Quest Journals
Journal of Research in Environmental and Earth Sciences
Volume 7 ~ Issue 6 (2021) pp: 24-28
ISSN(Online) :2348-2532
www.questjournals.org

Research Paper

Association between Indoor Climate of Endophilic *Aedes Aegypti*and Dengue Fever Incidence in Jeddah, Ksa

Masroor AliKhan*; Esam Al-Wesabi, Imtinan AkramKhan; Rizwan Ahmed
Public Health Pest Laboratory, Municipality of Jeddah, KSA.,
**Corresponding Author: Masroor AliKhan*

ABSTRACT
Dengue fever is an emerging threat to the Kingdom of Saudi Arabia. The spread of dengue fever cases and the life cycle in close association to human dwellings. Therefore, the indoor climate is more relevant to vector life cycle and the transmission of the dengue virus than the distant weather factors.
A fortnight collection of Aedes aegypti from indoor and outdoor pre-marked points was done with the help of Black hole light traps. Spearman's correlation coefficient was used to establish the relationship between indoor climatic factors with recorded dengue fever cases and vector abundance.
High number of dengue fever cases were recorded between May to August when outdoor average temperature was very high with less relative humidity comparing to indoor household climate. Vector collection was recorded more indoors during day when the mosquito remains active. The outdoor collection was high during night. The household indoor climate plays a significant role in the abundance of mosquito vector and transmission of dengue fever virus.
KEYWORDS*: Indoor climate; Dengue fever,Endophilic, Aedes aegypti*

Received 26 May, 2021; Revised: 07 June, 2021; Accepted 09 June, 2021 © The author(s) 2021. Published with open access at www.questjournals.org

I. INTRODUCTION:

Dengue fever is a mosquito borne viral infectious disease which is transmitted to humans by the bite of an infected female *Aedes aegypti* or *Aedes albopictus* mosquitoes. The dengue fever is prevalent in tropical and subtropical countries with hot and humid climate.

WHO (2019) estimated that there is a 30-fold increase in dengue fever incidence over the past 50 years. The spatial distribution of dengue vector *Aedes* aegypti has also increased (Gonzalez FJ et al, 2013).

Dengue fever is an emerging threat to Saudi Arabia. The disease is already prevalent in the South-West and is endemic in Jeddah, Makkah, Jazan and other satellite towns. The spread of dengue cases and mosquito abundance in the region is due to many variable climatic factors such as high humidity, temperature, precipitation. Urbanization, demographic changes, travel, lack of sanitation, inadequate water supplies are helping the vector mosquito to spread (Al Shehri 2013). As suggested (WHO, 2014) that the *Aedes aegypti* usually spend all its life near its breeding place. Therefore, the indoor climate of a locality is more relevant for the mosquito life than the distance weather (Ehelepole et al 2015).

The dengue fever virus was first isolated in 1994 from Jeddah (Fakeeh & Zakie 2001) since than the dengue fever cases increased many folds (Al-Ghamdi et al,2009). Local weather factors of the city are quite favorable for the spread of *Aedes* mosquito and dengue fever incidence (Al Shehri 2013). With the extensive efforts of the Jeddah Municipality and Ministry of health the dengue fever cases and mosquito abundance are very much restricted. Despite significant reduction in morbidity and mortality of dengue fever, the disease remains a serious Public Health issue in and around Jeddah city.

The transmission of dengue virus from vector mosquito to human beings is greatly influenced by local indoor climatic conditions (generally refers to the specific climatic conditions within a small area), human behavior and demography (Hales, S, 2002). Most of the studies carryout in this region are on the mosquito bionomics and the relationship between general climate of the city (Macroclimate) and mosquito abundance with dengue fever cases. The focus of this study is to examine the relationship between the dengue fever cases with local indoor climate and mosquito vector abundance. Indoor climate is usually ignored and general climate of the city is taken into consideration. Murdock et al. (2017) suggested that the parameters related to outdoor climatic conditions do not reflect indoor climate of *Aedes* mosquitoes. Unfortunately, very little literature is available on the *Aedes* mosquito abundance and dengue fever cases in relation to indoor climate. The breeding places of *Aedes aegypti* are found in the close vicinity of human dwellings and inside the houses and adult mosquitoes mostly rests indoors (endophilic). The correlation between entomological study and indoor climate with dengue fever incidence is significant for better understanding and solving the problem.

II. MATERIAL AND METHODS:

This study was conducted during 2016 to 2018, in Jeddah which is main entry point to holy city Makkah and receives millions of pilgrims throughout the year from every corner of the world to perform Umrah and Hajj. Jeddah is also a cosmopolitan business hub and seaport at the west coast of the kingdom (Lat. 21.29N & Long. 39.7 E). Climate of Jeddah is hot with relatively high temperatures and high relative humidity; the annual rainfall is very low. Annual average mean temperature is approximately 30°C and relative humidity 54% rainfall is very little in this region with an average of 6 mm annually. The indoor climate of *Aedes* aegypti was studied with thermometer and hygrometer to record the temperature and relative humidity usually due to its endophilic behavior. Fortnight collection was done to assess the density of the mosquito which was recorded by trapping the *Aedes* aegypti with the help of light traps installed indoors and outdoors at different areas of the city and its satellite towns. The *Aedes* females were identified with their morphological features. The outdoor climatic data was taken from National meteorology & Environmentcenter, Jeddah; the indoor climatic factors such as temperature and humidity were recorded inside the selected houses from where the presence of mosquito larvae was reported by surveillance team.

Statistical analysis was used to find out spearman's correlation coefficient and to establish the relationship between local microclimatic weather factors and dengue fever cases with vector abundance.

III. RESULTS AND DISCUSSION:

The recorded outdoor average temperatures during study period was 29.6^0C (Maximum Avg. 47.6^0C) and indoor average was 25.4^0C (Minimum Avg.25^0C) while relative humidity outdoor average was 54.1% and indoors 57% (Table: 2). Total number of female *Aedes* collected from different outdoor locations during three years was 58785 out of which day time outdoor collection was only 8843 females. And indoor collection was 61859 females (Table: 1).

High number of dengue cases were recorded between May and August when the outdoor temperature was very high during day and indoor temperature was cooler than outside (Table: 3). A comparative study of high and low dengue fever cases gives an idea of role of indoor climatic factors in the transmission of virus and *Aedes* abundance (Hayden 2010).

Buttikar, (1981) mentioned that in Saudi Arabia the temperature in the months of July & August is very high outdoor which may be lethal for the adult mosquito survival. The indoor collection was more during this study due to low temperature inside. Indoor climatic variables significantly influence the adult mosquito's abundance. (Evans MV et al., 2019)

The spearman's correlation values indicate that both the outdoor climatic and indoor climatic conditions of Jeddah city have a positive correlation between *Aedes* population with humidity and dengue fever cases. However, temperature has a negative correlation with both the parameters (*Aedes* density & dengue fever cases) (Table: 4).

The indoor and outdoor environment of *Aedes* mosquito breeding places exhibit a lot of variations. Temperature and relative humidity can vary greatly between indoor and outdoor environments (Cator LJ et al, 2013). The difference between outdoor and indoor collection of *Aedes* mosquito depends on the temperature and relative humidity prevailing inside and outside houses (Juliano et al, 2002). The indoor base temperature and relative humidity represents the microclimate which is important for the survival of mosquito larvae.Due to lack of vegetation in this area of study the indoor temperature is usually lower than outdoor temperature while relative humidity is also higher indoors. The temperature and relative humidity outside houses may not be good indicators of people's health as most of the time they spend their time indoors (Murdock et al, 2017).

The indoor climate variables are mainly responsible for transmission of dengue fever virus and have profound effect on the life history of dengue fever vector mosquito *Aedes aegypti*(Colwell et al 1998; Patz et al 2000 and Ratho et al2005.)

Outdoor climate:

According to the spearman's correlation in Marco climatic conditions(in Jeddah from 2016 to 2018) a positive correlation was found between the *Aedes* population with humidity (0.058) and dengue cases (0.070). However, temperature have the negative correlation with dengue cases (-0.104) and *Aedes* population (-0.089). According to our studies humidity have the positive correlation with dengue cases (0.986) and *Aedes* population (0.058)

Indoor climate:

According to the spearman's correlation in indoor climatic conditions a positive correlation was found between the *Aedes* population with humidity (0.021) and dengue cases (0.021). However, temperature have the negative correlation with dengue cases (-0.046) and *Aedes* population (-0.0265). According to our studies humidity have the positive correlation with dengue cases (1.000) and *Aedes* population (0.021).

IV. CONCLUSION:

Present study suggests the importance of indoor climatic conditions especially high Relative humidity and the low average temperature in the transmission of dengue fever virus and the abundance of its vector *Aedes aegypti*.

The outdoor climatic effects (Macroclimate) cannot be ignored as previous studies suggested their role in dengue fever spread in the study area. The present findings may help in improving the control measures keeping in mind the household microclimate.

ACKNOWLEDGEMENTS:

We are thankful to all our colleagues and friends for the continues help and support during this study. We are grateful and indebted to Public Health Pests Laboratory, Al Amana, Jeddah for providing the facilities to carry out this study.

REFERENCES:

[1]. Al shehri MSA. Dengue fever outburst and its relationship with climatic factors. World Appl. Sci. J. 2013; 22(4):506-515. 23

[2]. Al-Ghamdi K, Alikhan M, Mahyoub J. Role of climatic factors in the seasonal abundance of *Aedes* aegypti L. and dengue fever cases in Jeddah province of Saudi Arabia. Curr. World Environ. 2009; 4(2):307-312

[3]. Buttiker. Observation on urban mosquitoes in Saudi Arabia. Fauna of Saudi Arabia. 1981; 3:472-479

[4]. Cator LJ, Thomas S, Paaijmans KP, Ravishankaran S, Justin JA, Mathai MT, et al. Characterizing microclimate in urban malaria transmission settings: a case study from Chennai, India. Malar J. 2013; 12:84.

[5]. Colón-González, F. J., Fezzi, C., Lake, I. R., & Hunter, P. R. (2013). The effects of weather and climate change on dengue. PLoS neglected tropical diseases, 7(11), e2503. https://doi.org/10.1371/journal.pntd.0002503

[6]. Colwell RR, Epstein PR, Gubler D, Maynard N, McMichael AJ, Patz JA, Sack B, Shope R (1998) Climate change and human health. Science 279:963

[7]. Evans MV, Shiau JC,Solano N, Brindley MA, Drake JM, Murdock CC, 2018. Carry-over effects of urban larval environments on the transmission potential of dengue-2 virus. Parasit Vectors 11: 426.

[8]. Ehelepola N D B, Ariyaratne Kusalika, Buddhadasa, W M N P, Ratnayake, Sunil and Wickramasinghe Malani, A study of the correlation between dengue and weather in Kandy City, Sri Lanka (2003 -2012) and lessons learned, l. Infectious Diseases of Poverty (2015) 4:42 DOI 10.1186/s40249-015-0075-8

[9]. Fakeeh, M. and A.M. Zaki, 2001. Virologic and serologic surveillance for dengue in Jeddah, Saudi Arabia, The American Journal of Tropical Medicine and Hygiene, 65: 764-767.

[10]. Hales, S., N. Wet and W.A. Maridonald, 2002. Potential effect of population and climate changes on global distribution of dengue fever: An emprirical model. Lancet, 360: 830-834.

[11]. Juliano SA, O'Meara GF, Morrill JR, Cutwa MM. 2002. Desiccation and thermal tolerance of eggs and the coexistence of competing mosquitoes. Oecologia 130:458- 469.

[12]. Mary H. Hayden, Christopher K. Uejio, Kathleen Walker, Frank Ramberg, Rafael Moreno, Cecilia Rosales, Mercedes Gameros, Linda O. Mearns, Emily Zielinski-Gutierrez, and Craig R. Janes Microclimate and Human Factors in the Divergent Ecology of *Aedes* aegypti along the Arizona, U.S./Sonora, MX Border EcoHealth 7, 64–77, 2010

[13]. Masroor Ali Khan, Shabaan Elhossary, Imtinan Akram Khan, Mohammad H Al Zahrani, Fahad S Al Zahrani and Fasial M Al Bashri The impact of climatic variables with GIS application on the abundance of medically important mosquitoes (Diptera: Culicidae) in Jeddah, Saudi Arabia International Journal of Mosquito Research 2018; 5(5): 12-18

[14]. Masroor Ali khan, Khalid Al Ghamdi, Jazem A. Mehyoub, Rakhshan Khan ElNino related climate and dengue fever cases in Jeddah, Saudi Arabia FLORA AND FAUNA - 2019 Vol. 25 No. 1 PP 91-99

[15]. Murdock CC, Evans MV, McClanahanTD, Miazgowicz KL, Tesla B, 2017. Fine-scale variation in microclimate across an urban landscape shapes variation in mosquito population dynamics and the potential of *Aedes* albopictus to transmit arboviral disease. PLoS Negl Trop Dis 11: e0005640.

[16]. N D B Ehelepola, Kusalika Ariyaratne, W M N P Buddhadasa, Sunil Ratnayake and Malani Wickramasinghe A study of the correlation between dengue and weather in Kandy City, Sri Lanka (2003 -2012) and lessons learned. Infectious Diseases of Poverty (2015) 4:42

[17]. Paaijmans KP, Imbahale SS, Thomas MB, Takken W. Relevant microclimate for determining the development rate of malaria mosquitoes and possible impliations of climate change. Malar J. 2010; 9:196. https://doi.org/10.1186/1475-2875-9-196 P

[18]. Patz JA, McGeehin MA, Bernard SM, Ebi KL, Epstein PR, Grambsch A, Gubler DJ, Reiter P, Rombieu I, Rose JB, Samet JM, Trtanj J (2000) US national assessment on climate change: health report. Environmental Health Perspectives 108(4):367–376

[19]. Ratho RK, Mishra B, Kaur J, Kakkar N, Sharma K (2005) An outbreak of dengue fever in periurban slums of Chandigarh, India, with special reference to entomological and climatic factors. Indian Journal of Medical Science 59(12):518–526

[20]. World Health Organization: http://www.who.int/denguecontrol/mosquito/ en (2014). Accessed 20 February 2014

[21]. WHO (2020) "Dengue and severe dengue" Global stategy for dengue prevention and control.2012-2020. Annual Report.

Table: 1 Total No. of female *Aedes* trapped outdoor and indoor during 2016-18 in Jeddah.

Year	Total *Aedes* Mosquitoes (N=58785)	Outdoor collection		Total Indoor collection (N=61859)
		Aedes collected during day time (n=8843)	*Aedes* collected during night time (n=49942)	
2016	26921	4094	22827	20810
2017	17363	2335	15028	17518
2018	14501	2414	12087	23531

Table: 2 Showing the Maximum and Minimum outdoor and indoor Temperature and Relative Humidity during 2016-18 in Jeddah.

Year	Temp. (^{0}C)		RH (%)		Ave. Range		Average Temp. & RH			
							Outdoor		Indoor	
	Max	Min	Max	Min	Temp.	RH	Temp	RH	Temp	RH
2016	42	27	66	46	34	56	29.7	54	25.2	58.8
2017	47	23	68	45	34	56.5	29.4	54.9	25.9	56.9
2018	42	28	65	44	34	54.5	29.8	53.5	25.1	55.3

Table: 3 showing total number of dengue cases Month wise during 2016-18 in Jeddah.

DENGUE FEVER CASES			
Month	**2016**	**2017**	**2018**
January	179	250	141
February	144	200	133
March	259	221	194
April	729	254	544
May	955*	491*	699
June	799	483	818*
July	587	281	520
August	182	63	102
September	125	59	99
October	101	82	54
November	99**	60	30**
December	145	58**	59
Total	**4304**	**2502**	**3393**

*Maximum No. of Dengue cases
**Minimum No. of Dengue cases

Table: 4 The spearman's correlation values indicate that both the outdoor climatic and indoor climatic conditions of Jeddah

Correlations

			aedes	temp	humidity	Cases
Spearman's rho	aedes	Correlation Coefficient	1.000	-.089	.058	.070
		Sig. (2-tailed)		.607	.739	.685
		N	36	36	36	36
	temp	Correlation Coefficient	-.089	1.000	-.114	-.104
		Sig. (2-tailed)	.607		.507	.547
		N	36	36	36	36
	humidity	Correlation Coefficient	.058	-.114	1.000	.986**
		Sig. (2-tailed)	.739	.507		.000
		N	36	36	36	36
	Cases	Correlation Coefficient	.070	-.104	.986**	1.000
		Sig. (2-tailed)	.685	.547	.000	
		N	36	36	36	36

**. Correlation is significant at the 0.01 level (2-tailed).

Correlations

			aedes	temp	humidity	denguecases
Spearman's r	aedes	Correlation Coefficient	1	-0.265	0.021	0.021
		Sig. (2-tailed)	.	0.118	0.905	0.905
		N	36	36	36	36
	temp	Correlation Coefficient	-0.265	1	-0.046	-0.046
		Sig. (2-tailed)	0.118	.	0.79	0.79
		N	36	36	36	36
	humidity	Correlation Coefficient	0.021	-0.046	1	1.000**
		Sig. (2-tailed)	0.905	0.79	.	.
		N	36	36	36	36
	denguecases	Correlation Coefficient	0.021	-0.046	1.000**	1
		Sig. (2-tailed)	0.905	0.79	.	.
		N	36	36	36	36

** Correlation is significant at the 0.01 level (2-tailed).

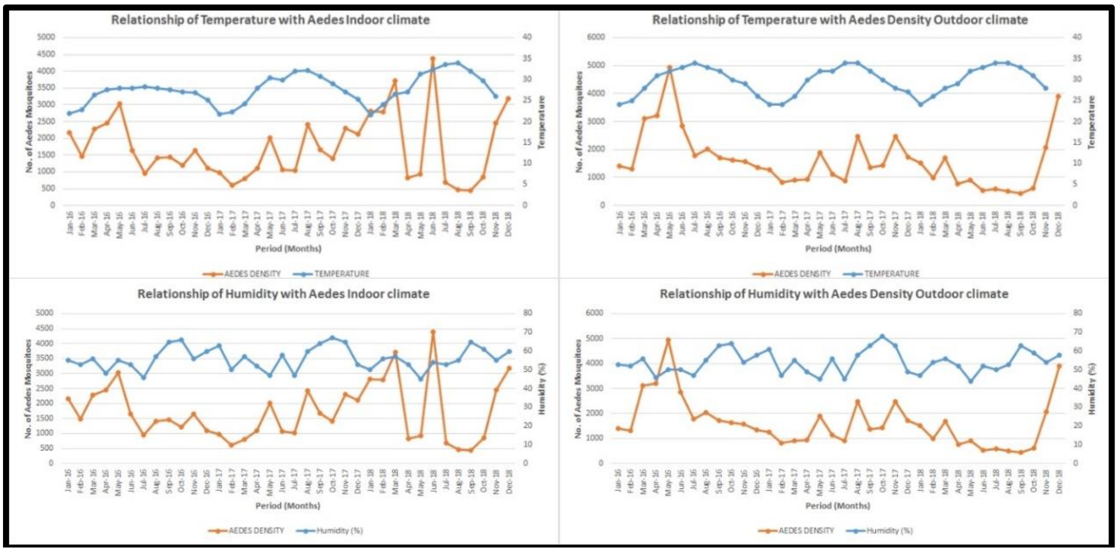

Fig 1: Showing Relationship of Temperature and relative Humidity with the densities of *Aedes* Mosquitoes collected during Jan 2016 to Dec 2018 in indoor and outdoor climatic conditions.

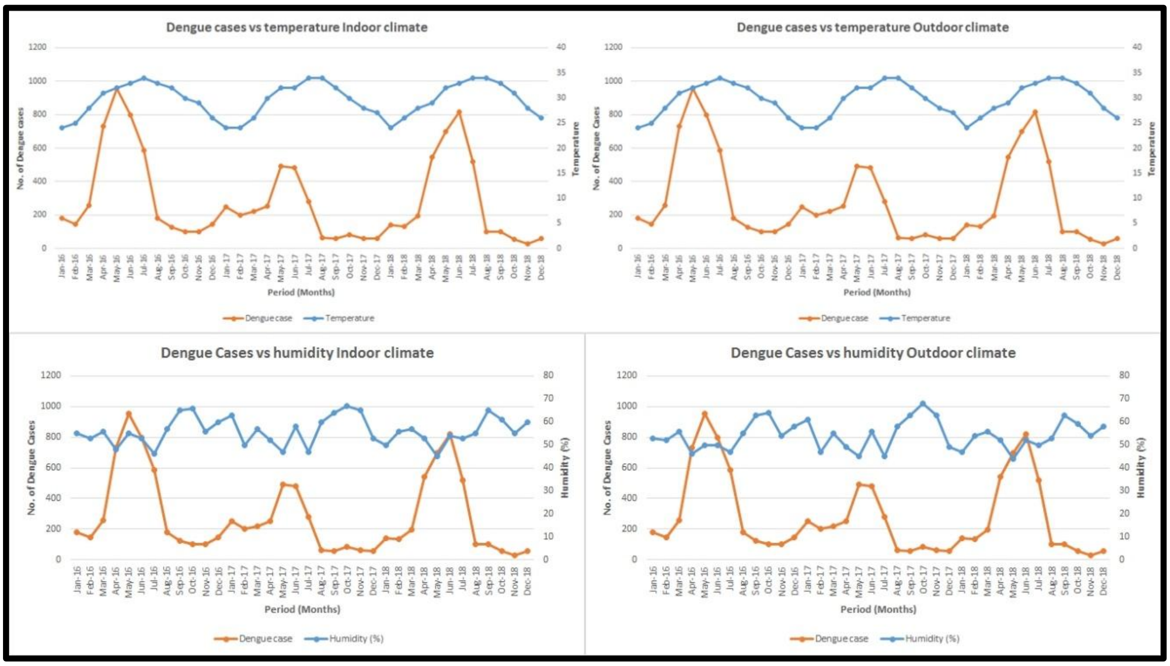

Fig 2: Showing association of Dengue cases with Abiotic factors (Temperature and Relative Humidity) during Jan 2016 to Dec 2018 in indoor and outdoor climate.