

Original Research Article

## Burden of Infectious Diseases and their Seasonal Variation in India

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### ABSTRACT

**Background:** In India, infectious diseases are the leading cause of mortality. Though, incidences are throughout the year but on peak during the specific season irrespective of the geographical region. Health sector need to manage the cases at least during peak of outbreaks.

**Purpose:** To determine the seasonal variation pattern outbreaks and cases.

**Methodology:** Database since 2010-2015 available at Website of IDSP, MoHFW, and Government of India was used. The diseases were classified as vector born, food & water born, vaccine preventable and a mixed category reporting fever only. Method of simple monthly average was used to obtain seasonal indices.

**Result:** Among the vector borne diseases, out of a total of 1496 outbreaks affecting 102109 persons, the deaths were 13.4/1000 cases; though, the outbreak of AES/JE was only 141 but CFR was 190.6/1000 cases contributing nearly half of the total deaths from vector borne diseases. The outbreaks of malaria were 328 affecting 28912 persons with CFR as 8.6/1000 cases. Dengue outbreak was highest (686) among the vector borne diseases affecting 70.8 persons per outbreak with CFR as 4.2/1000 cases. The outbreaks of food & water borne diseases were more than 3.5 times of vector borne diseases with CFR 4.9/1000 cases. The maximum outbreaks were of acute diarrhoeal diseases (2819) and lowest of cholera (378). Amongst vaccine preventable diseases, a total of 1592 outbreaks with maximum of measles followed by chicken pox and the lowest of mumps. Measles CFR was the highest (6.9/1000 cases). Vaccine preventable diseases excess outbreaks were seen during winter and spring seasons with peaks in March; while of vector born, food & water born and mixed class diseases during summer and autumn.

**Conclusion:** Infectious disease outbreaks follow seasonality; means either climate or temperature or both are associated; indicating appropriate preventive strategy well in time to combat excess outbreaks.

**Key word:** Outbreaks; Infectious diseases; Seasonal Indices; Seasonality.

### INTRODUCTION

The most leading causes of morbidity and mortality in developed nations are non-communicable diseases, while in developing nations both non-communicable as well as communicable diseases. All over the developing world vector born, food & water born and vaccine preventable diseases are a major public

health concern and have a retarding effect on development goal. These infectious diseases severely affect healthy years of life lost (HYLL), quality adjusted life years (QALY), potential year of life lost (PYLL) and moreover economy of individual's family as well as of nation. Thus, continuous surveillance in both time and location is of utmost importance to policy

makers, clinicians and health workers to set the priorities to control illness and promoting health to the population [1] as the changes in demographic, environmental, technological and climatic are underway and may anticipate a wide range of impacts upon the occurrence of old or new infectious disease. [2] Moreover, new pathogens particularly viruses are likely to continue to emerge and spread; challenging public health issues and may lead to morbidity and mortality. [3] India, being the signatory to the Sustainable Development Goals (SDGs), now needs to gear up its policies by working out its health priorities to achieve the stated targets. Infectious diseases though occur throughout the year, but in excess as an outbreak during specific seasons, community and geographical location that may extend for a few days or weeks or years. [4] India, being the second most populous country in the world is in the midst of a triple burden of diseases; the unfinished agenda of communicable diseases, non-communicable diseases linked with lifestyle changes and emergence of new pathogens and overstretched health infrastructure. Communicable diseases accounts for nearly half of India's disease burden which are associated with poor sanitation, contaminated food, inadequate personal hygiene, or poor access to safe water and moreover lack of basic health services. The favourable environmental, demographic and socio-economic factors further put India at a risk of epidemics of emerging infections. [3] Changes in climatic conditions and variability do affect transmission of infectious diseases indirectly via changes in biological and ecological processes. The major infectious diseases in India are the diseases of vector born, food & water born and vaccine preventable that affect all ages irrespective of their sex and region; but confined to mostly low and middle economic class who are in majority and have either poor access of health services or not seeking proper health care well in time in absence of correct knowledge about the disease and its

severity. These diseases can easily be reduced many fold but require attention of the people and the government as well. For vaccine preventable diseases vaccines are access easily and free of cost; still their occurrences, especially of outbreaks alert poor utilization rate whatever may be the reason. For centuries humans have known that climatic conditions affect epidemic infections, since well before the basic notion of infectious agents was understood late in the nineteenth century [2] but to what extent community is alert to prevent before the occurrence of outbreaks is a big question. Seasonal change in the incidence of infectious diseases is a common phenomenon in both temperate and tropical climates; hence a better understanding of seasonality of infectious disease outbreaks and persistence is likely to help the community and nation for optimal control strategies. Hence, the objective of the present analysis is to focus the seasonal variations of outbreaks and number of sufferers as well with major infectious disease so as the health managers can frame the strategy in advance within the available resources.

## **MATERIALS AND METHODS**

This analysis had used the data base covering whole of India which has been extracted from Website of Integrated Disease Surveillance Programme (IDSP) mentored by National Centre for Disease Control (NCDC), Directorate General of Health Services, Ministry of Health and Family Welfare (MoHFW), Government of India. [5] Project had reported a total of 9426 outbreaks with 463949 sufferers during 2010 to 2015. The class of major diseases considered for the analysis were vector borne diseases e.g. AES/JE, malaria, dengue, and chikungunya; food & water borne diseases e.g. cholera, acute diarrhoeal disease, food poisoning and hepatitis; vaccine preventable diseases e.g. measles, mumps and chicken pox and a mixed category reporting fever. Four meteorological seasons each of 3 months

were considered that are spring (March to May); summer (June to August); autumn (September to November) and winter (December to February). [6]

**Statistical Analysis:**

Analysis should be done using Microsoft Excel Software .The data was analysed for each class of disease as well for each specific disease within the class. Method of simple monthly average of time series analysis was used to obtain seasonal indices. [7]

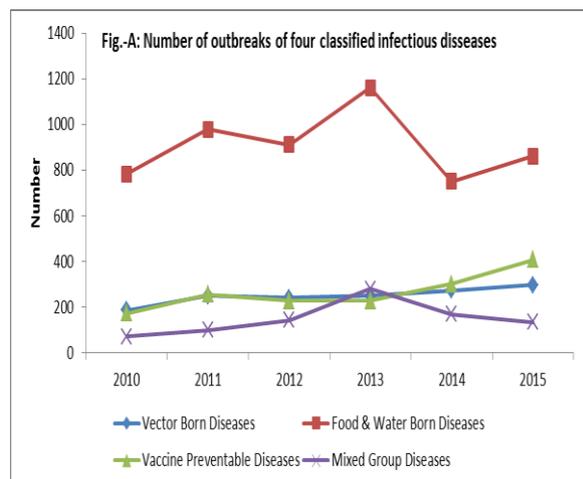
**RESULT**

As indicated in table-1 and Fig-A, since 2010 the number of outbreaks reported

was on an increase for both vectors born as well as vaccine preventable diseases (from 187 in 2010 to 297 in 2015 of vector born and from 173 in 2010 to 408 in 2015 of vaccine preventable diseases). While of food & water born and mixed groups diseases, number of outbreaks increased till 2013 and gone up to 1161 and 279 as against 784 and 70 in 2010; decreased thereafter to 751 and 169 in 2014 respectively but again an excess of 100 outbreaks of food & water born were reported in 2015; while mixed groups diseases outbreaks continued to decline till 2015.

**Table-1: Yearly Distribution of outbreaks of 12 main diseases:**

Diseases	Year					
	2010	2011	2012	2013	2014	2015
<b>Vector Born Disease</b>						
AES/JE	27	31	6	14	37	26
Malaria	55	86	11	43	54	79
Dengue	65	58	168	129	118	148
Chikungunya	40	73	56	64	64	44
Subtotal	187	248	241	250	273	297
<b>Food &amp; Water Born Disease</b>						
Cholera	54	55	94	93	37	45
Acute diarrhoeal disease	479	523	468	590	335	424
Food poisoning	201	304	254	380	297	309
Hepatitis & its type	50	96	94	98	82	83
Subtotal	784	978	910	1161	751	861
<b>Vaccine Preventable diseases</b>						
Measles	115	176	106	89	187	250
Mumps	3	10	20	25	17	30
Chicken Pox	55	69	102	114	96	128
Subtotal	173	255	228	228	300	408
<b>Mixed Group Diseases</b>						
Fever & its kind	70	99	143	279	169	133
Subtotal	70	99	143	279	169	133



As indicated in Table-2, overall 9426 outbreaks affecting 463949 persons (49.2

persons per outbreak) of the 12 listed infectious diseases were reported during 2010-15. Overall case fatality rate (CFR) was 7.2 per 1000 cases with 35 deaths per 100 outbreaks. Among the vector borne diseases, out of a total of 1496 outbreaks affecting 102109 persons, the CFR was 13.4 per 1000; the outbreak of AES/JE was though only 141 but CFR was 190.6 per 1000 cases contributing nearly half of the total deaths from vector borne diseases. The outbreaks of malaria were 328 affecting 28912 persons (88.1 persons per outbreak) with CFR as 8.6 per 1000 cases. Dengue outbreak was highest (686) among the vector borne diseases affecting 70.8 persons

per outbreak with CFR as 4.2 per 1000 cases. The outbreak of Chikungunya was also 341 affecting 58.3 persons per outbreak, but with very low CFR (0.5 per 1000 cases). The outbreaks of food & water borne diseases were more than 3.5 times of vector borne diseases affecting 281216 persons with CFR as 4.9 per 1000 cases. The maximum outbreaks were of acute diarrhoeal diseases (2819) and lowest of cholera (378) with 46.4 and 78.4 cases per outbreak. The CFR of cholera was highest (8.8 per 1000 cases) followed by acute diarrhoeal diseases (5.0 per 1000 cases). Outbreaks of food poisoning were also recorded as 1745 affecting 98927 persons

with CFR 3.8 per 1000 cases. In 503 outbreaks of hepatitis & its type, a total of 21874 persons suffered and 3.7 persons per 1000 cases died. Amongst vaccine preventable diseases, a total of 1592 outbreaks with maximum of measles (923) followed by chicken pox (564) and lowest of mumps (105) were recorded that were affecting 35540 persons with CFR as 4.6 per 1000 cases. CFR of measles was the highest (6.9 per 1000 cases) and lowest of chicken pox (1.2 per 1000 cases). In mixed group reporting fever & its type, a total of 893 outbreaks affecting 45084 persons were noted and CFR was also very high (9.4 per 1000 cases).

**Table-2: Case fatality rate during 2010-15 outbreak's for 12 main infectious diseases:**

Disease	Total outbreak	Total Cases	Cases per outbreak	Deaths	Deaths per 100 outbreak	CFR per 1000 cases
<b>Vector Born Diseases</b>						
AES/JE	141	4748	33.7	905	642	190.6
Malaria	328	28912	88.1	248	76	8.6
Dengue	686	48577	70.8	202	29	4.2
Chikungunya	341	19872	58.3	10	3	0.5
Subtotal	1496	102109	68.25	1365	91.24	13.4
<b>Food &amp; Water Born Diseases</b>						
Cholera	378	29641	78.4	261	69	8.8
Acute diarrhoeal disease	2819	130774	46.4	660	23	5.0
Food poisoning	1745	98927	56.7	373	21	3.8
Hepatitis & its type	503	21874	43.5	80	16	3.7
Subtotal	5445	281216	51.65	1374	25.23	4.9
<b>Vaccine Preventable Diseases</b>						
Measles	923	21009	22.8	145	16	6.9
Mumps	105	2351	22.4	5	5	2.1
Chicken Pox	564	12180	21.6	15	3	1.2
Subtotal	1592	35540	22.32	165	10.36	4.6
<b>Mixed Group Diseases</b>						
Fever & its kind	893	45084	50.5	423	47	9.4
Subtotal	893	45084	50.5	423	47	9.4
Grand Total	9426	463949	49.22	3327	35.30	7.2

Seasonal indices (SI) as shown in Table-3 clearly indicate that that from January to April excess outbreaks are seen only of vaccine preventable diseases but during the month of May outbreaks of vector born and food & water born were also in excess. From June to September, the excess outbreaks of vector born, food & water born and mixed group put triple burden. During October, excess outbreaks of food & water borne diseases are no more but vector born and mixed group persisted while in the month of November only excess outbreaks were of vector borne diseases. Though, the overall outbreaks of vector borne diseases

were at higher rate during May to November with peak in the month of September (SI=163.6) and among these outbreaks of AES/JE was much high during June to August compared to other 9 months with its peak in the month of July (SI=340). The higher outbreaks of malaria were spread over May to November with two peaks; one in the month of July (SI=193.9) and the other one in November (SI=168.3). Outbreaks of dengue were in excess since May to October with peak in September (SI=220.4); only a little less but almost same during the months August (SI=169.7) and October (SI=166.2). Outbreaks of

chikungunya had two excess episodes one during the month of April to May and other one during August to November with highest outbreaks in October (SI=147.8). The overall outbreaks of food & water borne diseases in excess were during May to September with peak in the month of July (SI=176.7). The excess outbreaks of cholera was similar to overall i.e. spread over May to September with peak in the month of July (SI=222.2); but excess outbreaks of acute diarrheal diseases were seen during the month of May to September only with peak in July (SI=210.3). Food poisoning excess outbreaks were from March to July with peak in the month of May (SI=155.4). The excess outbreaks of hepatitis & its kind were spread over January to April and June

to July with peaks in April and June. The outbreaks of vaccine preventable diseases in excess were during January to May with peak in the month of March (SI=214.8). The outbreaks pattern of measles and chicken Pox were similar to overall vaccine preventable diseases; but the spread of outbreaks in excess of measles initiates in Nov and continued till May while of chicken pox from Jan to May and both had peaks of outbreaks in the month of March. The excess outbreaks of mumps were found in the month of Jan and Feb as well as in August, September and October. The outbreaks of mixed group diseases in excess were during June to October with peak in the month of September (SI=220.4)

Table-3: Seasonal indices of outbreaks of 12 main infectious diseases during 2010-15

Diseases	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
<b>Vector Born Disease</b>												
AES/JE	68.1	25.5	51.1	93.6	93.6	289.4	340.4	110.6	59.6	34.0	17.0	17.0
Malaria	14.6	7.3	29.3	51.2	102.4	120.7	193.9	142.7	146.3	150.0	168.3	73.2
Dengue	31.5	19.2	70.0	78.7	110.2	101.5	108.5	169.7	220.4	166.2	73.5	50.7
Chikungunya	66.9	56.3	77.4	137.2	105.6	77.4	84.5	140.8	109.1	147.8	133.7	63.3
Subtotal	39.3	25.7	61.0	87.4	105.9	117.9	143.6	151.6	163.6	146.0	102.7	55.3
<b>Food &amp; Water Born Disease</b>												
Cholera	41.3	25.4	28.6	69.8	130.2	155.6	222.2	187.3	152.4	101.6	50.8	34.9
Acute diarrheal diseases	37.5	38.7	51.1	81.3	140.9	158.8	210.3	180.5	120.9	82.2	58.3	39.6
Food Poisoning	79.8	80.5	114.8	119.7	155.4	123.8	129.3	96.3	92.2	69.5	62.6	76.3
Hepatitis & its type	119.3	114.5	112.1	121.7	85.9	124.1	119.3	95.4	90.7	64.4	95.4	57.3
Subtotal	58.8	58.2	75.6	96.5	139.7	144.1	176.7	146.1	111.1	77.8	62.6	52.7
<b>Vaccine Preventable Diseases</b>												
Measles	106.6	140.4	192.4	140.4	110.5	53.3	59.8	65.0	55.9	71.5	104.0	100.1
Mumps	148.6	102.9	80.0	57.1	34.3	68.6	57.1	102.9	217.1	148.6	91.4	91.4
Chicken Pox	134.0	142.6	276.6	202.1	153.2	29.8	31.9	42.6	27.7	23.4	44.7	91.5
Subtotal	119.1	138.7	214.8	156.8	120.6	46.0	49.7	59.5	56.5	59.5	82.2	96.5
<b>Mixed Group Diseases</b>												
Fever & its kind	55.1	37.6	56.4	86.0	92.7	111.5	102.1	150.5	220.4	155.9	96.8	34.9
Subtotal	55.1	37.6	56.4	86.0	92.7	111.5	102.1	150.5	220.4	155.9	96.8	34.9

Table-4 & Fig-B indicates the seasonal indices of number of cases suffered with 12 listed infectious diseases. Overall, excess number of cases was during the months from July to November; though excess outbreaks were from May to November. Among the vector borne diseases, AES/JE outbreaks were from June to August, but excess number of cases reported was from Jun to July as well as in the month of April. Excess outbreaks of malaria were from June to November and cases in excess were also in these months except in the month of June. Dengue outbreaks in excess were observed since May to October, but cases in excess

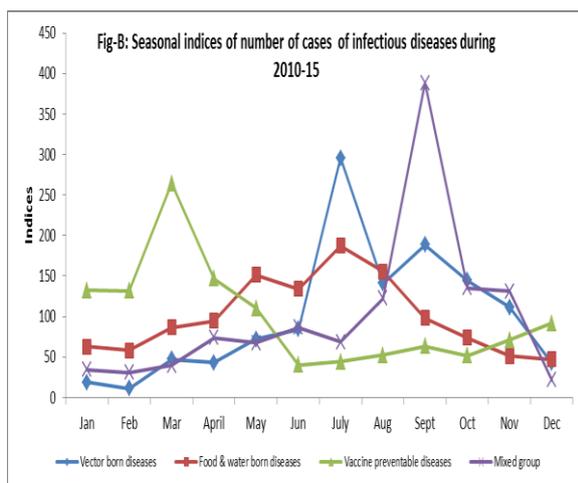
were confined to months July to October; in the month of July dengue cases index was much high (SI = 464.0) than August, September and October. In addition, from August to November, excess outbreaks of chikungunya were also in the months of April and May but cases reported in excess were only during the months of August to November. In food & water borne diseases, overall excess outbreaks were from May to September, but cases in excess were spread to May to August only. Though, the excess outbreaks of cholera were spread from May to October but excess cases were seen in July, August and October; highest in the

month of July (SI = 380.2). The excess outbreaks as well as cases of acute diarrheal diseases had same seasonal pattern i.e. excess from May to September. Like acute diarrheal diseases, food poisoning excess outbreaks and cases were reported during March to July. Hepatitis & its kind outbreaks and number of cases did not show any pattern; even less cases were reported in those months observing excess outbreaks. The excess outbreaks of measles were spread continuously from November to May, but excess cases were spread only from January to May. In all the months with excess outbreak of mumps, cases were in

excess but in the month of June, though number of outbreaks was less but cases were in excess (SI<sub>Outbreaks</sub> = 68.6 and SI<sub>Cases</sub> = 106.2). Similarly, in all the months with excess outbreak of chicken pox, cases were in excess but in the month of December, the number of outbreaks was less but cases were in excess (SI<sub>Outbreaks</sub> = 91.5 and SI<sub>Cases</sub> = 103.5). In mixed group, excess of outbreaks did not show excess of cases; outbreaks in excess were from June to October but cases in excess reported were since August to November; excess cases were also reported in those months with lesser number of outbreaks and visa vase.

Table -4: Seasonal indices of number of cases of 12 main infectious diseases during 2010-15

Diseases	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
<b>Vector Born Disease</b>												
AES/JE	79.1	41.5	46.5	166.3	47.0	276.8	388.7	36.9	27.3	84.4	2.3	3.3
Malaria	3.2	3.1	97.6	24.4	128.5	80.3	154.7	122.1	180.0	190.2	123.2	92.7
Dengue	10.8	5.4	24.8	31.6	47.9	81.9	464.0	114.9	245.4	101.7	51.9	19.7
Chikungunya	47.4	29.4	27.8	67.5	53.7	51.2	68.6	257.2	101.2	195.4	266.3	34.5
Subtotal	19.0	11.1	47.0	42.8	71.8	84.5	296.0	141.0	188.7	144.2	111.5	42.5
<b>Food &amp; Water Born Disease</b>												
Cholera	22.4	20.9	11.5	42.6	91.6	88.3	380.2	264.4	95.1	138.8	20.0	24.4
Acute diarrheal diseases	48.2	35.4	51.4	81.4	150.2	153.3	212.0	206.4	107.6	64.6	54.3	35.2
Food Poisoning	81.9	89.8	128.0	131.3	156.7	117.4	124.6	77.9	98.6	72.3	55.4	66.1
Hepatitis & its type	118.0	98.6	213.1	79.1	214.2	153.6	64.3	52.2	43.6	44.6	52.7	66.1
Subtotal	62.8	57.9	86.7	94.7	151.3	133.8	187.5	155.3	98.1	73.6	51.0	47.3
<b>Vaccine Preventable Diseases</b>												
Measles	122.9	127.3	271.8	134.6	101.8	39.6	45.1	60.0	58.4	61.7	88.5	88.3
Mumps	144.5	116.4	58.7	38.8	22.0	106.2	79.1	109.2	276.7	114.8	74.5	59.2
Chicken Pox	146.7	141.7	291.6	189.2	141.8	28.6	36.2	28.9	30.7	21.9	39.4	103.5
Subtotal	132.5	131.5	264.5	146.9	110.2	40.2	44.3	52.6	63.3	51.6	70.8	91.5
<b>Mixed Group Diseases</b>												
Fever & its kind	34.4	30.8	39.6	74.0	67.5	86.3	68.8	122.4	388.4	135.0	131.3	21.5
Subtotal	34.4	30.8	39.6	74.0	67.4	86.3	68.8	122.4	388.4	135.0	131.3	21.5



**DISCUSSION**

Infectious diseases account for a quarter of all human mortality and a similar fraction of morbidity and as per data on

medical certificate for causes of death, infectious and parasite diseases are second most leading cause of mortality in India. [8] Among the most important factors expected to influence future changes in infectious disease risks were travel, migration, and trade, which promote the spread of infections into new populations. [9] Better disease detection capability is vital but will present challenges as well as opportunities. New technologies must be embedded within functional national or international surveillance systems. [9] Continuous rise of vector borne diseases is a major concern; out of these AES/JE and malaria is a major threat to the mankind being highly fatal. The outbreaks of AES/JE and malaria among vector born are less than half compared to

others dengue and chikungunya but 96% mortality is solely due to AES/JE and malaria. Under the policy of government to control vaccine preventable diseases, the rising trend of outbreaks poses a question on the way of implementation and execution. Outbreaks of food & water borne diseases had extensively very large number of outbreaks (5445) even more than three times compared to the next vaccine preventable diseases (1592); though decreased much in 2014 from 2013 but further increased by 110 outbreaks in 2015 affecting nearly 60% of the people of all infectious diseases. Cholera with 378 outbreaks affecting 29641 persons being the most fatal (CFR = 8.8 per 1000) followed by acute diarrheal diseases (CFR = 5.0 per 1000) which had 2819 outbreaks affecting 130774 persons. Food poisoning and hepatitis had CFR almost equal about 3.7 but food poisoning outbreaks and affected persons were more than three times and four times respectively than the hepatitis & its kind. Among the vaccine preventable diseases the CFR of measles was much higher (CFR = 6.9 per 1000) than the mumps (CFR = 2.1 per 1000) and chicken pox (CFR = 1.2 per 1000) and at the same time the outbreaks and affected persons were also much higher. The outbreaks of mixed group of diseases, though showed decreasing trend, but CFR are very high 9.4 per 1000 next to AES/JE. Overall even if premature mortality is ignored, 9426 outbreaks nationwide affecting 463949 people is a major concern to expenses incurred on treatment as well as loss to man days.

The number of cases obviously will depend on number of outbreaks of a disease. Seasonal distribution of outbreaks of the infectious disease revealed that almost all the diseases had a seasonal variation. The outbreaks of vector borne diseases in excess were initiated at the end of spring (May) and continued till end of autumn with peak at the start of autumn i.e. in the month of September. Among the vector borne diseases, the maximum outbreaks of AES/JE and malaria were in July in summer

season and of dengue and chikungunya in September and October respectively in autumn season. The excess outbreaks of food & water borne diseases indicated the similar pattern to vector borne diseases outbreaks e.g. started in the last month of spring and continued till first month of autumn with peak in the month of July in summer. The outbreaks in excess of cholera, though, started in May and continued till October; the peak is in the month of July. Acute diarrheal diseases excess outbreaks and peak of outbreaks were almost similar to cholera; but of food poisoning excess outbreaks were confined to four months i.e. April to July with peak in May. The excess outbreaks of diseases hepatitis & its kind were in whole of the winter season and summer with almost same level. Excess outbreaks occurrences of vaccine preventable diseases were only during winter and spring with peak in March of spring season; peak of outbreaks of measles and chicken pox were also seen in the month of March of spring season, but mumps had two peaks one in January and other one comparatively much higher peak in September. The excess outbreaks of mixed group diseases were almost similar to diseases of vector born and food poisoning & water born i.e. starting from June and continued till October but peak was only like vector borne diseases i.e. in the month of September.

In study it is clear that cases are increasing in transition phase. At the end of the winter and early spring season the outbreaks of chickenpox, measles, viral hepatitis, food poisoning occurs and from the beginning of summer season cases of cholera, dengue fever, malaria start rising and are at peak in the autumn season. For acute diarrhoeal diseases, cases start rising in the late spring and are at peak in summer season and declining in early autumn season. Thus, the focus on the seasonality of infectious diseases and its variation from year to year is very important to understand the effects of long-term climate change that effects human health. However, seasonal

patterns are one major pathway for the potentially drastic effects of climate change on disease dynamics which lead to seasonal outbreaks. Thus, identifying the specific environmental factors during seasonal transmission is a critical step towards the impact on human health. [10]

## CONCLUSION

Control of the communicable diseases may entail measures for enhancing the socioeconomic development along with specific health measures for a sustained effect. The study highlights the need for further implementation of preventive measures like vaccination programme, need for good surveillance system, interpretation of disease outbreak data more scientifically, educating community through mass media about the seasonality effect on specific disease outbreaks and preventive measure to be taken at right time.

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