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A. aegypti density and the risk of dengue virus transmission (Part II)

This is the second in a series of two articles on Aedes aegypti density and the risk of dengue-virus transmission.

Measures of entomological risk

In general, correlations among entomological indices and dengue incidence rates are inconsistent, understudied, and poorly defined. This may be because the often used immature-mosquito indices are especially sensitive to sampling variation. Although more labour-intensive than the relatively simple immature-indices, monitoring adult mosquitoes, absolute pupal counts or
larval productivity may be more predictive of disease risk. To achieve these,

- There is an urgent need for rigorous field-based evaluations of the relationships among the available A. aegypti indices, virus transmission and disease.
- New rapid and inexpensive methodologies are needed for assessing risk.

It is becoming increasingly clear that dengue surveillance requires relatively large sampling efforts at frequent time intervals

Larval indices

These indices were developed to monitor the progress of vector eradication efforts and to protect Ae.aegypti-free zones from re-infestation.

- House or premises index (HI:% of houses infested with larvae and/or pupae) has been used most widely, but it does not take into account the number of containers with immature mosquitoes nor the production of adults from those.
- Container index (CI: % of water-holding containers infested with active immatures) only provides information on the proportion of water-holding containers that contain $\geq$ 1 immature mosquito; it does not account for variation in density or adult productivity.
- Breteau index (BI: number of positive containers/100 houses) is considered the most informative because it establishes a relationship between positive containers and houses, but it fails to account for adults produced from containers.

Since 1971, a variety of alternative indices were proposed, which attempted to account better for adult productivity. In general, many of those indices were discounted because of the high degree of sample variation and, perhaps more important, the severe logistical limitations that they posed.

Pupal methods

Advantages of using pupae as a measure of A. aegypti abundance are that

- Absolute counts of A. aegypti pupae are feasible in most domestic environments.
- Pupal mortality is slight and well-characterized
- The number of pupae/person shows a high positive correlation with the number of adults

Disadvantages of the pupal index concern the time and manpower necessary to carry it out and sampling variation.

Collecting individual pupae is time-consuming, especially from large containers. In areas where other Aedes species coexist in domestic habitats, pupae from each container must be held separately until they emerge as adults for proper identification. Development of A. aegypti within individual containers has an important cohort effect; that is, groups of larvae develop into pupae synchronously, so that the number of pupae observed is dependent on the day of survey. The difference of one day can result in collecting only a few pupae compared to potentially hundreds the next. Nevertheless, when it is applied to individual container types and when a sufficiently large number of houses are surveyed, the pupal index can be used to estimate adult density and the relative proportion of the adult A. aegypti population attributable to each kind of container. Large sample sizes are essential to overcome sampling problems associated with temporal and spatial variation in A.aegypti pupal production.

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Adult population densities

In nature, adult A. aegypti population densities are relatively low compared to most other mosquito species and difficult to estimate, which based on current technology makes routine adult surveillance problematic. Capture techniques focus on females and include collecting mosquitoes that come to bite human bait or collection by indoor sweeps with hand nets and other manual methods. A drawback to using humans to attract mosquitoes is the ethical concern of exposing collectors to virus infection. These kinds of capture techniques are labour-intensive and subject to complex operator and location influences. In an effort to standardize and make adult A. aegypti collection more straightforward, cardboard sticky lures are currently being evaluated. Disposable cards that contain a chemical mosquito attractant and are coated with an adhesive can be placed in houses to capture mosquitoes. In a laboratory study, the infecting virus serotype was correctly detected by reverse-transcriptase polymerase chain reaction up to 30 days after experimentally infected mosquitoes were applied to the lure. Field studies will define the capture efficiency of this technique.

An indirect measure of adult female presence or absence is the ovi position trap or ovitrap. Black glass or plastic jars (capacity 500ml) are partly filled with water. Eggs that were laid on a rough paddle or paper lining inside the trap can be collected and counted. The enhanced CDC ovitrap uses paired ovitraps with different dilutions (100% and 10%) of hay infusion and produces 8 times more A. aegypti eggs than regular ovitraps. Ovitraps do not provide estimates of A. aegypti population, but they can give insights into relative changes in the adult female populations. An important source of ovitrap error are biases, that have not been formally defined and likely vary from one site to another, associated with competition with other, natural oviposition sites.

The most effective adult A. aegypti collecting methodology is the backpack aspirator. Mosquitoes are collected from resting sites, principally dark protected indoor sites and densities can be estimated as the number of adults per house and as the number of houses positive for adults per number of houses sampled. Advantages of this method are that it results in collection of all physiological stages of female as well as male Ae. aegypti, not just females that are seeking a blood meal or laying eggs. The principal disadvantage is that it is labour-intensive and can be affected by variation in collector efficiency. Recent field studies indicate that efficiency of skilled collectors is in the range of 20% of the mosquitoes in a house. The fact that none of these methods is as informative or amenable to large-scale sampling as we would like, reinforces the statement made earlier – a most significant contribution to dengue surveillance and control would be development of an operationally feasible technique to monitor adult female A. aegypti population densities.

Analysis of Data

Without a clear understanding of the spatial dependence of risk-factor data, accurate quantification of mosquito density thresholds will not be possible. For example, if entomological risk factors, such as abundance, survival, dispersal and feeding behaviour vary spatially, we must use statistical techniques that do not assume that observations are independent. Numerous spatial statistical methods that account for the spatial structure of data are now available. At the operational level, information on the spatial characteristics of dengue risk factors will have important implications for selecting sampling strategies for surveillance, targeting control measures and providing the framework to develop dengue risk maps. Because they can be viewed as point processes, data on the distribution and abundance of A. aegypti and human dengue infections are well suited for spatial point pattern analysis and exploratory data analysis at different geographic scales. Historically, most people studying A. aegypti have characterized temporal, rather than geographic, patterns in mosquito abundance. In a few instances, spatial differences in A. Aegypti population indices and rates of reported dengue cases were correlated with surveillance and prospective longitudinal cohort data. In general, point pattern analysis allows one to test questions about clustering patterns for mosquito vectors and cases of disease among humans. For example, one can ask whether clustering patterns of dengue cases are primarily due to natural variation in A. aegypti population densities at households or whether clusters are merely the result of some apriori heterogeneity in the region where the study was conducted. It is also possible to determine the spatial scale over which clustering occurs and whether clusters are associated with proximity to specific features of interest, such as village meeting places, schools or markets. Geographic scale is especially important because of the modifiable areal-unit problem (MAUP). MAUP refers to variation in results when data are combined into sets of increasingly larger areal units or alternative combinations of base units at equal or similar scales. Both phenomena are common problems for dengue surveillance and control programmes because data are most commonly reported for areal units defined by political rather than epidemiological boundaries.

Based on findings of a recent study in which georeferenced larval, pupal and adult A. aegypti samples were collected, stages of the mosquitoes' life cycles were directly linked (e.g. larvae to pupae) were spatially correlated to one another. If, however, a step in the development process is skipped (e.g. larvae to adult) the correlation broke down. Another finding of the study was that entomological risk must be measured at the level of the household at frequent time intervals

Use of new knowledge in dengue control

When controlling Dengue, quantification of relationship between A. aegypti abundance and dengue virus transmission should be done. The most effective way to characterize the density-risk association is to carry out prospective longitudinal cohort studies that measure simultaneously mosquito density, dengue incidence and severity of disease. Study designs should not be limited to reported cases; rather they should include a variety of methods for monitoring the human population for symptomatic and asymptomatic infections. This could be done, for example, with a combination of scheduled blood draws and techniques for actively identifying disease. Prescribed serologic testing from a study cohort will capture all infections. Fever studies and monitoring attendance at some regular function, like school, will identify which of those infections resulted in disease, and from those individuals the severity of disease can be derived. Entomological and human data should be geo-referenced (and managed in geographic information systems) so that it can be analysed for epidemiologically relevant spatial and temporal patterns. Targeted reductions in adult female density in conjunction with incidence and disease monitoring would verify the existence of thresholds and quantify the relationship between abundance and incidence of disease. Absolute measures of disease reduction will be difficult to obtain and well tested simulation models can be used for this purpose.

Source

Aedes aegypti density and the risk of dengue-virus transmission- available from *http://edepot.wur.nl/136912*

Compiled by Dr. Madhava Gunasekera of the Epidemiology Unit

Table 4: Selected notifiable diseases reported by Medical Officers of Health 25th – 31st May 2013 (22nd Week)

RDHS	Dengue Fever		Dysentery		Encephaliti		Enteric		Food		Leptospiros		Typhus		Viral		Hu Rabies*		Chickenpox		Meningitis		Leishmaniasis		WRCD %	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	T*	C**
Colombo	94	3620	3	78	0	11	6	56	1	15	0	118	0	5	1	36	0	0	1	221	0	25	0	0	**77**	**23**
Gampaha	42	1565	1	59	1	9	2	19	3	16	11	168	1	9	10	108	0	0	4	88	1	50	0	2	**93**	**7**
Kalutara	41	754	2	65	0	11	2	37	3	12	5	201	0	1	0	10	0	0	2	140	1	35	0	1	**85**	**15**
Kandy	30	775	2	55	0	6	2	11	0	7	1	39	5	65	0	53	0	0	1	75	1	4	1	2	**78**	**22**
Matale	3	201	1	36	0	1	0	6	0	0	3	30	0	2	1	22	0	0	0	25	1	14	0	2	**92**	**8**
NuwaraEliya	1	106	0	78	0	2	1	5	0	3	2	14	4	39	0	11	0	0	2	45	0	1	0	0	**85**	**15**
Galle	17	358	1	40	0	8	0	2	66	70	2	114	1	24	0	6	0	1	5	138	0	23	0	0	**79**	**21**
Hambantota	4	155	0	22	0	2	0	7	0	9	5	127	0	37	0	63	0	0	1	55	2	13	6	126	**83**	**17**
Matara	9	250	3	30	0	9	2	12	0	27	3	105	1	37	6	105	0	2	3	159	2	31	3	47	**100**	**0**
Jaffna	12	445	10	99	0	5	7	232	61	68	0	5	3	314	0	9	0	0	3	109	0	28	0	0	**100**	**0**
Kilinochchi	1	27	0	13	0	0	0	6	0	2	0	9	0	15	0	0	0	0	0	2	0	6	0	5	**75**	**25**
Mannar	1	54	0	22	0	1	2	51	0	11	1	10	0	16	0	1	0	0	1	10	0	4	0	4	**100**	**25**
Vavuniya	1	41	0	22	0	10	0	5	0	8	3	44	0	2	1	1	1	2	1	18	0	19	0	4	**100**	**00**
Mullaitivu	4	74	0	6	0	1	0	6	1	4	0	22	0	5	0	0	0	2	0	3	1	3	0	8	**80**	**20**
Batticaloa	19	359	27	118	0	3	0	0	0	7	1	23	0	2	0	8	0	0	2	16	0	2	0	0	**79**	**21**
Ampara	3	67	2	44	0	0	0	4	0	2	7	17	0	0	0	1	0	0	2	45	0	7	0	1	**57**	**43**
Trincomalee	5	144	1	36	0	1	2	4	0	1	0	47	0	5	0	3	0	1	1	18	0	2	0	12	**67**	**33**
Kurunegala	36	1800	3	87	0	23	0	23	2	7	6	167	0	17	2	30	0	1	1	193	6	65	0	23	**92**	**8**
Puttalam	9	556	0	26	0	4	0	11	0	35	0	14	0	10	0	1	0	0	1	45	0	10	0	3	**77**	**23**
Anuradhapura	3	319	1	35	0	12	0	2	0	2	2	253	0	15	0	13	0	0	6	87	4	55	7	161	**74**	**26**
Polonnaruwa	6	187	0	37	0	0	0	10	0	0	10	120	0	2	0	18	0	1	7	77	1	9	5	68	**71**	**29**
Badulla	2	202	2	65	0	1	1	8	0	7	1	17	2	33	0	25	0	0	0	67	0	9	0	3	**71**	**29**
Monaragala	2	118	3	48	0	3	1	10	0	18	0	169	1	25	3	42	0	1	3	32	0	10	0	5	**82**	**18**
Ratnapura	40	930	10	197	0	77	4	27	0	15	7	205	0	17	7	129	0	1	1	80	2	43	0	8	**83**	**17**
Kegalle	16	530	5	37	0	10	0	9	0	4	10	80	1	49	5	119	0	0	1	173	6	52	0	0	**91**	**9**
Kalmune	8	454	3	65	0	1	0	3	33	58	0	4	0	2	0	4	0	0	2	49	0	6	0	1	**77**	**23**
SRI LANKA	**409**	**14091**	**80**	**1420**	**01**	**211**	**32**	**566**	**17**	**408**	**80**	**2122**	**19**	**748**	**36**	**818**	**01**	**12**	**51**	**1970**	**28**	**526**	**22**	**483**	**83**	**17**

Source: Weekly Returns of Communicable Diseases (WRCD).

***T=**Timeliness refers to returns received on or before 31st May , 2013 Total number of reporting units 329. Number of reporting units data provided for the current week: 278** Completeness

A = Cases reported during the current week. **B** = Cumulative cases for the year.**Hu Rabies*=** Human Rabies

Table 1: Vaccine-Preventable Diseases & AFP

25th – 31st May 2013 (22nd Week)

Disease	No. of Cases by Province									Number of cases during current week in 2013	Number of cases during same week in 2012	Total number of cases to date in 2013	Total number of cases to date in 2012	Difference between the number of cases to date in 2013 & 2012
	W	C	S	N	E	NW	NC	U	Sab					
AFP*	00	01	00	00	00	00	00	00	00	01	01	32	36	- 11.1 %
Diphtheria	00	00	00	00	00	00	00	00	00	-	-	-	-	-
Mumps	03	01	02	05	01	02	03	00	06	23	02	709	1909	- 62.8 %
Measles	24	03	24	00	00	03	00	01	02	57	00	550	20	+ 2650.0 %
Rubella	00	00	00	00	00	00	00	00	00	00	-	11	-	-
CRS**	00	00	00	00	00	00	00	00	00	00	-	05	-	-
Tetanus	01	00	00	01	00	00	00	00	00	02	00	10	05	+ 100.0 %
Neonatal Tetanus	00	00	00	00	00	00	00	00	00	00	-	00	-	-
Japanese Encephalitis	01	00	00	00	00	00	00	00	00	01	-	211	-	-
Whooping Cough	00	00	00	00	00	00	00	00	00	00	00	34	33	+ 03.1 %
Tuberculosis	25	83	11	07	27	18	30	00	31	232	96	3600	3668	+ 03.0 %

Key to Table 1 & 2

Provinces: **W**: Western, **C**: Central, **S**: Southern, **N**: North, **E**: East, **NC**: North Central, **NW**: North Western, **U**: Uva, **Sab**: Sabaragamuwa.

RDHS Divisions: **CB**: Colombo, **GM**: Gampaha, **KL**: Kalutara, **KD**: Kandy, **ML**: Matale, **NE**: Nuwara Eliya, **GL**: Galle, **HB**: Hambantota, **MT**: Matara, **JF**: Jaffna, **KN**: Killinochchi, **MN**: Mannar, **VA**: Vavuniya, **MU**: Mullaitivu, **BT**: Batticaloa, **AM**: Ampara, **TR**: Trincomalee, **KM**: Kalmunai, **KR**: Kurunegala, **PU**: Puttalam, **AP**: Anuradhapura, **PO**: Polonnaruwa, **BD**: Badulla, **MO**: Moneragala, **RP**: Ratnapura, **KG**: Kegalle.

Data Sources:
Weekly Return of Communicable Diseases: Diphtheria, Measles, Tetanus, Neonatal Tetanus, Whooping Cough, Chickenpox, Meningitis, Mumps., Rubella, CRS,
Special Surveillance: AFP* (Acute Flaccid Paralysis), Japanese Encephalitis
CRS** =Congenital Rubella Syndrome
AFP and all clinically confirmed Vaccine Preventable Diseases except Tuberculosis and Mumps should be investigated by the MOH

Dengue Prevention and Control Health Messages

To prevent dengue, remove mosquito breeding places in and around your home, workplace or school once a week.

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Comments and contributions for publication in the WER Sri Lanka are welcome. However, the editor reserves the right to accept or reject items for publication. All correspondence should be mailed to The Editor, WER Sri Lanka, Epidemiological Unit, P.O. Box 1567, Colombo or sent by E-mail to **chepid@sltnet.lk. Prior approval should be obtained from the Epidemiology Unit before publishing data in this publication**

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