

## ORIGINAL PAPER

**Seasonality of Suicidal Behavior in Mysuru, Karnataka, India: A Populace Based Analysis***Alwyn D'souza<sup>1</sup>, Shakunthala Venkat<sup>2</sup>*<sup>1</sup>Chronobiology Lab, Department of Studies in Zoology,  
Manasagangotri, Mysore, Karnataka, India<sup>2</sup>University of Mysore, Department of Studies in Zoology,  
Manasagangotri, Mysore, Karnataka, India**Abstract**

**Objectives:** In India there are very few epidemiological studies that describe the association between suicides and physical factors, which underlie seasonal changes, particularly temperature. We investigated the role of temperature in suicidal behaviors and have analyzed whether the affiliation varies with gender and age in Mysuru, India between 2007 and 2016. **Methods:** Suicide data, categorized by Month of suicide, age, gender, and method of suicide were provided by 22 Karnataka state police stations. The data was subjected to chi-squared distribution test and the frequency of suicides at each seasons with respect to age and gender were analyzed. **Results:** A total of 4254 completed suicidal cases were obtained in the examined period. A clear seasonal pattern was observed, with suicidal frequencies being highest between February and May (40%) and lowest between June and January (10%) and the percentage of suicidal incidences in the age group of 21-40 is more (56.2%) compared to other age groups. **Conclusion:** This study shows that suicides followed a seasonal pattern, with a maximum peak in summer. We have observed that suicidal rates are high among males and this examination also reveals a higher rate of suicidal incidences among younger ones comparatively. Hence we speculate that seasonal changes in temperature account for variations in the number of suicides. Temperature, which increases the concentration of serotonin neurotransmission, may trigger increased impulsivity and promote suicidal behaviors, which require a further more research to clarify the role of temperature in triggering neurobiological changes in brain.

**Keywords:** Serotonin, Temperature, Seasonality, Suicide, Mysuru**Introduction**

India's share towards worldwide suicidal deaths has been expanded from 25.3% in

1990 to 36.6% in 2016 among women and from 18.7% to 24.3% among men, in spite of the fact that suicide is very personal and an act performed by an individual, suicidal

death can be described as multidimensional, multifactorial melancholy [1], in spite of the fact that the internal and external characteristics of a person such as physical and mental wellbeing, individual and family encounters were some of the known variables related with suicide [2,3], The climatic conditions particularly natural temperature is one of the major factor associated with suicide[4,5], Petriduo et al [6] opines that suicide rates are influenced by sunshine/temperature, Hiltunen et al [7] stated that there is an association of increased mortality with that of long day length. In the interim a few examinations showed the diverse impacts of temperature concurring to gender and age, especially distinctive seasonal trends in suicides among males and females [8] Many studies, have reported that the seasonal spring peaks are greater in rural areas compared to urban areas [9].

Daylight actuates neurobiological changes in the mammalian mind particularly by means of regulation of serotonin neurotransmission [10]. Some of the investigations have demonstrated that the concentration of serotonin is most reduced in winter where as high amid the late spring season [11] along with the rate of production of serotonin by the brain is straightforwardly related with the bright sun exposure. There is additionally a broad proof that mental issues or disorders that have been related with serotonin brokenness, for instance suicidality and depression are profoundly delicate to seasonal changes, overwhelmingly to day light.

Suicide rates and climatic conditions shift over areas and regions across the globe, the affiliation between temperature and suicide may depend on the connected demonstrating strategy and balanced variables related climate factors [12,13]. Since the seasonal

fluctuations in suicide has turned into a perceived and noteworthy fact, it is advantageous to recognize factors that constantly show the relationship with seasonal fluctuations and suicidal behavior.

In India there are very few studies to examine the association of suicides with physical factors, except the study in Varanasi [14]. Mysore district is located in the southern part of the state of Karnataka, India (latitude 11°45' to 12°40' N and longitude 75°57' to 77°15' E) with the temperature in the district varies from 15° c in winter to 35° c in summer, promoting an increased interest in association between temperature and suicide.

Thus, in the present examination we have endeavored to inspect the relationship among temperature and suicide and to explore whether the affiliation varies with Gender and age.

### **Methodology**

The data for the present study was collected in the police stations in and around the Mysore District. The records of completed suicides cases in the police station were considered for our study.

The data was obtained from Karnataka State Police UDR (unnatural death report) from January 2007 to December 2016. For the computational purpose the data was distinguished/categorized on the basis of the age, sex, month, Further, they divided in to the suicides occurred at the different seasons (Three seasons winter, summer, Rainy).

### **Statistical Analysis**

The data was subjected to chi square distribution test and the frequency of the suicides at each season, age and gender.

Cross tab analysis was used to check for the association between temperature and suicide, season and suicide, age and suicide, gender and suicide using IBM SPSS statistics Version 22.0.0.

## Results

Total of 4254 completed cases were obtained. Of that 2914 (68.5%) were males and 1340 (31.49%) females. Of this, 45.43% was poisoning, 18% burning, 22.33% drowning, hanging 28.23%, fall from height is 1.48% and the least was cutting the veins i.e., 0.11%. Incidence of suicide by poisoning observed to be predominant in this region. Table1 depicts the details of the number of cases recorded by age, season and gender in different seasons. The frequency of suicides at different seasons revealed that the suicides cases are more on summer (40%) seasons rather than rainy and winter (reduced to 10%). The percentage of suicide incidence in the age group of 21-40 is more 56.2% compared to the other age groups. Table 2 shows that Chi-square distribution for all the

combination is significant with probability  $P < 0.001$ , 99% confidence level. Cross correlation between season and age groups is significant, whereas between gender and season is not significant. The graph (Figure 1) reveals the monthly suicide incidence for 10 years and it predicts the summer seasons and it is significantly different compared to other seasons of the year. It is consistently observed for the period of 2007-2016. The Figure 2 represents the yearly tendency of the suicide incidence for 10 years with respect to increase in temperature. Irrespective of the seasons/age/gender the tendency of the suicide incidence are in the increasing order and also depicts the comparison of the suicide cases with that of average temperature of the month. Compared to winter and rainy season the completed suicide cases in summer season is more on the age group of 21-40 years as well as in both the genders. The completed suicide cases in summer are more in all the age groups compared to winter and rainy. The least mortality was observed in between the 81- 100 years age group.

**Table 1. Number of Suicidal deaths and frequencies with reference to age, gender and Season**

Age group	Gender		total	Seasons			Total
	Male	Female		summer	Rainy	winter	
0-20	266 6.25%	115 2.7%	381 8.95%	52 1.22 %	0 0	329 7.73%	381 8.95%
21-40	1625 38.19%	765 17.98%	2390 57.17%	1647 38.71%	726 17.06%	17 0.39%	2390 56.18%
41-60	827 19.44%	377 8.86%	1204 28.30%	0 0	524 12.31%	680 15.98%	1204 28.30%
61-80	169 3.97%	75 1.76%	244 5.73%	0 0	0 0	244 5.73%	244 5.73%
81-100	27 0.63%	8 0.18%	35 0.82%	0 0	0 0	35 0.82%	35 0.82%

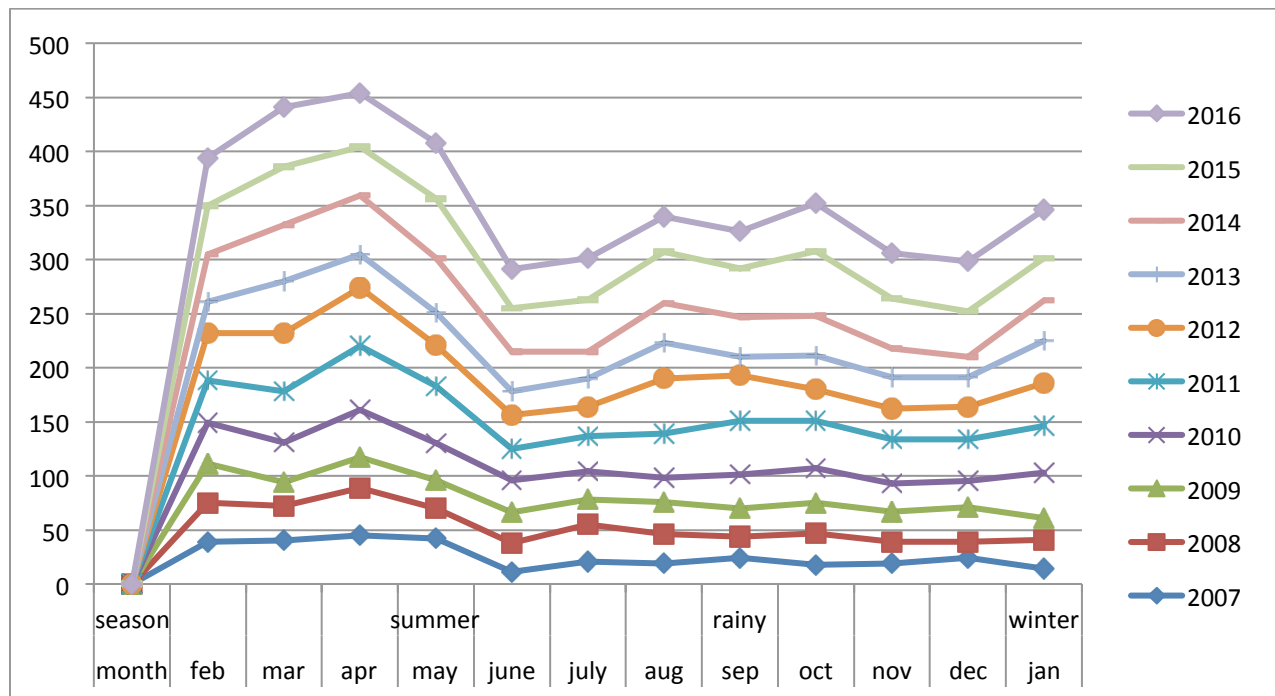
Total	2914 68.50 %	1340 31.49 %	4254	1699 39.93 %	1250 29.3 %	1350 31.73%	4254
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Summer: February-May    Rainy: June-September    Winter: October-January

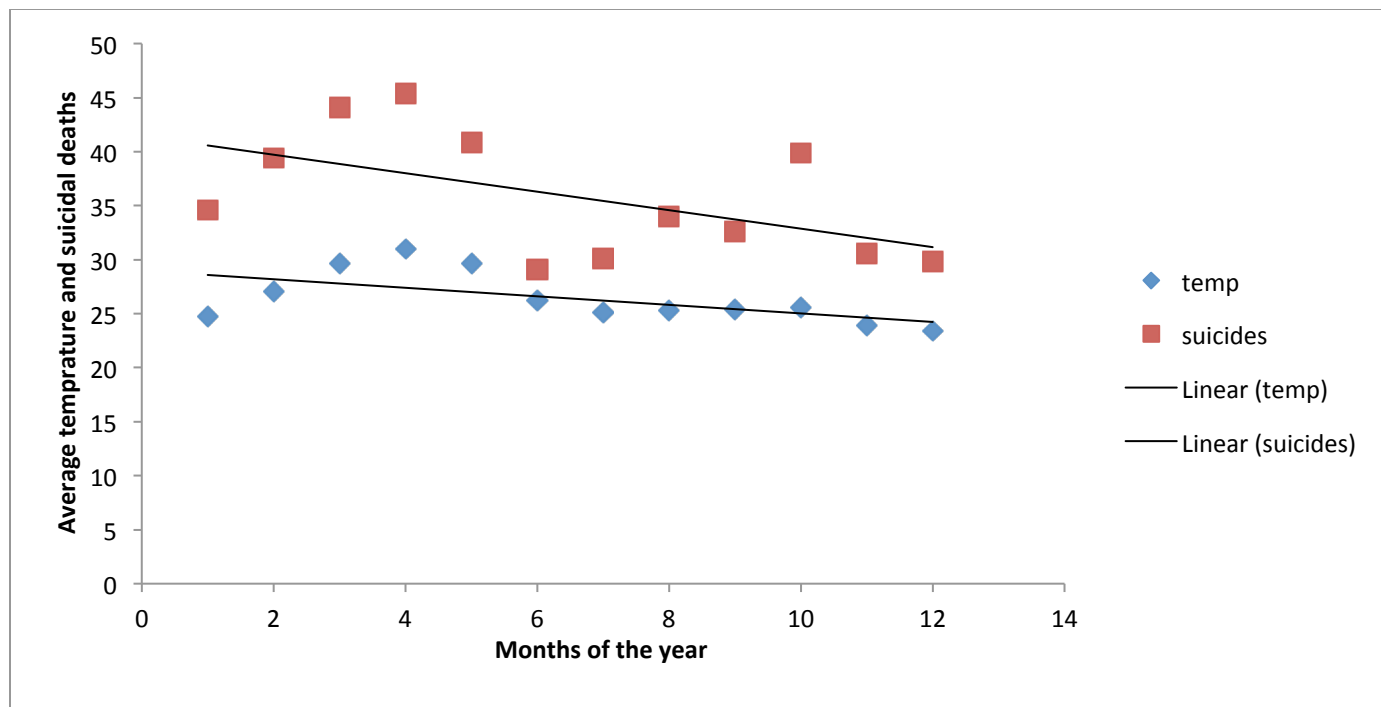
**Table 2. Cross-tab analysis show the suicide cases evaluated with different seasons, age and gender (P<0.001)**

Gender	Season			Total	Age	Season			total
	Summer	Winter	Rainy			Summer	Winter	Rainy	
Male	68.1	67.7	69.8	68.5	0-20	3.1	25.2	9.0	9.0
Female	31.9	32.3	30.2	31.5	21-40	96.9	58.1	1.3	56.2
					41-60	0.0	41.9	52.1	28.3
					61-80	0.0	0.0	18.7	5.7
					81-100	0.0	0.0	2.7	0.8
				.460					.000*

\*Significant



**Figure 1. Distribution of trends of suicidal deaths from 2007 to 2016 with reference to seasons**



**Figure 2. Graph showing the suicidal deaths and average temperature**

## Discussion

Suicide incidence in Mysuru rural area followed a clear seasonal pattern over the investigated period of 10 years (2007-2016), because suicidal frequencies were high in summer for both genders, the internal and external characteristic of individuals such as mental, physical, personal and family experiences, educational and community were known factors associated with suicide [2,3,15,16]. In the present study the complete suicidal events analyzed in the Mysore rural region was collected from police stations, of which poisoning was found to be more, since Mysore rural region is known for its agriculture and presumably the accessibility of pesticides within their vicinity could be the major reason for the increased rate of poisoning. Among the age groups, incidence of suicide found to be more in the age group of 21-40. Several studies have found there is an association

between age and seasonality in suicides, Maeset.al.[17] reported that suicide rate among younger people was increased in spring, whereas the rate within older adult was raised in late summer. Kim et al [18] found that older age group suicides are more compared to young one in Korea. Further researchers have documented that a suicide peak was observed in young aged individuals in winter and fall apart in summer [19,20].

In our study among both genders completed suicides of males increased compared to female and are also associated with onset of summer and summer season, Cross correlation chi square test reveals that there is an association of summer with young age incidence of suicides. Through it is speculative the several studies have also reported association of age and seasons. Preti [21] found different seasonal trends in suicide between male and females. Studies

performed in Scotland oxford revealed a seasonal variation of female suicide attempt with increased rates during summer and decreased rate in winter, but no significant seasonal attempt was found [22,23]. In our study a clear difference in the gender effect is seen and significantly associated with seasons. Interestingly, suicide peaks in the time series graph for 2007-2016 periods were not the same, but the suicide pattern in Mysore rural have seasonality and associated with temperature. The maximum temperature of the month and the suicide peaks are correlating with each other. Another important trend observed by this study is there is increasing trends in the suicide rates (fig.1) Does the climate change in future have the same effect? Gender effects in the present situation are probably also exposure to sunshine/ temperature stress is more in males due to field work compared to females. Further this is supported by Preti [24] and Page et al [5] suicide by Italian males were more strongly associated by weather factors. Seasonality in the younger people was more in the present study. Irrespective of the age, gender, days and seasonality the suicides have an increasing trend year after year. To conclude this, one of the conceivable components to explain the critical summer peaks of suicides, we can consider the role of neurotransmitters in suicidal behaviors, serotonin concentration is frequently associated with impulsive and aggressive behaviors [25], in addition it has been shown that 5-HTT is in a hyper functional state amid depression in seasonal affective disorders and normalizes after light treatment and in natural summer remission [26]. Hence we hypothesized that suicide and temperature to be lowest in the winter and highest in summer.

### **Limitation**

The methodological points of interest of this Study, investigation of long time series (2007-2016) and adoptable methodology are contrasted with certain limitations; first it cannot be excluded that other environmental variables such as moistness, air pressure, rainfall, pollutants might contribute to suicidal incidences. We focused on temperature because it is the only major variable which varies vastly from one season to another and it offers a ideal neurobiological model speculating the suicidal incidences. Second, this study is restricted to southern part of Karnataka, India, that is a reason with moderate climate in southern Asia. It cannot be excluded that the results would differ in regions with different temperature ranges. At last, because of the constrained nature of the information, we were incapable to incorporate data on different particular components related to suicide such as hereditary factors, family qualities, community characteristics and mental well being.

### **Conclusion**

This is the first study from India showing that seasonal affects account for variations in the number of suicides among both genders. We showed that suicidal incidences are co related with temperature and have proposed based on available evidence that temperature may increase the concentration of serotonin neurotransmission which could trigger the psychological impulsivity and promote suicidal behaviors. India, specifically where suicide rates are incredibly high, ought to work in improving responses to suicide related with climate

change, such as by adopting suicide prevention program including public suicide awareness campaigns, safer access to pesticides and conducting furthermore research in different areas with more number of cases switching from individual to ecological based investigations and also by focusing on the role of melatonin hormone which is affected by sunshine and which plays a major role in mood regulation since most of the studies are concentrating on serotonin neurotransmission but no attempt has been made to investigate the role of other hormones and neurotransmitters which are known to show sunlight dependence (cortisol, L-tryptophan, melatonin) to clarify the role of temperature in activating neurobiological changes, which may add to prevent the suicidal behavior.

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**Corresponding Author**

Alwyn D'souza, M.sc  
Ph.D Research Scholar  
Chronobiology Lab  
Department of Studies in Zoology,  
Manasagangotri, Mysore, Karnataka, India  
Tel: 09739406037

**Email:** Alwyn.dsouza.2002@gmail.com