MONTHLY DENGUE UPDATE

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Contents

Importance of monitoring and management of insecticide resistance in effective *Aedes* control

Dengue fever is endemic in Sri Lanka and is a significant public health hazard, with approximately 40000 cases recorded annually. Insecticides play the most crucial role in controlling mosquito vectors of diseases worldwide. Six classes (organochlorines, organophosphates, carbamates, pyrethroids, pyrroles, and phenyl pyrazoles) of insecticide have been recommended by WHO for use against adult mosquitoes in public health programmes worldwide (WHO, 2016). While insecticide-based interventions have been effective in controlling Aedes mosquito populations in Sri Lanka for several years, due to the reliance on a few active ingredients that are registered and used in public health, resistance to the first four classes of insecticides has now evolved in the majority of regions (Figure 1). Over the past decade, the use of pyrethroids such as deltamethrin and permethrin has been gradually increasing as a proportion of all the total insecticide use for dengue control. Organophosphates, such as malathion, fenitrothion and pirimiphos-methyl, are also widely used, particularly in response to disease outbreaks or when mosquito numbers are high. Pyrethroids are used in both indoor residual spraying and space spraying activities (Gan et al., 2021; WHO, 2016)

When mosquito populations are subjected to insecticide-induced selection pressure, they may develop resistance. The term "resistance" refers to an insect strain's evolved Ability of mosquitoes to survive exposure to a standard dose of insecticide; this ability may result from physiological or behavioural adaptation (WHO, 2016). In an average population, these resistant strains are infrequent. However, the widespread use of insecticides might lower the usually vulnerable population, giving resistant strains a competitive edge over susceptible strains. They swiftly become the majority of the mosquito population when there is no intraspecific competition. As a result, the insecticide is no longer effective, and the insects are resistant (Becker et al., 2010). Mosquito populations may even develop "cross-resistance," which means that they are resistant to one insecticide of a particular class and other insecticides in the same category, even when it has never been treated with the other insecticides. More severe is the phenomenon of "multiple resistance," where separate detoxification mechanisms for unrelated insecticides are present, resulting in an insect population resistant to different classes of insecticides, which makes control with insecticides extremely difficult (WHO, 2017; Becker et al., 2016). Therefore, insecticides in control programmes should always include insecticide resistance monitoring and management (WHO, 2016; Gan et al., 2021). Monitoring for resistance should be a critical component of any vector control effort. Before initiating control activities, mosquito susceptibility should be

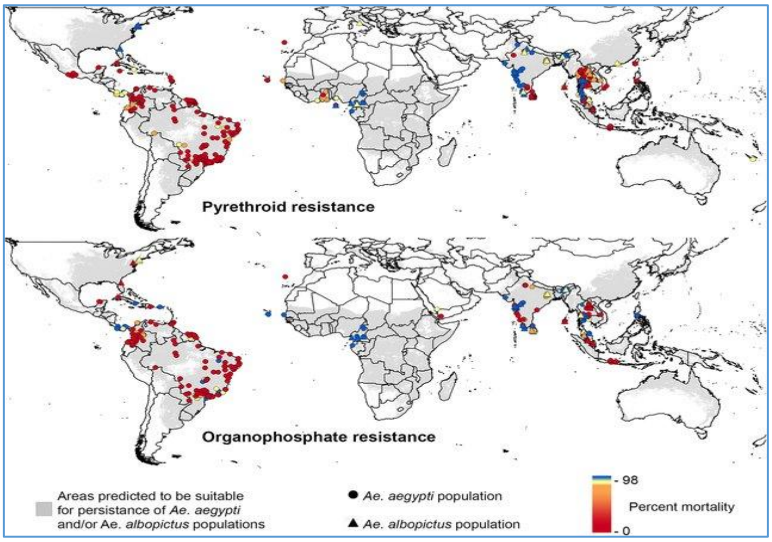

Figure 1. Global distribution of insecticide resistance data in Aedes mosquitoes (Source. Kraemer et al. 2015)

determined to give baseline data for insecticide selection and application strategy selection. Regular observation will enable early discovery of resistance, allowing for implementing resistance management techniques. In the case of late detection, proof of control failure will support the insecticide's replacement.

Typically, an insecticide quickly enters the integument and reaches the site of action. The place could be a critical enzyme, nerve tissue, or protein receptor. Insecticide chemicals bind to the site and impair key processes when concentrations reach a necessary level, resulting in insect death. Resistance can be selected at any point along this pathway (Becker et al., 2010). Numerous diverse and complex ways contribute to pesticide resistance development, including genetic, physiological, behavioural and ecological factors and indirectly on the volume and frequency of applications of insecticides. This resistance mechanism (figure 2) consists of target-site resistance, metabolic resistance, Cuticular resistance, and behavioural adaptation (Gan et al., 2021).

1. Metabolic resistance

Metabolic resistance occurs when a mosquito's enzyme systems alter, causing quicker than regular insecticide detoxification. The detoxifying process stops the insecticide from reaching the mosquito's target site. Esterase, monooxygenases, and glutathione S-transferases (GSTs) are thought to be significant insecticide metabolisers (WHO, 2016). Generally, esterase confers resistance against ester-bond-rich compounds such as organoph- osphates, carbamates, and pyrethroids. GSTs are capable of mediating resistance to organo-chlorines, organophosphates, and pyrethroids, whereas monooxygenases are active against all pesticide classes (Gan et al., 2021)

2. Target-site resistance

Target-site resistance develops when a mutation occurs in the insecticide's target protein receptor. The insecticide can no longer attach to the receptor's designated target site, leaving the insect unharmed or less affected. The mutation in the sodium channel receptor confers “knockdown resistance” to DDT and pyrethroids (mediated by the kdr genes). The mutation occurs in the protein acetylcholinesterase (a neurotransmitter), causing Ace-1 resistance. The gamma-aminobutyric acid receptor (rdl) gene confers resistance to dieldrin and fipronil.

3. Cuticular resistance

Cuticular resistance is achieved by thickening or altering the cuticle's chemical makeup to inhibit pesticide penetration. Reduced penetration allows for more time for metabolic enzyme activation and detoxification. Since most pesticides are lipophilic, cuticular resistance is thought to confer cross-resistance.

4. Behavioural adaptation

Behavioural adjustments were developed to avoid or minimize interaction with pesticides and reduce uptake to prevent unwanted outcomes. In reaction to indoor insecticide spraying, some malaria vectors have moved to outdoor resting. Avoiding insecticides by mosquitoes is classified mainly as temporal and spatial avoidance. For example, ‘temporal avoidance' includes moving away from insecticide-treated areas, whereas ‘spatial avoidance' involves moving away from insecticide-treated places. Mosquitoes avoid feeding on hosts in places heavily treated with insecticides.

Importance of insecticide resistance management

Although insecticides used to be efficient in managing mosquito-borne diseases, recent trends suggest that insecticides are losing effectiveness in preventing disease transmission. Insecticides can potentially harm the environment and ecosystems.

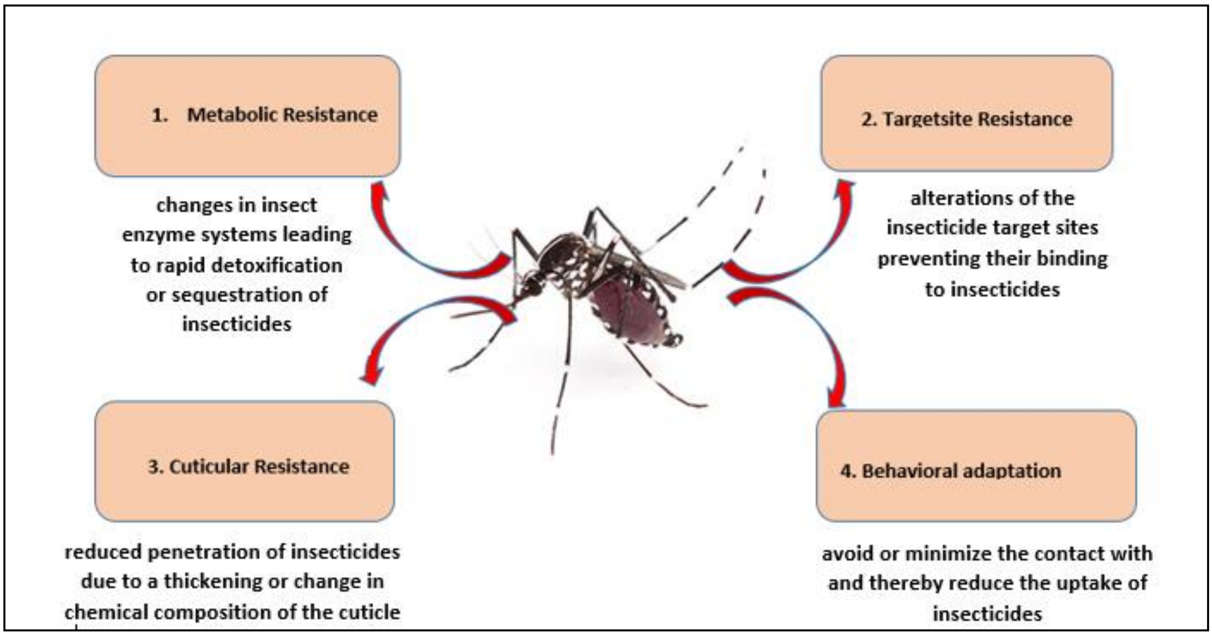

Figure 2. Mechanism of insecticide resistance

Mosquitoes may develop cross-resistance to poisons that a particular insect population has never been exposed to. We also need to control resistance carefully in mosquito populations because the number of effective insecticides on the market is limited, as is the number of new compounds that may be introduced.

To justify the use of control against a specific insect population, a thorough examination of the harm and threat to human life must be conducted. To determine effective insecticides and application methods, adequate timing and frequency of treatment should be gathered. The target population's resistance to various insecticides must be assessed to determine the most efficient insecticide/ insecticide group and the correct dosage.

Moreover, the insecticide's most vulnerable life cycle stage should be recognized before insecticide treatment. Biological and physical controlling measures might be combined to optimise the controlling effect. Dengue fever and pesticide resistance are disturbing trends in many Southeast Asian countries, including Sri Lanka. Thus, knowing mosquito resistance and susceptibility mechanisms is critical for developing an effective control method of Aedes mosquitoes in these endemic regions (Gan et al., 2021, Karunarathna et al., 2018.)

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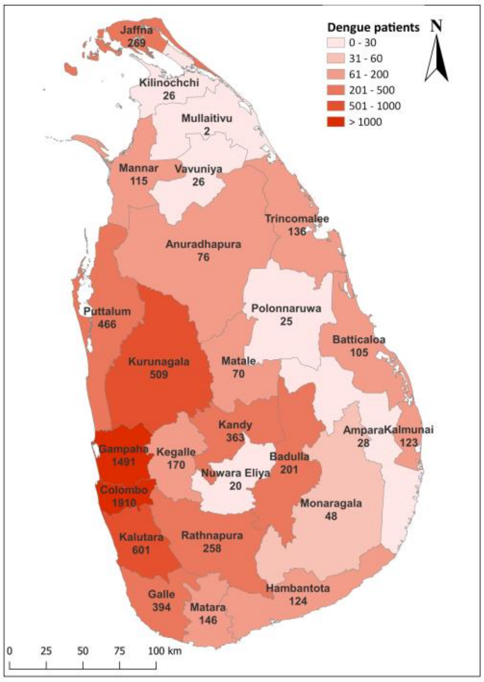
3. SUMMARY OF ENTOMOLOGICAL AND EPIDEMIOLOGICAL SURVEILLANCE DATA – JANUARY 2022

SUMMARY OF ENTOMOLOGICAL AND EPIDEMIOLOGICAL SURVEILLANCE DATA						
Provi	District	Entomological surveillance data				Epidemiological surveillance data
		(Source - returns of entomology surveys received by NDCU)				(Source-DenSys)
		No. of Premises			Main type of containers positive for larvae and percentage positivity	Month
		Inspected	Positive Found	Positive %		January
WP	Colombo	632	47	7.4	Discarded items(24.2%), Concrete slabs (24.2%), Temporary removed items (19.4%)	1910
	Colombo MC				Data not Received by NDCU	
	Gampaha	806	26	3.2	Temporary removed items (20.8%), Tube wells (20.8%),Ornamental items (16.7%)	1491
	Kalutara	1314	183	13.9	Discarded items (34.7%), Temporary Removed items (17.8%), Tyres(7.5%)	601
	NIHS	901	89	9.9	Temporary Removed items (38.4%), Discarded items (15.4%), Ornamental Items (12 %)	
CP	Kandy	942	69	7.3	Discarded items (19%),Water storage other items (16.5%), Temporary removed items (16.4%)	363
	Matale	700	26	3.7	Discarded items (37.5%),Tyres (20%),Covering items (17.5%)	70
	Nuwara Eliya				Data not Received by NDCU	20
SP	Galle	1200	106	8.8	Discarded items (17.4%), Ornamental items (17.4%), Tyres (14.4%)	394
	Hambantota	922	122	13	Water storage other items (19.4%), Water storage barrels (18.2%), Ornamental items (15.9%)	124
	Matara	1300	102	7.8	Discarded items (23.6%), Water storage other item (22.8%),Water storage barrels(15.9%)	146
NP	Jaffna	1218	134	11	Water storage other items (21%), Ornamental items (18.3%), Discarded items (12.3%)	269
	Kilinochchi				Data not Received by NDCU	26
	Mannar	300	31	10.3	Water storage other items (35.3%), Discarded items (11.8%), Ornamental items (8.8%)	115
	Vavuniya	1704	108	6.3	Discarded items (38.8%), Water storage other items (24.4%),Tyres(8.1%)	26
	Mullativu				Data not Received by NDCU	2
EP	Ampara	174	33	19	Tyres (37.7%), Discarded items (35.8%), Waterstorage other items (5.6%)	28
	Batticaloa	1304	204	15.6	Discarded items (18.6%), Temporary Removed items (18.2%), Other items (16.2%)	105
	Trincomalee				Data not Received by NDCU	136
	Kalmunai	825	132	16	Temporary removed items(25.1%) , Discarded items(20.4%), Other items (11.5%)	123
NWP	Kurunegala	2004	175	8.4	Discarded items (21.8%), Temporary Removed items (10.4%), Tyres (9.5%)	509
	Puttalam	530	58	10.9	Discarded items (23.6%) Water Storage other (18.4%),Ornamental items (5.4%)	466
NCP	Anuradhapura	266	43		Water storage other items (25%), Tyres (15.6%), Other items(15.6%)	76
	Polonnaruwa	700	84	12	Discarded items (40.9%), Tyres (20.4%), Temporary Removed items (18.2%)	25
UP	Badulla	315	29	9.2	Water storage other items (18.2%), AC & Refrigerator s(18.2%)Water storage (15.2%)	201
	Monaragala	1998	279	14	Discarded items (51.8%), Water Storage barrels (13.5%), Ornamental ite ms (9.6%)	48
SGP	Rathnapura	1100	155	10.9	Discarded items (34.8%), Water storage other items, (10.7%), Covering items (9.9%)	258
	Kegalle				Data not received by NDCU	170
	Sri Lanka	**21155**	**2238**	**10.6%**	**Discarded items (28.8%), Temporary Removed items (10.7%), Water storage other items (8.9%)**	**7702**

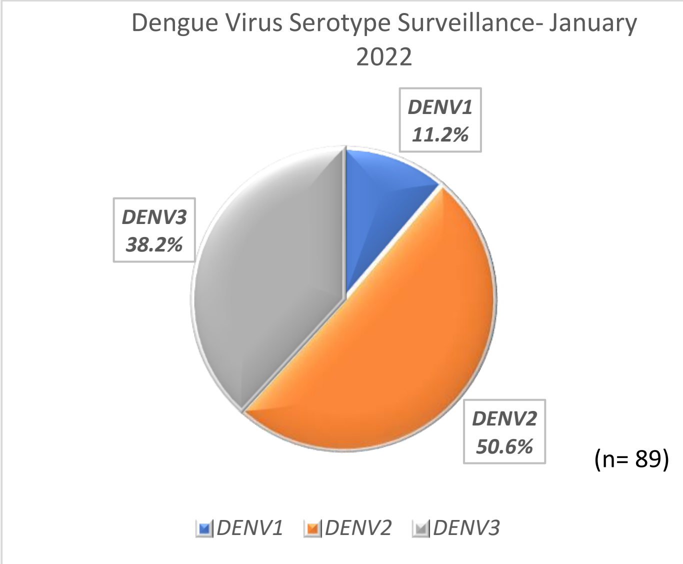
4. DISTRIBUTION OF DENGUE PATIENTS – JANUARY 2022

Distribution of Dengue Patients - January 2022



5. VIRUS SURVEILLANCE DATA

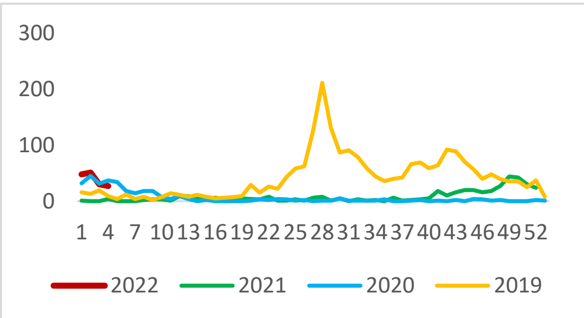
The Circulating Dengue Virus Serotypes in 2022 from major hospitals in Sri Lanka



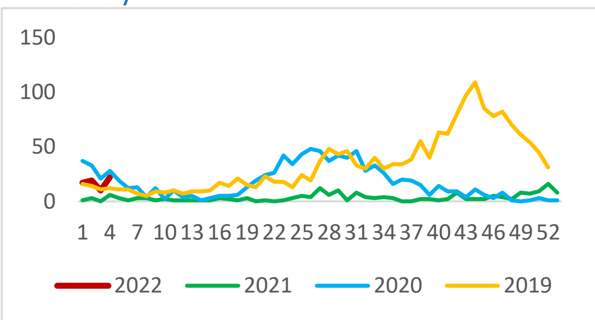
Source: Department of Virology, MRI and Centre for Dengue Research, University of Sri Jayewardenepura

Current High Risk MOH Areas - Epidemiological Trends (Source: DenSys)

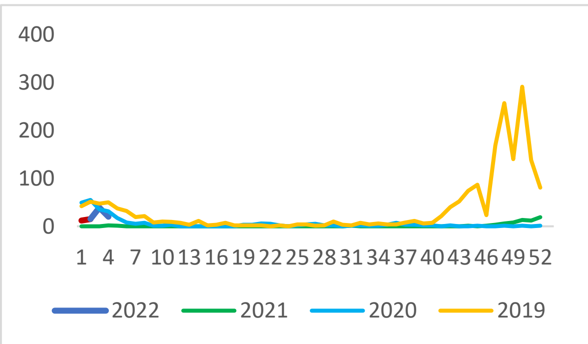
Beruwala



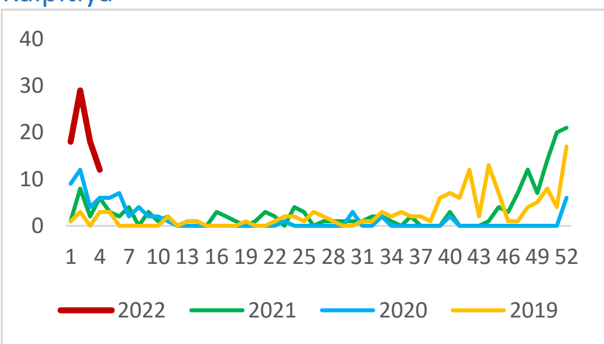
MC Kandy



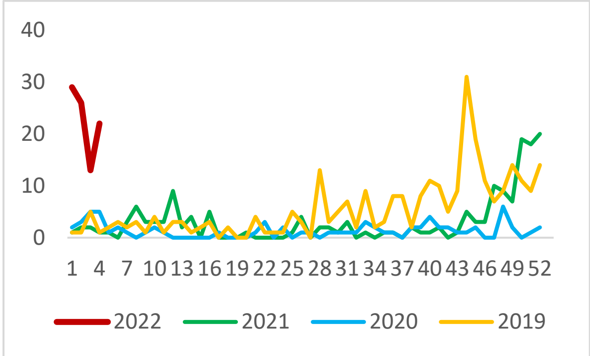
MC Jaffna



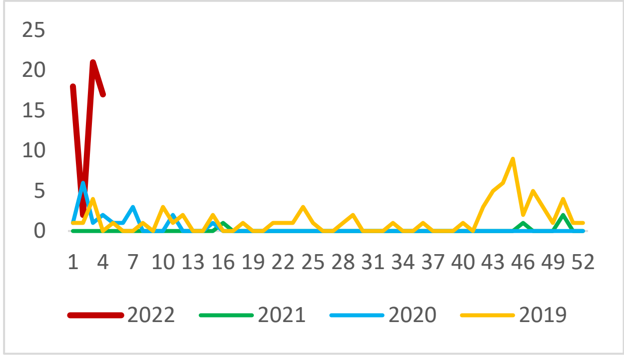
Kalpitiya



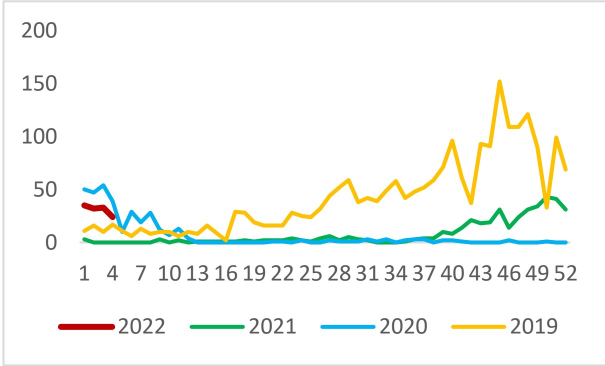
Wennappuwa



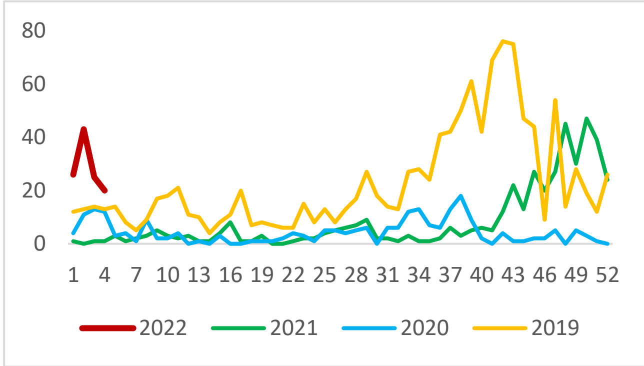
Pottuvil



Gothatuwa



Attanagalla



5. ENTOMOLOGICAL FORCAST OF HIGH-RISK AREAS

District	MOH Area	GN Division
Colombo	Ratmalana	Kadawala
Gampaha	Negombo	Periyamulla
	Negombo	Kochchikade
	Negombo	Talhena
	Negombo	Nikula Road
	Seeduwa	Mukalangamuwa
Kalutara	Beruwela	765/765A
	Kalutara	729
	Horana	610A-Aramanagolla
	Mathugama	795A-Badugama
Puttalam	Puttalam	Puttalam East
	Kalpitiya	Manadalakuda
Kurunegala	MC Kurunegala	Theliyagonna
	Mawathagama	Mawathagama
Jaffna	Jaffna MC	J/77
Mannar	Mannar	Thoddaweli

District	MOH Area	GN Division
	Mannar	Eluthnoor
	Mannar	Uppuklam North
Rathnapura	Embilipitiya	New town
Monaragala	Kataragama	Karavila
	Buttala	Dikiyaya
Matara	Weligama	Polarthumodara
	Matara MC	Welegoda
Galle	Ambalangoda	Heppumulla
	Udugama	Thalapitiya
Batticaloa	Valachchenei	Kalmadu
	Valachchenei	Karuwakern6y 202A
	Kiran	Murakkodanchenai
	Vellavely	97A
	Oddamavady	207A
Vavuniya	Vavuniya	Vavuniya Town

Dengue vector surveys were conducted in 347 GN areas inspecting 21155 premises in January.
Here, the Entomological forecasting has been done by considering the districts currently recording a high number of Dengue cases that are also recorded high values for Entomological indices against their conventional threshold values.

6. SPECIAL ACTIVITIES AND EVENTS CONDUCTED BY THE NATIONAL DENGUE CONTROL UNIT

Special Mosquito Control Programme in the Western, Central, Northern, Eastern, Southern, North Western and Sabaragamuwa Provinces from 4th to 10th January 2022









Community Engagement Programme at Piliyandala and Kesbewa MOH areas on 15th ,19th & 22nd of January 2022



Training and simulation on Dengue outbreak response and vector surveillance for PHI of SL Army	Dengue review and supervision in Jaffna and Mannar Districts
	 

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Any comments, suggestions, and contributions for the MDU Sri Lanka are welcome.

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