Journal of Communicable Diseases
Volume 54, Issue 4 - 2022, Pg. No. 69-73
Peer Reviewed & Open Access Journal

Research Article

Standardisation of Units for Assessment of Adult Disease Vector Density under Vector Control Programmes in India

Ramesh Chandra[1], Ashish Kumar[2], Rahul Kumar Singh[3], Shaukat Kamal[4], SN Sharma[5], RS Sharma[6], PK Srivastava[7]

[1,2,3]Regional Office of Health & Family Welfare, Lucknow, India.
[4]National Centre for Disease Control (NCDC), Patna, Bihar, India.
[5]Consultant, National Centre for Disease Control, Delhi, India.
[6]Advisor, WHO for VBD and Ex-Additional Director, National Centre for Vector Borne Diseases, Control (erst while NVBDCP), Sham Nath Marg, Delhi, India.
[7]Former Joint Director, National Vector Borne Disease Control Programme, Delhi, India.
DOI: https://doi.org/10.24321/0019.5138.2022105

I N F O

Corresponding Author:
Shaukat Kamal, National Centre for Disease Control (NCDC), Patna, Bihar, India.
E-mail Id:
shaukatkamal25@yahoo.in
Orcid Id:
https://orcid.org./0000-0002-3358-15724
How to cite this article:
Chandra R, Kumar A, Singh RK, Kamal S, Sharma SN, Sharma RS, Srivastava PK. Standardisation of Units for Assessment of Adult Disease Vector Density under Vector Control Programmes in India. J Commun Dis. 2022;54(4):69-73.

Date of Submission: 2022-09-08
Date of Acceptance: 2022-12-17

A B S T R A C T

Vector density is one of the most frequently used monitoring parameters of entomological surveillance under any vector control programme. Vector control applications are guided by the density of vectors or their abundance in different seasons and settings. The vectors of different common vector-borne diseases viz. malaria, filaria, kala-azar, dengue, chikungunya, Zika and Japanese Encephalitis (JE) have different bionomics. Scientists, researchers, and public health entomologists of various research institutes and programmes are engaged in studying vector bionomics through vector surveillance activities. The most common parameter used to estimate the density of vector and non-vector species of both mosquitoes and flies is the collection of species in a given unit of time. In the malaria control programme, it started as a collection of resting vector mosquitoes at a specified time of dawn and dusk. These are expressed in a number of forms viz. 'per man hour', 'per ten man hour' and 'ten man hour' to ascertain the level of vector population and its increasing or decreasing trend with climatic factors which may be correlated with the active transmission of the disease. The minimum level of density at which active transmission was evidenced has been termed as 'critical density'. Various vector species have different critical densities. Many other parameters are used to estimate vector or non-vector populations but such different units may often lead to confusion among the field functionaries. This article describes the significance of 'per man-hour density', the methodology which has been in practice for ages and the statistical method for its calculation. To avoid misconception, it should be understood that the density expressed for a particular species is the 'differential density' and not the absolute density.

Keywords: Vector Borne Diseases (VBDs), Vector Density, Absolute Vector-Density, Differential Vector Density

Introduction

Control and elimination of malaria and vector-borne diseases are realised with coordinated efforts of scientists, researchers, public health entomologists, epidemiologists and field staff engaged in various aspects, viz., diagnosis, treatment, vector's influence with its prevalence, and bionomics. Besides control and/ or elimination activities, the surveillance and monitoring of the activities are important and indicate the progress and impact of programme activities. There are various parameters to be observed in both epidemiological and entomological surveillance and assess the impact from baseline data. In entomological surveillance, various techniques are used for sampling the mosquito population. In the case of malaria vectors, the capture of adult mosquitoes is done by biting or landing collection using animal or human bait, light trap collection etc. However, such collections do not represent the actual mosquito population in the locality, though these collections give much vital information. Therefore, the average number of anopheline and vector mosquitoes in relation to human, cattle or mixed dwellings is required to be generated as a baseline and subsequently at regular intervals. This is done by estimating the Man-Biting Rate (MBR) or Cattle-Biting Rate (CBR) per night in a given period of time in a particular geographical area. The most common parameter used is to estimate the density of the vector and non-vector species of both mosquitoes and flies. The density is expressed in several forms viz., density 'per man hour', 'per ten man hour' and 'ten man hour' to ascertain the level of vector population, in pre and post-intervention phases and also to correlate at which level, the active transmission of the disease may occur.

Earlier, Per Man Hour Density (PMHD) was used to estimate the critical density of a vector. This concept of critical density was developed by Sir Ronald Ross[1] in 1910 in his book Prevention of Malaria. The concept described that it was not necessary to reduce the vector population to 'zero level' for interruption of malaria transmission. This concept of critical density level was later exemplified by Barber and Rice in Macedonia.[2] However, Russell and Ramachandra Rao,[3] 1942 described the critical density in respect of Indian Anophelines. To estimate the relative density in different seasons or in different months, the hand collection method using a suction tube and torch is the most common procedure. The resting collections of adult vector mosquitoes are done by a team of entomologists and insect collectors. To avoid the variation in the collection by different persons, the total collection is pooled and then the average is taken per unit of time usually an hour. This gives a uniform procedure for comparison purposes from baseline data, provided the same tools are used. In recent times, different tools are used to collect mosquitoes which may not be comparable with the density observed in earlier years. Therefore, the commonest parameter used to estimate density needs to be clearly understood and its relevance in malaria transmission must be analysed.

The perusal of different research papers, reports and manuals revealed that the units for quantifying the vector are not being used uniformly and are expressed in a number of forms, due to which common consensus on the critical density of the vector cannot be made to ensure that a single unit is used for expressing the minimum level or threshold for transmission to be established or to continue. Moreover, the vector and non-vector species populations co-exist in a particular environment, which may suit one or more species and may not suit other species. Other factors, like congenial conditions of the environment, also govern the prevalence of a particular species, which may vary from one geographical area to the other. Thus, the numbers of any particular vector or non-vector species must be recorded and documented in uniform formats and not be expressed in different estimation units otherwise such estimation may lead to confusion among the researchers and field staff.

Methodology

To describe the relevance of vector density, various research papers, reports, and guidelines about entomological surveillance have been reviewed. The significance and its statistical calculations were also referred to from programme guidelines and literature.

Discussion

The units used for expressing the density of various disease vectors by various entomologists working in public health have been depicted in Table 1. It is evident from this table that a number of units have been described to express the density of disease vectors, viz.'per man hour', 'per ten man hour', 'ten man hour' etc. and even per cent of houses in a locality positive for adults of Aedes aegypti. The most widely used unit of vector density is 'per man hour' and is being exercised in national programmes for quantifying malaria,[4] kala-azar (KA),[5,6] Filaria[7,8] and Japanese encephalitis (JE)[9,10] vectors. The term 'per man hour' is self-explanatory. It means the number of individuals of a particular vector species collected by a person/collector in a time span of one hour and is represented by the formula mentioned on the ensuing page.

The unit of density of filaria vector is being exercised as 'per ten man hour' in the National Filaria Control programme,[5] which means that the number of individuals of filaria vector species (*Culex quinquefasciatus*) collected by an insect collector in a time span of ten hours or two persons/ collectors in a time span of five hours vice versa, probably

ISSN: 0019-5138
DOI: https://doi.org/10.24321/0019.5138.2022105

to reduce the resultant density by one-tenth (1/10) in comparison to that of malaria, KA and JE vector density. This may be due to the prevalence of a large population of *Culex quinquefasciatus* and to keep pace with malaria, KA, and JE vectors' density. It is represented by the following formula:

Adult vector density[1] (per man hour density)	=	Number of mosquitoes collected / Actual time spent for collection (number of man hours spent in search)
	OR	
Adult vector density(per man hour density)	=	Total number of individuals of a vector mosquito species collected / Number of man hours (no. of collectors X time spent (hrs.) in search

Adult vector density[5] (per 10 man hour catch)	=	Number of Culex quinquefasciatus collected / Time (in hours) spent on mosquito collection X 10

Table 1.Density of Vector Mosquitoes/ Sand Flies Species and their Unit of Measurement

S. No.	Vector Species	Maximum Density Reported	Unit of Measurement
1.	Anopheline vectors & other sp	-	Per man hour
2.	*Culex quinquefasciatus*	-	Per ten man hour[5]
3.	Sandflies	-	Per man hour[6]
4.	*Culex quinquefasciatus*	-	Ten man hour (only females to be considered)[7,8]
5.	*Anopheles culicifacies*	45.00	Per man hour[9]
6.	*Anopheles culicifacies* in Gujarat	35.00	Per man hour[9]
7.	*Anopheles culicifacies* in Odisha	90.00	Per man hour[9]
8.	*Anopheles culicifacies* in Uttarakhand	50.00	Per man hour[9]
9	*Anopheles culicifacies* in Uttar Pradesh	160.00	Per man hour[9]
10	*Anopheles minimus* in Assam	3.60	Per man hour[9]
11.	*Anopheles stephensi* in Delhi	8.00	Per man hour[9]
12.	*Anopheles stephensi* in Gujarat	1.90	Per man hour[9]
13.	*Anopheles fluviatilis* in Gujarat	20.00 (females only)	Per man hour[9]
14.	*Anopheles fluviatilis* in Odisha	10.00	Per man hour[9]
15.	*Anopheles fluviatilis* in Laksar (UK)	200.00	Per man hour[9]
16.	*Culex tritaeniorhynchus*	618.67	Per man hour[10]
17.	*Phlebotamus argentipes*	60.00	Per man hour[11]
18.	*Phlebotamus papatasi*	42.00	Per man hour[11]
19.	*Culex quinquefasciatus*	151.50	Per man hour[12]
20.	*Culex tritaeniorhynchus*	10.80	Per man hour[12]
21.	*Anopheles annularis*	6.89	Per man hour[13]
22	*Anopheles culicifacies* in Maharashtra	80.00	Per man hour[14]
23.	*Culex quinquefasciatus*	14.00	Per man hour[15]
24.	*Aedes aegypti*	48.90	% of houses positive for adults[16]
25.	*Culex quinquefasciatus*	810.00	Ten man hour[17]

Some researchers[12] have applied 'per man hour density' for quantifying *Culex quinquefasciatus*, which was nearly double in comparison to another author[17] which sometimes creates confusion, though other factors are responsible for variation in relative densities in different seasons and geographical areas. It is also pertinent to mention here that the population of any dioecious species will include both male and female individuals and considering the females only for expressing the density of any species will not be justifiable as has been used by some researchers.[9] Hence corrective measures need to be initiated by considering both males and females for the estimation of the population

ISSN: 0019-5138
DOI: https://doi.org/10.24321/0019.5138.2022105

density in further studies. There may be different objectives for the studies, however, uniformity needs to be maintained for sustained and regular monitoring for which programme guidelines are formulated and disseminated. Guidelines are also amended from time to time and reporting formats are also revised or compressed but it is important to note that the basic information required for monitoring and analysis should not be compromised.

The most common parameter for density is resting collections through an aspirator and it facilitates in assessing the mosquito fauna of the area, seasonal prevalence of mosquitoes and vectors, resting habits of vector population (indoors or outdoors), and impact of vector control measures. It will also be appropriate to mention at this juncture that during collection, all individuals of vector and non-vector mosquito/ fly species should be collected in the recommended time but while processing the specimens, species-wise segregation may be done. The density of a particular species is not absolute rather it is a relative density for vector or non-vector species.

Conclusion

It can be concluded from the above discussion that on examining the various units of expressing the density of vector and non-vector species of public health importance, the most suited unit should be 'man-hour density' in a given unit of time, usually one hour. The tools used for monitoring the relative density and comparing with baseline data or historical data should be the same otherwise the results may not give the correct comparison. This can be exemplified by the use of aspirators through the mouth and mechanical aspirators. Both data cannot be compared for density purposes and also for assessing the impact of vector control measures under vector-borne disease control programmes.

Acknowledgements

The references and guidelines of National Vector Borne Disease Control Programme (Now National Centre for Vector Borne Disease Control Programme) have been of great help in drafting the paper for its usefulness among field personnel and researchers, which are gratefully acknowledged.

Source of Funding: None

Conflict of Interest: None

References

1. Ross R. The prevention of malaria. J Murray. 1910;669.
2. Barber MA, Rice JB. Malaria studies in Greece. The relation of housing to malaria in certain villages of east Macedonia. Am J Hyg. 1935;22(3):512-38. [Google Scholar]
3. Russell PF, Rao TR. A study of density of Anopheles culicifacies in relation to malaria endemicity. Am J Trop Med. 1942;22(5):535-58. [Google Scholar]
4. National Vector Borne Disease Control Programme (NVBDCP erstwhile NMEP). Operational . Manual for Malaria Action Programme (MAP), Government of India. 1995;223.
5. National Vector Borne Disease Control Programme (NVBDCP erstwhile NMEP). National. Filaria Control Programme Operational Manual. Government of India; 1995;127.
6. National Vector Borne Disease Control Programme (NVBDCP erstwhile NMEP). Manual on visceral leishmaniasis (Kala-azar). Government of India. 19 96;182.
7. National Vector Borne Disease Control Programme (NVBDCP). Operational guidelines on elimination of lymphatic filariasis. Government of India. 87.
8. National Vector Borne Disease Control Programme (NVBDCP).Guidelines on elimination of lymphatic filariasis, India. Interruption of transmission through Mass Drug Administration with DEC and albendazole disability alleviation through home based management of lymphodema and hospital based hydrocelectomy. Government of India. 2009;108.
9. Indian Council of Medical Research (ICMR). A profile of National Institute of Malaria Research (NIMR). Government of India; 2009;268.
10. Indian Council of Medical Research (ICMR). Centre for Research in Medical Entomology (CRME) - Two decadal results on Japanese encephalitis control trial studies of field station at Vridhachalam, South Arcot District, Tamilnadu. Government of India. 2011;455.
11. Mukhopadhyay AK, Hati AK, Chakraborty S, Saxena NB. Effect of DDT on Phlebotamus sand flies in Kala-azar endemic foci in West Bengal. J Commun Dis. 1996; 28(3):171-5. [PubMed] [Google Scholar].
12. Gakhar SK, Vandana. Seasonal variations of culicine mosquitoes in district Rohtak. J Commun Dis. 1996;28(3):199-205. [PubMed] [Google Scholar]
13. Nandi J, Rao JS, Dasgupta RK, Sharma RS. Ecological observations on the anopheline mosquitoes of Jalpaiguri Duars, West Bengal. J Commun Dis. 1996;28(4):279-86. [PubMed] [Google Scholar]
14. Yadava RL, Rao CK, Biswas H. Field trial of cyfluthrin as an effective and safe insecticide for control of malaria vectors in triple insecticide resistant areas. J Commun Dis. 1996;28(4):287-98. [PubMed] [Google Scholar]
15. Chand G, Pandey GD, Tiwary RS. Prevalence of Wuchereria bancrofti infection among the tribals of Panna district of Madhya Pradesh. J Commun Dis. 1996;28(4):304-7. [PubMed] [Google Scholar]

ISSN: 0019-5138
DOI: https://doi.org/10.24321/0019.5138.2022105

16. Shriram AN, Sehgal SC. Aedes aegypti (L) in Port Blair, Andaman and Nicobar islands - distribution and larval ecology. J Commun Dis. 1999;31(3):185-92. [PubMed] [Google Scholar]
17. Singh S, Dhariwal AC, Bora D, Lal S. Status of lymphatic filariasis in Lucknow district, Uttar Pradesh. J Commun Dis. 2009;41(1):39-44. [PubMed] [Google Scholar]

ISSN: 0019-5138
DOI: https://doi.org/10.24321/0019.5138.2022105