

Original Research Article

Seasonal variation and role of meteorological conditions in reported chicken pox cases in a residential hostel of Ramgarh

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ABSTRACT

Background: Chicken pox is an acute, common, and highly contagious disease caused by the varicella zoster virus (VZV). Chicken pox is predominantly a childhood disease characterized by pruritic vesicular exanthema with systemic symptoms such as fever, loss of appetite, and malaise. Primary infection tends to occur at a younger age and is usually benign in immunocompetent children but can be life-threatening in adults and immunocompromised individuals, with an attack rate approaching >85% after exposure. This study attempts to evaluate the trend of chickenpox cases in a residential hostel in Ramgarh.

Methods: This was a record based descriptive study done using reported Chicken Pox cases in the OPDs during the period from January 2015 to December 2018. Monthly average for meteorological data (Min and Max temperature, Precipitation and Humidity) for Ramgarh was recorded for the study period. Seasonality and trend was identified for chicken pox cases during this period by plotting the monthly number of clinically diagnosed cases over time period to identify any repeated pattern. Poisson's distribution was used to estimate association between meteorological variables and incidence of chickenpox cases.

Results: Analysis revealed strong correlations ($r=0.7553$, $p<0.0001$) between humidity and precipitation. There was a significant correlation between Incidence of varicella and meteorological factors under study (all $p<0.05$).

Conclusions: The findings of this study will aid in forecasting epidemics and in preparing for the impact of climate change on the varicella epidemiology through the implementation of public health preventive measures such as promoting good hygiene practices, temporary closure of educational institutions, active vaccination and campaigns that include press releases and media events to encourage preventive activities.

Keywords: Meteorological factors, Residential hostel, Varicella

INTRODUCTION

Chicken pox is a highly contagious disease caused by the varicella zoster virus (VZV).¹ Chicken pox is predominantly a childhood disease that is characterized by pruritic vesicular exanthema with systemic symptoms such as fever, loss of appetite, and malaise. In nonvaccinated populations, primary infection tends to occur at a younger age.² The disease is usually benign in immunocompetent children but can be life-threatening in adults and immunocompromised individuals, with an

attack rate approaching >85% after exposure.³ Humans are the only known hosts for this virus, which exists as only one recognised serotype. Viral shedding occurs from the nasopharynx via droplets and aerosols and also from the skin lesions.⁴

The incubation period of the disease is usually 14–16 days. The contagious period starts 1–2 days before the appearance of the exanthem and lasts till all the vesicles have crusted, usually within 5–7 days.¹ VZV may induce pneumonia or encephalitis, sometimes with persistent

sequelae or death. Secondary bacterial infections of the vesicles may leave disfiguring scars or result in septicemia.⁵

Hostelers, by virtue of peculiarities of living conditions, such as congregation in living dormitories present a vulnerability to spread of contagious diseases. Institution of control measures during outbreaks becomes a challenge here due to difficulty in isolating the cases. Intermingling of students results in challenges to institute control measures, which needs to be tailored to suit the situation. Aggressive intervention measures such as segregation, contact tracing and strict surveillance will result in control any outbreak.

Potential transmission of infectious diseases including chickenpox is believed to be affected by changes in climate, and some studies have examined the relationship between weather variability and the incidence of infectious diseases.⁶⁻⁸ This residential hostel in Ramgarh district in Jharkhand is located at an altitude of 1789 metres. The climate is generally dry with average rainfall of 1344 mm. the temperature varies from 18 to 33°C. The present study was conducted to estimate trend and seasonal variation of registered clinical cases of chicken pox and also to explore the meteorological conditions dependent transition of patterns of incidence of chickenpox cases from 2015 to 2018 in Ramgarh.

METHODS

This record based descriptive study was done using reports of Chicken Pox cases among students in a residential hostel of Ramgarh. This residential hostel accommodates approx. 500 students at a point of time.

There is fluctuation of the strength of students at the hostel due to leave/completion of course, thus the susceptible student population is not stable for any fixed period of time. Students reporting to the OPDs during the period from January 2015 to December 2018 were included in the study. Monthly average for Meteorological data (Min and Max temperature, Precipitation and Humidity) for Ramgarh was recorded for the study period.

A database was created and the data was checked for missing data, errors, outliers and duplicate reports. Seasonality and trend was identified for chicken pox cases reported from 2015 to 2018 by plotting the monthly number of clinically diagnosed cases over time period to identify any repeated pattern. The 'Seasonal Index' was also calculated (Seasonality Index of a period indicates how much this period typically deviates from the annual average). It is calculated by dividing monthly average over time average multiplied by 100.9 Poisson's distribution was used to estimate association between meteorological variables and incidence of chickenpox cases. Analysis of data was done by Stata Ver 16.0 after data cleaning.

RESULTS

The total number of patients reported to have clinical chicken pox during the whole study period (4 years) was 259 (Table 1), distributed as follows: 56 in 2015, 55 in 2016, 71 in 2017 and 77 in 2018, showing an average monthly incidence of 5.4 cases. The highest seasonal index was during January and February (180.56 each month) whereas the lowest was during September (37.04).

Table 1: Distribution of chicken pox cases by month over a 4-year surveillance (2015-2018).

	Year				Total	Monthly average	Seasonal index
	2015	2016	2017	2018			
January	9	7	12	11	39	9.75	180.56
February	7	13	7	12	39	9.75	180.56
March	3	4	6	6	19	4.75	87.96
April	3	4	4	7	18	4.5	83.33
May	5	5	5	7	22	5.5	101.85
June	3	2	5	2	12	3	55.56
July	3	3	5	3	14	3.5	64.81
August	2	2	3	3	10	2.5	46.30
September	3	2	1	2	8	2	37.04
October	3	2	2	2	9	2.25	41.67
November	7	5	12	10	34	8.5	157.41
December	8	6	9	12	35	8.75	162.04
Total	56	55	71	77	259	5.4	

The age distribution of registered cases of chicken pox showed that mean age of the cases was 18.14 years

(Minimum 16 and Maximum 21 years) with a standard deviation of 1.26. The series in Figure 1 shows a

downward trend; that is, the series values tended to decrease over time. The series also has a distinct seasonal pattern with annual rise during January and February. The plot of data over time suggested a model with both a trend component and a seasonality component. The model performance characteristics were verified or validated by comparison of its forecasts with actual data using single moving average. Smoothing models typically employ a simple function of previous observations to provide a forecast of the variable of interest. The smoothing is used to remove noise and better expose the signal of the underlying causal processes. Moving averages are a simple and common type of smoothing used in time series analysis and time series forecasting.

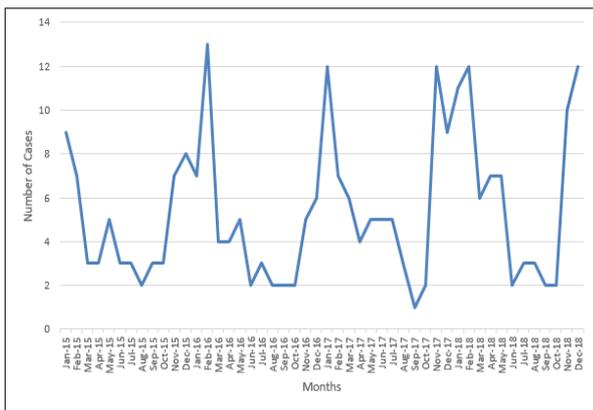


Figure 1: Seasonal distribution of clinically diagnosed chicken pox cases.

A moving average is obtained by calculating the mean for a specified set of values and then using it to forecast the next period. That is, $M_t = (y_t + y_{t-1} + \dots + y_{t-n+1}) / n$, where Y_t - Observation at time t and M_t : Moving

average at time t , which is the forecast value at time $t+1(Y_{t+1})$.

The forecast values showed good agreement with the actual values, indicating that the model had a satisfactory predictive ability as shown in Figure 2.

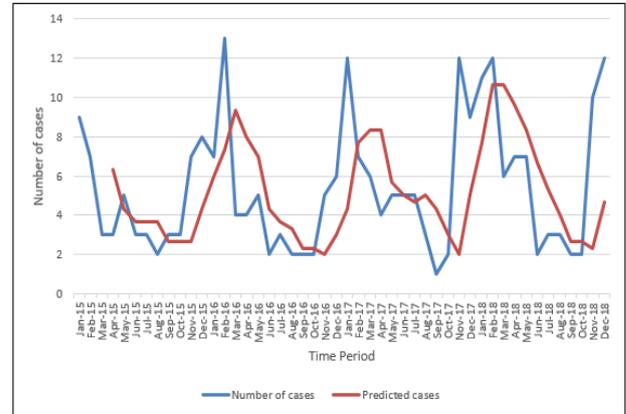


Figure 2: Prediction from exponential smoothing, trend, and multiplicative seasonality.

During the study period minimum and maximum temperature was 2°C and 47.28°C respectively with a mean temperature of 26°C. Relative humidity ranged from 23% to 86% with a mean of 53.94%. Daily rainfall averaged from 0 to 292 mm with a mean of 56.14 mm. Analysis revealed strong correlations ($r=0.7553$, $p<0.0001$) between humidity and precipitation. Therefore, to avoid potential issues with collinearity, analysis was done including either precipitation (A) or humidity (B) together with other predictors to explore the relationships between humidity and precipitation and varicella incidence.

Table 2: Poisson's distribution model for association between meteorological factors and incidence of Varicella

	Coefficient	Std Error	Z	P> z	95% Confidence Interval	
					Lower Boundary	Upper Boundary
(A)						
Intercept	11.9264	1.271972	9.38	0.000	9.433377	14.41942
Average Temperature	-0.2270853	0.0503365	-4.51	0.000	-0.3257429	-0.1284276
Precipitation	-0.0111281	0.0055388	-2.01	0.045	-0.021984	-0.0002723
(B)						
Intercept	15.26503	1.426575	10.7	0.000	12.46899	18.06106
Average temperature	-0.2492125	0.0430128	-5.79	0.000	-0.333516	-0.164909
Humidity	-0.0628117	.0178817	-3.51	0.000	-0.0978591	-0.0277642

There was a significant correlation between Incidence of varicella and meteorological factors (all $p<0.05$) (Table 2). Each 1 mm rise in average rainfall corresponded to a 1.11% decrease in monthly varicella incidence. A 1°C

rise in temperature corresponded to a decrease of 23% monthly varicella cases. Likewise, a 1 % rise in relative humidity corresponded to a decrease of 6.2% in the monthly incidence of varicella.

DISCUSSION

In recent decades, meteorological conditions have been widely studied for their potential as early warning tools to prevent climate-sensitive infectious diseases such as fecal-oral infection disease, malaria, respiratory tract infections and Dengue fever.¹¹⁻¹⁴ Our study, demonstrates that weather factors have a significant influence on varicella incidence in Ramgarh. Particularly, we found that temperature was inversely correlated with varicella incidence. These findings are consistent with those of Garnett et al. who found that in the West Indies fewer varicella infections occur in tropical regions than in temperate regions.¹⁵ In a study conducted by Elizabeth White in Kerala, it was found that most number of cases occurred in January and February, being the coldest months of the year.¹⁶

We found that relative humidity was inversely correlated with varicella incidence and similar findings have been observed in Hong Kong and the West Indies.^{15,17} The mechanism for the potential association between relative humidity and varicella incidence and transmission could be hypothesized that in a lower relative humidity, air particles would be smaller and VZV could be suspended for longer in the air and therefore travel over a longer distance, thereby increasing transmission opportunity. We found that a 1 mm rise in rainfall corresponded to a decrease of 1.11% of monthly Varicella cases which is in contrast to the findings of Yang et al. who showed that 1 mm rise in rainfall corresponded to an increase of 0.20 % or 0.30%, in the weekly number of varicella cases in Jinan.⁶

Some methodological limitations were present in this study. Firstly, the study was carried out in a residential hostel which do not capture all cases in the community. The population here addressed is male students in young age group. Secondly, weather information obtained from one fixed station might not be representative of the whole city. Thirdly, owing to this investigation being an ecological study, it is important to note that varicella transmission is multifactorial; besides meteorological factors, other environmental and host factors may also play a role in transmission of VZV. Our current study focused only on the meteorological factors and further studies to incorporate other environmental and host factors, including demographic factors, geographical data, population density, ethnicity etc are warranted.

CONCLUSION

Explication of the effects of weather variability on infectious disease epidemiology has become incredibly valuable to public health officials and practitioners in controlling diseases. The findings of this study will aid in forecasting epidemics and in preparing for the impact of climate change on the varicella epidemiology through the implementation of public health preventive measures such as promoting good hygiene practices, temporary

closure of educational institutions, active vaccination and campaigns that include press releases and media events to encourage preventive activities.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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