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Mosquitoes & vulnerable spaces: Mapping local knowledge of sites for dengue control in Seremban and Putrajaya Malaysia

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A B S T R A C T

Dengue is a mosquito-borne viral infection that continues to represent a significant health challenge in many tropical and subtropical regions. At a local scale, dengue prevention and control is a cooperative effort as favorable vector breeding sites may be found across residential, commercial and public spaces within a community. However, many vector control initiatives do not take into account local understanding of dengue risk and how this impacts the actions of residents to prevent dengue by eliminating breeding sources. The objective of this study was to use a participatory mapping approach to identify spatial perceptions of risk to dengue at a community scale. Four mapping groups were formed in two urban Malaysian communities that have experienced high dengue rates, divided into male and female groups to encourage gender equity. Participants were asked to draw a map of areas they associated with dengue and mosquito breeding in their communities, and to describe the important features on the map. Sketch map features were digitized into a GIS to create a georeferenced map of community knowledge, translating the outputs into formats accessible to stakeholders. Community spaces linked to dengue identified in the mapping exercises differed between the two communities, and included green spaces, construction projects, drainage networks and abandoned land areas. The findings indicated that resident perceptions of some vulnerable areas, such as green spaces, differed from the views of local public health staff, and could influence the actions of residents to adequately destroy breeding sites. This highlights the need to understand local knowledge of mosquito breeding in order to enhance co-operative efforts with vector-control workers, and increase the effectiveness of dengue prevention efforts at a local scale in Malaysia.

Introduction

Dengue is a vector-borne disease that presents an important global health challenge, with 40% of the world's population living in areas where there is a transmission risk from *Aedes* mosquitoes. The morbidity and mortality associated with dengue has widespread implications, including loss of workers from the labor force and a burden on health systems (Suaya et al., 2009). In Southeast Asia, health costs associated with dengue are estimated to be US$950m per year, and the disease burden (based on disability-adjusted life years) is greater than many other conditions including Japanese encephalitis, upper respiratory infections, and hepatitis B (Shepard, Undurraga, & Halasa, 2013). Dengue hemorrhagic fever (DHF) and dengue shock syndrome (DSS) are severe forms of the disease, with Malaysia reporting a fatality rate of approximately 3.6%, compared with 0.003% in neighboring Singapore (Beatty et al., 2010). A vaccine has yet to be developed in order to combat the illness, therefore the emphasis is on measures to control vector populations (Gubler, 2002). In Malaysia, this involves education and awareness campaigns, as well as insecticide fogging to reduce transmission that is concentrated in areas with identified cases. In addition, a WHO Asia-Pacific Dengue Strategic Plan (2008–2015) is underway to reverse the rising trend of dengue in Southeast Asia by strengthening capacity across country borders to prevent disease transmission.

However, combatting dengue relies not only on the work of health officials, but also on participation of residents and community leaders to remove breeding sites from residential and community spaces. Insecticide fogging activities carried out by vector-control staff can only target adult mosquito populations, so

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breeding sources such as plastic containers, discarded tires, or flower vases filled with water have implications for the surrounding neighborhood and are critical to dengue control. Despite this important role played at a neighborhood level, vector control initiatives in Malaysia are generally top-down approaches that do not take into account local perceptions of breeding sites. To improve the effectiveness of control efforts, research is needed to better understand these perceptions and how they impact the actions of residents to protect themselves and their communities from dengue. This study provides insight on perceptions of risk at the local level through a participatory mapping approach carried out in two areas experiencing high dengue rates in Malaysia.

Participatory mapping opportunities

Mapping tools are increasingly being used for disease surveillance, vector control and health promotion activities (Eisen & Eisen, 2011; Hay et al., 2009). In particular, geographic information systems (GIS) have been introduced in operational control programmes for malaria (Martin, Curtis, Fraser, & Sharp, 2002) and real-time surveillance of West Nile Virus (Shuai, Buck, Sockett, Aramini, & Pollari, 2006). Some dengue control programs use a GIS to monitor daily mosquito surveillance data (Ai-leen & Song, 2000).

While the use of GIS has been criticized as undemocratic due to barriers that limit stakeholder involvement, innovative new tools and methods are being developed that are both inexpensive and engage communities in the process (Elwood, 2006; McCall & Dunn, 2012). Moreover, the increasing accessibility of high-resolution satellite imagery, geospatial datasets and GIS platforms opens new avenues for health applications of GIS. For example, Google Earth imagery has been used in Nicaragua to create a base map in order to monitor areas of mosquito infestation (Chang et al., 2009), and to create maps of the Congo River for vaccination teams (Kamadjeu, 2009). In rural Indonesia, inexpensive open source GIS software was successfully trialled for mapping health indicators by clinic staff (Fisher & Myers, 2011).

Participatory geographic information systems (PGIS) is an approach that inputs community knowledge into a GIS platform, and is increasingly being applied to involve stakeholders in delineating local boundaries and prominent landmarks (Dunn, 2007; Kyem, 2004). Within a health context, PGIS has been used to create detailed maps of urban wards in Dar es Salaam, Tanzania, designed to facilitate larval surveillance and control of malaria (Dongus et al., 2007). In Bo, Sierra Leone, input from local elders and long-term residents was used to create a detailed municipal map to inform public policy applications, such as identifying hospital catchments (Ansumana et al., 2010). In Bangladesh, community involvement through PGIS was used in deep tubewell planning to prevent arsenic poisoning (Hassan, 2005).

Participatory sketch mapping methods have been used to assess perceptions of risk held by individuals and across different communities, particularly in the context of disaster planning (Gaillard et al., 2013). For example, this method has been used to identify areas prone to flooding hazards in Masantol, Philippines, including weak points along dikes and vulnerable populations, such those living in poorly constructed houses and locations inhabited by elderly residents (Cadag & Gaillard, 2012). However few research projects have incorporated participatory approaches and geographic methods such as GIS to increase understanding of community perceptions of health risks (Beyer, Comstock, & Seagren, 2010). In particular, combatting mosquito-borne diseases such as dengue relies on cooperative efforts and communication between health officials and residents, and maps can provide useful planning and decision-making tools. This study used a participatory mapping approach to collect local-level knowledge of breeding sites and dengue risk across two different Malaysian communities. This information was georeferenced to create visualizations that can be used by residents and community vector control staff to enhance two-way dialog, as well as inform community-based and municipal decision-making on dengue prevention.

Methods

Study location: Seremban and Putrajaya

The Malaysian municipalities of Putrajaya and Seremban are situated in South-western Malaysia and are approximately 20 and 100 km away from Kuala Lumpur city centre, respectively. Both are well-connected to Kuala Lumpur by road networks and train lines used by commuters (Fig. 1). Located approximately 3° north of the equator, the region is characterized by a humid tropical climate. Putrajaya is a planned government city established in the late 1990s, located in a 'Multimedia Super Corridor' connected to the neighboring IT-hub Cyberjaya and the capital Kuala Lumpur. A large proportion of housing in Putrajaya is owned and maintained by the government and residents are mostly civil servants with above average socioeconomic status (Moser, 2010). In contrast, Seremban is a more characteristic Malaysian town consisting of an ethnically diverse population, surrounded by oil-palm agriculture and tropical forest. Putrajaya and Seremban are subdivided into neighborhoods called 'tamans' or 'precincts' respectively, which were used as the unit of analysis for the study. Both research sites are of interest because dengue is an ongoing concern in the municipalities. Between 2009 and 2011, the average dengue rate in Seremban and Putrajaya was approximately 200 cases per 100,000 persons, and above the national target of less than 50 cases per 100,000 persons (Malaysia Ministry of Health, 2010).

In Malaysia, the core dengue control activities carried out by the public health department are household larval surveys to identify and destroy breeding sites, and insecticide fogging to destroy adult mosquitoes. The focus of these activities is on areas where dengue cases have been identified. Media such as flyers, billboards and radio advertisements are used to disseminate information on

Fig. 1. Map of study sites in peninsular Malaysia in reference to capital city Kuala Lumpur.