J Vector Borne Dis 46, June 2009, pp. 160–163

Effectiveness of net covers on water storage tanks for the control of dengue vectors in Sri Lanka

P.H.D. Kusumawathie[a], A.M.G.M. Yapabandara[b], G.A.J.S.K. Jayasooriya[a] & C. Walisinghe[c]

[a]*Regional Office, Anti Malaria Campaign, Dutugemunu Mawatha, Watapuluwa, Kandy;* [b]*Regional Office, Anti Malaria Campaign, Matale;* [c]*Office of the Divisional Director of Health Services, Kundasale, Sri Lanka*

Key words Dengue vector control – net covers – Sri Lanka – water storage tanks

Dengue fever/dengue haemorrhagic fever (DF/DHF) is an important public health problem in Sri Lanka since early 1990s. From the years 2000–08, the reported number of suspected and serologically positive DF/ DHF cases varied from 4749 to 15,643 involving 25–88 deaths, with a major epidemic in 2004. At present, the disease is prevalent in many urban and semi-urban areas of the country with higher incidence in Colombo, Gampaha, Kalutara, Kurunegala, Kegalle, Ratnapura and Kandy districts[1]. In addition to DF/DHF, the country experienced several outbreaks/epidemics of chikungunya since mid-2006 involving several thousands of cases per episode[2].

Entomological investigation carried out in DF/DHF prevalent areas showed that *Aedes aegypti* (Linnaeus) and *Ae. albopictus* (Skuse), the vectors of DF/DHF, breed in a wide variety of container habitats[3,4]. However, in areas with irregular water supply, ground level water storage cement tanks have been identified as important breeding sites of *Ae. aegypti* and *Ae. albopictus*[3–7]. In the DF/DHF transmission areas of the Kandy district, 11–72% (Mean 30, SD 18.96) of households use ground level cement tanks to store water for domestic and peridomestic use, for various durations, depending on the intervals of water supply[3,4]. Although, use of larvivorous fish is a potential tool for *Ae. aegypti* and *Ae. albopictus* control, its use in the domestic and peridomestic water storage tanks is limited as it requires frequent and repeated applications due to low survival rate of fish in these tanks, probably with the direct supply of chlorinated water into the tanks. Use of temephos (1% sand granules) involves high cost of application (material and labour) and has the potential of developing vector resistance. Use of net covers for water storage tanks would be a potential tool to control *Aedes* larvae including *Ae. aegypti* and *Ae. albopictus* in water storage cement tanks. This study was carried out to determine the effectiveness of plastic net covers in *Aedes* control in the domestic and peridomestic ground level water storage cement tanks in Kandy district that contributed 4.7–14.7% to the total DF/ DHF burden in the country over the years 2001–08.

This study was an interventional study of one year duration (August 2005–July 2006) with pre and post-intervention periods each of six months duration. The study site was Degaldoruwa, a village in the Divisional Director of Health Services (DDHS) area Kundasale in the Kandy district of Sri Lanka. This area is endemic for DF/DHF (Records of the Office of the Deputy Provincial Director of Health Services, Kandy). Forty percent of households use ground level cement tanks to store water for some weeks at a time due to irregular water supply. These tanks have been identified as the major breeding sites of *Ae. aegypti* and *Ae. albopictus* in the area[4].

During the study, 92 rectangular ground level water storage cement tanks (surface area 1– 4 m^2) were se-

lected with the assistance of village health volunteers and the entomological teams working in the area. Of these, 46 tanks were randomly selected for application of plastic net covers (intervention) while the rest (46 tanks) served as a control to the experiment. For the experimental tanks, net covers were prepared by a local carpenter according to the measurements provided by village health volunteers. Each net was prepared by fixing a double layer of plastic net (pore size, 1.6 x 1.6 mm) between two wooden frames. The undersurface of the frame that touches the wall of the tank was lined with a 5 cm thick rubber layer (soft arpico sheet) in order to prevent mosquitoes entry into the tank between the wooden frame and the tank wall. A side view of a net cover and a picture of a tank covered with a net cover are shown in Figs. 1 and 2, respectively.

Monthly larval surveys in water storage tanks were started in August 2005 by a trained entomological team attached to the Regional Office, Anti Malaria Campaign, Kandy. During the larval surveys, each tank was examined for *Aedes* larvae and 20 *Aedes* larvae (or all larvae, if the tanks had <20 *Aedes* larvae) were randomly collected from each *Aedes* positive tank by dipping or pipetting. Larvae were collected in separate containers (one container per one tank) and identified at the III and IV instar stages using standard keys[8]. I and II stage larvae were allowed to develop to III and IV stages and pupae to adults and were then identified. At the end of six months pre-intervention data collection period, randomly selected 46 tanks were applied with plastic net covers and continued monthly larval collections for another six months. The households those received net covers were educated on the correct use of the net covers to prevent mosquito breeding in the tanks. During this study, each tank in each survey was considered as an individual observation, making a total observations of 1104 (equivalent to 1104 tanks). Pooled *t*-test was carried out to compare the mean monthly number of tanks positive for *Aedes* larvae (i) pre- and post-intervention in the net applied tanks, and (ii) post-intervention, between net applied and control tanks.

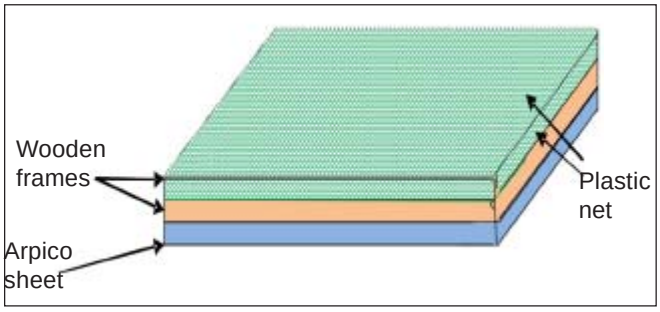

Fig. 1: Side view of a model of plastic net cover used to cover the ground level water storage cement tank

Fig. 2: A photograph of a ground level water storage cement tank covered with a plastic net cover

Four species of *Aedes* larvae (n = 73, 54.48%) were encountered in the water storage tanks (n = 134) with the majority of *Ae. albopictus* (n = 55, 41.05%) and *Ae. aegypti* (n = 18, 13.43%), while the remaining contained larvae of *Ae. macdougalli* (Edwards) 53 (39.55%) and *Ae. vittatus* (Bigot) 8 (5.97%). During pre-intervention six months period, 63 (monthly mean 10.5, SD 2.141) net cover applied tanks and 33 (monthly mean 5.5, SD 2.217) control tanks were positive for *Aedes* larvae. During the post-intervention period, 7 (monthly mean 1.17, SD 1.344) net cover applied tanks and 31 (monthly mean 5.17, SD 3.023) control tanks were positive for larvae of the same species (Table 1). There was a significant reduction in mean number of tanks positive for *Aedes* mosquito larvae in the net cover applied tanks in post-intervention period as compared to pre-intervention period ($t = 9.0980$, $p = 0.001$; 95% CI 7.031–

Table 1. Number of tanks positive for *Aedes* immatures (larvae and pupae) in the net cover applied and control tanks during pre- and post-intervention periods

Period	Month	No. of tanks positive for *Aedes* larvae	
		Net cover applied area	Control area
Pre-intervention	Aug 2005	10	8
	Sep	12	3
	Oct	12	4
	Nov	6	5
	Dec	12	9
	Jan 2006	11	4
	Total	63	33
	Monthly mean	10.5	5.5
Post-intervention	Feb 2006	0	6
	Mar	3	2
	Apr	3	9
	May	1	9
	Jun	0	3
	Jul	0	2
	Total	7	31
	Monthly mean	1.17	5.17

11.629). Also, during the post-intervention period, there was a significant reduction in mean number of tanks positive for *Aedes* larvae in the net cover applied tanks as compared to control tanks ($t = –2.9616$, $p = 0.01$; 95% CI 0.991–7.008) (Table 2).

Ground level water storage cement tanks produce a number of mosquito species including potential vectors of malaria, dengue and dengue haemorrhagic fever, filariasis and Japanese encephalitis[9]. Thus, mosquito control in water storage tanks is important for mosquito borne disease control and prevention as well as for reduction of mosquito nuisance. The present study shows that the use of plastic net covers is an effective measure for prevention of *Aedes* mosquito breeding in ground level cemented water storage tanks provided the net covers are used properly. Thus, proper use of net covers is of utmost importance in preventing *Aedes* mosquito breeding in the ground level cemented water storage tanks. During this study, *Aedes* larvae were encountered in 7 (2.54%) tanks with plastic net covers during the post-intervention period. Investigations revealed that the net covers in these tanks were sometimes dis-positioned due to frequent use of the tanks. This situation may be corrected by incorporating a ringed net window to the net cover enabling easy handling of the net cover (to open the window when using the tanks and to keep it close when the tank is not in use) without dis-positioning of the net covers on the tanks.

Plastic net covers are user friendly and less costly. A net cover of 2 m^2 can be prepared locally at an average cost of US$ 10 (~ 1000 Sri Lankan Rupees) that can be afforded by the majority of the community. If the net cover is protected from direct sun light and the wooden frame coated with enamel paint, the net cover lasts for 2–3 years. Since plastic net covers give good *Aedes* mosquito control in water storage cement

Table 2. Comparison of mean number of tanks positive for *Aedes* immatures in the plastic net cover applied and control tanks during pre- and post-intervention periods

Treatment	Pre-intervention		Post-intervention		*t*-value* (*p*-value)
	Mean number of tanks positive for *Aedes* larvae	SD	Mean number of tanks positive for *Aedes* larvae	SD	
Net cover applied	$10.5^{a,1}$	2.1409	$1.17^{a,2}$	1.3437	9.0980 (0.001)
Control	$5.5^{b,1}$	2.2174	$5.17^{b,1}$	3.0231	0.2156 (0.05)
t-value (*p*-value)	3.9736 ($p = 0.002$)		–2.9616 ($p = 0.01$)		

^{a,b}Means with the different superscript letter in each column are significantly different; ^{1,2}Means with the same superscript number in each row do not differ significantly; *t-test comparing pre- and post-intervention periods and treatments.

tanks, advantages of using such measures needs to be incorporated in the health messages in order to encourage people to use such measures for DF/DHF and chikungunya control in the country.

Acknowledgement

Financial support by the National Dengue Coordinating Unit, Ministry of Health, Sri Lanka is gratefully acknowledged. Cooperation given by the Provincial Director of Health Services, Central Province and the Deputy Provincial Director of Health Services, Kandy, in field activities is much appreciated.

References

1. Ministry of Health, Sri Lanka. Surveillance report on dengue fever/dengue haemorrhagic fever 2007. *Epidemiological Bull* 2008; *49:* 1–20.
2. Epidemiological Unit [Home page on the Internet] Sri Lanka. Investigation of the outbreak of chikungunya fever-2006/7 Sri Lanka. The Centre for Prevention and Control of Communicable Diseases. Available from: *http://www.epid.gov.lk/pdf/chikungunya/OBOFCHIGYA.pdf*.
3. Kusumawathie PHD, Fernando WP. Breeding habitats of *Aedes aegypti* Linnaeus and *Ae. albopictus* Skuse in a dengue transmission area in Kandy, Sri Lanka. *Ceylon J Med Sci* 2003; *46:* 51–60.
4. Kusumawathie PHD, Fernando WP. *Anopheles maculatus* (Theobald) and *Anopheles elegans* (James) breeding in water storage containers in Kandy, Sri Lanka. *Ceylon J Med Sci* 2002; *45:* 71–6.
5. Kusumawathie PHD, Siyambalagoda RRMLR. Distribution and breeding sites of potential dengue vectors in Kandy and Nuwara Eliya districts of Sri Lanka. C*eylon J Med Sci* 2005; *48*(2): 43–52.
6. Epidemic of dengue fever/dengue haemorrhagic fever in Tangalle, Ministry of Health. Sri Lanka Weekly Epidemiological Report 2001; *29*(50): 1–4.
7. Yapabandara AMGM, Abeykoon AR. *Aedes aegypti* and *Ae. albopictus* breeding sites in the Matale Municipal Council area. *Proc Sri Lanka Assoc Adv Sci* 2002, *58:* 20.
8. Barraud PJ. *The Fauna of British India,* v. V. London: Taylor and Francis 1934.
9. Kusumawathie PHD, Wickremasinghe AR, Wickremasinghe DR, Jayasooriya GAJSK. Disease transmitting mosquito species breeding in water storage tanks in Kandy, Sri Lanka. *Proc Sri Lanka Assoc Adv Sci* 2005; *61:* 8.

Corresponding author: Dr P.H.D. Kusumawathie, Regional Office, Anti Malaria Campaign, Dutugemunu Mawatha, Watapuluwa, Kandy, Sri Lanka.
E-mail: kukan_kan@yahoo.com

Received: 4 November 2008 *Accepted in revised form:* 19 March 2009