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El Nino related climate and dengue fever cases in Jeddah, Saudi Arabia

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ABSTRACT

The focus of this study is to find the relationship between El Nino and dengue fever cases in the study area.Mosquito density was recorded with the help of light traps and through aspirators collection. Climate data were obtained from National Meteorology and Environment centre. (Year wise El Nino and La Nina data are according to NOAA & Golden Gate Weather Services). Statistical methods were used to establish the correlation coefficient between different factors.

A high significant relationship was observed between Relative Humidity and Dengue fever cases, but *Aedes* abundance had no significant relationship with either Relative humidity and Temperature. Our conclusion is that the El Nino does not affect the dengue transmission and Aedes mosquito abundance in this region, which is supported by earlier works.

Figures : 06 References : 37 Tables : 03

KEY WORDS : Aedes, Climate, Dengue fever, El Nino, Mosquito density.

Introduction

Changes in the temperature and the atmospheric pressure in the Pacific Ocean(ENSO- El Nino Southern Oscillation& La Nina) influences the dengue fever and abundance of *Aedes* mosquito species in different parts of the world. It was observed that the dengue transmission is synchronized with El Nino in eight South-east Asian countries[32]. There is almost no study on the relationship between *Aedes* mosquito abundance, Dengue transmission and El Nino phenomenon in this region of Saudi Arabia where dengue fever cases are increasing.

El Nino Southern Oscillation is a climatic change of the Pacific Ocean which causes year to year variability and influences the world climate. The El Niño Southern Oscillation (ENSO) comprises changes in sea surface temperatures in the Pacific Ocean (El Niño) and in atmospheric pressure across the Pacific basin (Southern Oscillation). In some cases, El Niño (a warm event) is followed by La Niña[37] (a cold event). Despite ongoing mosquito control methods by different agencies, the dengue fever cases are not declining. The global warming and El Nino Southern Oscillation bring the anomalies in climatic conditions and affecting the density of mosquitoes. ENSO may also act indirectly by causing changes in water storage practices brought about by disruption of regular supplies. Dengue transmission is strongly influenced by environmental conditions, human behaviour and demography. This is because the mosquitoes responsible live in close contact with humans in urban areas, laying their eggs in containers like drums, buckets, tyres, flowers pots and vases.

Dengue fever which is a mosquito borne viral disease is likely to be influenced by El Nino. A significant correlation between El Nino Southern Oscillation (ENSO) events and dengue epidemic was recorded in Indonesia and South America[12]. El Nino is not only responsible for

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TABLE-1 : Showing the intensities of El Nino and La Nina

El Nino			La Nina		
WEAK	MODERATE	STRONG	WEAK	MODERATE	STRONG
2006-07	2009-10	—	2011-12	2007-08	—
2011 to 2014 No El Nino			—	2010-11	—
2015-16 very strong El Nino and La Nina					

higher incidence of dengue fever cases but it also plays an important role in the density of mosquitoes. Every year hundreds of dengue patients die and thousands are hospitalized[37]. During 1997-98 a very strong El Nino effect was observed and reported a very high rate of Dengue transmission due to high temperatures which helped the mosquitoes to reproduce faster and spread dengue fever virus more efficiently[32].

The relationship between rainfall, the abundance of mosquitoes and outbreak of malaria is well documented[27]. There is no literature available on the relationship between mosquito density, climatic factors, dengue fever cases and El Nino effects in Saudi Arabia. Changes in climate affects the vector density and dengue fever cases both directly and indirectly[17].

There is an association between El Nino and mosquito borne diseases, The dengue fever cases are affected by changing climatic conditions[1,23].

Vector borne disease transmission and the primary vector of many diseases, the mosquitoes are very sensitive

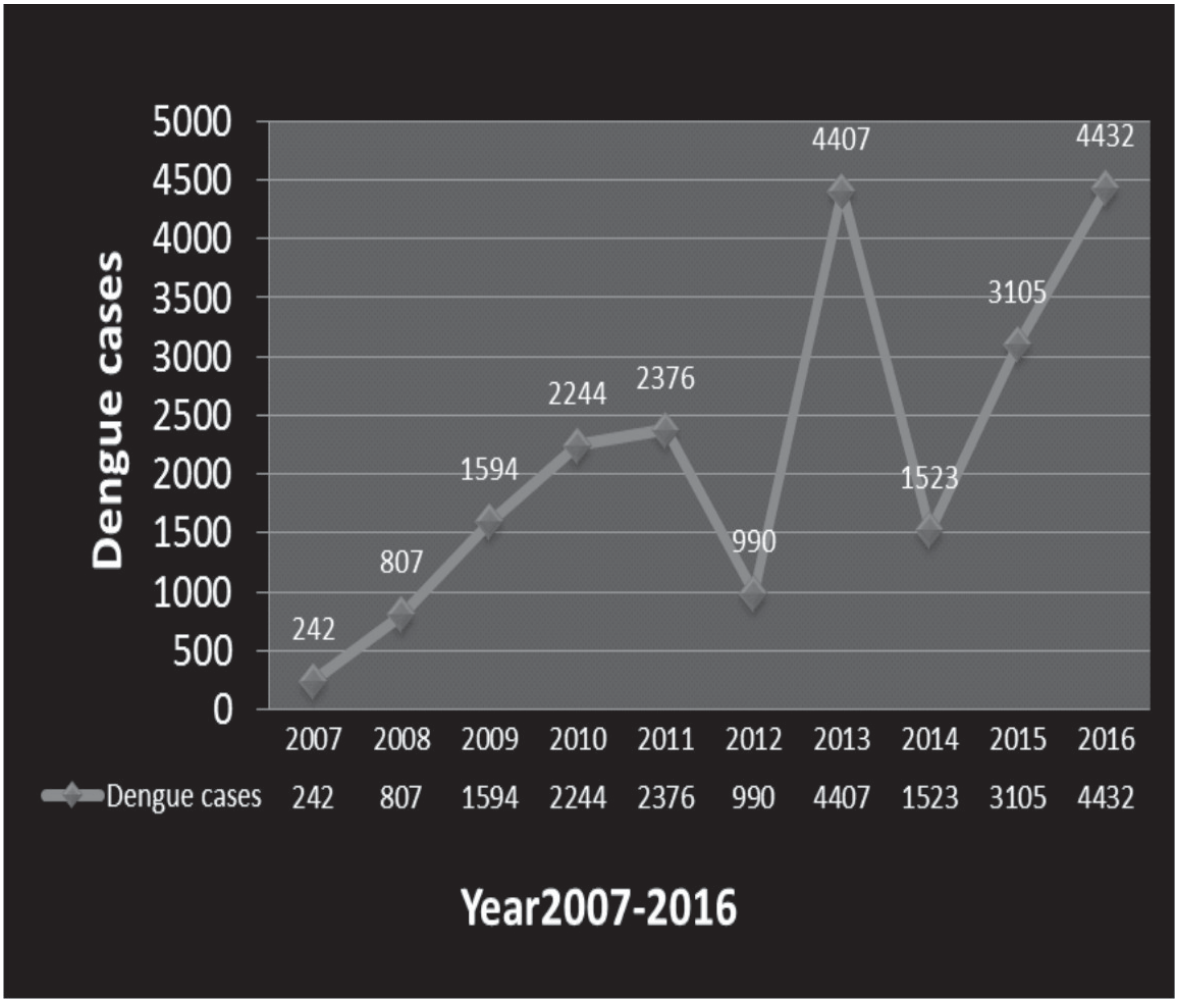

Fig.1 : Dengue fever cases from 2007 to 2016,Source: Ministry of Health Jeddah

TABLE-2 : Display of the total number of *Aedes* females collected and the number of positive dengue fever cases reported from 2007 to 2016.

Months Year 2007 to 2016	Total Dengue cases	Average Dengue cases	Total *Aedes* female collected	Average collection Of *Aedes*	Avrg. RH %	Avrg. Temp. ^{0}C
January	1152	115.2	6855	685.45	55.5	21.3
February	1211	121.1	5083	508.325	57.8	22.2
March	2287	228.7	6391	639.075	55.8	23.5
April	3561	356.1	4736	473.575	53.98	26.83
May	5865	586.5	5746	574.575	52.2	28.31
June	6840	684	4847	484.7	52.1	30.16
July	3753	375.3	4657	465.7	49.68	31.5
August	1480	148	5767	576.7	54.86	31
September	789	78.9	5392	539.2	62.77	29
October	507	50.7	5093	509.325	60	27.4
November	551	55.1	5965	596.45	58.2	24.84
December	1149	114.9	6892	689.2	58.8	23.4

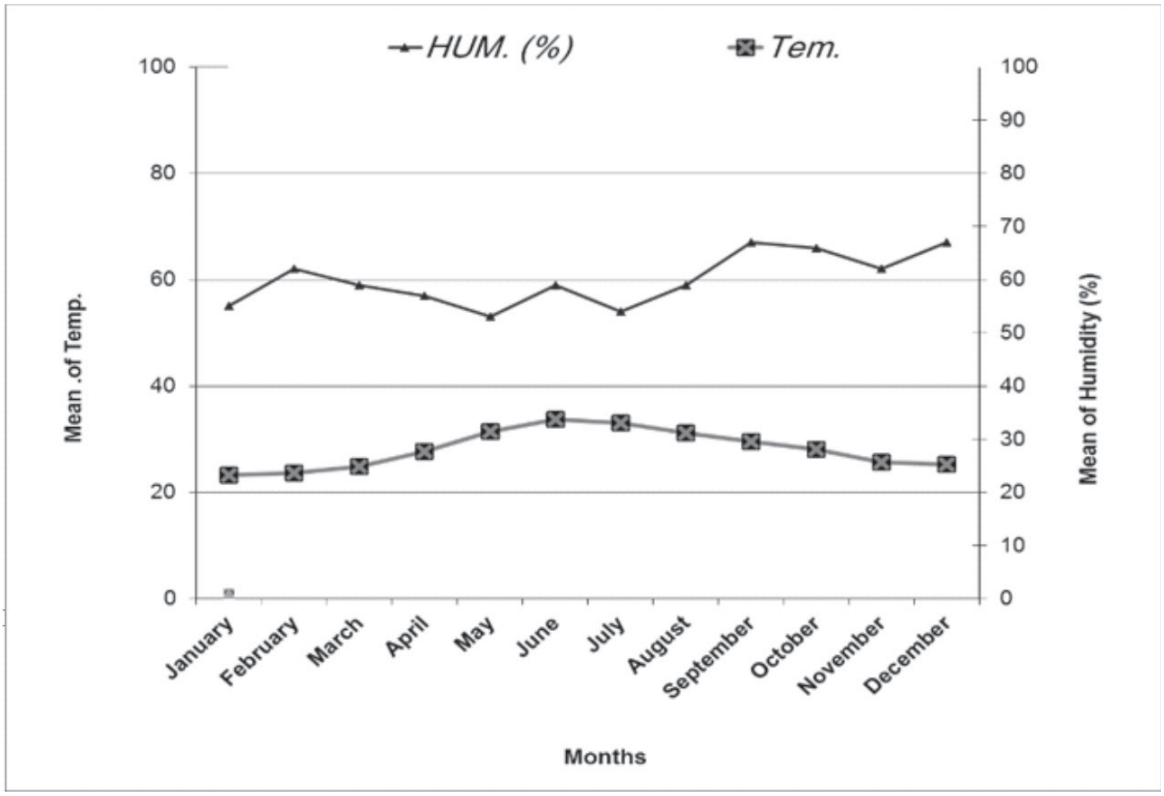

Fig.2: Mean temperature and humidity per month from 2007 to 2016

TABLE-3 : Pair wise comparison of parameters from 2007 - 2016

Parameters pairs	r*	P value
Density-Temperature	0.11	0.275
Density-Humidity	0.28	0.0042
Density– Dengue cases	-0.02	0.784
Temperature–Humidity	0.38	0.0001
Temperature– Dengue cases	0.14	0.157
Humidity- Dengue cases	-0.45	<0.00001

* spearman correlation coefficient

to temperature fluctuations and other factors of climate[1]. Increase in temperature decreases the intrinsic incubation period of the pathogens and vector becomes infectious more quickly[26]. Increase in temperature helps to accelerate the life cycle of the vector and bring changes in their behaviour[5,35].

Dengue fever mosquito, *Aedes aegypti's* population is controlled by environmental factors[6]. Many workers are of the opinion that the mosquito density and development may be determined by climatic conditions of the particular region[5,35].

Jeddah is a commercial centre of Saudi Arabia and is the gateway to Makkah. It is located at the junction of latitude 21^0 29 North and longitude 39^0 07 East[1]. The climate of this region is usually warm and very humid which provides ideal conditions for enhancing the vector population and rise in viral diseases including dengue fever cases. The scarcity of drinking water in this region and erratic water supply to the residential areas promote the water storage practices providing breeding places for the mosquito vectors specially *Aedes aegypti* which breed in urban environment and artificial containers[37]. The situation in this region of Saudi Arabia is very complicated in relation to dengue fever cases. The first dengue case[9] was reported from Jeddah in 1994, since then the number of dengue cases are showing an increasing trend, high number of dengue fever cases were reported during 2013 when the number reached to 4407 cases[4]. During 2016 the number increased to 4432. A worker studied the mean temperature of only four stations over Saudi Arabia and their relationshipwith ENSO phenomena[2].

The previous record of mosquito density and dengue fever cases indicates the possibility of outbreak and spread may be predicted. The focus of this study is

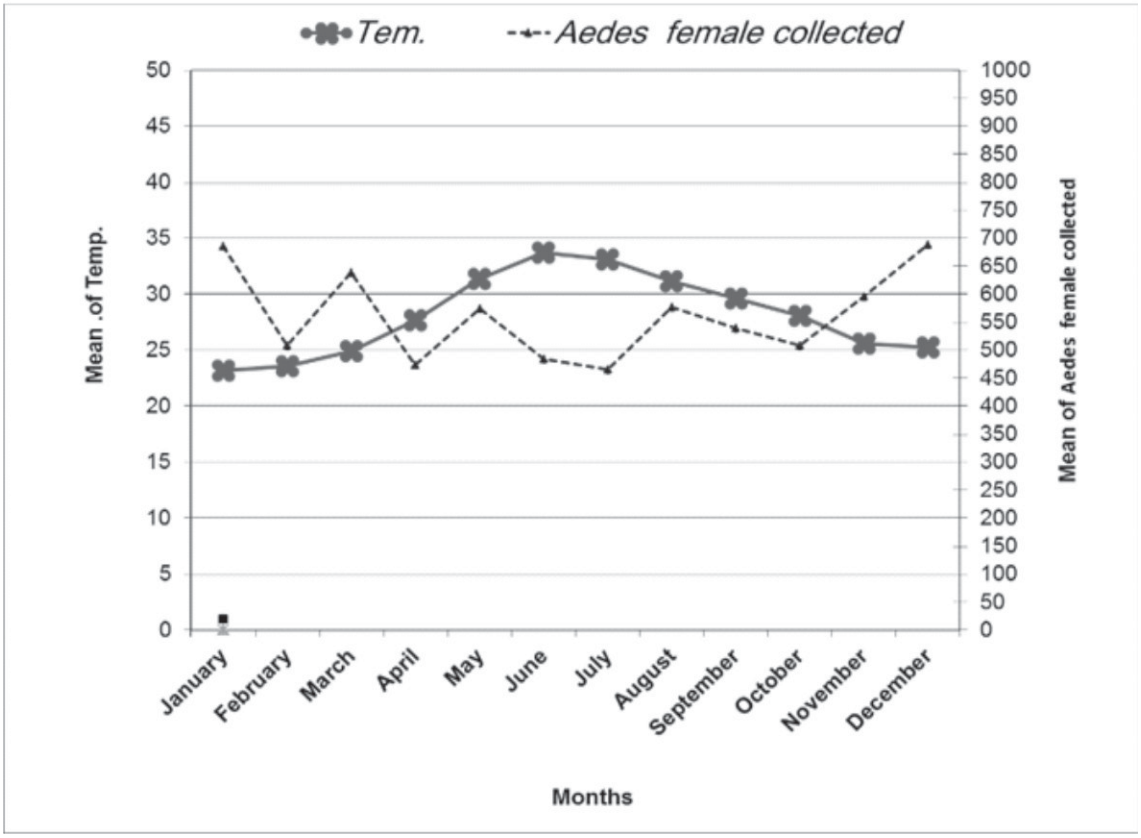

Fig.3 : Mean *Aedes* density and temperature per month from 2007 – 2016

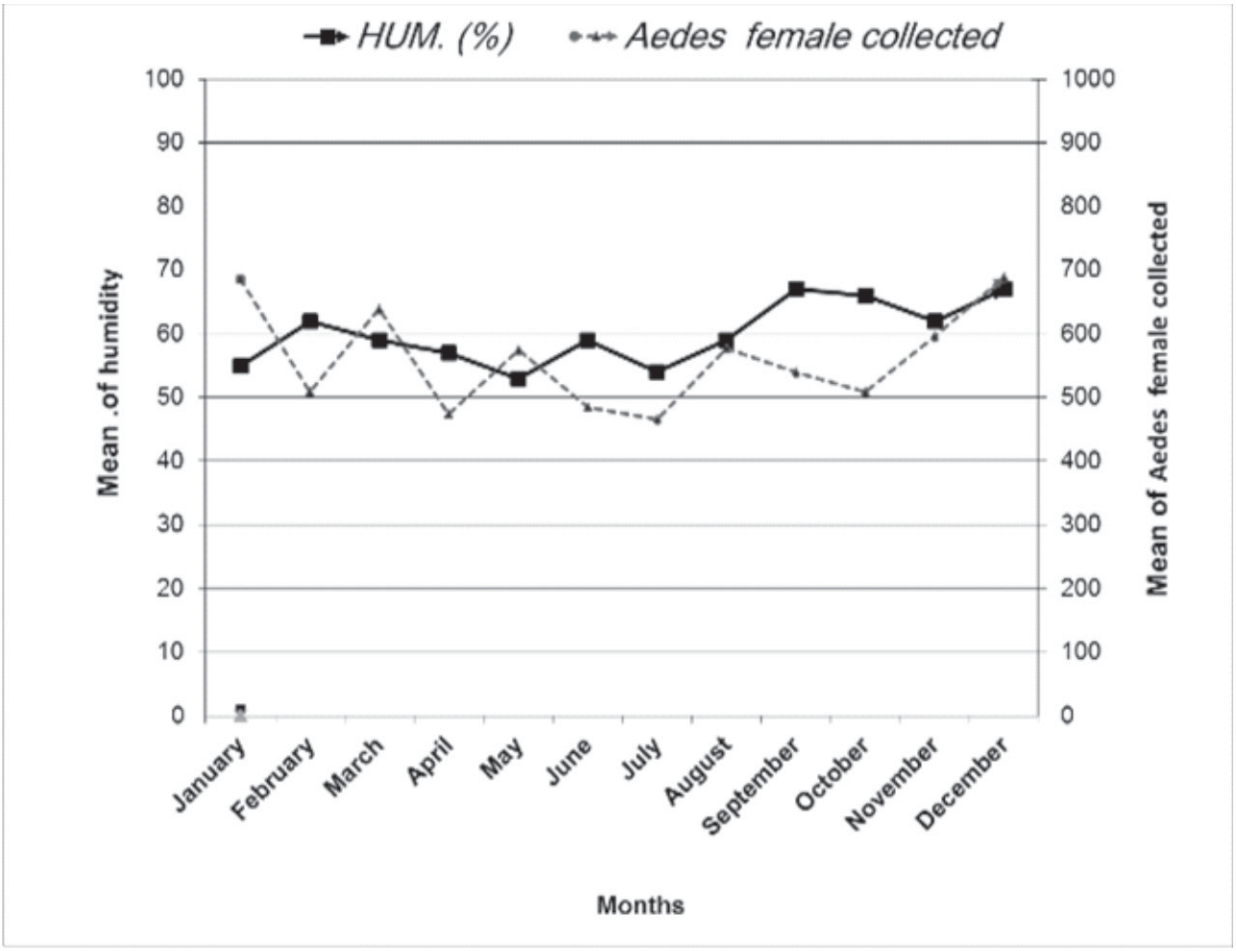

Fig.4: Mean *Aedes* density and humidity per month from 2007 – 2016

to find a relationship between ESNO, dengue fever and *Aedes* abundance in this region of Saudi Arabia.

Methodology

Annual dengue fever cases record was obtained from national ministry of health. *Aedes aegypti* mosquito population estimates were provided by Dengue Fever Research station, King Abdulaziz University, Jeddah. The density of mosquitoes especially *Aedes aegypti* was recorded by the Black Hole Light traps from various densely populated areas of the city. Trapped adult female *Aedes aegypti* mosquitoes were morphologically identified. Meteorological data were procured from National Meteorology & Environment centre, Jeddah. The data collected from 2006 to 2016 were taken into account to correlate the effects of El Nino and La Nina on the dengue fever cases and the abundance of *Aedes aegypti.* The classification of El Niño and La Niña years was according to Golden Gate Weather Services[14]. The El Nino and La Nina are categorized as weak, moderate or strong were downloaded from NOAA (National Centre for Environmental Information).

To determine the correlation between different weather parameters of Jeddah and the effects of El Nino on dengue cases and *Aedes* mosquito density the statistical methods were used to find out spearman's correlation coefficient. The data were analysed from 2007 to 2016 on monthly basis. The average maximum and minimum temperature, high and low humidity, precipitation during all these years were taken into consideration.

Results and Discussion

The main purpose of this research was to ascertain the influence of El Nino related weather patterns on the abundance of the *Aedes aegypti* mosquito and the number of dengue fever cases in Jeddah city. Climate of Jeddah city is usually hot and humid which contribute to the high density of *Aedes* mosquito population. Although the rainfall is very low in this region even then the mosquito population flourish due to water storage.Manmade water storage tanks and receptacles are the ideal place for the breeding of mosquitoes.

During 2015-16 the El Nino was very strong[31] while during 2007 to 2014 it was either moderate, weak or of no occurrences (Neutral) (Table-1). Spearman's correlation coefficient (Table 3) explains the 'r' value and

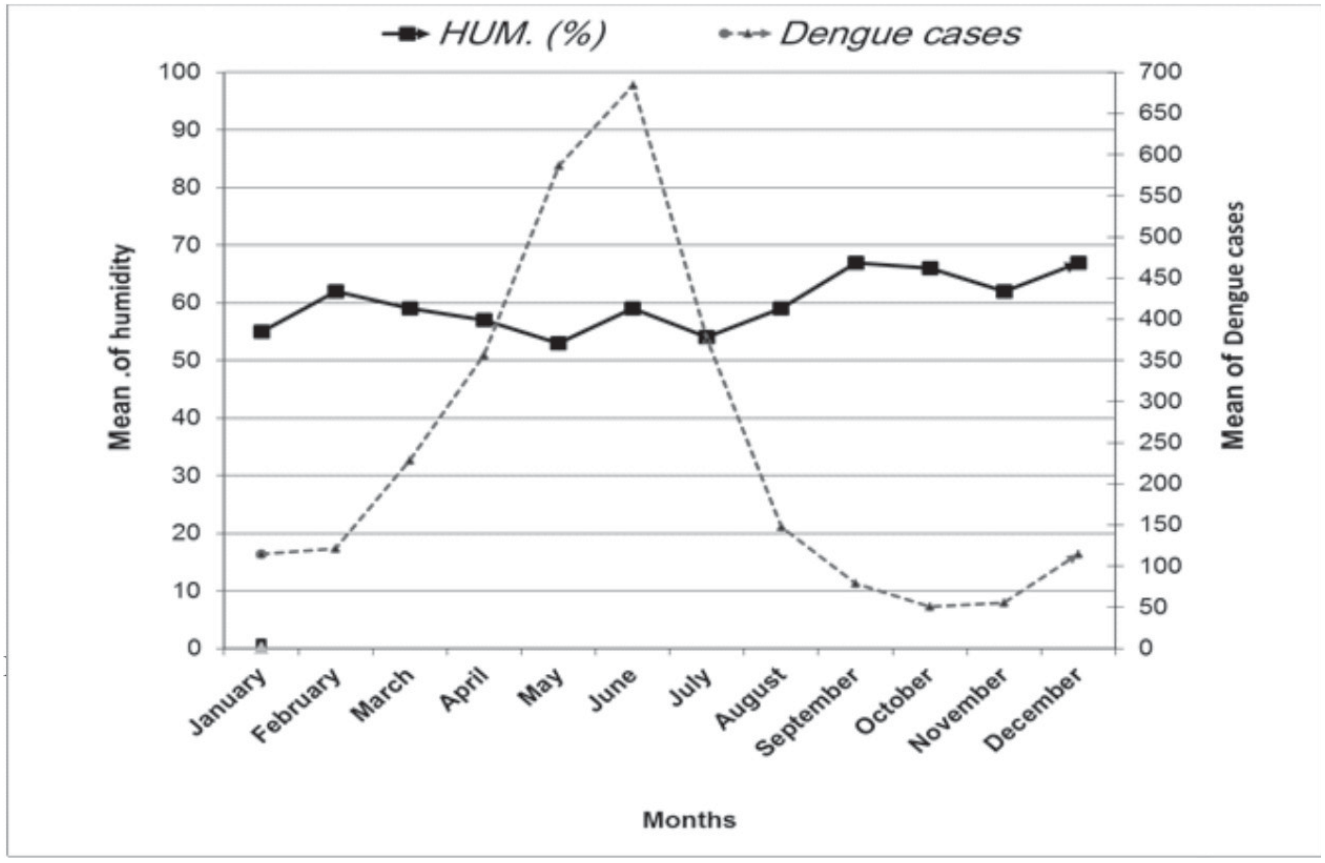

Fig. 5: Mean Dengue cases and humidity per month from 2007-2016

'p' value between dengue fever cases and *Aedes* mosquito abundance in relation to climatic parameters. There is high significant relationship between dengue fever cases & humidity. It was observed that temperature did not exhibit any significant relationship with the mosquito *Aedes* density. We could not find any significant correlation between different climatic parameters and dengue fever cases and mosquito density.

Highest number of dengue fever cases (4432) were reported during 2016 when a strong El Nino was present, but during 2013 when there was no El Nino effect, the reported dengue fever cases were almost same (4407). The rising trend of dengue fever cases from 2007 to 2011 may not be due to El Nino as during this period the effect was either weak or moderate. During 2011 to 2014 El Nino was not recorded[31].

On examination the relationship between ENSO and monthly dengue fever cases in Pacific Islands, there was positive correlation[19] while there was negative values in Vietnam[1,25]. The inconsistence nature of these association may be due to regional variations in the effects of ENSO on climatic factors and dengue fever cases[30].

There was an opinion that generalization should not be made about the association between ENSO and dengue transmission[16]. Our views are also corroborating with this whether or not an epidemic occurs depends not only on mosquito abundance but also on the history of dengue in that region. Studies in Noumea& Puerto Rico found little or only sporadic association[7,22]. Our studies also reveal the same results, showing very little or no impact of ENSO on the number of dengue fever cases in Jeddah.

Therefore, it may be concluded that El Nino Southern Oscillation does not affect the rise or fall of dengue fever cases or the *Aedes* density in this region of Saudi Arabia which is contradictory to other votis[12,32] which shows a significant positive correlation of dengue fever cases and *Aedes* abundance with El Nino and La Nina.

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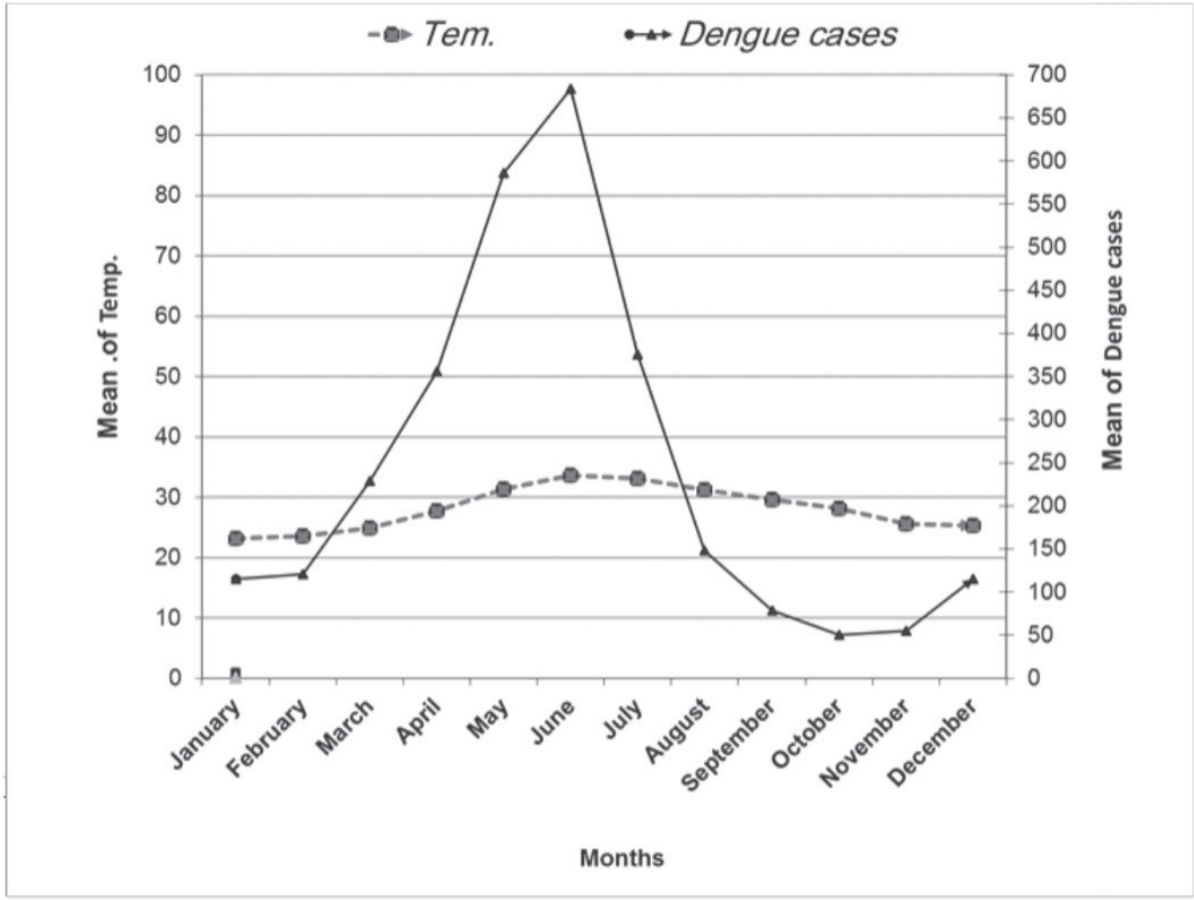

Fig.6: Mean dengue cases and Temperature per month from 2007 – 2016

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