Original Research Article

Geographical distribution and seasonal prevalence of *Aedes aegypti* in Urban Lahore, Pakistan

ABSTRACT

Objective

Seasonal prevalence of female *Aedes aegypti* was studied to determine its habits and its transmission season in Lahore, Pakistan.

Method

The study was carried out by placing black modified ovitraps indoor & outdoor in 25 different households per town in ten administrative areas of the city. The placement of ovitraps was done by stratified random sampling method. Data was collected on weekly basis and monthly indices of adult and larvae were calculated. High (>9 Breteau Index) indoor prevalence of adult was found in Data Gunj Bakhsh and Iqbal Town, moderate (5 to 9 Breteau Index) was observed in Aziz Bhatti town only.

Results

In all other seven study areas indoor prevalence of adult was found low (<5 Breteau Index). Regarding outdoor prevalence of adults, high (>9 Breteau Index) was not detected from any area, moderate (5 to 9 Breteau Index) was observed in Aziz Bhatti, Gulberg, Shalimar and Nishtar towns. In all other six study areas outdoor prevalence of adult was found low (<5 Breteau Index). During the months September, October, November, March and April *Aedes aegypti* density was found high and no adult or larva was found during the months of December, January, February, June and July. Prevalence of *Aedes aegypti* in various seasons was detected significantly ($p < 0.05$) different.

Conclusion

It is concluded that Ae. aegypti is widely distributed in all the towns of Lahore but some areas like Iqbal town and Data Gunj Baksh town had high indoor prevalence.

Keywords: *Aedes aegypti*, ovitraps, index, prevalence

INTRODUCTION

Background

Dengue Fever (DF) and Dengue Hemorrhagic Fever (DHF) are rapidly growing public health issues in tropical and sub-tropical regions of the world [1]. In Pakistan, DF is endemic and mainly found in urban areas of the country. For the last couple of years, an increasing number of DF has been reported from different parts of the country, Punjab province being a major contributor [2]. It is now considered one of the big public health problems [3]. Globally, dengue virus is the most wide spread arbovirus, causing an estimated 390 million infections per year [4]. Global number of deaths reported only in 2013 for males and females are 4238 and 4324 respectively, with a mortality rate of 0.12 per 100,000 infected cases[5].

One of the viable options of controlling dengue virus transmission to human population is by reducing the population of dengue vector *Aedes aegypti (Ae. Aegypti),* which primarily feeds on human blood for nourishment of its eggs. It breeds in various natural and artificial water containers, inside and outside the houses [6]. Unabated human population growth, substandard housing, inadequate water supply, poor waste management systems and rapid industrialization, all contribute as background factors to the increase of artificial breeding places for dengue vector. The climatic conditions (temperature, rainfall and relative humidity), being the critical factors, however, provide adequate basis for dengue epidemic [7]. The aforementioned conditions, in one way or the other, increase the prevalence of *Ae. aegypti*. Therefore, proper identification of resting and feeding habits, transmission season and habitat always help to control dengue vector population [8]. Thus, the objective of present study is to estimate the prevalence of *Ae. aegypti*.

MATERIAL AND METHODS

The cross-sectional design was employed to attain the objectives of the current study. Administratively, the city of Lahore, Pakistan, is divided into ten towns, nine being managed by the civil and one by military administration (Cantonment Area). The city of Lahore spreads over a total land area of 404 km² and is growing at a considerable rate. It experiences hot and humid conditions during the months of May, June and July when the average temperature ranges between 46°C-50°C. Following the end of July, the monsoon season sets in with heavy rainfall. December, January and February, on the other hand, are the coldest months when the temperature usually drops to below 5°C. Lahore was chosen for this study as dengue cases were reported during the year 2010.

A total number of 25 sentinel sites per town were selected indoors and outdoors by convenient sampling. Black colored, modified-mosquito-attracting ovitraps were placed indoors (ID) and outdoors (OD) of the selected sites. Sentinel-ovitrap distribution varied from one trap per 2 to 20 km^2 at different sites depending on the human population density. Through this sampling plan, an overall percentage of 0.03 to 0.008 of the houses within the site had been sampled. As it was the time of dengue epidemic in Lahore, even this sort of sampling plan worked well. Indoor ovitraps were placed in the common rooms, bathrooms and kitchens while outdoor ovitraps were placed under the trees, near leaked water pipes, air coolers, etc. The ovitraps were filled with water (~300ml) and wooden dipsticks were added that served for the ovipositioning of the female mosquito (Fig 1).

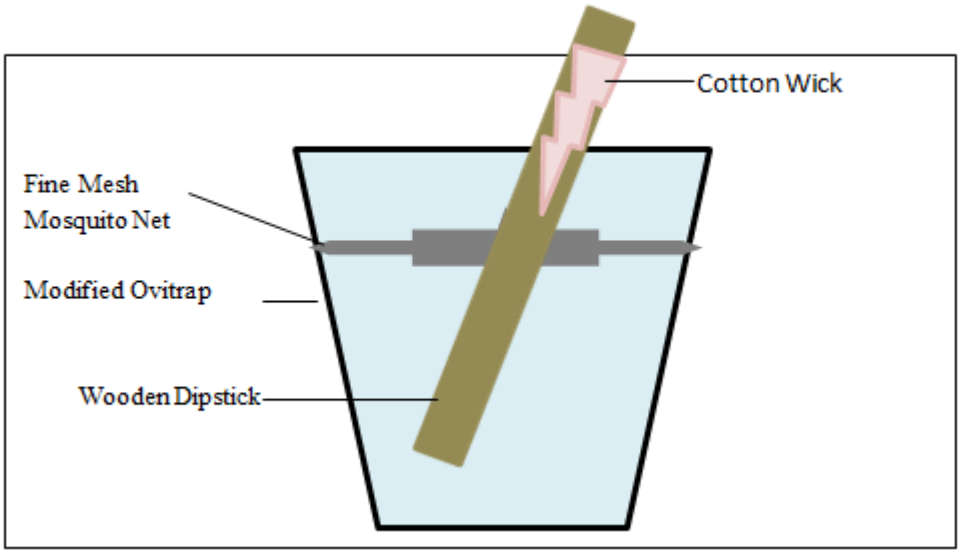

Fig. 1 A modified ovitraps

Ovitraps surveillance

The ovitraps were constructed as described by **Lee 1992** with some modifications. The ovitraps consisted of 15 cm plastic container with straight, slightly tapered sides. The top diameter measured 7.8 cm; the base diameter was 6.5 cm. The outer wall of the container was coated with a layer of black oil paint. A wooden oviposition paddle (20x2.5x0.3 cm) was placed diagonally into each ovitrap. A cotton wick soaked with 10% sucrose solution was attached to the upper middle part of the oviposition paddle to make it more attractive to the female mosquito. Each ovitrap was filled with tap water to a level of 13 cm and hay infusion was added to it. A fine mesh of 2 mm wire gauze was also fixed at 10 cm of the ovitrap to ensure no escape of adult imago. All the ovitraps were collected after 7 days and replaced with fresh ovitraps and paddles. Continuous ovitraps surveillance was conducted for one year from September 2011 to August 2012.

Larvae collection

On weekly basis each ovitrap was emptied and replenished with fresh material, water of ovitraps was collected in Ziploc bags and bags were labeled. All material was brought back to

the laboratory at Lahore College for Women University, Lahore, for incubation under 28-30°C temperature and 65-75% humidity. The ovitraps were emptied into rearing trays and a pinch of chicken liver powder was added as a food source for the hatching larvae. Trays were covered with 2 mm fine mesh frame to avoid adult escape and larvae were hatched in 24-48 hours. Late 3rd or 4th instar larvae were identified under stereoscopic microscope and counted and identified by using Zootaxa, mosquito identification key [9]. The number of larvae was recorded for each positive ovitrap and town.

Data Collection

The houses selected for study were based on stratified random selection. The data was segregated and analyzed. Entomological surveillance of mosquito density was evaluated in terms of Breteau Index (**BI**): number of positive containers per 100 houses inspected. The data was entered in Microsoft Excel 2010 program and analyzed using SPSS version 16. Statistical analysis was performed using *t*-test. Significance was determined at 5% level ($p < 0.05$).

RESULTS AND DISCUSSION

Lahore has been stratified into three different areas on the basis of prevalence data collected from ten towns of the city. The stratification was based on Breteau Index; low <5 Breteau Index, moderate 5-9 Breteau Index and high >9 Breteau Index. Critical Index is ≥5 (Breteau Index), which is thought of as a serious risk of an outbreak of disease [10]**.**

High (>9 Breteau Index) indoor prevalence of adult was found in Data Gunj Bakhsh and Iqbal Town, moderate (5 to 9 Breteau Index) was observed in Aziz Bhatti town only. In all other study areas (07) indoor prevalence of adult was found <5 Breteau Index (Fig. 2). High (>9 Breteau Index) outdoor prevalence of adult was not detected from any area, moderate (5 to 9 Breteau Index) was observed in Aziz Bhatti, Gulberg, Shalimar and Nishtar towns. In all other study areas (06) outdoor prevalence of adult was found <5 Breteau Index (Fig. 3).

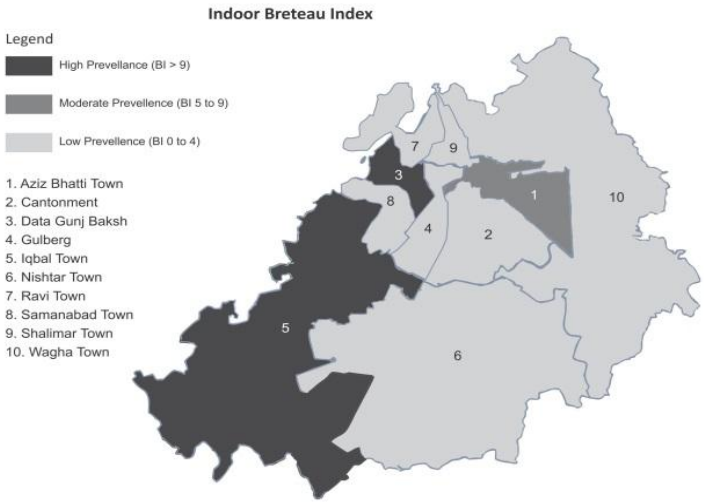

Fig. 2 Geographic distribution of *Ae. aegypti* (indoor)

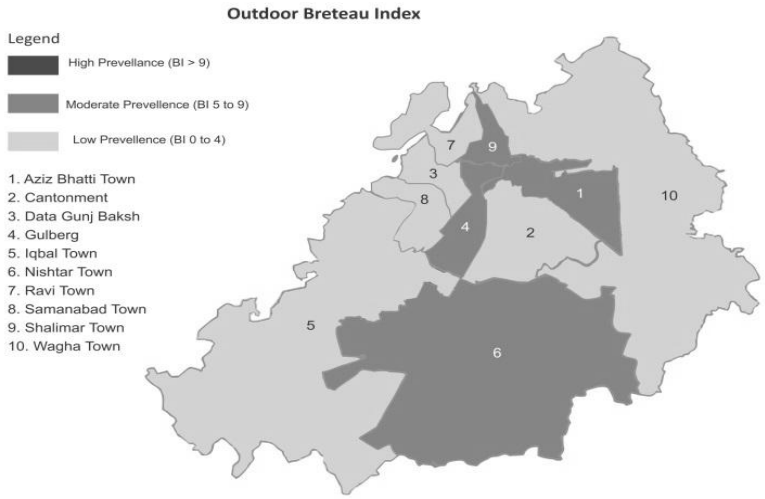

Fig. 3 Geographic distribution of *Ae. aegypti* (outdoor)

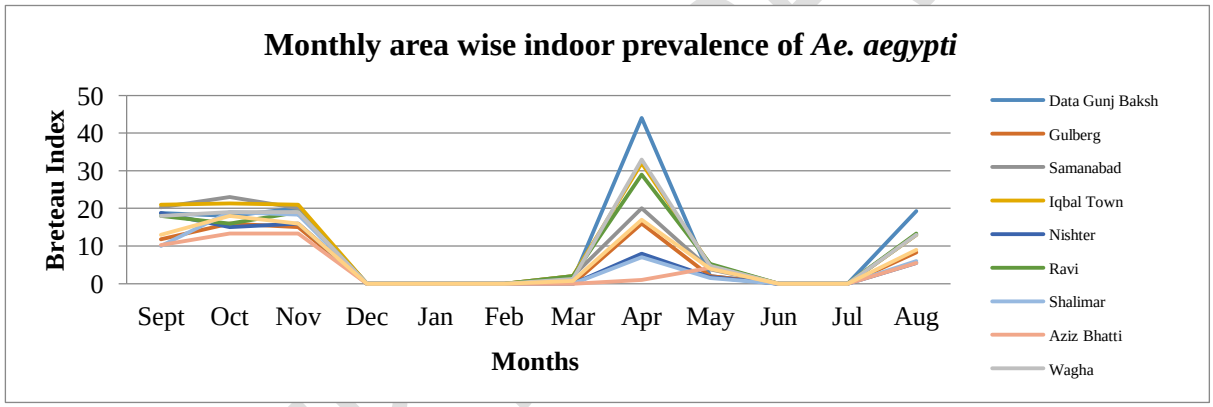

Fig. 4 Monthly areawise indoor prevalence of *Ae. aegypti* in Lahore, Pakistan

During the months of December (2011) and January, February, June and July (2012) no larvae per ovitrap were observed. Geographical and seasonal indoor and outdoor prevalence of *Ae. aegypti* has been given in Fig. 4 & 5, respectively.

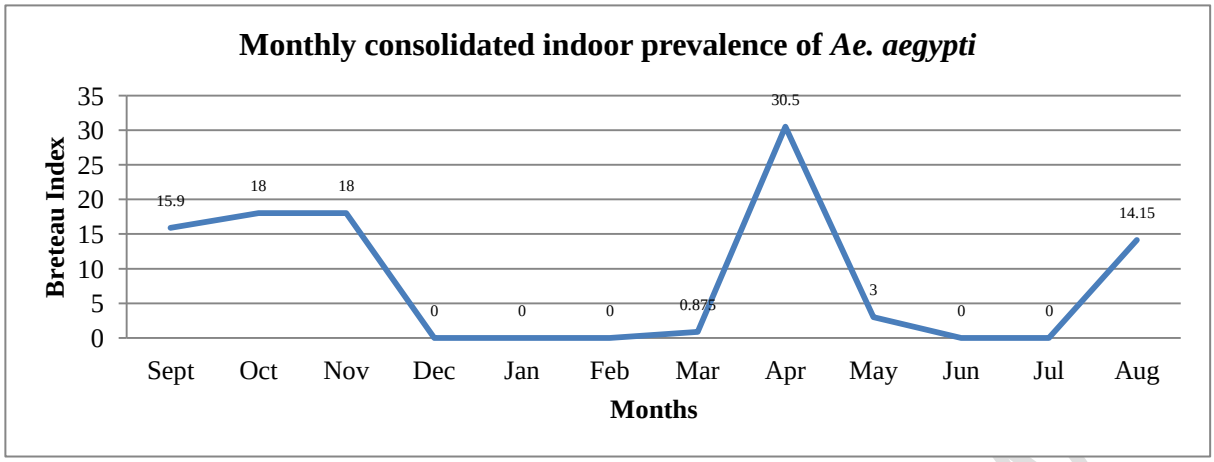

Fig. 5 Monthly consolidated indoor prevalence of *Ae. aegypti* in Lahore, Pakistan

Outdoor prevalence of month wise, area wise and consolidated shown in Figs. 6 and 7.

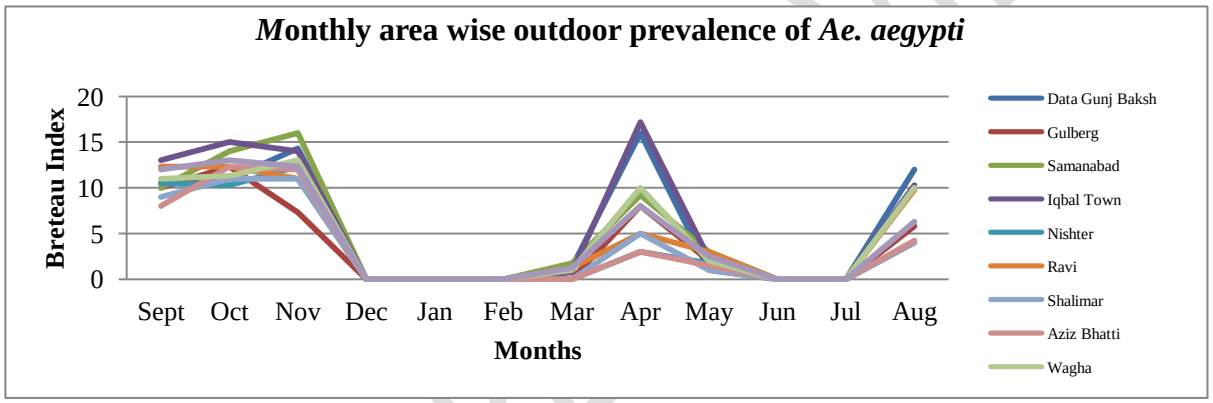

Fig. 6 Monthly areawise outdoor prevalence of *Ae. aegypti* in Lahore, Pakistan

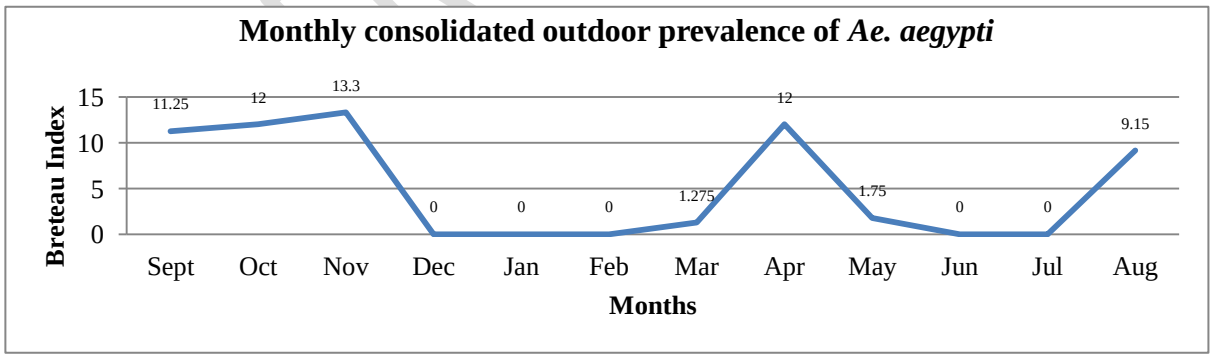

Fig. 7 Monthly consolidated outdoor prevalence of *Ae. aegypti* in Lahore, Pakistan

Town wise, indoor and outdoor Breteau Indices of district Lahore are shown in Fig. 8

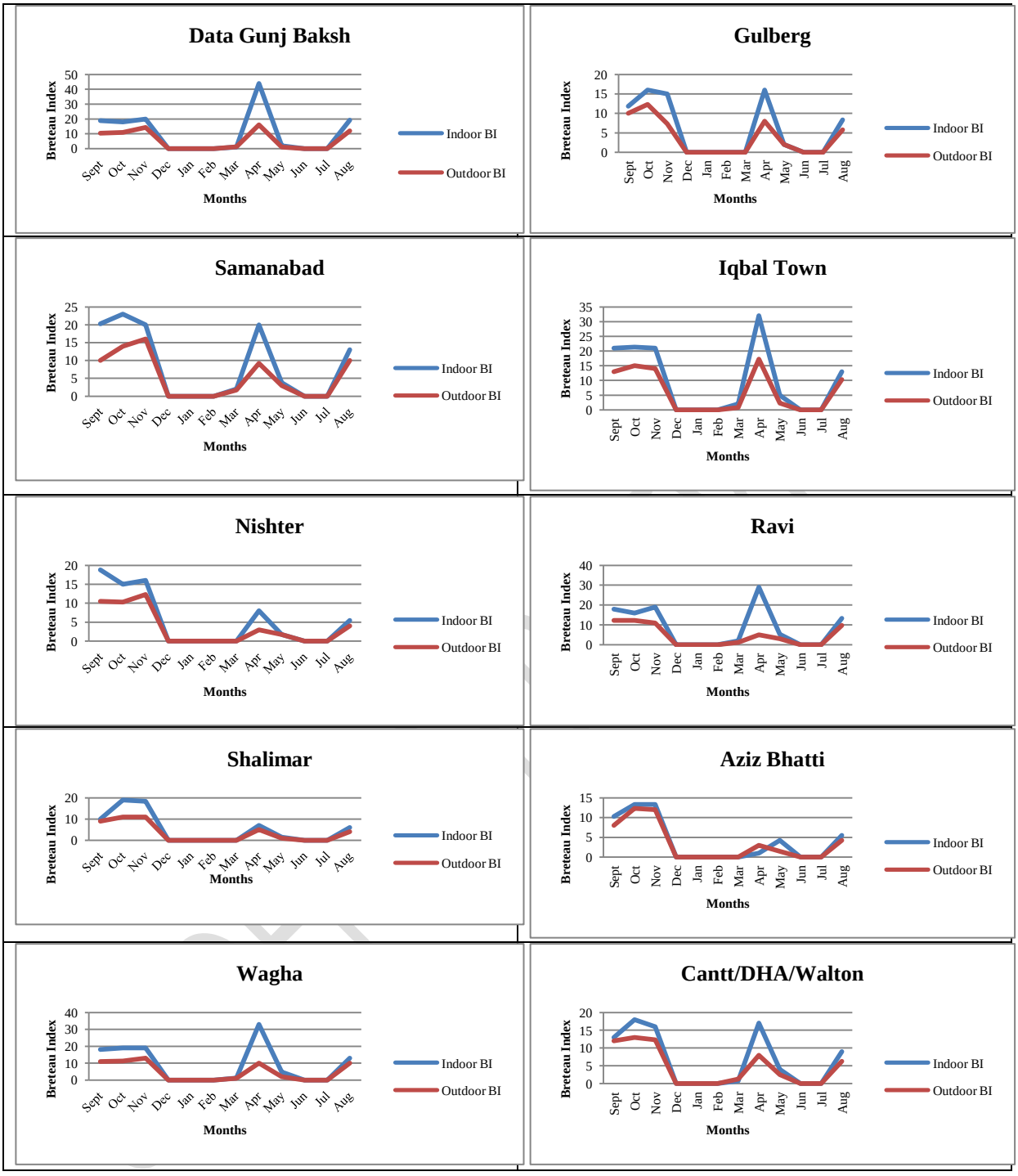

Fig. 8 Town wise indoor and outdoor Breteau Index

The mean of larvae was found significantly ($p < 0.05$) higher in the indoor residential area than the outdoor. The percentage of *Ae.aegypti* larvae recorded indoors is higher in Samanabad, Data Gunj Baksh and Iqbal Town (Fig. 9).

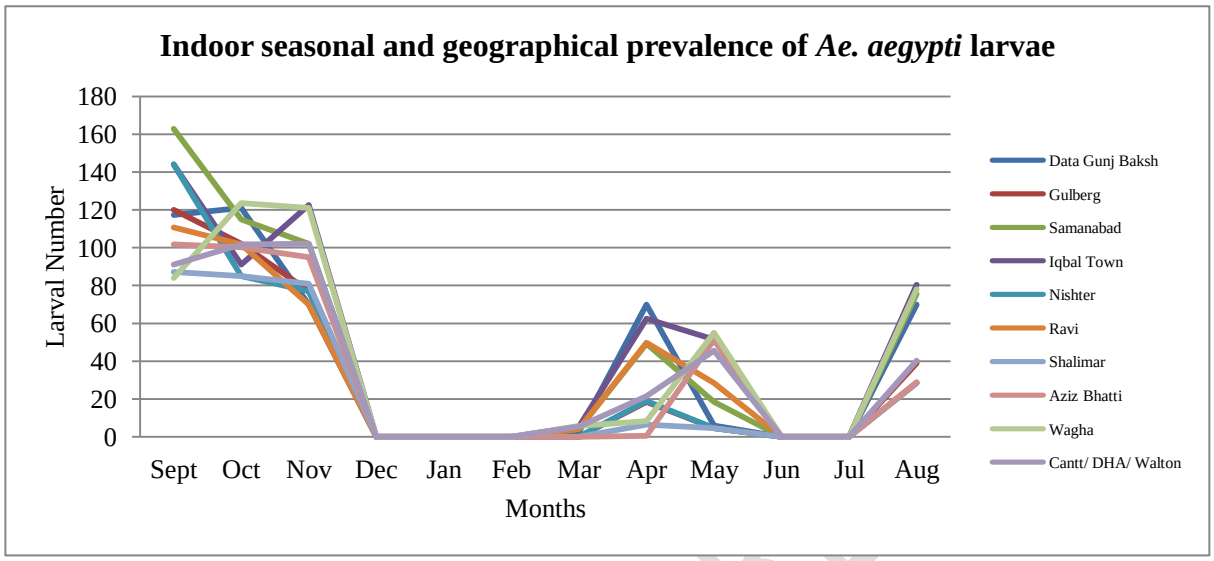

Fig. 9 Indoor seasonal and geographical prevalence of *Ae.aegypti* larvae in Lahore

From outdoor larvae studies, higher density was found in Ravi, Samanabad and Gulberg as shown in Fig. 10.

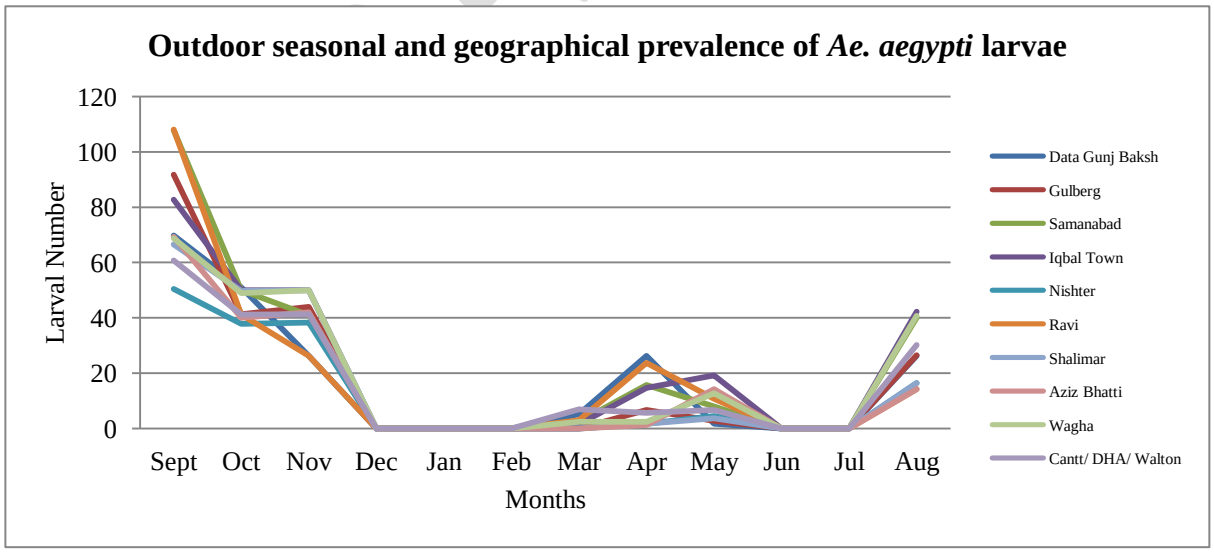

Fig. 10 Outdoor seasonal and geographical prevalence of *Ae. aegypti* larvae in Lahore

Continuous egg-collection, from ovitraps at 250 sentinel sites, distributed over ten towns in one year period, confirmed that *Ae. aegypti* is widely distributed in Lahore. Association between *Aedes* population densities and the socio-economic status of the inhabitants was observed, as the highest vector density (>9 BI) was found where people have the low life quality (Data Gunj Baksh and Iqbal town) and the low vector density (<5 BI) was observed at a site with high life quality like Aziz Bhatti town. Vector control interventions like thermal fogging could not be done properly in the areas like Data Gunj Baksh and Iqbal town due to narrow streets.

Ae. aegypti was found more prevalent during the months of September, October, November, March and April, as in the said months weather (temperature and humidity) is favorable for breeding. [11] reported the same observations in his study.

Indoor prevalence was reportedly significantly high as compared to outdoor; same was reported by Hawley in 1988 [12]**.** Prevalence of *Ae.aegypti* was also reported high during the months mentioned in our study by Qureshi et al 2017 and Jahan and Sarwar 2013 in urban Lahore, Pakistan [13-14]. *Aedes* mosquito prevalence was reported prevalent in slum areas and also in affluent areas[15]. same has been observed in our study. In **1956**, **Smith** reported that settlement sites had abundant natural and artificial water containers providing breeding places[16]. our study also confirmed the Smith observations. Various types of natural and artificial containers were found in residential sites which provided favorable habitat for *Ae. Aegypti* breeding in Dar es Salaam [17], same has been observed in Lahore. Rainfall in monsoon is a major cause to increase the dengue vector density and adult mosquito longevity [18].

It was found that water supply system was poor and water pipes were found damaged and leaking, making the breeding places. Current energy crisis also added dengue vector prevalence as continuous water supply is disconnected due to load shedding of electricity and people are compelled to store water in containers which are one of the major sources of raised prevalence [19]. The man made larval breeding places "old tires, used plastic bottles, air cooler, pipes, pots, open drainage etc" were commonly found. The open drains had stagnant water with fallen leaves and other debris blocking the drain and providing opportunity for breeding. Poor sanitary conditions and lack of cleanliness were the primary causes for dengue vector prevalence. There are many reasons for high indoor larval density but the larvicidal activities were poor inside the houses and most of the people did not even bother to search properly for the dengue larvae in their household water storages. For efficient control of dengue vector the integrated vector management is the best strategy.

Conclusion

It is concluded that *Ae. aegypti* is widely distributed in all the towns of Lahore but some areas like Iqbal town and Data Gunj Baksh town had high indoor prevalence. There is a visible impact of environmental conditions on the population of *Ae. aegypti* and found zero density in extreme temperature during winter and summer seasons.

Declaration

e. Ethics approval

The University Institute of Public Health Committee and the Research Ethics group of the University of Lahore gave ethical approval.

h. Consent for publication

All the authors agreed for the publication into this reputable journal.

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