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Research Article

Impact of Vector Control Activities during the Yellow Fever Epidemic in Luanda, Angola, 2016

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Abstract

Angola is one of the countries included in the endemic areas of yellow fever transmission in Africa. At the end of December 2015, an outbreak of Yellow Fever was detected in Luanda. The objective was to evaluate the impact of the vector control activities carried out in the epicenter of the yellow fever epidemic on House, Breteau and Containers indices. The work was carried out in Tempo Muda district belonging to Viana Municipality during one month (April - May, 2016). All the deposits that contained water at the moment of the inspection were reviewed. The control methods used were biological control Bacillus thuringiensis (Bactivec®) as larvicide; chemical control using pyrethroid insecticide as adulticide, environmental control and social mobilization through education to the community. At the end of each week the indices were calculated.

Results: High values of the House, Container and Breteau indices was found in Tempo Muda district at the beginning of the work followed by one decrease which demonstrates the effectiveness of the anti-vector measures implemented. The highest positivity with Aedes aegypti was found in containers such as, basins 158 (30.6%) followed by buckets 122 (23.6 %) representing between them more than half (54.2%) of the deposits.

Conclusion: These results suggest that the actions through integrated actions against the vector inside and outside the home it is a fundamental component in the control of Yellow Fever epidemics where there is not high coverage of people immunized by the vaccine or where do not have the vaccine.

ABBREVIATIONS

ULV: Ultra Low Volume; NICD: National Institute for Communicable Diseases; HI: House Index; CI: Container Index; BI: Breteau Index

INTRODUCTION

Angola is one of the countries included in the endemic areas of yellow fever transmission in Africa and where there have been outbreaks of this disease in 1971 and in 1988 in its capital Luanda, as well as, sporadic cases identified through the surveillance system. Prior to these outbreaks, serological samples were taken for antibodies to arboviruses where it was shown that the virus was active in some areas of the south and southeast of the country where the ecological conditions are favorable, but note that if there were cases, these ones were not notified due to the absence of facilities for diagnosis previous and during the decade of the 60's of the last 20th century [1-3].

During the 1971 epidemic, 65 cases were reported with 42 deaths although these numbers probably do not reflect the extent of the epidemic, as shown by serological sampling [4], and where co-infection was also reported in patients with Chikungunya virus. The transmission of this epidemic was interrupted by means of a massive vaccination program and vector control measures using aerial fumigation ultra-low-volume (ULV) with malathion [5]. At the end of December 2015, a new outbreak of Yellow Fever was detected in Luanda, Angola. The first cases were confirmed by the National Institute for Communicable Diseases (NICD) in South Africa on January 19, 2016 and by the Pasteur Institute in Dakar, Senegal on January 20 of the same year [6]. Subsequently, a rapid increase in the number of cases in Luanda and in different provinces of Angola were registered which led to the implementation of a vaccination program that began in the capital and progressively was extended to the rest of the country where notification of cases and confirmed local transmission were registered.

Yellow fever virus is an RNA virus that belongs to the genus *Flavivirus*. It is related to West Nile, St. Louis encephalitis, and Japanese encephalitis viruses. Yellow fever virus is transmitted to people primarily through the bite of infected *Aedes* or *Haemagogus* species mosquitoes. Mosquitoes acquire the virus by feeding on infected primates (human or non-human) and then can transmit the virus to other primates (human or non-human). Yellow fever virus has three transmission cycles: jungle (sylvatic), rural and urban [7].

In Angola the are different factors, such as, ecological conditions, the presence of primates and the presence of several species of mosquito vectors that contribute the occurrence of the sylvatic, rural and urban cycles of the Yellow Fever. Among the vector species are *Aedes africanus* responsible for the maintenance of sylvatic transmission; *Aedes Simpsoni* in rural habitats in the northeast of the country; *Aedes Metalicus* and *Aedes vittatus* responsible in the southwest and in the central west *Aedes luteocephalus.* In urban area such as Luanda and the capitals of the majority of the provinces *Aedes aegypti* is present with a strong association with humans and is the responsible for the transmission [8].

The epicenter of the Yellow Fever outbreak that began in December, 2015 was considered by the health Angolans authorities to be in the Viana Municipality in the neighborhood known as km 30, where a national reference market with a large concentration of people from all over the country is located. This municipality registered high infestation of *Aedes aegypti* before to the occurrence of the outbreak contributing for the rapid spread of cases in Luanda and the rest of the country [9].

Due at this situation, was oriented by the national health executives of the country to carry out anti-vector fight actions in this locality, as a complement to the vaccination in the population. The objective of this work was to evaluate the impact of the measures implemented against to *Aedes aegypti* on the House, Breteau and Containers indices, indicators used in the monitoring and surveillance of this mosquito vector.

MATERIALS AND METHODS

Viana is one of the municipalities that belong to Luanda province. It is situated in the northeast of the province latitude 9.0000°, longitude. 13.3333^0. It has an approximate extension of 615 km^2. This municipality is divided into two communes and these in turn in several neighborhoods one of them called Km 30 [10] (Figure 1). This area was designated as the epicenter of the Yellow Fever outbreak for this reason was chosen for the implementation of vector control. This one is constituted by sectors and these in turn are divided into several districts. The work area is located in Sector D composed by (Kilamba, Yinbinza, Diogo Batalla, Brisa, Bahía and Tempo Muda districts).

Area sampled

The anti-vector control activities were implemented in the Tempo Muda district divided in 11 localities with a total of 1,986 houses. This place was chosen due of the high incidence of cases and deaths registered at the beginning of the epidemic. The water supply of this place is through cisterns trucks so it is necessary to store water for human activities.

Time and methodology of sampling

The work was carried out during one month (April 13 to May 13, 2016). The larval sampling at the beginning of the implementation was realized in the entire Tempo Muda district with eight specialists in Entomology belonging to the Malaria Control Program implemented in Angola, together with the Cuban team. In the first week all the deposits that contained water inside and outside of the houses at the moment of the inspection were reviewed. The same procedure was carried out in the following three weeks of evaluation in the location (9) with 150 houses chosen for the evaluation the impact of anti-vector measures. In the second week, 88.6% of the total number of dwellings was randomly sampled, in the third week it was 77% and in the fourth week 33% due to lack of personnel who was to move to other areas of the city where the number of cases were increased rapidly. It is important to note that this work was carried out during the critical moment of the epidemic in the country.

Houses, container and Breteau indices were determined weekly during the work time.

The larvae were collected by means of a dropper and kept in flasks with 70% alcohol with the data of the date and place of collection, as well as, the type of deposit. Taxonomic classification by larvae morphological keys [11,12] was carried out in the Entomology laboratory of the National Malaria Program in Luanda.

Control vector activities implemented

Biological control: A concentrated aqueous formulation of *Bacillus thuringiensis israelensis* 266/2 Bactivec® (minidosis) was used for larval control. The dose used was 1ml by 50 liters of water in containers with water in homes as well as: tanks (in kitchens and in the houses roofs), drums, cisterns, vases, tires, among others. This product was applied at the beginning of the implementation.

Chemical control: The chemical control was used to control the adult mosquito. Thermal treatments (intra and extra domiciliary) were performed with cypermethrin (25%). These treatments were carried out covering the total of houses in the neighborhood for 3 consecutive days, repeating at 7, 15 and 21 days after the start date of the implementation of anti-vector activities. The intra-domiciliary applications were made in the morning between 08:00- 13:00 hours. The extra domiciliary treatments were realized in the sunset starting to 18:00 hours until 20:00 hours.

Equipment used

For the intra-domiciliary treatments 7 bazookas (SWINFONG 50) were used and for the extra domiciliary 3 bazookas TF 95 mounted on truck.

Environmental control

The Environmental control was performed by the management and destruction of the different breeding sites detected during the sampling. The methods used were destruction the containers like cans or by modification of the container such as filling of used car tires with earth or hollowing for the non-accumulation of water, protection of blocks of cement under roofs, as well as, bottles or other containers that could accumulate water in rainy season etc.

Figure 1 Illustration of the location of the neighborhood Km 30 in the Viana Municipality, Luanda, Angola.

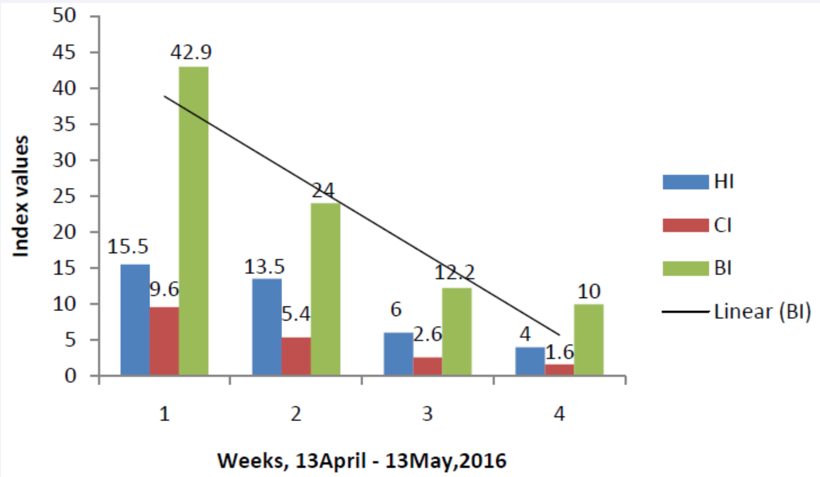

Figure 2 Behavior of Values of House Index (HI), Container Index (CI) and Breteau Index (BI) in locality (9), Viana Municipality, Luanda, April-May, 2016.

Social mobilization

In each house the specialists gave educational information about different topics such as, mosquito breeding sites, Yellow Fever transmission mode and control to encourage community participation in stopping the epidemic.

STATISTICAL ANALYSIS

Entomological indicators evaluated

House Index (HI); Breteau index (BI) and Container index (CI) were calculated before the treatments in 100% of the locality (9) chosen for the evaluation (150 houses), in the second week in 132 houses and in the third and fourth week in 115 houses.

(HI): The percentage of houses infested with *Aedes aegypti* immature stages.

(BI): the number of positive container per 100 houses.

(CI): The percentage of containers infested with *Aedes aegypti* immature stages per 100 houses.

A nonparametric test was used for more than 2 related Q samples from Cochram IBM® SPSS Statistics Version 21 to measure the impact of the measures on the reduction of the calculated indices.

RESULTS AND DISCUSSION

Throughout the study we obtained the values of the House, Container and Breteau indices for the 11 localities of the Tempo Muda district are showed in the (Table 1), as well as, the total of closed house during the inspection and the average of container per household.

Table 1: House (HI), container (CI) and Breteau (BI) indexes values in the Tempo Muda district in general and its localities, Viana Municipality, Luanda, April, 2016.

Samplinga areas	Total Houses visited	Houses with *Aedes aegypti*	HI	Total containers inspected	Containers With *Aedes aegypti*	CI	BI	Total of closed houses
Tempo Muda District (11localities)	1 865	243	13,02	10 859	516	4,75	27,6	121
Location (9)	142	22	15,5	637	61	9,6	42,9	8
Rest of localities	1 723	221	12,8	10 222	455	4,45	26,4	113

Abbreviations: HI: House Index; CI: Container Index; BI: Breteau Index

Table 2: Types and number of containers inspected and their positivity to *Aedes aegypti* in the Tempo Muda district, Viana Municipality, Luanda, April, 2016.

Type of Deposit	Total Inspected	Total positive with *Aedes aegypti*	Positivity (%)	Positivity (%) Location (9)
Drums	3,050	70	13.6	6.5
Buckets	2,529	122	23.6	29.5
Basins	2,481	158	30.6	36.1
Tanks in kitchens	1,730	80	15.5	16.4
Cisterns	953	72	13.9	8.2
Washing machine	101	14	2.7	3.3
Coolers storing water	15	-	-	-
Totals	10,859	516	100%	100%

The total of containers inspected with water by type and its positivity to *Aedes aegypti* in the Tempo Muda district is shown (Table 2), highlighting that the highest positivity was found in basins 158 (30.6%) followed by buckets 122 (23.6 %) representing between them more than half (54.2%) of the deposits. A total of 668 deposits (cement blocks, used car tires, cans, etc.) suffered environmental control either by manipulation or modification of the same that were not included.

The total of containers with *Aedes aegypti* in the locality (nine); 22 (36.1%) corresponded to basins; 18 (29.5%) to buckets; 10 (16.4%) tanks in kitchens; 4 (6,5%) to drums, 5 (8,2%) cisterns and 2 (3,3) washing machines in the yards of the houses.

The application of biolarvicides was regarding in 1 865 (93.9%) of the total number of houses 1 986 present in the Tempo Muda district and in 142 (94.6%) of them corresponding to the total of houses in locality (9). Intra domiciliary treatment with cypermethrin against adult mosquito in Tempo Muda was carried out in a total of 1,749 (88%) and in the same number of houses in locality (9) where the biolarvicides were applied.

Breteau index decreased from 42.9 to 10 in the locality (9) (Figure 2) demonstrating the impact of vector control activities evidenced in a reduction of *Aedes aegypti* infestation. This reduction was also observed for the house and container indices.

Significant differences were found for the indices values between the first and the fourth week of follow-up of the evaluation Q = 92,348 for 3 degrees of freedom and $p < 0,05$ demonstrating the effectiveness of the measures implemented, except between the third and the fourth week.

The values of the entomological indices are closely correlated between them and are used as indicators to measure the risk of transmission of Dengue and Yellow Fever in one area, however, their meaning is a matter of controversy, because they only give an empirical evaluation [13,14].

Despite the claim that larval indices do not adequately reflect adult production [14] and their limitations in terms of their interpretation and validity, they still constitute the main tool for measuring success in vector control programs and continue being essential indicators in the epidemiological surveillance of Dengue and Yellow Fever [15].

In the present work, a reduction in the values of these indices was obtained during the evaluation carried out three weeks after the interventions against the vector. Nevertheless, in the last two weeks, the reduction was not very marked due that is known that when intense control activities are carried out, it's very difficult to eliminate completely the mosquito population and the majority of the control program reduce mosquito populations to an economically allowable value for them [16,17].

One study carried out in a locality of Costa Rica [18] through community participation interventions concluded that this is a complementary alternative to traditional surveillance campaigns and control; they called attention to the need to maintain continuous supervision by health personnel in order to guarantee the effectiveness and sustainability of community participation initiatives that can be implemented in a specific place.

During an outbreak of Yellow Fever occurred in Luanda in the rainy season of 1971, it was found that the water storage vessels were responsible for 85% of the deposits with *Aedes aegypti*, the rest were abandoned containers, mainly with rainwater, used car tires, bottles, ornamental vessels, etc. On the other hand, this study mentioned that the *Aedes* indices varied greatly, reaching values close to 40 for the Breteau index. In 2013 a new Dengue epidemic was registered in Luanda [19] where again the water storage container reached 63.1% of the positivity to *Aedes aegypti*. Our results coincide with the results obtained by those authors helped by the characteristics of the area studied where the water supply is through cisterns trucks with an unstable frequency.

The high percentage of homes inspected favored the wide application of Bactivec® doses in water tanks and the elimination of a large number of potential breeding sites for *Aedes aegypti* factors that contributed to the interruption of transmission and a decrease in the occurrence of suspected and confirmed cases in this neighborhood. Besides the beginning of the study coincided with the end of the rainy season and the beginning of the dry season, which favored the existence of dry breeding sites during the sampling and that the majority of containers with *Aedes aegypti* were for storage water for human activities inside the houses.

We highlight here two important aspects that favored the presence of *Aedes aegypti* in the study area, the first the water supply is by cistern trucks and the frequency is weekly or biweekly which explains the large number of containers per house many times uncovered and the second aspect is the characteristics of the neighborhood where is present an eminently commercial area where large amounts of non-biodegradable containers are accumulated, such as bottles, plastic cups and others that prior to the period studied (5 months belonging to the rainy season) could have been breeding sites for the vector.

CONCLUSION

These results suggest that the actions and promotion of vector control activities should be intensified to empower families through educational instructions about mosquito larvae control. It also shows that the approach to the vector must be through integrated actions inside and outside the home and that it is a fundamental component in the control of Yellow Fever epidemics where there is not high coverage of people immunized by the vaccine or where you do not have the vaccine.

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