Variation in the Temporal and Place Effects on the Dengue Fever Mosquito Vector *Aedes aegypti* (L.) in Jeddah Province

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Black - Hole light traps were operated during January 2013 until June 2014, in an attempt to pin point the variations based on place and time of the Dengue Fever Mosquito Vector (DFMV) population density. This was carried out in order to determine the relationship between its density and the prevailing conditions of temperature and relative humidity, as related to the actual positive cases of dengue fever infection. The study showed a continued presence of the mosquito vector throughout the year, with significant differences in the population density and the time of the vector recovery. The results also showed a negative correlation between population density and temperature, whereas a positive correlation with the relative humidity. Our results showed two seasonal prominent activity peaks during February and November, during the year 2013 with a projected indication that a high peak might occur in 2014.The population density showed variation, according to the locations where Um-Alsalm locality indicated significant recovery of dengue fever vectors. Khozam locality displayed the least recovery throughout the year. The highest dengue fever (DF) infection was recorded in Aziziyah, Old Airport and the University localities, followed by Khozam and Al-Balad localities. However, other localities are currently under investigation proved to have no reported cases of dengue fever (DF) infection throughout the year.

Key words: Dengue fever, Variation in the Temporal, Jeddah Province , *Aedes aegypti*.

Currently, there is an expected high possibility in the increase of the population numbers of a variety of mosquito vectors, carrying and causing human ailments and sufferings, aggravated by the omnipresent fearful scare of the Dengue Fever (DF). The DF is the most dreaded viral disease in most parts of the world (Divid *et al.*, 2003). In addition, recent reports indicated that newly DF infections might reach 50 million people annually (WHO, 2005). Biologically, the saliva of infective female vectors *Aedes aegypti* transmits the different incriminated virus serotypes that are causing the dengue fever. This occurs when they are feeding from the human host in order to produce eggs for their next generations. It is needless to mention that once the female is infected, it may be able to contract the dengue viruses throughout its lifetime (WHO, 1990). Moreover, contemporary ecological investigations on the effects of time and place variations on the population of the mosquito dengue vector in Saudi Arabia were very scarce or meager, but some previous field inventory surveys reported by (Mattingly and Knight, 1956) who documented the presence of 25 species from Eastern, Western and Southern Saudi Arabia. The most predominant mosquito species, based on reproduction and

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distribution was *Culex pipiens* Molestus as reported by Buttiker, (1981) whereas Wills *et al.*, (1998) reconfirmed the availability of a number of mosquito species from the Eastern region. Recently, Abdulla and Merdan, (1995) have conducted studies and indicated the presence of a great number of mosquito species in the South western region, within the Abha province. In addition to that, Al-Zaharani, (2001) was able to authenticate the presence of 19 mosquito species in Tihamma locality. More fieldwork on mosquito species was conducted by Al-Khraiji, (2005), who documented the widespread distribution of 15 mosquitoes species in Riyadh. Four of the 15 mosquito species belong to the genus *Anopheles*; 9 species belong to the genus *Culex*; and one species belongs to both *Aedes* and *Culiseta*. Ghrmah, 2010 used Clark traps to estimate the field population density, together with the evaluation of the efficacy of some insecticides against the dengue fever mosquito vector *Aedes aegypti*, in and around Jeddah province. The dominant mosquito genera and species that have become vital economically, together with the testing of their sensitivities to some insecticides was carried out on the predominant mosquito species *Culex pipiens,* in search of a more effective insecticide (Mahyoub, 2011). Finally, Al-Maghamsi, (2013) has studied the population dynamics of certain mosquito genera within Makkah Al-Mukarramah cosmopolitan city.

The main objectives of this study were to follow up and document the variations in the population density, based on time and place on the dengue fever mosquito vector (DFMV). This will be done by determining its seasonal activity throughout the year and by investigating the type and degree of correlation between the population density and the incidence of the assured cases of infection with the dengue fever. The population density mostly related to the concomitant conditions of climatic effects of increasing temperatures and relative humidity. Moreover, a base-line data involving population density will be generated according to the respective localities. Finally, a specific goal of determining the localities that have high, medium or low infection rate with positive cases of the dengue fever viruses will be reached.

Fig. 1. Localities of dengue fever mosquito sample collection.

MATERIAL AND METHODS

To achieve the desired objectives of the different localities those were selected to represent the metropolitan Jeddah city shown in (Fig. 1). Black hole light traps were operated weekly to monitor and collect mosquito species, by securing traps in the selected positions within the chosen localities for each day of the study before sunset, and to recover adult mosquito species overnight. The recovered mosquito samples were handled carefully for each day and from each locality. The samples were then kept each in 250 ml plastic containers, each with the relevant pertinent information registered on the labels of each container. On the labels, the numbers of *Aedes aegypti* from each trap and location were recorded. The climatic and the environmental data of temperature and relative humidity during the period of field surveys were obtained from the General Directorate of Metrology and Environmental Protection Bureau. This was collected with the aim of visualizing the effect of both factors on the seasonal activity of the dengue fever mosquito vector. At the same time, the number of positive

assured cases was provided by the primary health care centers that were supervised by the Directorate of Health Affairs of Jeddah city.

The experimental design used was a completely randomized design, where the analysis of variance (ANOVA), was carried out to determine the seasonal fluctuation of the mosquito vector. For comparison purposes, the population density was determined by using the least significant difference (LSD), at the 0.05 level of probability. In addition to that, the Pearson correlation coefficient was used to estimate the degree of correlation between temperature and relative humidity, and the positive assured cases caused by the dengue fever mosquito vector (DFV) SAS, 2001).

RESULTS AND DISCUSSION

Our results showed a continued presence of the dengue fever mosquito vector *A. aegypti* throughout the season, with significant differences based on the locality and time of collection. Moreover, the statistical analysis reflected two distinct activity peaks during February 2014, when the monthly average samples collected was 61.0 mosquito individuals, followed by an appreciable decrease in their numbers during the months of March and August of the same year. In addition to that, there was a clear recurrent resurgence with increasing numbers during September and October, with a second activity peak during November, which was characterized by a monthly average of mosquito samples collected at 69.5 of trapped mosquitoes. It was evident that there is no significant difference between the monthly average of trapped mosquitoes during January, December 2013 and January 2014. (Fig.2, Table 1.)

There were significant differences between the population density of the dengue fever mosquito vector (DFMV), based on data collected from different localities where mosquito numbers recovered from Um-Alsalm locality was highly significant throughout the year, whereas those recovered from Khozam locality were significantly low (Table 2.). The assured positive cases of infection were based on time and its relationship with the environmental conditions and population density of the dengue fever virus vector. These factors showed a positive correlation between the positive infection cases and the degree of temperature but not significant where r=0.133 and significant p=0.345. On the contrary, there was an insignificant or negative correlation with the relative humidity where r = -0.132 and a significant correlation p=0.343. Moreover, the correlation between the number of positive infection cases

Table 1. Comparison of the monthly average of the adult mosquitoes of *A. aegypti* mosquito recovered during January 2013 until January 2014

Month	Means of *Aedes aegypti*
January	50.75^{bcde}
February	61.00^{bc}
March	40.25^{defg}
April	43.50^{cdef}
May	46.25^{cde}
June	45.25^{cde}
July	39.25^{defg}
August	36.25^{efg}
September	20.50^{g}
October	23.75^{fg}
November	69.50^{ab}
December	75.50^{bcd}
January 2014	87.50^{a}
F value	6.52
LSD	20.302

* Means with the same letter are not significant difference at alpha = 0.05

Table 2. Differences in population density of the dengue fever mosquito vector from the sample collection sites during January 2013 until January 2014

Location	Means of *A. aegypti*
Umsalam	8.404^{a}
Al-Janoub	$3.\ 346^{de}$
Khozam	0.654^{g}
Al-Jameiah	7.25^{ab}
Al-Balad	1.019^{f}
Buraiman	5.769^{bc}
Al- Aziziyah	4.769^{cde}
Al sharafiyah	4.135^{cd}
Jeddah-al-jadidah	5.058^{cd}
Al-matar	4.385^{cde}
Obhur	3.00^{e}
F value	10.47
LSD	1.99

* Means with the same letter are not significant difference at alpha = 0.05

and the number of dengue fever mosquito vector population density was not significant with r=0.11 and a significant correlation p=0.409 (Figs 3-6). In addition, there were significant differences between the assured infection cases based on the months of the year, where the highest significant infection cases were reported during May and June within Jeddah premises, as compared to the rest of the months of the year (Table 3). Our results indicated differences between the number of assured infection cases, with dengue fever vector based on the number of samples recovered from the collection sites, where the localities and neighborhoods of Aziziyah, Old Airport and the University localities have reported the highest infection rate. The highest infection rate displayed a weekly average close to 5.0 assured infection cases, as compared to the infection rate in the localities of Al-Balad and Khozam, which was very low, with an average between 2.0 to 3.0 assured cases per week. The residential areas that are within the localities of Um-Alsalm, South, Briman, Al-Sharaffiah, New Jeddah, Obhor remained clear from any dengue fever infection (Fig 7).

Data analysis showed the continued widespread presence of the dengue fever mosquito vector throughout the year in Jeddah province as characterized by a clear variation in its population density fluctuation. This might be attributed to the combined effect of environmental conditions, especially to both factors of temperature and relative humidity, during the time of sample collection. Our results are in agreement with the previous studies that documented significant differences in the dengue mosquito vector population throughout the year, based on the time of collection, as it was affected by the climatic factors during the year (Farghal, 1974; Al-Kharaji, 2005; Ghrmah, 2010; Mahyoub, 2011; and Al-Harbi, 2013). Furthermore, this study showed vast differences in the population density of the dengue fever mosquito vector, based on the collection site, which might be because in these residential neighborhoods, intensive buildings were under

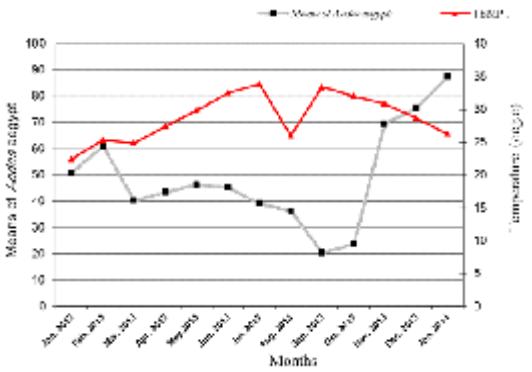


Fig. 2. The relationship between temperature and the dengue fever vector in Jeddah province during (2013-2014)

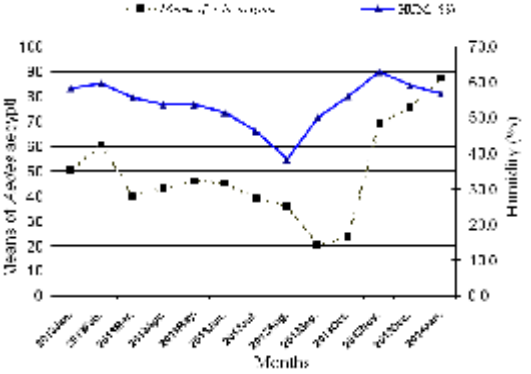


Fig. 3. The relationship between the relative humidity and the dengue fever vector in Jeddah province during (2013-2014).

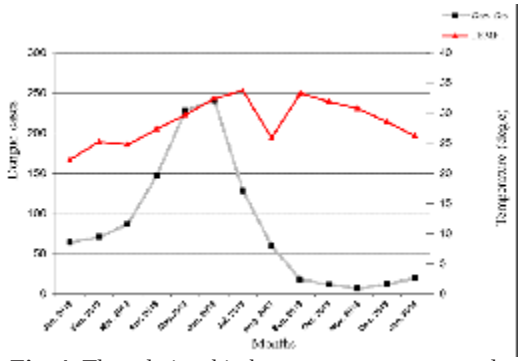


Fig. 4. The relationship between temperature and infection cases by the Dengue fever mosquito vector.

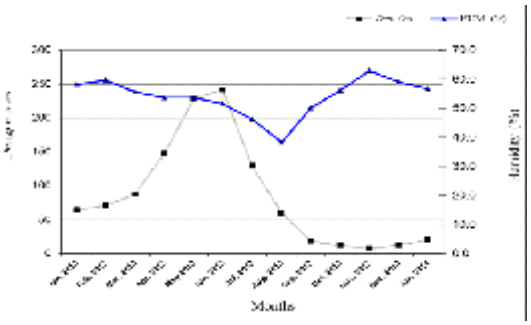


Fig. 5. The relationship between relative humidity and the infection cases by Dengue fever mosquito vector

construction. Buildings under constructions included botanical nurseries, a number of public parks and many small building blocks factories, which are considered the focus for breeding and multiplication of reproductive mosquitoes that belong to this particular genus. In addition to that and with the unavailability of water for construction, plenty of open uncovered water containers were used to conserve water for building purposes, as citizens were obliged to do so, this might be considered another factor for creating a favorable situation for conducive vector multiplication.

Our results were also in line with Al-Thabiany *et al.*, 2012, who conducted surveys on mosquitoes as related to water containers in the Holy city of Makkah Al-Mukarramah. His results proved the widespread presence of mosquitoes, especially in sites with uncovered water containers inside houses. This situation is considered favorable for *Aedes* mosquitoes to be most abundant. Our results showed and reflected the correlation between the assured dengue fever infection cases and the density of its vector population, based on the vector special behavior during feeding and piercing. This was because females of *A. aegypti* have the habit of feeding themselves from more than one host, which is different from other mosquito species. Therefore, this particular type of feeding behavior gave females an added advantage for widespread infection of the members of the same family. This behavior intrinsically created more opportunities for the females to complete their life cycles, within the house due to availability of hosts (Arunachalam *et al.*, 2010). The severely infected

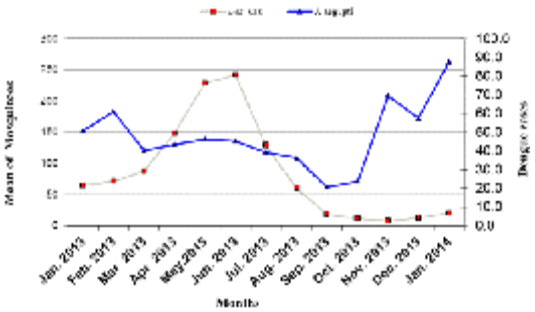
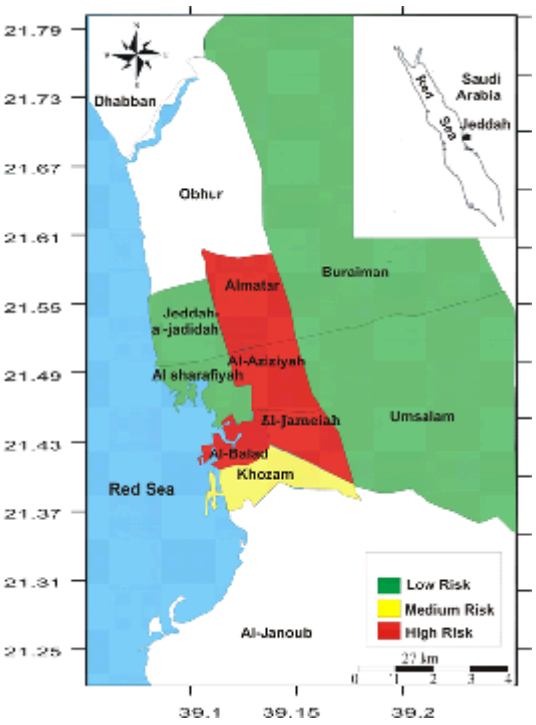


Fig. 6. The relationship between population density and the infection cases by the Dengue fever mosquito vector

Table 3. The comparative monthly average of the assured dengue fever infection cases during January 2013 until January 2014

Month	Means of *Dengue cases*
January	64.75[c]
February	71.25[c]
March	87.25[c]
April	147.75[b]
May	228.75[a]
June	241.75[a]
July	129.25[b]
August	60.00[c]
September	18.75[d]
October	12.00[d]
November	7.25[d]
December	12.50[d]
January 2014	20.50[d]
F value	35.12
LSD	34.89

* Means with the same letter are not significant difference at alpha = 0.05



Low risk: Mean of dengue 0- 2 / year
Medium risk: 2 <Mean of dengue 5 / year
High-risk: Mean of dengue 5 / year

Fig. 7. The numerical variation in the population density and infection cases by the Dengue fever mosquito vector at study sites

cases were restricted to the poorly impoverished localities where poor workers of private companies live in appalling conditions of overcrowding in residential quarters. These cases correspond with the seasonal periods for the outbreak of infection cases, during the second quarter of May-July. This witnessed a low population density of the dengue mosquito vectors outdoors, due to high temperatures, as shown from the study, with negative correlations between population density and the prevailing degree of temperature, reported previously by Khormi *et al*., 2013. Finally, our study found a negative correlation with temperature and a negative correlation with the relative humidity.

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