ORIGINAL ARTICLE

Geospatial Epidemiology of chicken-pox disease in India between 2015-2021: A GIS based analysis

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Abstract

Introduction: In this paper, we introduce geographical information systems (GIS) as a tool to study trends in disease spread in time and space. Based on data gathered by the integrated disease surveillance programme (IDSP), we can see where outbreaks of Chickenpox have occurred. **Objective:** The aim of this study is to assess the trends in chickenpox diseases in India between January 2015 and April 2021 using GIS maps. **Methods:** For the collection of secondary data relating to chickenpox, a free app called collect 5 was used for collecting data weekly from the IDSP website and then storing them in an online server. In this project, variables that needed to be processed with QGIS were combined with table attributes of many shapefiles of India and presented as maps. **Results:** Between Jan 2015 and May 2021, 1269 chickenpox outbreaks (27,257 cases) have been recorded. Thirty-one deaths have been confirmed, with most occurring in Bihar and Uttar Pradesh. Nineteen states did not report any deaths. According to the seasonally adjusted trend, the number of cases was highest during the months of January and March. **Conclusion:** In summary, geographic information systems have become an invaluable tool for mapping the hotspots of acute epidemics and planning public health interventions to prevent the spread of these diseases.

Keywords

Varicella Zoster; Healthcare Informatics

Introduction

Due to its wide distribution, chickenpox is highly contagious acute disease of the herpes virus family that typically occurs in epidemic waves. (1) The majority of population-based data about the burden of varicella are from high-income countries, according to a World Health Organization (WHO) position paper. Approximately 140 million cases of varicella are reported each year worldwide. There are also 4.2 million severe complications and 4200 deaths associated with varicella. (2) In high-income countries, the majority infections occurred before adolescence. There is a greater susceptibility to age-related diseases in tropical settings, such as in South Asia. (2) The absence of a non-human reservoir makes it a potential candidate for eradication provided an effective vaccine and precise investigative tests are available. (3) Till then public health efforts are needed to prevent the disease from spreading. For this only tool needed is updated knowledge about its epidemiology. As well as affecting the spread of disease through space and time, environmental and demographic variables also affect the interaction between hosts and pathogens.

Geospatial technology includes geographical information systems (GIS), global positioning systems (GPS) and satellite-based technologies such as remote sensing (RS). GIS is known for geographic data capture, input, update, manipulation, transformation, analysis, query, modelling and visualization of all forms of geographically referenced information through a set of computer programs. The GIS provides dynamic maps to understand the geographical

distribution of diseases for analysis on the frequency of cases, disease mapping, the spatial cluster of diseases, disease association with environmental factors, network analysis, etc. (4) There is a dearth of data on national burden of the disease from India. Estimates are derived from outbreak records in the surveillance database of a country.

Aim & Objective

To estimate the trends of chicken-pox disease in India from Jan 2015 to April 2021 using GIS maps.

Material & Methods

Study Area: All the states of India were taken into consideration.

Research Design: Cross-sectional study was conducted between May through July 2021.

Sample Size: All cases of chicken-pox (Varicella) disease reported by the various districts of India to the Govt of India were taken as a sample size.

Process of selection of sample: All the outbreaks reported by various districts from all over India on the IDSP website were selected for study between Jan 2015 to April 2021.

Study Tool: A study tool was prepared and the Epi Collect 5 free data collection app (5) was used to collect secondary data about chickenpox that is freely available on the Govt. Website: www.idsp.nic.in on a weekly basis and was stored in the online server. (6) An outbreak was defined as more cases of a disease than expected in a specific location over a specific period. (7)

Data analysis: Once the secondary data was collected and synced with the main computer, it was downloaded as CSV files and stored on a personal computer. The data was cleaned and any discrepancy noted was verified with the main data available on the website www.idsp.nic.in. Thereafter variables that were required to be processed with QGIS were merged with table attributes of various shapefiles of India which were downloaded from various free data houses. Data was merged with the layer in use and different parameters were accessed via the properties of that layer such as graduated, highlights, color combination, etc. were selected and maps were prepared. Using the print command, images of the maps were prepared. Quantitative data were analyzed using Epi Info, a software from CDC, which is free software and various proportions were calculated with diagrams. (8)

Results

State and district wise distribution of death cases: Out of 29 states/Union territories, 1269 chickenpox outbreaks were documented between Jan 2015 and May 2021. This added up to 27,257 cases. State-wise records show that the highest number of cases were reported by the state of Bihar (8413) and the second-highest from Uttar Pradesh 2,640 followed by Jharkhand (1793) and Chhattisgarh (1,522). (Figure 1 and Table 1) District level analysis revealed that 306 districts in the country reported outbreaks in the last five years. (Figure 2)

Year and Season wise trend: The year-wise trend shows that the highest number of cases (9165) were reported in 2016 and the decreasing trend was observed thereafter. The season-wise trend shows that the number of cases was highest reported in the winter months as compared to other months of the year. (Figure 3)

Lab diagnosis of outbreaks: 347 (27.35%) samples from the reported outbreaks were sent for serological testing. Out of these 347 samples, it was analysed that 230 (66%) samples of outbreaks were positive for the varicella virus. Reports were not available for samples sent for 108 (31%) outbreaks. (Figure 4)

Discussion

In the current geospatial analysis of chickenpox outbreaks, it was observed that the burden of varicella is unevenly distributed in the country. The maximum number of cases was observed in states with the majority of the population living in low and lower-middle socioeconomic status states. States reporting high cases also ranked low in Sustainable Development Goals (SDG) ranking by NITI Aayog. (9) There has been no fixed trend in the number of cases year-wise but the sudden rise of cases and deaths in 2016 can be noted. It decreased in 2020 which may be attributed to COVID 19 restrictions and non/under-reporting. Kadri SM et al., in their study from Jammu & Kashmir, demonstrated a rising trend in the number of cases from 2013 to 2015. (10) The country-wide analysis of seven years revealed peak cases between January and April. Similar results were gathered by the systematic review in Asian countries which shows that incidence peaked in January in Taiwan and in March in India. (11) This can be attributed to various epidemiological factors like usually living close doors, the ambient temperature inside the houses, close proximity in winters, etc. Whereas Kadri S M et al., from Jammu & Kashmir, observed the peak in July-August months from 2013 to 2015. (10)

The countrywide case fatality rate in the current analysis was around 0.11%, which is almost similar to various observations from Asian countries. (12) However, it was too low as compared to a few studies among hospitalized varicella patients. (13) Only around one-fourth of outbreaks sent samples for diagnosis. Although WHO says that laboratory confirmation is not routinely recommended as part of a standard surveillance system. This is because the suspected case definition is specified in settings without routine immunization (14)

GIS-based surveillance assists in updating and mapping the public health disease epidemiological information. It has emerged as an essential tool for monitoring the national ongoing disease control programs at the grassroots level using the geostatistical exploration survey methods or the random survey methods. (4) This is just one of the several uses of GIS technology in health.

Conclusion

The current analysis using retrospective data from the government's website along with GIS technology for mapping the outbreaks of Chickenpox disease gives an insight into the hot spots for the disease. The highest number of cases were reported in 2016 and the decreasing trend was observed thereafter. Bihar and Uttar Pradesh reported maximum number of cases.

Recommendation

The availability of relevant epidemiological data for example, age, sex distribution through IDSP website could be helpful in mapping the socio demography of diseases.

Limitation of the study

Due to availability of limited variables and lack of defined denominator (population size for particular age group and area) the morbidity and mortality rates could not be calculated which is one of the limitations of the study.

Relevance of the study

Due to the paucity of national burden data of Chickenpox in India, the estimates from the surveillance data of outbreaks between 2015-2021 report 1269 chickenpox outbreaks and 27,257 cases across the country. The GIS-based analysis reports the highest number of cases from states of Bihar, Uttar Pradesh, Jharkhand and Chhattisgarh.

Authors Contribution

AM: Concept and designed the study, collected data and drafted the manuscript; NSRP: Helped in data analysis and interpretation; MS: Helped in drafting manuscript and completing it; AB: Edited and refined the manuscript.

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Tables

TABLE 1 NUMBER OF CASES AND DEATHS REPORTED BY STATES/UNION TERRITORY.

S.no	State/Union Territory	Number of Cases	Number of Deaths
1	Andhra Pradesh	56	0
2	Arunachal	253	0
3	Assam	835	0
4	Bihar	8413	11
5	Chhattisgarh	1522	1
6	Dadra &NH	443	0
7	Daman & Due	29	0
8	Gujrat	399	0
9	Haryana	118	0
10	Jharkhand	1793	2

S.no	State/Union Territory	Number of Cases	Number of Deaths
11	Jammu and Kashmir	1129	0
12	Karnataka	1870	1
13	Kerala	968	2
14	Madhya Pradesh	837	0
15	Maharashtra	605	0
16	Manipur	20	0
17	Meghalaya	218	0
18	Nagaland	37	0
19	Odisha	1011	0
20	Puducherry	124	0
21	Punjab	1525	2
22	Rajasthan	105	2
23	Sikkim	22	0
24	Telangana	13	0
25	Tamil Nadu	1571	0
26	Tripura	35	0
27	Uttarakhand	141	0
28	Uttar Pradesh	2640	7
29	West Bengal	525	1
Total		27257	31

Figures

FIGURE 1 TOTAL NUMBER OF CASES REPORTED BY VARIOUS STATES.

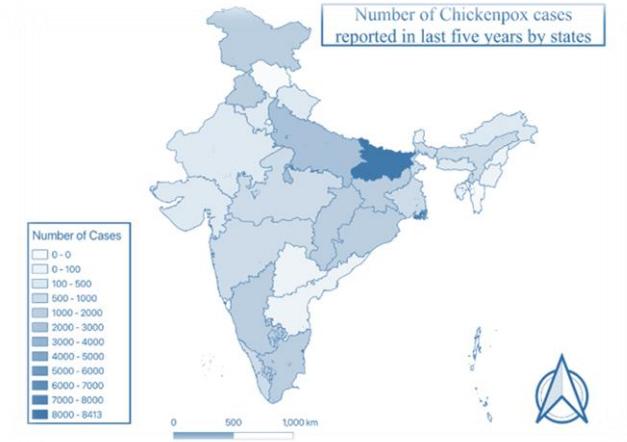

FIGURE 2 NUMBER OF DEATHS REPORTED BY STATES

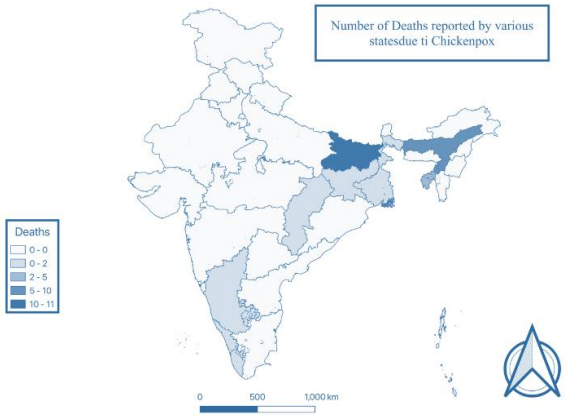

FIGURE 3 SEASON WISE CASES FOR LAST 5 YEARS

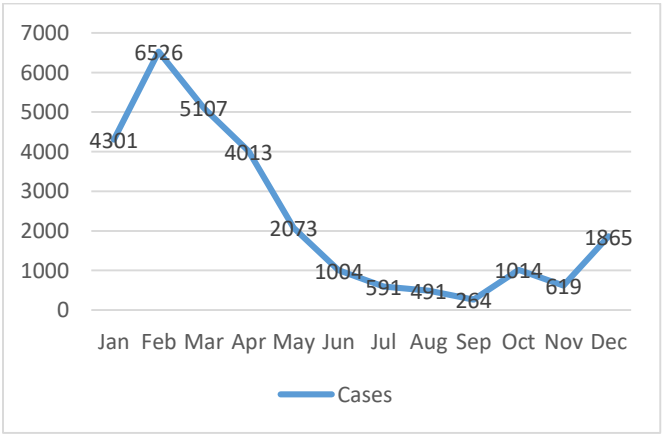

FIGURE 4 STATES WHICH SENT SAMPLES SENT FOR SEROLOGICAL TESTING.