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Modelling of COVID-19 positive cases at tertiary care hospital of Bundelkhand region of Uttar Pradesh using regression models

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ABSTRACT

Background: Corona viruses signify a most important group of viruses mostly affecting human beings. It is a respiratory infection with common signs and symptoms of fever, cough, sore throat, headache, and loss of taste, loss of smell, respiratory symptoms. In India till 31st December 2020, the total number of confirmed cases were 1,02,86,310; with active number of cases were 2,52,699 number of cases recovered were 98,81,732 while number of deaths were 1,49,018. Objective of the study was to find the quadratic and cubic model of COVID-19 positive cases at tertiary care hospital of Bundelkhand region of Uttar Pradesh.

Methods: A hospital based study was carried out with confirmed covid-19 cases admitted to Government Medical College Banda, UP. 1486 cases have been taken from the period of 1st April 2020 up to 31st December 2020.

Results: In this study maximum cases (30.14%) belongs to the age group of 30-45 years. Male population is more than females in all districts. In this study the cubic model shows the best fit with the highest R-square value. Difference in the proportion in each age group (p value<0.001) and sign and symptoms (p value < 0.001) were statistically significant.

Conclusions: The current study focused on presenting trends in the Bundelkhand region, Uttar Pradesh with respect to the outbreak of COVID-19. The spread of COVID-19 cases follow cubic model. We conclude that cases of COVID-19 will decline in the coming days heading towards the reduction in daily number of cases.

Keywords: Bundelkhand, COVID-19, Cubic model, Recovery rate

INTRODUCTION

Corona viruses signify a most important group of viruses mostly affecting human beings having a zoonotic transmission. This is the third instance of the emergence of a novel coronavirus in the past two decades after severe acute respiratory syndrome (SARS) in 2003 and Middle East respiratory syndrome coronavirus (MERSCoV) in 2012. 1,2

It is a respiratory infection with common signs and symptoms of fever, cough, sore throat, headache, and loss of taste, loss of smell, respiratory symptoms and breathing difficulties. It can cause pneumonia, severe acute respiratory syndrome (SARS), kidney failure and death in the more severe cases.

In the first week of January 2021, worldwide the total number of confirmed cases were 8,76,43,764 with active cases 2,26,18,698 and recovered cases were 6,31,33,355 while number of deaths were 18,91,711.³

COVID-19 was declared as a Public Health Emergency of International Concern by the end of January 2020, according to the standards of International Health Regulations (2005) by the World Health Organization.⁴ WHO had declared the infection to be a pandemic on 11th March.

In India, first case of COVID-19 was reported on 30 January 2020 from Kerala. In response to global call Government of India asked all citizen to observe a 14-hours 'Janata' (people's) curfew on 22 March to contain and sensitize nations for COVID-19 pandemic. Followed by Nationwide, four phases of lockdown, starting from 25th March to 31st May .The first unlocks 1.0 phase started from 1st June to 30th June 2020. Till 31st December 2020, there were seven unlock phases to control the spread of Corona virus outbreaks in the country. Initially all services and activities were suspended except few emergency and essential services like hospitals, pharmacies, banks, grocery shops and also prohibition of all social sports, entertainment, cultural, academic and religious activities.

In India till 31st December 2020, the total number of confirmed cases were 1,02,86,310; with active number of cases were 2,52,699; number of cases recovered were 98,81,732 while number of deaths were 1,49,018. Also, in Uttar Pradesh, at the end of year 2020 the total number of confirmed cases were 584,966, active cases were 14,155 and recovered cases were 5,62,459 while total number of deaths were 8,352.5

In GAMC, Banda designated, for L3 level hospital, by UP Government, where all eligible COVID-19 positive for L3 level were admitted from all four district; Banda, Chitrakoot, Mahoba and Hamirpur. A total 1486 positive patients were admitted till 31st December from all the four districts. In light of above background, the present study was designed to find the quadratic and cubic model of COVID-19 positive cases at tertiary care hospital of Bundelkhand region and also to find the final outcome of COVID-19 patients.

METHODS

A hospital based study was carried out where consecutive patients with confirmed COVID-19 cases admitted to Government Medical College Banda, Uttar Pradesh. The data has been taken from the period of 1st April 2020 up to 31st December 2020. All desired data was obtained from Medical Record Section, Government Medical College Banda, UP. The clinical outcomes (i.e., discharges, mortality, and length of stay) were monitored. In this study 1486 COVID -19 cases were taken for analysis which have been admitted in GAMC Banda.

Case definition and classification

A standard protocol which included case definitions for categorization of COVID-19 infection, detailed management plan, baseline and follow up investigations and treatment according to clinical severity was devised by a group of experts from GAMC Banda. This discharge policy was taken and reviewing the guidelines for COVID-19 by the MOHFW, Government of India. Symptomatic COVID-19 patients were categorized in mild, moderate and severe. Patients with uncomplicated

URTI or non-specific symptoms such as fever, sore throat, cough; nasal congestion, body ache and headache were classified to have mild disease. Patients having pneumonia with significant radiological features but without the signs of severe pneumonia were categorized as moderate disease. Severe pneumonia included a patient with fever, plus one of the following: respiratory rate >30 breaths per min, severe respiratory distress, uncontrolled diabetes and hypertension) and SPO₂ <90% on room air.

Inclusion criteria

All the COVID-19 positive cases were included in the study whose laboratory report for COVID was positive.

Data collection

The medical records of patients were analysed by the research team of the Department of Community Medicine, Government Medical College Banda. Epidemiological, clinical and laboratory, characteristics, treatment and outcomes data were obtained with data collection forms from electronic medical records and history given by patients. Information recorded included demographic data, medical history, exposure history, signs and symptoms, laboratory findings.

Statistical analysis

Initially data has been entered in MS Excel, and then transferred to trial version of SPSS 20.0. The district wise distribution of age, gender, marital status and sign and symptoms were determined in number and percentage. Also the monthly distributions of COVID-19 cases were calculated in number and percentage. Data were presented with charts and line graphs.

Regression is a statistical technique that attempts to estimate the strength and nature of relationship between a dependent variable and a series of independent variables. Regression analyses may be linear and non-Linear. Two classes of regression model were used to fit the cumulative data on COVID-19. These are: quadratic and cubic models: $R = A + Bx + Cx^2$ and $R = A + Bx + Cx^2 + Dx^3$ equations were employed to develop the desired model. The equations representing each model are presented in Tables.

RESULTS

The study was based on 1486 COVID- 19 cases out of which 739 cases were admitted from Banda district, 213 cases from Chitrakoot district, 241 from Hamirpur district and 293 cases from Mahoba district. The important findings of demographic, clinical data and characteristics are presented in Table 1. Majority of the cases (448) belongs to the age group of 30-45 years, 44% cases were from Banda district followed by age group of 15-30 years (427 cases). Banda contributes highest number of cases in all age groups among the four districts. The male

population is more than females in all districts. Banda alone contributes 49.5% male and 50.3% female's cases. Married cases (79.6%) were more than unmarried (20.4%) cases. Overall numbers of asymptomatic cases were higher in all four districts.

Difference in the proportion in each age group (p value<0.001) and sign and symptoms (p value<0.001) were statistically significant and gender (p value=0.56) and marital status (p value=0.16) were not significant (Table 1).

Table 1: Demographic and clinical distribution of COVID-19 patient's district wise at GAMC, Banda.

Characteristics	District				Total	Chi-	D l
Age (in years)	Banda	Chitrakoot	Hamirpur	Mahoba	Total	square	P value
<15	20 (32.3)	9 (14.5)	11 (17.7)	22 (35.5)	62 (100.0)	42.26	0.000
15-30	227 (53.2)	69 (16.2)	63 (14.8)	68 (15.9)	427 (100.0)	•	
30-45	197 (44.0)	72 (16.1)	95 (21.2)	84 (18.8)	448 (100.0)		
45-60	143 (50.2)	37 (13.0)	40 (14.0)	65 (22.8)	285 (100.0)		
60-75	126 (56.5)	21 (9.4)	29 (13.0)	47 (21.1)	223 (100.0)		
≥75	26 (63.4)	5 (12.2)	3 (7.3)	7 (17.1)	41 (100.0)		
Gender							
Female	236 (50.3)	62 (13.2)	71 (15.1)	100 (21.3)	469 (100.0)	2.03	0.56
Male	503 (49.5)	151 (14.8)	170 (16.7)	193 (19.0)	1017 (100.0)		
Marital Status							
Married	573 (48.4)	169 (14.3)	201 (17.0)	240 (20.3)	1183 (100.0)	5.06	0.16
Unmaried	166 (54.8)	44 (14.5)	40 (13.2)	53 (17.5)	303 (100.0)		
Sign and							
symptoms							
Asymptomatic	343 (42.5)	130 (16.1)	155 (19.2)	179 (22.2)	807 (100.0)	37.60	0.000
Symptomatic	396 (58.3)	83 (12.2)	86 (12.7)	114 (16.8)	679 (100.0)		

Table 2: Monthly distribution of COVID-19 cases at GAMC, Banda.

Month	Admitted	Discharged	Death	Transfer out
April	7(0.5)	3 (0.2)	0 (0.0)	0 (0.0)
May	68 (4.7)	45 (3.2)	0 (0.0)	0 (0.0)
June	183 (12.3)	185 (13.1)	0 (0.0)	0 (0.0)
July	386 (25.9)	382 (27.1)	0 (0.0)	4 (20.0)
August	171 (11.5)	112 (7.9)	5 (16.7)	4 (20.0)
September	289 (19.4)	246 (17.4)	10 (33.3)	5 (25.0)
October	137 (9.2)	210 (14.9)	8 (26.7)	2 (10.0)
November	148 (10.0)	133 (9.4)	4 (13.3)	2 (10.0)
December	97 (6.5)	93 (6.6)	3 (10.0)	3 (15.0)
Total	1486 (100.0)	1409 (100.0)	30 (100.0)	20 (100.0)

Table 3: Model summary and parameter estimates.

Model	Admission							
Model	Model Summary				Parameter estimates			
	R-Square	F	df	Sig.	Constant	b1	b2	b3
Quadratic	0.612	4.738	2	0.058	-698.250	232.495	-14.103	
Cubic	0.658	3.203	3	0.121	-1461.390	561.800	-57.961	1.827
Discharged								
Quadratic	0.552	3.696	2	0.090	-668.577	219.218	-13.141	
Cubic	0.575	2.254	3	0.200	-1210.965	453.265	-44.312	1.299

Maximum number of cases were admitted in month of July (25.9%) followed by September (19.4%) at Government allopathic medical college, Banda. After month November, the COVID-19 cases were declining. Only 6.5% cases were admitted in December. 94.81%

cases were recovered and discharged while 2.01% cases deceased (Table 2). From Table 3, we can see that the quadratic and cubic functions are appropriate models for the growth of the total number of cases due to COVID 19. Of the two models the cubic function shows the best fit

with the highest R-square value. As can be seen also in the graphs in Figure 1 and Figure 2, the cubic function has the best fit.

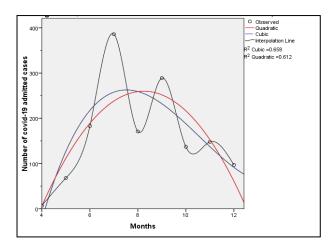


Figure 1: Quadratic and cubic model of COVID-19 cases at GAMC, Banda.

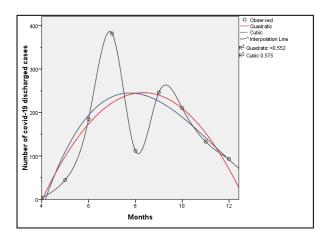


Figure 2: Quadratic and cubic model of COVID-19 discharged cases at GAMC, Banda.

DISCUSSION

This study was done to assess district wise association of various demographic and clinical characteristics. In this study maximum cases (30.14%) belongs to the age group of 30-45 years, followed by age group of 15-30 years (28.76%). The mean age of patients in our study was (mean age-39.5 year). Although similar age pattern (mean age of 40.3 year) was observed in a study done by Gupta et al at another tertiary care hospital from northern India. The present study shows preponderance among males (68.4%). A male preponderance was also observed in the previous study. 8

We also found that a higher number of cases was reported after the relaxation of lockdown than was reported during the lockdown period. The increased spread of the disease after the relaxation of lockdown could be due to poor adherence to the recommended preventive measures in India. This may be expected because when restrictive measures are lifted, exposures to disease risks become higher.

The most common symptom of fever followed by dry cough and breathlessness reported at GAMC Banda patients are also very similar to that observed in other part of our country and also worldwide.⁹ In our study the recovery and mortality rate were 94.81% and 2.01% respectively. The below 1.5% mortality rate observed in India is almost half of the average worldwide mortality rate of 3%.¹⁰

In this study the cubic function is appropriate model for the admitted cases. The cubic function shows the best fit with the highest R-square value. Also in the previous study it was found that cubic model was the best fit for COVID- 19.¹¹

CONCLUSION

From the regression analysis, we conclude that the spread of COVID-19 cases follow cubic model. We may also conclude that the cases of COVID-19 will decline in the coming days heading towards the reduction in the daily number of cases. But this should be achieved by proper safety measures and following the guidelines of the Government of India.

According to G. E. P. Box (1979), "Models, of course, are never true, but fortunately it is only necessary that they be useful". This is due to the primary basis that models were formulated with various assumptions.

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Institutional Ethics Committee

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