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Evaluation of results on present conventional and alternative vector control activities in prevention and control of Dengue/Dengue Haemorrhagic Fever (DHF)

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A total of 395 and 243 houses in two selected wards of Kyimyindine and Tamway townships, respectively were surveyed for *Aedes aegypti* adults and larvae to obtain baseline entomological indices. Establishment of innovative larval control methods has been achieved during pilot surveys and laboratory experiments were successfully undertaken before the intervention. Even during the hot dry season, more than 50% of the total houses examined were found to be positive for larvae in both townships. During pre-intervention surveys, all entomological indices increased after the onset of rain. A training workshop to transfer the innovative larval control methods to the local community was held at Kyimyindine (intervention) Township. Close supervision and appropriate larval control methods were introduced in the intervention township. The methods included periodic augmentative release of larvivorous fish and dragon-fly nymphs, and use of cotton net sweepers. Post-intervention evaluations were undertaken twice per month. All indices gradually decreased to a very low level in intervention ward (Breteau Index dropped from 201 to 62). At the same time, the indices remained unchanged or were slightly above pre-intervention levels in non-intervention ward of Tamway Township (Breteau Index varied from 100 to 127). There was also a significant reduction of key premises (χ^2= 14.49, p<0.0001) and key containers (χ^2= 25.49, p<0.0001) in intervention ward. Regarding dengue morbidity, decrease in both clinically suspected dengue and reported DHF cases were evident at the intervention township. It showed that regular close-monitoring with active community participation is effective and is essential for prevention and control of dengue/DHF.

INTRODUCTION

Dengue Fever/Dengue Haemorrhagic Fever (DF/DHF) is the most important mosquito-borne viral disease in the world in terms of morbidity, mortality and economic cost, with over 100 million cases per year. The global resurgence of DF/DHF has been threatening more than 2.5-3 billion people in over 100 countries worldwide. Methods for controlling or preventing dengue mainly rely on combating the mosquito vectors. In the light of the rising problem, it is important to activate the community-based alternative vector control strategies. Selective and integrated mosquito vector control with community and inter-sectoral participation was proposed by the World Health Organization in 1995 as one of the five major components of the global strategy for dengue prevention and control in the regions [1]. The Tropical Diseases Research Programme (TDR) from the World Health Organization also encouraged the development and evaluation of community-based mosquito control strategies and scaling-up of successful pilot community-based interventions.

Dengue Fever (DF)/DHF has become an increasing public health problem in South-east Asia region including Myanmar, facing complex emergency outbreaks situations frequently. It is endemic in Myanmar with a 3-4 year epidemic cycle. The average number of cases and deaths per year for the whole country were 2537 and 107 during 1970 to 1986 [2]. The incidence has been increasing over the past 2-3 decades and upward trend is still continuing [3]. The trend is also more or less similar in succeeding years up to the present period.

There are limitations in present control measures such as changing water, sieving or tipping and covering water containers, spraying houses around 100 yards radius from hospitalized DHF cases. An increasing effort is being made to control the vector through community participation by reducing larval habitats, but densities still remain very high [4]. The major vector, *Aedes aegypti*, breeds primarily in man-made containers such as domestic water storage tanks, metal drums, cans, earthen pots, used tyres and other items that retain water including natural habitats. Although public health measures for source reduction are being undertaken, there still remains to develop efficient larval control programmes using all locally available vector control methods (such as biological, chemical and mechanical means), which should include community awareness and full participation. There is a need to upgrade alternative vector control activities targeted against *Aedes* larvae and adults with active community participation.

Categorization of containers (major, minor and miscellaneous) by types and quantitative determination of larval abundance by visual estimates have already been developed and tested by Department of Medical Research, Lower Myanmar (DMR-LM). It is important to determine the prevalence of *Aedes aegypti* larvae positive houses/ containers, key premises and key containers by proper sampling. Missing one key container could be equivalent to missing 1,000 flower vases containing *Aedes aegypti* larvae [5]. Our study was carried out with the aim for evaluating dengue/DHF prevention and control activities based on appropriate integrated cost-effective vector control methods with emphasis on targeting key premises/key containers and sustained active community participation for reduction of DHF in Myanmar.

General objective

- To determine the effectiveness of alternative vector control methods in comparison to the present conventional control methods with a view to develop a sustainable selective and integrated vector control model for reduction of morbidity and mortality of DHF in Myanmar

Specific objectives

- To determine the prevalence of key premises/key containers at the two selected wards of two sub-urban townships in Yangon Division before and after intervention
- To compare selected entomological indices regarding *Aedes aegypti* larval and adult mosquito densities at these two selected wards
- To critically assess and reinforce the current vector control activities with closely supervised control methods in the intervention township

MATERIALS AND METHODS

Study design

The study was a quasi-experimental field intervention study with non-randomized control, starting from April 2003 to October 2003. The actual planning and standardization and establishment of laboratory and field methods were accomplished one year prior to the starting date. Pre and post-intervention indicators were House Index (HI=the percentage of houses that have larvae in at least some positive containers), Container Index (CI=the percentage of

larvae positive containers), Breteau Index (BI=number of positive containers per 100 houses inspected) and adult mosquito density (by ten minutes aspirator catching per house).

Study area

Thar-Du and Ka-Ga wards from Kyimyindine and Tamway townships, respectively with high endemic DHF cases in sub-urban area of Yangon Division were selected purposively to ensure that the socio-economic situation, housing condition, container categories/types and the composition of under 15 years population of two wards are as similar as possible. Out of 27 wards in Kyimyindine Township, Thar-Du ward (east and west) comprised of 469 houses of which 30% were partitioned (into housing units) to accommodate usually two to four persons, and sometimes up to twelve families. Altogether there were 1,135 families, making a total population of 5,233 including 2,496 under 15-year of age. Most houses (60%) were double-storey and the rest were single or high-rise buildings. Each family has water for domestic use in its own containers. There were three community tanks (two covered and one uncovered). Thar-Du was the intervention ward using appropriate larval control measures with close-supervised monitoring and community participation for comparison with routine control measures. Out of 20 wards in Tamway Township, Ka-Ga ward comprised of 606 houses of which 38% were partitioned into two to fourteen housing units. Altogether there were 1,473 families, making a total population of 6,404 including 2,531 under 15-year of age. There were also three (covered) community tanks.

Study methods

A total of 395 and 243 houses in Thar-Du and Ka-Ga wards, respectively were surveyed for *Aedes aegypti* adults and larvae to obtain baseline entomological indices. The number of houses inspected was based on the expected level of infestation and the desired level of confidence in the results. A total number of nearly 10,000 housing in each study township, the expected House Index was 50% (preliminary data) and a 95% confidence interval of 44%-56%, it would be necessary to inspect 300 houses [1]. Establishment of innovative larval control methods has been achieved as pilot surveys and laboratory experiments were being undertaken. The methods included periodic augmentative release of larvivorous fish [6, 7] and dragon-fly nymphs [8], and the use of cotton net sweeper [9, 10]. Ethical consideration was reviewed and approved by Ethical Review Committee, DMR-LM.

Community motivation, supervision and technology transfer: A training workshop to transfer the larval control methods to the local community was held at Kyimyindine (intervention) Township. Close-supervision and appropriate larval control methods were introduced in intervention township by Medical Entomology Research Team from DMR-LM in collaboration with health personnel from Department of Health, local authorities and non-governmental organizations such as Myanmar Maternal and Child Welfare Association, Myanmar Red Cross Association and Auxiliary Fire Brigade. Locally developed cotton net sweepers together with instruction for use were distributed to all wards of Kyimyindine Township.

Surveys: There were altogether ten surveys including three pre-intervention (during April and May 2003) and seven post-intervention evaluations (June-September, 2003). Post-intervention surveys were undertaken bi-weekly. Activities included inspecting and counting domestic water storage containers, positive *Aedes* larval estimation by visual method [10] and catching adult mosquitoes by aspirator. Every alternate house (i.e., 200 households in Kyimyindine Township and 135 households in Tamway Township) was selected for evaluations 3 to 7 based on the preliminary findings of more than 50% larvae positive of the total houses examined

in both townships even during the hot dry season (Surveys 1 and 2). Evaluations 8 and 9 in Kyimyindine and 8th survey in Tamway were inspections of the remaining alternate houses so that actual larval situation from houses that were not sampled previously could be ascertained from two wards. The final two evaluations included complete inspection of all houses as that of surveys 1 and 2 (a total of 394 and 243 houses in Thar-Du and Ka-Ga wards, respectively).

Close monitoring and intervention (Biological control): During post-intervention evaluations, the appropriate larval control methods were implemented to reduce larval populations in Thar-Du ward. The local larvivorous fish and dragon-fly nymphs were released in positive and key containers during every post-intervention survey with the help of the local community. Dragon-fly nymphs (pond variety) *Crocothemis servilia* (Drury) were collected from Kandawmin Lake near DMR-LM and larvivorous fish (*Aplocheilus panchax*) were caught from natural water bodies such as pond and creeks in Hlinethaya Township, the outskirt of Yangon City.

Close monitoring and intervention (Mechanical control): Dipping with cotton net sweeper in larvae positive metal drums was undertaken by the local community weekly with the supervision of the research team especially in the first two surveys.

Aedes aegypti adult mosquito surveillance: Ten minutes catching mosquito with aspirator [11] was performed on 30 randomly selected houses in each ward once before and two times after intervention period. Using two aspirators, two staff spent three hours collecting adult mosquitoes at Thar-Du ward of Kyimyindine Township (visiting 15 houses each between 8:30 and 11:30 hours local time), and then on the following day at Ka-Ga ward of Tamway Township. Indoor density of *Aedes aegypti* female adult was determined by ten minutes aspirator catching per house.

Instrument for data collection, processing and analysis

Household/family units, domestic water containers examined and *Aedes* larvae positive containers were recorded using separate survey forms. Cotton net sweepers and aspirators were used for larvae and mosquito adult collections, respectively. Data entry, sorting and data analysis were carried out using Microsoft excel and STATA. Chi-square tests for bivariate analysis and Poisson regression for group data were used for multivariate analysis. 'Z' test" was used for detection of differences in two proportions (rates).

RESULTS

Even during the hot dry season, more than 50% of the total houses examined were found to be positive for larvae in both townships (Table 1). In pre-intervention surveys (surveys 1 to 3), all entomological indices increased due to the onset of rain. Post-intervention surveys (evaluations 4 to 10) were undertaken twice a month and all indices gradually decreased to a very low level in Thar-Du ward while they remained unchanged or slightly above pre-intervention levels in Ka-Ga ward (Fig. 1-A, B & C). A sustained reduction was only achieved after several evaluations by undertaking repeated supervision and close-monitoring in Thar-Du ward. By adjusted sequence of measures and time, using Poisson regression model, the prevalence rate ratio of the two townships was 0.87 ($p<0.0005$). In other words, the prevalence of finding larvae positive houses in Thar-Du ward of Kyimyindine Township was significantly reduced.

It was clearly evident that more than half (63% in Thar-Du ward of Kyimyindine and 55% in Ka-Ga ward of Tamway townships) of positive containers were produced by only 15% of the total houses (key premises). This is also true for key containers as the majority of the key containers detected were from key premises, 33 key containers (80%)

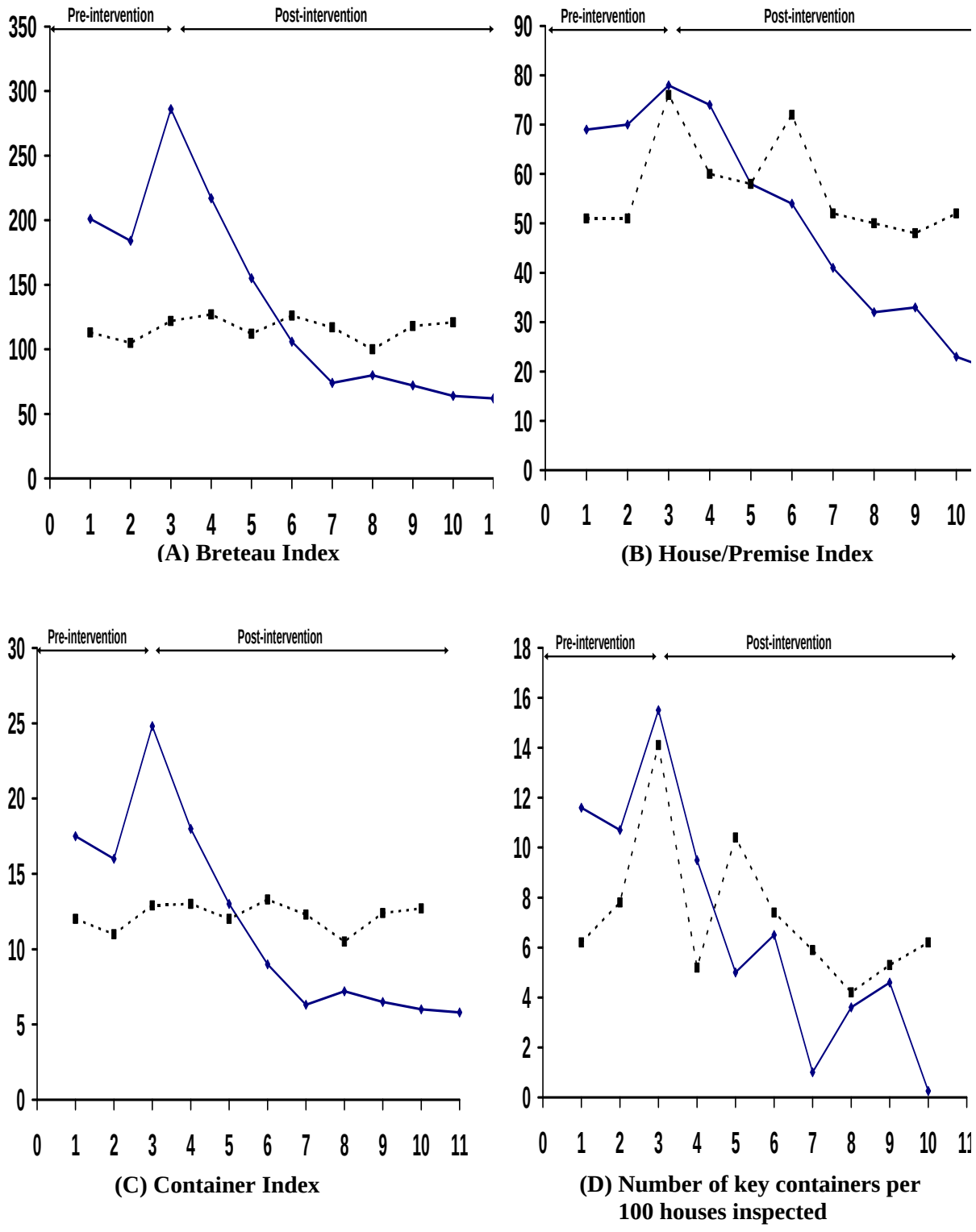

Fig. 1. *Aedes aegypti* larval density indices and number of key containers per 100 houses inspected in Thar-Du ward, Kyimyindine Township (unbroken lines) and Ka-Ga ward, Tamway Township (broken lines) during the study period, April-October 2003.

Table 1. Total number of houses and containers harbouring *Aedes aegypti* larvae in Thar-Du ward of Kyimyindine (intervention) Township and Ka-Ga ward of Tamway (non-intervention) Township,Yangon, April and October 2003

Evaluation (2 wks interval)	No. of houses inspected	No. of houses with *Aedes* larvae positive (%)	No. of containers inspected	No. of *Aedes* larvae positive containers	BI
Kyimyindine					
*Before**					
1-April	395	273 (69)	4549	795	201
2-May	394	276 (70)	4538	725	184
3-May	200	156 (78)	2305	572	286
*After**					
4-June	200	148 (74)	2406	434	217
5-July	200	116 (58)	2355	310	155
6-July	200	108 (54)	2355	212	106
7-Aug	200	82 (41)	2358	148	74
8-Aug	195	62 (32)	2155	156	80
9-Sept	195	64 (33)	2155	140	72
10-Sept	394	89 (23)	4228	252	64
11-Oct	394	80 (20)	4228	244	62
Tamway					
*Before**					
1-April	243	124 (51)	2289	275	113
2-May	243	124 (51)	2311	255	105
3-May	135	103 (76)	1280	165	122
*After**					
4-June	135	81 (60)	1280	171	127
5-July	135	78 (58)	1280	151	112
6-July	135	97 (72)	1280	170	126
7-Aug	135	70 (52)	1280	158	117
8-Aug	120	60 (50)	1140	120	100
9-Sept	243	117 (48)	2308	287	118
10-Oct	243	126 (52)	2308	294	121

*Period in relation to beginning of close monitoring and supervised vector control activities in Thar-Du ward of Kyimyindine Township

BI = Breteau Index (Number of positive containers per 100 houses inspected)

Table 2. Total number of *Aedes aegypti* larvae positive houses in Thar-Du ward of Kyimyindine (intervention) Township and Ka-Ga ward of Tamway (non-intervention)Township, Yangon, April and October 2003

No. of houses examined	No. of larvae positive houses (%)	Houses with no. of container positive			No. of larvae negative houses (%)
		One (%)	Two (%)	Three & above (%)	
Kyimyindine (KMD)					
Before 395	273 (69)	133 (34)	80 (20)	60 (15)	122 (31)
After 394	80 (20)	38 (10)	30 (7)	12 (3)	314 (80)
Tamway (TME)					
Before 243	124 (51)	62 (26)	31 (13)	31 (13)	119 (49)
After 243	126 (52)	68 (28)	30 (12)	28 (12)	117 (48)
Prevalence rate ratio (adjusted before and after effect)					
KMD:TME	0.87: 1	0.81: 1	1.11: 1	0.75: 1	
(95% confidence interval)	(0.86 - 0.88)	(0.8 - 0.82)	(1.09 - 1.13)	(0.74 0.77)	

in Thar-Du ward of Kyimyindine Township and 9 key containers (60%) in Ka-Ga ward of Tamway Township. The number of *Aedes aegypti* larvae positive houses with one or more positive containers in April and October 2003 (evaluations 1 and 10) is shown in Table 2. Defining household as a denominator, the proportion of finding larvae positive house between the two wards was 0.87:1 with 95% confidence interval of 0.86-0.88. Adjusted "before and after effect", total larvae positive houses as well as key premises were significantly lowered in Thar-Du ward than in Ka-Ga ward. There was a significant reduction of total positive containers (χ^2=50.06, p<0.0001), major positive containers (χ^2=26.06, p<0.0001) and key containers (χ^2=25.49, p<0.0001) in Thar-Du ward. Also, 25% - 50% reduction of key premises was evident in Thar-Du (intervention) ward (χ^2=14.49, p<0.0001) (Table 3).

Regarding *Aedes aegypti* adult density in study areas, there was also a 50% reduction in mosquito population of intervention ward and was statistically highly significant (χ^2=10.45, p=0.001).

DISCUSSION

Our study was a quasi-experimental field intervention study. The main aim was to evaluate and reinforce the present conventional dengue/DHF prevention and control activities using integrated vector control. Special emphasis was given on targeting key premises 15%) and key containers (60-80%) by using appropriate larval control methods such as bio-control (locally available larvivorous fish and dragon-

Table 3. Total number of *Aedes aegypti* larvae positive different container categories and number of key containers before and after intervention in Thar-Du ward of Kyimyindine Township and Ka-Ga ward of Tamway Township, Yangon, April and October 2003

Container categories	No. of containers examined	No. of larvae positive containers	Key containers	Prevalence rate ratio *
Kyimyindine				
Before (1st survey)				C 1 (Positive) 0.47 (0.46-0.48)
C 1	1089	196	27	
C 2	3337	568	17	
C 3	123	31	2	
Total	4549	795 (17.5%)	46	C 1 (Key) 0.52 (0.51-0.54)
After (10th survey)				
C 1	1032	80	1	
C 2	3174	161	0	C 2 (Positive) 1.27 (1.26-1.27)
C 3	22	3	0	
Total	4228	244 (5.8%)	1	
Tamway				
Before (1st survey)				C 2 (Key) 0.95 (0.93-0.96)
C 1	408	110	11	
C 2	1839	152	4	
C 3	42	13	0	C 3 (Positive) 0.76 (0.7-0.83)
Total	2289	275 (12%)	15	
After (10th survey)				
C 1	427	116	9	C 3 (Key) Not relevant
C 2	1855	170	6	
C 3	26	8	0	
Total	2308	294 (12.7%)	15	

* = Adjusted before and after effect (95% Confidence interva)

C1 = Major container category (e.g. metal drums, barrels, ceramic tanks)

C2 = Minor container category (e.g. earthen pots and small jars, flower vase)

C3 = Miscellaneous (e.g. discarded old batteries, broken pots, plastic bottles, car tyres)

fly nymphs) and mechanical control (using locally developed cotton net sweepers).

The predatory rates, catching, transportation and release of bio-control agents into positive containers, and efficient larval sweeping were successfully carried out as have been in previous studies [6, 7, 8]. The mean percent removal of *Aedes aegypti* larvae per drum was 85.36%±10.74 and it was found to be a simple and cost-effective mechanical control method that was readily accepted by the community. A pilot field study, involving periodic augmentative release of dragon-fly nymphs performed by Sebastian *et al*. [8] was an excellent work and this technology was used in this study showing that sustained bio-control could be achieved with the awareness and enthusiastic participation of local householders in Yangon. Larvivorous fish (*Aplocheilus panchax*) was also an appropriate, simple bio-control technology since this local fish is available in peri-urban areas of Yangon.

Baseline entomological indices in pilot surveys were found to be higher than DOH annual reports. To assess the levels of *Aedes aegypti* infestations, we applied the most common three larval indices, mainly HI, BI and CI. Actually, Breteau Index (BI) establishes a relationship between positive containers and houses, and is considered to be the most informative and relevant for focusing control efforts on the management or elimination of the most common habitats [1]. *Aedes aegypti* adult mosquito density was monitored using a locally developed aspirator (ten minutes catching per house) instead of using human as baits for mosquito collection in the past.

In our study, about one thousand larvivorous fish and three hundred dragon-fly nymphs were utilized. Approximately 70% of households accepted the introduction of these fish whereas about 30% of the households utilized the dragon-fly nymphs. Some of the local drums and cement tanks already have the dragon-fly nymphs (container variety) *Bradinopyga geminata* (Rambur) and the community seeded these nymphs into other major containers that do not contain these nymphs. Naturally, before the intervention, it showed that more than half of total positive and key containers were from key premises and the majority was from major container categories. This would be concluded that it is essential to detect key premises (premises with at least three positive containers for *Aedes aegypti* larvae) and key containers (containers that have at least 500 larvae in each container) that are producing high numbers of dengue vectors. Proper mapping of high risk areas

(hot spots) and reducing child vector contact are of paramount importance. Detection of key containers near areas where children congregate during the daytime must be taken care of immediately.

Dengue is a worldwide problem but a common approach is a realistic thing [12]. Emphasis should be on the development of effective sustainable control programmes based on source reduction using community participation [13, 14].

Myanmar has a strong local NGOs and this should be exploited for mapping, detection and elimination of key containers under the supervision of the local township administrative and health authorities [10]. The present results demonstrate the feasibility and effectiveness of close supervision, community motivation and active participation. Community participation in various levels such as households, school and day-care centres etc. has been achieved and dengue vector densities have been reduced in a sustainable manner during the study period. There is a potential benefit for children of <15 years in intervention ward. It is recommended that proper mapping and concentrating on key premises and key containers and utilizing appropriate larval control methods are the critical success factors and should be encouraged utilizing active community participation. More health education on source reduction should be given to the health staff and the community including NGOs than at present.

Although both larval and adult indices gradually decreased to a very low level in intervention ward, a sustained reduction was only achieved after several evaluations. The first two surveys were pilot studies. From third to seventh surveys, every alternate house (200 and 135 households in Kyimyindine and Tamway townships, respectively) was inspected based on the preliminary findings that more than 50% of the houses were positive for larvae in both townships. More repeated supervision and close monitoring is needed for sustainability of the innovative vector control measures. If the study could have been undertaken on more than two townships using paired randomization, the results would have been more convincing.

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