Demand-supply gaps in human resources to combat vector-borne disease in India: capacity-building measures in medical entomology

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ABSTRACT

Vector-borne diseases account for a significant proportion of the global burden of infectious disease. They are one of the greatest contributors to human mortality and morbidity in tropical settings, including India. The World Health Organization declared vector-borne diseases as theme for the year 2014, and thus called for renewed commitment to their prevention and control. Human resources are critical to support public health systems, and medical entomologists play a crucial role in public health efforts to combat vector-borne diseases. This paper aims to review the capacity-building initiatives in medical entomology in India, to understand the demand and supply of medical entomologists, and to give future direction for the initiation of need-based training in the country. A systematic, predefined approach, with three parallel strategies, was used to collect and assemble the data regarding medical entomology training in India and assess the demand-supply gap in medical entomologists in the country. The findings suggest that, considering the high burden of vector-borne diseases in the country and the growing need of health manpower specialized in medical entomology, the availability of specialized training in medical entomology is insufficient in terms of number and intake capacity. The demand analysis of medical entomologists in India suggests a wide gap in demand and supply, which needs to be addressed to cater for the burden of vector-borne diseases in the country.

Key words: Arthropod vectors, capacity-building, medical entomology, vector-borne diseases

INTRODUCTION

Vector-borne infectious diseases, such as malaria, dengue, yellow fever and plague, account for a significant proportion of the global burden of infectious disease; indeed, nearly half of the world’s population is infected with at least one type of vector-borne pathogen.¹ In the past three decades, there has been dramatic global re-emergence of epidemic vector-borne diseases. Many of the diseases that were effectively controlled in the middle part of 20th century have re-emerged and new pathogens have also emerged, both of which are causing major epidemics of disease.²

In recent years, vector-borne diseases have developed as a serious public health problem in countries of the World Health Organization (WHO) South-East Asia Region, including India. Many of these, particularly dengue, Japanese encephalitis (JE) and malaria, now occur in epidemic form almost on an annual basis, causing considerable morbidity and mortality.³ Apart from the health impact on humans, vector-borne diseases pose a serious threat to food security, ecosystems and socioeconomic development, by affecting animal and plant populations.

WHO declared “vector-borne diseases” as the theme for 2014. To advance the agenda of the WHO theme, there is a need to ensure renewed commitment to the prevention and control of vector-borne diseases, by strengthening the capacity of public health systems to combat them. Systematic evaluation of biological and ecological factors that affect the dynamics of transmission of vector-borne disease is necessary, in order for control programmes to successfully anticipate outbreaks and intervene with preventive actions. Hence, it is imperative to have a health workforce that is specialized in dealing with vector-borne diseases, for their containment at national, state and district levels.
The discipline of medical entomology is concerned with insects and arthropods that impact human health. It deals with biology, ecology and the application of modern tools in the management of vectors and vector-borne diseases. In view of emerging and re-emerging vector-borne diseases in India, there is a growing need for entomologists in the field of public health. Against this background, this study was undertaken to review the capacity-building initiatives in medical entomology in India, to understand the demand–supply gap of medical entomologists in the country, and to give future direction for the establishment of need-based training.

**METHODOLOGY**

Data regarding capacity-building initiatives in medical entomology were collected using three strategies. A systematic, predefined approach was used for obtaining this information. Each step was conducted in a parallel manner, and the information was entered into an Excel spreadsheet.

The first search strategy consisted of using the information available on the Internet during October 2013 to March 2014. The online search was conducted using the Google search engine. The first step in this strategy involved identifying a set of key words encompassing various domains related to medical entomology courses. The key words included were “medical entomology”, “public health entomology training/courses”, “vector-borne diseases” and “medical arthropods”. The search was limited to courses offered in India and to collaborations between Indian and foreign institutes, if any. The websites of the Indian Council of Medical Research, National Centre for Disease Control and National Institute of Malaria Research were searched from October 2013 to March 2014, using the key words of the identified subjects and training programmes. The search was not restricted by course duration or the type of degree/certification awarded on successful completion. Detailed information about the courses was collected from the respective institutions or from the designated websites of these institutions. The majority of information regarding the available courses and institutions was gathered using this strategy.

The second strategy involved a detailed review of the literature to identify medical entomology courses. Indexed and non-indexed journals in the field were identified and searched for notifications and invitations for nominations for educational courses. The search was limited to journals published in English language within the last five years, that is from January 2009 to December 2013. Key institutes involved in research in medical entomology were identified from the author affiliations. Additional information about short-term training in malariology and parasitology could be obtained from this strategy.

The third strategy involved contacting experts in the field of medical entomology in India. This was done through email and/ or telephone. The experts were requested to share information about the courses offered in their institutes and also to suggest the names of other institutes offering courses in the identified fields. This strategy was useful to gather information on course curricula and the availability of courses.

The search was directed at obtaining data on the following parameters: name and location of the institute offering the course, theme and course duration, course structure, and eligibility criteria. These parameters were incorporated in a matrix. The institutional data were entered in this matrix and the findings were triangulated wherever possible, using alternative strategies. Any other salient features of relevance to the courses were also incorporated subjectively into this matrix.

To undertake the supply–demand analysis of medical entomologists in the country, first the supply was calculated, based on the output from long-term training programmes. The cumulative output from all training was calculated, to estimate the annual supply of medical entomologists in the country. The demand for medical entomologists was computed by gathering information on the requirement for medical entomologists in practice, research and education. For this purpose, an Internet search was done to note the requirement and vacancies for medical entomologists in various institutions. Based on the information on long-term training programmes in medical entomology, the demand for faculty in these institutions was calculated. In parallel, information on the demand for medical entomologists was also gathered by contacting experts in the field of entomology, to identify programmes/projects where medical entomologists are required.

**RESULTS**

**Training programmes**

The training programmes in medical entomology in India can be broadly classified into three categories, depending on the type of institutions offering the course and the duration of course:

1. medical entomology as a part of syllabus in medical schools
2. long-term academic programmes in medical entomology
3. short-term training in medical entomology

**Training in medical schools**

Undergraduate training in medical entomology is mostly provided within the realms of medical colleges, where medical entomology is taught as a part of community medicine (preventive and social medicine). The course curriculum includes theoretical knowledge about arthropod vectors and disease transmission through the vectors, as well as entomology specimen demonstration. The syllabus is designed to give medical graduates a broad overview about arthropods and insects of public health importance. Students are taught vector biology in the context of disease transmission and vector control. Students are also introduced to various vector-management strategies and integrated vector control. At present, undergraduate teaching in medical entomology is imparted to 52 455 medical undergraduates annually, across 400 medical colleges in India.
Apart from the undergraduate curriculum in medical colleges, medical entomology is also an integral part of postgraduate courses in preventive and social medicine/community medicine, which includes Doctor of Medicine (MD; Community Medicine/Preventive and Social Medicine) and postgraduate diplomas in public health, namely Diploma in Public Health (DPH) and Diploma in Community Medicine (DCM). MD/DPH/DCM candidates are expected to have knowledge of medical entomology and apply the principles of medical entomology in prevention and control of vector-borne illnesses at field level. The postgraduate curriculum includes details of vector biology and transmission and studies these from a public health perspective. The course also includes international initiatives and national programmes directed towards prevention and control of vector-borne diseases. The annual output of MD courses is 786, offered in 229 medical colleges; 90 for DPH, offered in 39 medical colleges; and 11 for DCM, offered in six medical colleges. Postgraduate programmes in tropical medicine, at the School of Tropical Medicine, Kolkata, also include medical entomology as an important component. The annual intake is seven for MD (Tropical Medicine) and 12 for Diploma in Tropical Medicine Health (DTMH).

Long-term academic programmes in medical entomology (see Table 1)

Recognizing the need for specialized graduates in the field of medical entomology, some institutions are providing specialized courses in the subject; however, the numbers are low, with most institutes clustered in the southern part of the country. Specialized courses in medical entomology include diploma, master’s, doctoral and fellowship courses.

Doctoral courses (PhD) in subjects related to medical entomology (PhD Zoology/PhD Community Medicine/MPH/PhD Biotechnology) are offered by Pune University; Puducherry University; Madurai Kamaraj University; the National Institute of Malaria Research in collaboration with Goa University; Indraprastha University; Jiwaji University, Gwalior; Kumaun University, Nainital; and Maharshi Dayanand University, Rohtak. The course is usually completed over a period of three to five years. Eligibility requirements for enrolling for a PhD programme include either an MD in community medicine/social and preventive medicine, or an MSc in zoology/medical entomology. The intake capacity of the candidates depends on the availability of faculty and varies accordingly. Other postgraduate courses include a Postgraduate Diploma/MSc in Medical Entomology/Public Health Entomology. A Postgraduate Diploma in public health entomology is offered by The Tamil Nadu Dr MGR Medical University at the Institute of Vector Control and Zoonoses, Hosur. The postgraduate diploma course takes two years and candidates with a BSc in the discipline of zoology botany/life sciences/medical laboratory technology/microbiology/biochemistry, or a BVSc or MBBS or BE/BTech degree with biotechnology qualifications can apply for the course. For in-service candidates, lateral entry into the second year of the diploma course is available at Dr MGR Medical University.

A two-year postgraduate degree course in public health entomology (MSc [PHE]) is offered by the Vector Control Research Centre, Puducherry. The programme is designed to

<p>| Table 1: Institutions offering courses in medical entomology across India |
|-----------------------------|-----------------|--------------|-----------------------------|</p>
<table>
<thead>
<tr>
<th>Institute</th>
<th>Course</th>
<th>Duration</th>
<th>Eligibility criteria</th>
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<tr>
<td>Pune University, Puducherry University; Madurai Kamaraj University</td>
<td>PhD (Medical Entomology)</td>
<td>3–5 years</td>
<td>MD (Community Medicine/Social &amp; Preventive Medicine/MSc (Medical Entomology)</td>
</tr>
<tr>
<td>National Institute of Malaria Research in collaboration with Goa University; Indraprastha University; Jiwaji University; Kumaun University, Nainital; Maharshi Dayanand University, Rohtak</td>
<td>PhD (Medical Entomology)</td>
<td>3–5 years</td>
<td>Life science graduation and cleared National Eligibility Test exam conducted for Junior Research Fellowship</td>
</tr>
<tr>
<td>The Tamil Nadu Dr MGR Medical University at the Institute Of Vector Control And Zoonoses, Hosur</td>
<td>Postgraduate Diploma in Public Health Entomology</td>
<td>2 years</td>
<td>BSc (Zoology)/BSc (Microbiology)/MBBS</td>
</tr>
<tr>
<td>Vector Control Research Centre (Indian Council of Medical Research), Puducherry</td>
<td>MSc (Public Health Entomology)</td>
<td>2 years</td>
<td>BSc, Zoology, Botany, Life Sciences, Medical Laboratory Technology, Microbiology, Biochemistry, BVSc, MBBS, BE, and BTech</td>
</tr>
<tr>
<td>National Centre for Disease Control</td>
<td>Fellowship training programme on Malaria Entomology and Parasitology</td>
<td>1 month</td>
<td>WHO-nominated candidates</td>
</tr>
<tr>
<td>National Centre for Disease Control</td>
<td>Fellowship training programme on Malaria</td>
<td>1 month</td>
<td>WHO-nominated candidates</td>
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address the growing need for entomologists in the field of public health, in view of emerging and re-emerging vector-borne diseases in India. Apart from these specialized programmes, WHO fellowship programmes are also available at the Vector Control Research Centre, Puducherry, covering various aspects of vector biology and vector-borne diseases and their control. The National Centre for Disease Control, New Delhi, offers programmes on malariology and malaria entomology and parasitology. These programmes are of one-month’s duration each and are conducted on a periodic basis for WHO-nominated candidates (see Table 2).

**Short-term training in medical entomology**

The National Centre for Disease Control, New Delhi; National Institute of Malaria Research, New Delhi; Vector Control Research Centre, Puducherry; Regional Medical Research Centre, Bhubaneswar; Centre for Research in Medical Entomology, Madurai; and Armed Forces Medical College, Pune, are some of the premier institutes of the country offering short-term training programmes in medical entomology. Short-term training is usually a specialized course focusing on specific audiences and designed to deliver skill sets specific to their needs.

**Other capacity-building measures**

WHO has developed and expanded various entomology training programmes for vector biology and control of vector-borne diseases and partnered with premier health institutions of the country to enhance entomology capacity for effective outbreak response and control. Also, over the last few decades, various other initiatives have been undertaken by WHO, states, nongovernment organizations, and the public–private partnership sector, but none of these efforts have resolved the need for quality medical entomological capacity that is comparable to the standards available in various foreign universities.

Most of the entomology training available in the country is modelled on classroom teaching. Some courses are rather academic in nature, such as the various public health degrees awarded by different medical universities across the country, including the MD in Preventive and Social Medicine, Social and Preventive Medicine, Community Medicine or Community Health Administration. These generally have similar course content and style of imparting education and are three-year degree programmes that qualify for a degree from the Medical Council of India.

Many institutes in the country, including degree colleges, medical colleges, universities, defence research and development establishments, and institutes of the Indian Council of Medical Research do conduct continuing medical education (CME) or continuing education programmes for a few days, on various aspects of vectors and vector-borne diseases, for scientists, administrators, policy-makers and public health professionals. Some agriculture universities, including Punjab Agriculture University, Ludhiana; CCS Haryana Agriculture University, Hissar; institutes of the Indian Council of Agriculture Research; and Acharya NG Ranga Agriculture University, Bapatla, Guntur, offer compressed doctoral programmes that lead to a PhD (Entomology). There are various universities in India awarding PhD (Zoology) with a dissertation or thesis topic in entomology, which is designed to cater for the needs of individuals who wish to practise entomology but who do not have a postgraduate degree in public health/community medicine/medical entomology to orient them in public health entomological concepts and practices.

Most universities do not have a specialized entomology department but instead offer courses in entomology. Many entomologists receive a general undergraduate degree in biology or zoology and then specialize in entomology at the postgraduate level. Research/teaching positions in universities, the government and industrial organizations require either a master’s degree or, in most cases, a PhD.

Medical and public health entomologists work for central, state and local public health departments, and deal with problems of pest control. Entomologists engaged in public health work in different areas of research and in the control of house flies, mosquitoes, cockroaches, lice, fleas, sand flies, ticks and many other pests that pose a health hazard or nuisance problem.

Public health specialists in military positions work as entomologists for the armed forces and supervise pest-control operations at a large number of military bases in India and abroad (when on deputation). Research work and the protection of military personnel against insect-borne diseases and parasites are important aspects pertaining to entomology in the armed forces.

**The role of professional organizations in capacity-building in medical entomology (see Box 1)**

The Entomological Society of India encourages and promotes the dissemination of entomological knowledge in the

<table>
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<th>Institute</th>
<th>Course</th>
<th>Duration</th>
<th>Desired qualification</th>
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<tbody>
<tr>
<td>National Centre for Integrated Pest Management, New Delhi</td>
<td>Integrated pest/vector management</td>
<td>4 weeks</td>
<td>Health managers/professionals working in the relevant areas</td>
</tr>
<tr>
<td>Armed Forces Medical College, Pune</td>
<td>Entomology for those working in the vector-borne disease control department</td>
<td>10 days</td>
<td>Medical officers/officers in the vector-borne disease control department</td>
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**Table 2: WHO fellowship programmes in India**
country. It arranges meetings that provide opportunities to its members and others interested in the subject to keep in touch with entomological activities, both in India and abroad. The Entomology Academy of India has been taking a keen interest in capacity-building in entomology in the country, including medical entomology. The organization conducts CME and short-term training and workshops on research and updates in entomology. The Indian Society for Malaria and other Communicable Diseases and the National Academy of Vector Borne Diseases are national-level professional organizations that publish journals, organize annual conferences and publish newsletters in the field of medical entomology and vector-borne diseases. The Indian Society for Parasitology, Indian Society of Advancement of Insect Sciences, Society of Mosquitoes and Mosquito Borne Diseases in India, National Environmental Science Academy and National Academy of Sciences, India, are national-level professional bodies that have vector-borne diseases and medical entomology as one of their major areas of work.

**Box 1:** Various national societies related to entomology in India

- National Academy of Vector Borne Diseases
- Indian Society for Parasitology
- Indian Society for Malaria and Other Communicable Diseases
- Indian Society of Advancement of Insect Sciences
- Entomological Society of India
- Entomological Academy of India
- Society of Mosquitoes and Mosquito Borne Diseases in India
- National Environmental Science Academy
- National Academy of Sciences, India

**Initiatives under the National Vector Borne Disease Control Programme**

The National Vector Borne Disease Control Programme has contributed to the development of human resources in vector-borne diseases, by providing training to health professionals and non-health sector professionals, as well as developing training materials.7

**Role of the National Centre for Disease Control**

Realizing the limited capacity of the health staff in medical entomology, the National Centre for Disease Control has been providing various short-term training courses in medical entomology, through the Centre for Medical Entomology and Vector Management located at New Delhi. This centre conducts various ad hoc and regular training courses on vector-borne diseases and their control. This centre also maintains the National Reference Entomological Museum.8

**Role of the National Institute of Malaria Research**

The National Institute of Malaria Research conducts short-term and long-term training courses in the field of vector control, microscopy, entomology, surveillance, quality assurance of rapid diagnostic tests, insecticide bioassay, bioenvironmental control, field applications of biocides, indoor residual spraying, preparation of blood smears for diagnosis, malaria in pregnancy, anti-malaria operations, and new tools such as remote sensing and geographical information systems in the prevention and control of vector-borne diseases. The National Institute of Malaria Research also delivers training to national and international participants from all levels.9

**Role of the National Institute of Virology**

The National Institute of Virology, Pune, a premier virology institute of the country, also conducts training and projects in medical entomology. This institute has nurtured a large number of trained entomologists, PhD students, short-term trainees and arbovirus experts, for more than 60 years. It has contributed immensely in India’s efforts to combat vector-borne diseases and its major achievements include from recognition to vaccine development of vector-borne diseases such as Kyasanur Forest disease (KFD) and Chandipura virus infection. Several new species of ticks, lice, fleas, sand flies and mosquitoes, together with a new species of rodent, have been described by the scientists of the institute.10

**Demand–supply analysis**

Based on the results on the specialized training programmes in medical entomology, it was observed that the annual output of trained specialists in medical entomology is below 100 and far below the need for medical entomologists in the country. Under the Integrated Disease Surveillance Project, each state surveillance team needs one medical entomologist at the state headquarters, amounting to 35 consultants, and there is a need for entomologists for 643 districts. Apart from this, there is need for trained medical entomologists for training and education of medical entomologists to meet the growing needs of the country. Medical entomologists are also needed to work in vector-borne disease programmes and malaria programmes. The demand analysis estimates that there is a need for at least 1000 specialists in medical entomology. This suggests a wide gap in the demand and supply of these professionals, which needs to be addressed.

**DISCUSSION**

Epidemic vector-borne diseases have been among the most important emerging infectious diseases on a global scale.11 In India, malaria, dengue, chikungunya, filariasis, JE and visceral leishmaniasis are major prevalent vector-borne diseases. Failure to control disease vectors, and the illnesses transmitted by them, has resulted in recurrent outbreaks all over the country.12 In order to address this issue, it is imperative
to attend to the shortage of medical entomologists and vector-control experts for planning, implementing, monitoring and evaluation of vector-borne disease control programmes, through strengthening capacity in medical entomology and through various capacity-building initiatives. These include academic programmes, training courses and institutional capacity-building.

Training in medical entomology is being delivered as a small part of medical education and through a few dedicated programmes in medical entomology. Taking into account the large population of the country, the number of training programmes and the enrolment capacity in most programmes still remains low.

Vector-borne diseases are expanding geographically, seasonally and in severity. Prevention of vector-borne diseases is becoming more complex, requiring advanced approaches with specialized skills. Currently, there are no long-term specialized courses in subspecialties of medical entomology such as vector biology, transmission dynamics, and advancing technologies in vector-borne diseases. Introducing courses on subspecialties would expand the horizons of learning in medical entomology and this possibility needs to be explored. Also, there is room for disease-specific specialized courses. In a country like India where more than one vector-borne disease exists, it is desirable to have an expert for each disease. Doctoral (PhD) courses can be strengthened by increasing emphasis on field aspects of medical entomology; in the present form, the course focus is mainly on research, which may not prepare candidates well for control of vector-borne diseases at field level.

In view of the scarcity of experts in medical entomology and high demand for trained manpower, there is scope for introducing distance learning courses that can cater to a large number of candidates with a limited number of faculty members. Apart from an increase in the number of courses and intake capacity, improvement in the output of courses and their quality also demands attention. Identifying competencies, developing the curriculum and strengthening capacity for training for specialized medical entomology programmes is an urgent need. Many of the trained medical entomologists pursue careers in applied fields such as molecular biology, biotechnology or microbiology, rather than working on entomological aspects. Medical entomologist careers can be made more attractive by expanding their traditional role and augmenting them with knowledge in public health, programme management and technology application, especially geographic information systems and data management, and providing a role in the design, deployment and monitoring of new interventions.13

Building institutional capacity is a crucial capacity-building measure, along with human resources. Both are closely interrelated and complement each other. At present, few organizations are taking initiatives in this regard. More attention needs to be given in this area, as institutional capacity-building addresses a long-term requirement.

Considering the large population of India, the supply of medical entomologists is far from sufficient for the ever-growing demand for specialists in this field. There is an urgent need to bridge the gap between the demand and supply of medical entomologists in the country. Institutional strengthening, collaboration, and development of a network of training institutes to synergize resources are possible steps that can be taken to strengthen the capacity of medical entomologists in the country on a long-term basis. This involves generation of innovative ideas on sustainable financing for health promotion, such as allocation of a percentage of taxation on tobacco and alcohol for the creation of a health-promotion foundation.

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