Control and Community Mobilization

The vector control interventions adopted were in accordance with WHO guidelines; these includes; community mobilization (scrubbing and drying of unused containers by health promoters); focal space spraying of affected areas using a knock-down insecticide and larviciding of outdoor productive containers [3]. The fogging intervention was implemented in areas where clusters of cases were reported. To encourage the communities to take part in vector control measures, various information education and communication activities were conducted during the course of chikungunya-dengue outbreak, which included demonstration of *Aedes* larvae to the people in their house premises, information about the variety of habitats, periodicity of the mosquito as it is diurnal, importance of source reduction, and scrubbing of water-stored vessels as its eggs can withstand humidity for even a year and can resume life when the container becomes wet with water, the importance of weekly interventions of these activities as the life cycle of mosquitoes is only 7-10 days, etc. These activities were conducted in visited housing, school meetings, women societies, Mass media...etc. to control chikungunya dengue by reducing the various sources of *Aedes*, anti- chikungunya dengue awareness program through public addressing system and interpersonal communication.

Results

Table 1 and figure 2 shows that, the percent of house index of *Aedes aegypti* was reduced from baseline during subsequent weeks in both Kassala and Red Sea states. The intervention of house inspection indoor and outdoor coupled with community mobilization and fogging spraying in Kassala state was continuo only till week 7 and till week 14 in Red sea.

The reduction in house index from baseline in Kassala state was reduced by 90.4% (29.3-2.8) / 29.3) X100) in week 7. While the House index was reduced from baseline in Red Sea Sate by 87.1% (24.1-3.1) / 24.1) X100) in week 14. The reduction of House index was greater in Kassala compared to Red Sea State; this may be returned to habitats of storing water and the problem of lacking water in Red sea practiced by the public, i.e. overhead water tanks and underground water containers, commercial cement water tanks and spring water …etc. in Red Sea State. Concerning container index, it was reduced by 89.6% in Kassala State in week 7 compared to 89.0% in Red Sea State in week 14 as shown in table 2 and figure 3.

Table 1: Percent of Weekly House Index (HI) of *Aedes aegypti* in Kassala state during Chikungunya-dengue outbreak 2018

Week No. Baseline	Kassala 29.3	Red Sea 24.1
Week1	12.2	9.9
Week 2	9.4	8.7
Week 3	11.2	7.4
Week 4	4.2	5.8
Week 5	4.2	6.0
Week 6	2.9	4.5
Week 7	2.8	3.2
Week 8	-	4.3
Week 9	-	5.2
Week 10	-	5.3
Week 11	-	4.9
Week 12	-	4.2
Week 13	-	3.1
Week 14	-	3.1

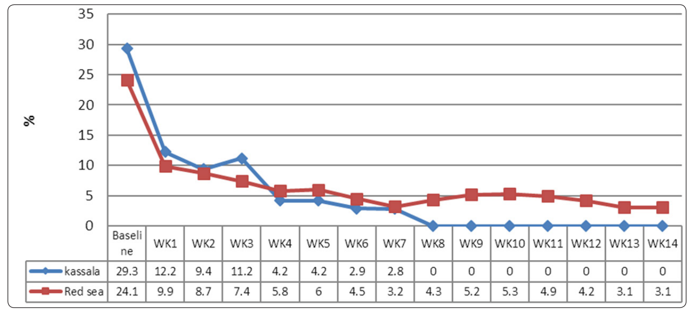

Figure 2: Percent of Weekly House Index (HI) of *Aedes aegypti* in Kassala state during chikungunya-dengue outbreak 2018

Table 2: Percent of Weekly Container index (CI) of *Aedes aegypti* in Kassala state during chikungunya-dengue outbreak 2018

Week No. Baseline	Kassala 25.0	Red Sea 10.0
Week1	26.0	6.3
Week 2	16.5	5.1
Week 3	11.0	3.6
Week 4	8.5	2.9
Week 5	6.3	2.2
Week 6	3.4	1.4
Week 7	2.6	2.0
Week 8	-	2.4
Week 9	-	2.4
Week 10	-	2.1
Week 11	-	2.2
Week 12	-	1.6
Week 13	-	1.3
Week 14	-	1.1

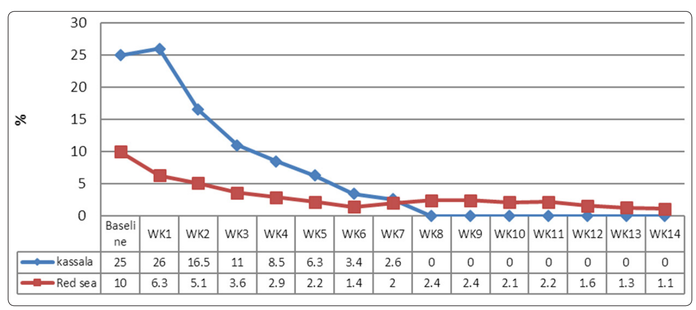

Figure 3: Percent of Weekly Container index (CI) of *Aedes aegypti* in Kassala state during chikungunya-dengue outbreak 2018

Discussion

Aedes aegypti is an important vector for dengue virus infection. Apart from dengue virus, *Aedes aegypti* is also the vector for transmission of other viruses presenting serious public health threats: chikungunya, Zika and yellow fever [12-14].

The present study clarified that, the percent of house index of *Aedes aegypti* was reduced from baseline during subsequent weeks in both Kassala and Red Sea states. This may be attributed to the intervention of house inspection indoor and outdoor coupled with community mobilization and fogging spraying in the affected localities of two States. Also this may be because inspections of houses may increase public knowledge and awareness and thus contribute in part to improved household practices that reduce entomological activity. Previous findings agree with our study finding of a quasi-experimental study performed in Costa Rica reported a sharp decline in larval indices with an adequate reservoir management [15]. However, Lima et al. conducted a systematic review with meta-analysis to identify the most effective vector control strategies worldwide and the factors that contributed to the success or failure of each strategy, the conclusion was that integrated interventions were the most effective method for the control of *Aedes aegypti*, always considering the influence of eco-bio-social determinants in the virus-vector-man epidemiological chain and community engagement [16]. Another study supported our study findings revealed in all clusters received intervention (house inspection and community involvement). It found that overall, there were 8422 houses and 33 688 inhabitants in the intervention clusters and 10 748 houses and 42 992 inhabitants in the control clusters. Overall, 78% of the intervention households and 76% of the control households perceived that the activities realized by the vector control workers were necessary, and 13% and 11%, respectively, remembered that a positive breeding site had been found in the past [17,18]. In summary, our study proved that integrated interventions (house inspection, community mobilization, fogging spraying) were effective way to combat *Aedes* mosquito.

References

1. Rezza G (2014) Dengue and chikungunya: long-distance spread and outbreaks in naïve areas. Pathogens and global health 108: 349-355.
2. Chevillon C, Briant L, Renaud F, Devaux C (2007) The Chikungunya threat: an ecological and evolutionary perspective. Cell 16: 80-8.
3. World Health Organization Dengue: (2009) Guidelines for diagnosis, treatment, prevention and control. Geneva: WHO.
4. Gubler DJ (2011) Dengue, urbanization and globalization: the unholy trinity of the 21st century. Trop Med Health 39: 3-11.
5. Pan American Health Organization (PAHO) (1994) Dengue and dengue hemorrhagic fever in the Americas: guidelines for prevention and control. Washington: PAHO.
6. Tun-Lin W, Kay BH, Barnes A (1995) The premise condition index: a tool for streamlining surveys of Aedes aegypti. Am J Trop Med Hyg 53: 591e4.
7. Kay B, Vu SN (2005) New strategy against Aedes aegypti in Vietnam. Lancet 365: 613-617.
8. Hyams KC, Oldfield EC, Scott RM, Bourgeois AL, Gardiner H, et al. (1986) Evaluation of febrile patients in Port Sudan, Sudan: isolation of dengue virus. American Journal of Tropical Medicine and Hygiene 35: 860-865.
9. Malik A, Earhart K, Mohareb E, Saad M, Saeed M, et al. (2011). Dengue hemorrhagic fever outbreak in children in Port Sudan. Journal of Infection and Public Health 4: 1-6.
10. Lewis DJ (1995) The Aedes mosquitoes of the Sudan. Annals of Tropical Medicine and Parasitology 49: 164-173.
11. Min E, Hazeleger W, van Oldenborgh GJ and Sterl A (2013) Evaluation of trends in high temperature extremes in North-Western Europe in regional climate models Environmental Research Letters 8: 1-6.
12. Weaver SC, Lecuit M (2015) Chikungunya virus and the global spread of a mosquito-borne disease. N Engl J Med 372: 1231-1239.
13. Honein MA (2016) Zika virus. N Engl J Med 374: 1552-1563.
14. Barnett ED (2007) Yellow fever: epidemiology and prevention. Clin Infect Dis 44: 850-856.
15. Marín Rodríguez R, Marquetti Fernández MdC, Díaz Ríos M (2009) Indices larvales de Aedes aegypti antes y después de intervenciones de control en Limón, Costa Rica. Rev Cubana Med Trop: 61.
16. Lima EP, Goulart MO, Rolim Neto ML (2015) Meta-analysis of studies on chemical, physical and biological agents in the control of Aedes aegypti. BMC Public Health: 15: 858.
17. Vanlerberghe VEERLE, Toledo ME, Rodriguez M, Gomez D, Baly A, et al. (2009) Community involvement in dengue vector control: cluster randomised trial. Bmj 338: b1959.
18. Focks DA, Chadee DD (1997) Pupal survey: an epidemiologically significant surveillance method for Aedes aegypti: using data from Trinidad. Am J Trop Med Hyg 56: 159-67.