



Short Communication

High Risk Mapping and Response Play Vital Role in Dengue Fever Control

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ABSTRACT

Dengue fever causes an estimated 50 million infections annually and approximately 2.5 billion people are at risk around the globe. Directorate of Health Services (DHS), Capital Development Authority/ Metropolitan Corporation, which is responsible for urban Islamabad, has developed long term strategic plan in the very beginning when the dengue epidemic had erupted first time in the year 2011. DHS, MCI/CDA adopted WHO strategy for vector control, however, a new strategic tier was additionally introduced i.e. high risk mapping and response. The team of DHS (Health) envisaged that the load of disease followed by precise micro plan/ mapping that details out distribution of disease, vector (pre-adult and adult stage), as well as sectors vulnerable for dengue be earmarked for timely interventions in window period (winter). The results of high risk mapping followed by focused intervention are remarkable. The last 10 years data reflect the load of disease through these interventions introduced by DHS is at least 5-10 times less as compared to immediate surroundings, as Rawalpindi and rural Islamabad do not prepare high risk mapping during the window period.

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Authors' Contribution

AS planned the study, conducted the research and wrote the manuscript. HO and MIA helped in completing the task and English correction.

Key words

High risk mapping, Dengue fever, Vector, Control, Environmental factor

Dengue fever is a mosquito-borne viral infection (Simmons *et al.*, 2012), which causes an estimated 50 million infections annually and approximately 2.5 billion people are at risk around the globe (Gubler, 2002). Recently, an estimated 390 million DENV infections occur each year, of which 96 million were seemingly evident (Bhatt *et al.*, 2013). It is transmitted by vector species *Aedes aegypti* and *Aedes albopictus*, which poses a global threat to humans due to its high adaptability to urban communities (Araujo *et al.*, 2015). In 2012, WHO reported that dengue outbreaks place a large burden on communities, healthcare systems, and economies in most tropical countries worldwide. According to WHO, Asia, Americas, Africa, and the Mediterranean regions are affected by the emerging and prevailing DENV (WHO, 2012). Dengue vector (*Ae. aegypti* and *Ae. albopictus*) typically breeds well in human-made container habitats such as water storage jars in and around human settlements including those in dense urban areas (David *et al.*, 2009; Tsuzuki *et al.*, 2009). In the absence of a vaccine, dengue control focuses on reducing vector abundance through insecticides, biological control of larvae, or measures to reduce breeding sites (Tun-Lin *et al.*, 2009; Vanlerberghe *et al.*, 2009). It has no specific treatment, but appropriate and timely medical care frequently saves the lives of patients. Only way to prevent dengue virus transmission is to combat mosquitoes

carrying disease.

The long term strategic plan was developed by DHS, CDA/MCI in the very beginning when the dengue epidemic had erupted first time in the year 2011, as an aftermath of 2010 flood in Punjab, Pakistan. DHS, CDA/MCI adopted WHO strategy of vector control in toto. WHO strategy for vector control based on five key elements (i) Advocacy, social mobilization and legislation, (ii) Multi-sectoral collaboration, (iii) Integrated approach, (iv) Evidence-based decision-making, (v) Capacity building (WHO, 2004). In addition, a new strategic tier was introduced i.e. High Risk mapping. The team of the DHS envisaged that the load and precise micro plan/ mapping that details out distribution of disease, vector (pre-adult and adult stage) as well as sectors vulnerable for dengue and focused finally and timely interventions.

Keeping in view the importance of high risk mapping, the study was initiated to explore risk factors for the presence of DENV in urban Islamabad.

Materials and methods

The Federal Capital of Pakistan; geographically, is situated at northern latitudes 33° 42' 0" and eastern longitudes 72° 10' 0" lying at an altitudes of 457 to 610 m above sea level. Its elevation is 507 meters (1,663 feet). Islamabad lies in the sub-tropical, sub-humid continental climatic zone. Total area of the Federal Capital of Pakistan is 906 square Km and is bounded on the west by Attock, Hazara in the north, Rawalpindi in the south and Poonch of Azad Kashmir in the east.

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Survey was conducted in urban Islamabad during window period i.e., winter was utilized from January to March. Urban Islamabad was selected to prepare high risk mapping to take measures to control dengue fever in Islamabad. There were 29 sectors and each sector divided in to four sub-sectors. Moreover, there were two towns (Rawal and Margalla town) and a Saidpur model village in urban Islamabad. 100% Islamabad sectors and towns under the jurisdiction of DHS, CDA was visited. Street maps of urban Islamabad were utilized to prepare high risk maps. Teams were constituted to conduct survey and prepare high risk maps. Each team was comprised of two workers and a supervisor. Islamabad was divided in to four zones i.e., 1- I and H-series, 2- G- series, 3- E and F-series and 4-Towns/Model village. Data of high risk factors was collected and later on it was reflected on the street maps of Islamabad. High risk areas in each sector/ street were marked as red, moderate risk areas were marked as orange and low risk area was marked as green. All these high risk areas were visited regularly throughout the year and larviciding was done in areas from where *Aedes* species were collected. Moreover, larviciding were also conducted in all potential breeding sites. Indoor residual spray (IRS) activities were conducted in those houses from where dengue cases reported in last year before transmission of dengue virus. Pamphlets were distributed among general public and banners were installed for awareness.

Results and discussion

Figure 1 shows 29 sectors i.e., 8 sectors in I- Series; 4 in H-Series; 9 in G-Series; 7- in F-Series; 2 in E-Series; and two Towns (Rawal and Margalla) and Saidpur model village in urban Islamabad. Teams of DHS, CDA, MCI visited all sectors, sub-sectors, towns and saidpur model village in window period (January to Mach). High risk areas (mosquito breeding sites and houses from where dengue cases reported) were noted and later on all risk factors were identified. Figure 2 shows different high risk areas i.e., roads, streets, nallas, blocks, markets, mosques, schools, parks, hospitals, churches and katchi abadies, which harbors risk factors including discarded drums, vases, buckets, earthen jars, used tyres, water jars, ant traps, coconut shells, tin, bottles, discarded boxes (cigarette, saver, juices etc.), clay pot used for domestic pets, rubbish, fountains, ditches along road and other water containers. These risk factors contribute in mosquitoes breeding. Three colours (red, yellow and green) were used to differentiate high, medium and low risk areas. Different shapes were also used for mosques, schools, markets, parks, hospitals, churches, nallahs, and dengue cases. The main purpose of high risk mapping is to locate mosquito breeding sites and dengue virus load (dengue patient's house). In most localities, small number of containers regularly serve as

the primary producers of *Aedes* larvae (Lloyd, 2003), each ecological setting has its own unique set of key containers (Tun-Lin *et al.*,1995). In Peru, for example, seemingly not useful containers, located outdoors and filled with rainwater, represent the most important factor *Ae. aegypti* production (Morrison *et al.*, 2004), In Mexico, tires and bottles were the most important habitats for the *Ae. aegypti* population (Lloyd *et al.*, 1992), whereas in Vietnam large concrete tanks and jars, were the main source of immature *Ae. aegypti* development (Kay *et al.*, 2002).

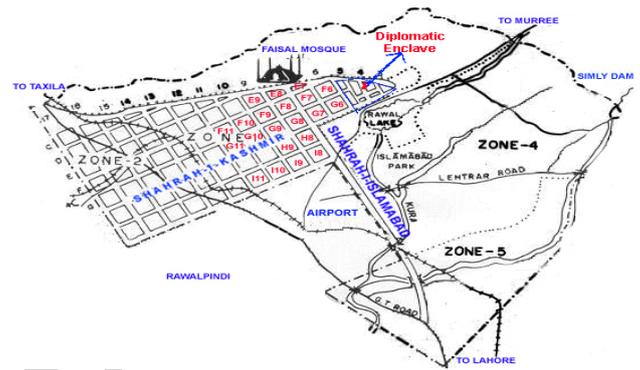


Fig. 1. Location map of the study area. (<http://www.google.com.pk/map> of Islamabad).



Fig. 2. High risk map of G-7/1 (Sub-sector of G-7) prepared by directorate of health services, CDA/ MCI, Islamabad.

Figure 3 shows 4262 hot spot/ high risk areas including 16 hospitals, 2074 houses, 57 water bodies/nullahs, 75 nurseries, 199 tyre shops, 24 marriage halls, 461 hotels/ restaurants, 15 grave yards, 2 garbage sites, 48 petrol pumps, 350 mosques/churches, 250 workshops, 272 parks, 119 junk shops, 14 katchi abadies, 1 IJP road, 10 bus stands and 275 under construction buildings. These high risk areas harbor mosquito breeding sites and virus load (dengue patients). DHS CDA/MCI focused these high risk areas on priority since window period (winter) to control dengue fever. Moreover, varieties of vegetation were also witness during study period. The plant community of

Islamabad consists of *Justicia adhatoda* L., *Mangifera indica* L., *Tamarix aphylla* (L.) H. Karst., *Acacia modesta* Wall., *Dodonaea viscosa* (L.) Jacq., *Zizyphus nummularia* (Burm. F.) Wight and Arn., *Pinus roxburghii* Sarg., *Apluda mutica* L., *Quercus incana* Bartr., *Woodfordia fruticosa* (L.) Kurz., *Broussonetia papyrifera* (L.) Venten., *Fiscus palmata* Forsk. and *Dicliptera roxburghiana* Nees (Rashid *et al.*, 1987). Dengue fever is strongly correlated with (i) environmental factors (temperature and humidity), (ii) mosquito breeding sites, (iii) human population density and (iv) dengue virus. In addition, slums, nallahs, junk shops workshops, bus stands, under construction buildings and tyre shops were also contributed in dengue virus transmission.

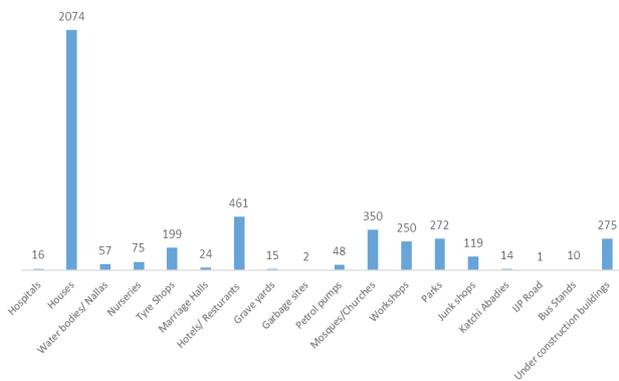


Fig. 3. Hot spots/ high risk areas identified in urban Islamabad.

Figure 4 shows number of mosquitoes that the team of DHS, CDA/ MCI had collected. In 2019, they collected 33051 samples of mosquitoes of which 4376 were *Aedes aegypti* and *Aedes albopictus* and remaining 28675 were *Culex* species. The mean maximum temperature in the hottest month of June is 40 °C; while the mean minimum temperature of January is 3 °C. The mean annual rain fall is about 1000 mm, 70 percent of which falls during the summer monsoon season (July, August and September) and remaining 30 percent falls in winter (December, January and February) (Nizami *et al.*, 2004). Maximum dengue cases were reported from those sectors, where human population density was more. Minimizing of entomological indices alone is not enough in estimating dengue transmission risk, because host density, ‘herd immunity’, the circulating viral serotypes and environmental factors (especially climate and urbanization) all contribute to such risk (Kuno, 1995). Larvicidal activities, indoor residual spray (IRS), fogging and social mobilization play important role to curb the transmission of dengue virus. A total of 4376 larvicidal activities in different larval habitats was conducted, 33375 indoor residual spray (IRS), and 19375 fog (space spray) activities in high risk areas were carried

out in 2019. Moreover 88340 pamphlets were distributed among general public and 300 banners were installed for public awareness. Community was also educated through pamphlets, banners, lectures and seminars etc. Different researchers also supported social mobilization, larvicidal and adulticidal activities to contain dengue fever. A drop in dengue incidence associated with an extensive emergency vector control campaign which included multiple space sprays (Teng *et al.*, 2007). Mosquito populations can rapidly recover after space spraying, unless measures are taken to ensure that the spray also reaches breeding sites (Reiter, 1992). While space sprays can initially reduce adult mosquito populations rapidly, they require regular re-application to maintain control (Reiter and Gubler, 1997). Human knowledge and behavior play an important role in the transmission of the disease (Ibrahim *et al.*, 2009), vector control relies on the effective participation of all people in the area (Thenmozhi *et al.*, 2005).

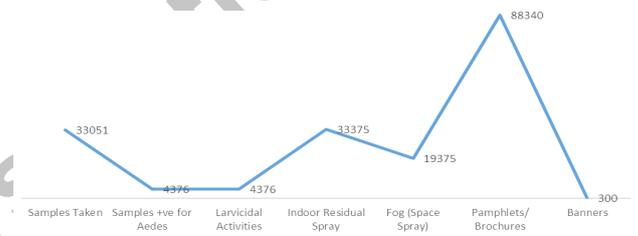


Fig. 4. Action taken by directorate of health services, CDA/ MCI in urban Islamabad in 2019.

Figure 5 shows dengue fever cases reported from urban Islamabad were 98, 06, 49, 15, 71, 117, 55, 39 and 2074 in 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018 and 2019, respectively. Whereas the reported dengue fever cases from Rawalpindi and Rural Islamabad were 675 and 578, 258 and 258, 2601 and 373, 1440 and 96, 4000 and 526, 1000 and 2700, 937 and 2980, 412 and 382, 6654 and 12459 in 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018 and 2019, respectively. The results show disease load in urban Islamabad. It is 5-10 times less as compared to rural Islamabad and Rawalpindi. The reasons of minimum dengue cases reported from urban Islamabad were (i) DHS, CDA/ MCI prepare high risk map in window period (winter season), (ii) DHS adopted WHO strategy for vector control based on five key elements i.e., a, advocacy, social mobilization and legislation, b, multi-sectoral collaboration, c, integrated approach, d, evidence-based decision-making, e, capacity building. High risk mapping is the key element, which is practicing in DHS, CDA/ MCI since 2011. On the other hand, Rawalpindi, rural Islamabad did not prepare high risk maps, so maximum cases were reported from Rawalpindi and rural Islamabad since 2011.

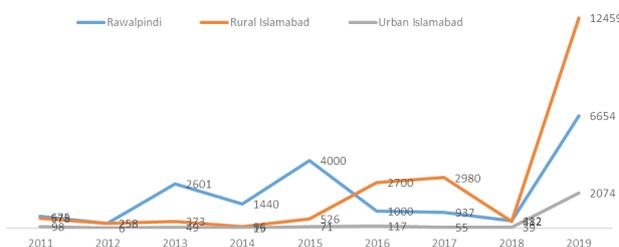


Fig. 5. Dengue fever cases reported from Rawalpindi, Rural Islamabad and Urban Islamabad since 2011.

Once the high risk areas maps prepared then intervention to contain dengue fever becomes easy and the following advantages may be seen i.e., (i) rationale/logical management of dengue fever, (ii) data base of the mosquito breeding sites, (iii) data base of dengue patients from where dengue case reported, (iv) optimal utilization of resources (Operational and HR), (v) early and focused intervention and reduce environmental pollution.

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Statement of conflict of interest

The authors have declared no conflict of interest.

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