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WHEN, WHICH AND WHERE OF DISEASE INCIDENCE IN INDIA: AN IDSP ANALYSIS

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ABSTRACT
In 2004 the Union Ministry of Health & Family Welfare, Government of India, rolled out an Integrated Disease Surveillance Project (IDSP), a decentralized state-based disease surveillance system. The purpose of the study is to analyze country wide IDSP data from 2011 to 2013 to identify the disease and district associated with the seasonal peaks in disease incidence numbers, and to identify the gaps in the existing surveillance system. Weekly datasets from IDSP were sourced from National Centre for Disease Control- New Delhi, GOI through due process. The disease outbreak incidence numbers are summed up and sequenced quarterly. In the next step the incidence peak quarters were identified and analyzed. The highest number of cases were reported in July to September (Quarter 2) of 2011 (34%), second quarter of 2012 (31%), and second quarter of 2013 (34%). Acute diarrhoeal disease (ADD) (40.85%) constitutes the biggest reason for peak disease incidence followed by dengue/ chickungunya (19.50%), food poisoning (18.44%), PUO (fever of unknown origin) (13.20%), and Cholera (8%). 13 districts have reported the reoccurrence of diseases during the peak outbreak incidence period of all the years. The main diseases that are showing a clustering effect are ADD (average number of cluster in the three years = 3), and Dengue and Chickungunya (2) and Cholera (2). The reported disease outbreak data under IDSP accounted for 1% of missing information on the date of disease outbreaks and approximately 25% of missing date of reporting of the same. The IDSP disease outbreak reporting procedure suffered a time lag of a minimum 3 days and a maximum time lag of 64 days. The study highlights the time, disease and district that need to be prioritized for better focus of resources. Also the more critical question of “why” regarding the disease incidence should be further researched up on.

KEYWORDS: time series, India, outbreak, spatial analysis, surveillance system.

INTRODUCTION

In 2004 the Union Ministry of Health & Family Welfare, Government of India, rolled out an Integrated Disease Surveillance Project (IDSP), a decentralized state-based disease surveillance system, intended to detect early warning signals of epidemic prone diseases, so that timely and effective public health actions can be initiated in response to health challenges in the country at the state and the national level. Major components of the project are [1]:

1. Integration and decentralization of surveillance activities
2. Strengthening of public health laboratories
3. Human Resource Development – Training of State Surveillance Officers (SSO), District Surveillance Officers (DSO), Rapid Response Team (RRT), other medical and paramedical staff
4. Use of Information Technology for collection, collation, compilation, analysis, and dissemination of data
5. Avian Influenza Human Component

Under the project weekly (Monday to Sunday) disease surveillance aggregated data on epidemic prone disease are being collected from reporting units such as sub centers, primary health centers, community health centers, hospitals including government and private sector hospitals and medical colleges. The data from various health institutions are collected on three reporting forms, namely the Suspected (S) cases, the Presumptive (P) cases, and the Laboratory-confirmed (L) cases filled in by health workers, clinicians and clinical laboratory staff respectively. Investigation on the data collected is performed by the Medical Officers and the Rapid Response Teams.

Reasons for disease surveillance data can include the need to assess the health status of a population, establish public health priorities, create an early warning system based on past experience and reduce the burden of disease in a population by appropriately targeting effective disease prevention and control activities [2]. Prompt detection of an outbreak of infectious disease may lead to control measures that limit its impact and help prevent future outbreaks. According to the Oxford Handbook of Public Health Practice, two of the principal objectives of an effective surveillance system are to "give early warning changes of incidence," and "detect outbreaks early". Unfortunately, the reality of public health practice is that most monitoring agencies routinely fall short of these objectives, because of coordination delays.

The purpose of this study is:

1. To analyze country wide IDSP data from 2011 to 2013 through time series analysis to identify for seasonal peaks. Also knowing the disease and district associated with the seasonal peaks would help in future disease

prevention and control. The need is to answer three questions:

a. In a year when do diseases occur most?
b. Which diseases occur most?
c. Where (district) do these diseases occur most?

2. To identify the gaps in the existing surveillance system and suggest newer methodologies to capture health happenings from varied potential sources of information.

METHODOLOGY

Weekly datasets from IDSP for the years 2011-2013 was sourced from National Centre for Disease Control- New Delhi, Government of India through due process. Data cleansing was performed using SAS University Edition. The dataset was divided according to Regions i.e. Central, East, North, South, and West. The reported disease outbreak incidence numbers were summed up and sequenced quarterly (April-June being the first quarter), for time series data analysis. In the next step the incidence peak quarter in each of the three years was identified. The dataset was further subset to only include 5 diseases contributing the highest number of cases reported per region during the period of the incidence peak quarter. Five districts from each region reporting the highest number of cases for those diseases was extracted and the analysis was performed on these districts. The Variable cases are defined as the Number of individuals affected by a particular disease for which a record was made. The district level analysis was mapped using the ARC GIS software. The reporting of disease outbreaks was evaluated by identifying the time lag between outbreak date and reported date. Also, the data was checked for inefficiencies and inconsistencies with the ground reality. On the basis of the identified gaps in the existing surveillance system, we have suggested newer methodologies for the development of an indicator-based public health surveillance system.

RESULTS

Figure 1(a) shows the quarterly country wide distribution of all disease outbreaks for three years (2011, 2012, and 2013). The number of reported cases (incidence) is showing a clear increasing trend. Also there is a clear cyclical disease outbreak incidence with maximum incidence in the second quarter of every year. The highest number of cases reported has been in the second quarter of 2011 (34%), second quarter of 2012 (31%), and second quarter of 2013 (34%). Figure 2 (a, b, c) and Table 2 (a, b, c) shows the composition of diseases during the peak outbreak incidence period of the second quarter of 2011, 2012, and 2013 respectively. Acute diarrhoeal disease (40.85%) constitutes the biggest reason for peak disease incidence followed by dengue/ chickungunya (19.50%), food poisoning (18.44%), PUO (fever of unknown origin) (13.20%), and Cholera (8%). Figure 2(d) shows the composition of 13 districts that have reported the reoccurrence of diseases during the peak outbreak incidence period of all the years. Figure 3 (a, b, c) and Table 3 (a, b, c) show the groups of districts that form a cluster of a same disease occurring during the second quarter of 2011, 2012, and 2013 respectively. The main diseases that are showing a clustering effect are Acute Diarrhoeal Disease (average number of cluster in the three years = 3), and Dengue and Chickungunya (2) and Cholera (2).

TABLE 1(a) Quarterly Incidence of all Diseases in India

	2011		2012		2013	
Quarter	Number	Percent	Number	Percent	Number	Percent
Quarter 1	17937	27%	23607	31%	25403	29%
Quarter 2	24122	34%	28436	31%	28596	34%
Quarter 3	14504	21%	12559	16%	14959	17%
Quarter 4	10778	17%	14351	22%	16151	19%
Total	67341	100%	78953	100%	85109	100%

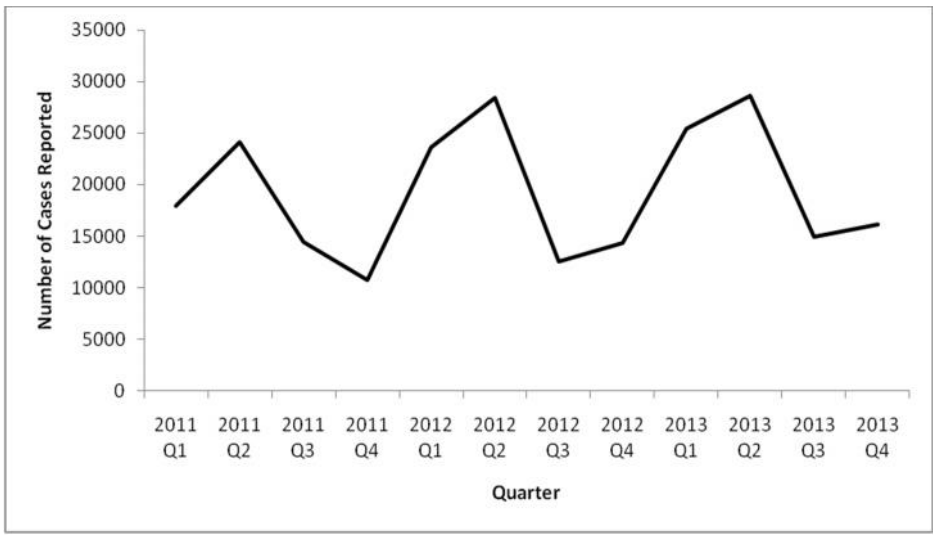

FIGURE 1 (a) Quarterly Incidence of all Diseases in India for the years 2011, 2012, 2013
First Quarter of every year is April to June (1 year is April to March)

TABLE 1 (b) Quarterly Incidence of all diseases in the Central Region of India

	2011		2012		2013	
Quarter	Number	Percent	Number	Percent	Number	Percent
Quarter 1	593	14%	940	23%	1441	15%
Quarter 2	3842	55%	3170	47%	4456	59%
Quarter 3	1914	20%	780	7%	1810	13%
Quarter 4	387	10%	1533	23%	702	13%
Total	6736	100%	6423	100%	8409	100%

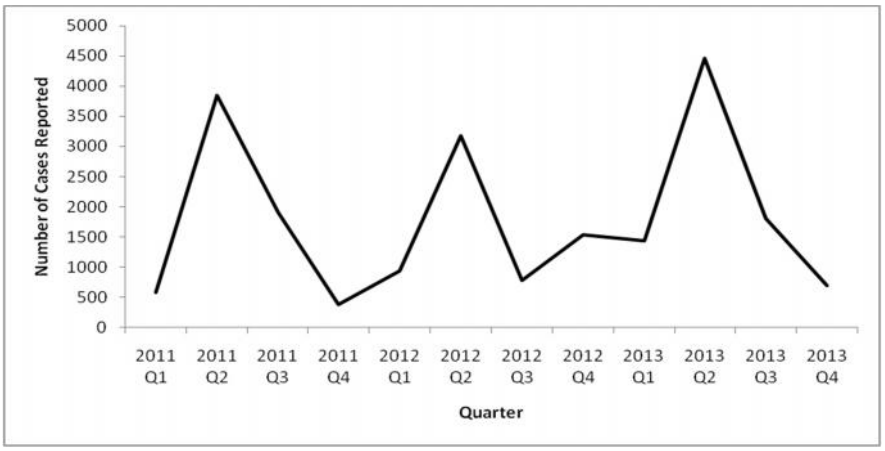

FIGURE 1 (b) Quarterly Incidence of all diseases in the Central Region of India for the years 2011, 2012, 2013
First Quarter of every year is April to June (1 year is April to March)

TABLE 1 (c) Quarterly Incidence of all diseases in the East region of India

	2011		2012		2013	
Quarter	Number	Percent	Number	Percent	Number	Percent
Quarter 1	5630	26%	5728	32%	9802	33%
Quarter 2	8766	36%	5918	29%	10470	31%
Quarter 3	4282	21%	3126	12%	5671	20%
Quarter 4	2022	17%	4538	27%	5111	16%
Total	20700	100%	19310	100%	31054	100%

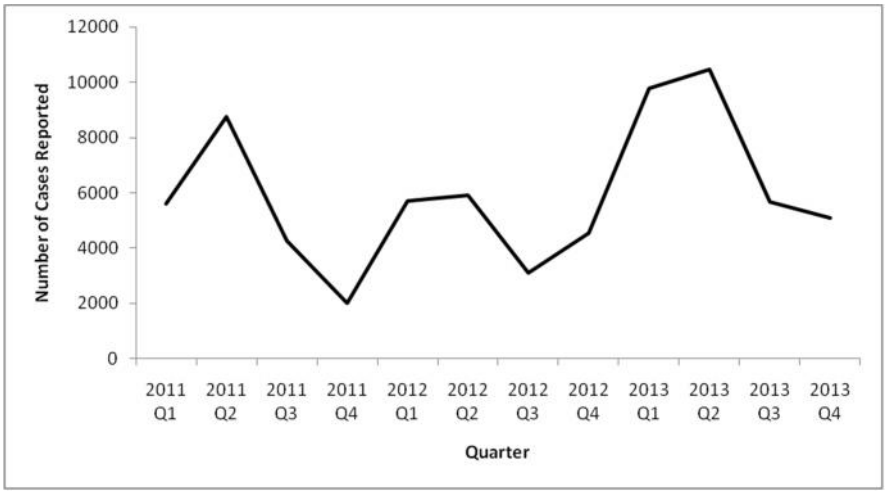

FIGURE 1 (c) Quarterly Incidence of all Diseases in the East Region of India for the years 2011, 2012, 2013
First Quarter of every year is April to June (1 year is April to March)

TABLE 1(d) Quarterly Incidence of all diseases in the North region of India

	2011		2012		2013	
Quarter	Number	Percent	Number	Percent	Number	Percent
Quarter 1	1520	30%	2854	31%	2505	29%
Quarter 2	4172	35%	7041	43%	4947	45%
Quarter 3	979	20%	1521	14%	1557	12%
Quarter 4	2584	15%	1181	12%	1508	15%
Total	9255	100%	12597	100%	10517	100%

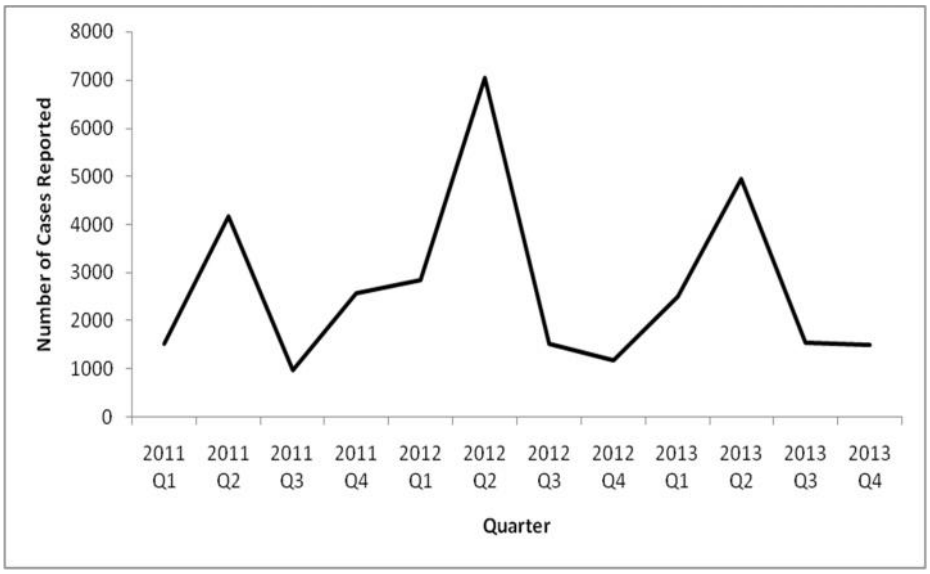

FIGURE 1 (d) Quarterly Incidence of all Diseases in the North Region of India for the years 2011, 2012, 2013
First Quarter of every year is April to June (1 year is April to March)

TABLE 1 (e) Quarterly Incidence of all diseases in the South region of India

	2011		2012		2013	
Quarter	Number	Percent	Number	Percent	Number	Percent
Quarter 1	4830	31%	5081	33%	5817	29%
Quarter 2	3444	28%	4783	27%	4502	28%
Quarter 3	3237	23%	3242	14%	3010	15%
Quarter 4	2781	18%	4357	27%	6279	28%
Total	14292	100%	17463	100%	19608	100%

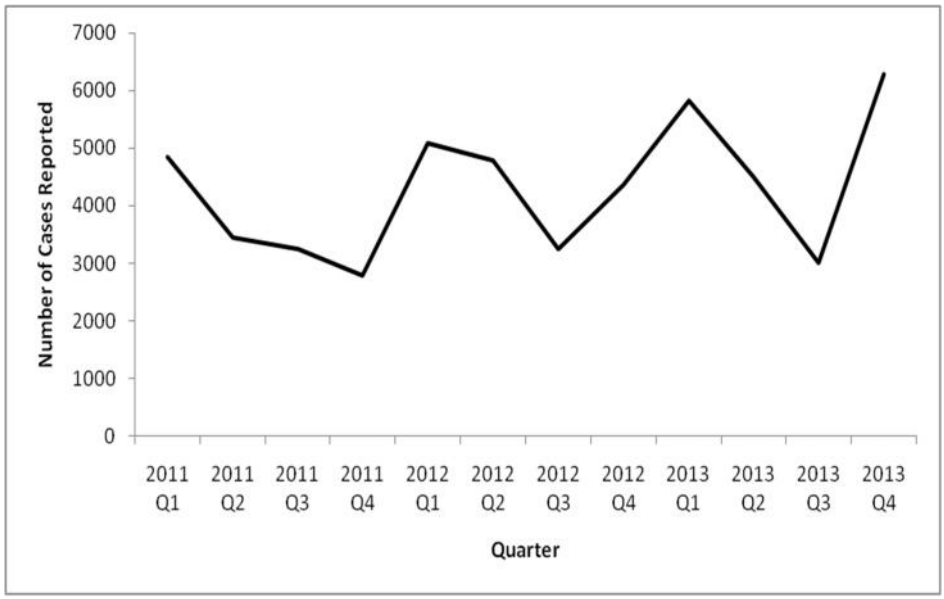

FIGURE 1 (e) Quarterly Incidence of all Diseases in the South region of India for the years 2011, 2012, 2013
First Quarter of every year is April to June (1 year is April to March)

TABLE 1 (f) Quarterly Incidence of all diseases in the West region of India

	2011		2012		2013	
Quarter	Number	Percent	Number	Percent	Number	Percent
Quarter 1	5364	29%	9004	28%	5838	28%
Quarter 2	3898	28%	7524	29%	4221	35%
Quarter 3	4092	22%	3890	27%	2911	21%
Quarter 4	3004	21%	2742	16%	2551	15%
Total	16358	100%	23160	100%	15521	100%

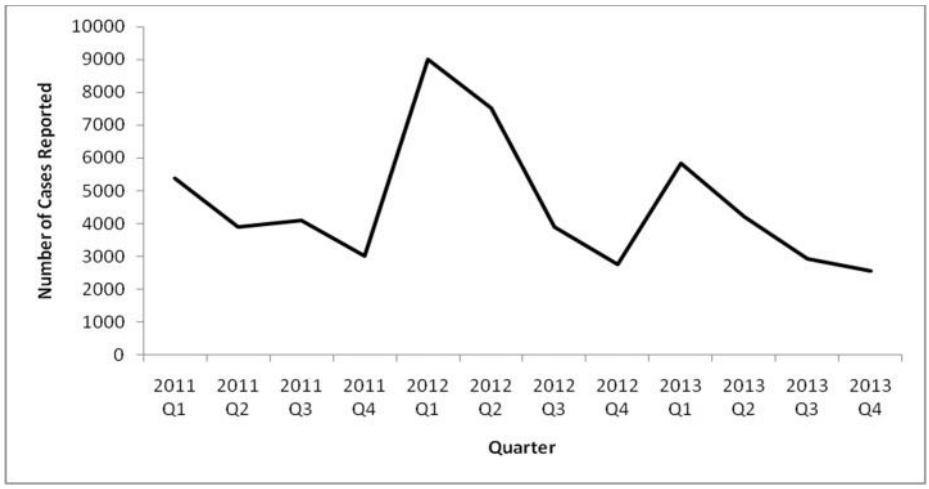

FIGURE 1 (f) Quarterly Incidence of all Diseases in the West region of India for the years 2011, 2012, 2013
First Quarter of every year is April to June (1 year is April to March)

When and where of public health happenings is an important factor that helps in identifying early warning signals of diseases and thus ensures the efficiency of a public health surveillance system. The reported disease outbreak data under IDSP accounted for 1% of missing information on the date of disease outbreaks and approximately 25% of missing date of reporting of the same. The IDSP disease outbreak reporting procedure suffered a time lag of a minimum 3 days and a maximum time lag of 64 days. Moreover, detailed location information as a field apart from the district in which the outbreak occurred wasn't reported, however the location was recorded in the free-flow text of the comments section.

TABLE 2 (a) Incidence of the top 5 diseases per region in India in the Second quarter of 2011

Region	Disease	District	Number	Percent
Central				
	Acute Diarrhoeal Disease			
		Bilaspur	121	13%
		Damoh	151	16%
		Dhamtari	118	13%
		Raipur	322	35%
		Raisen	208	23%
	Acute Diarrhoeal Disease Total		920	100%
	Dengue & Chikungunya			
		Betul	252	66%
		Bhind	46	12%
		Raipur	3	1%
		Tikamgarh	80	21%
	Dengue & Chikungunya Total		381	100%
	Food Poisoning			
		Bilaspur	42	18%
		Janjgir	6	3%
		Kanker	35	15%
		Mahasamund	100	44%
		Raipur	46	20%
	Food Poisoning Total		229	100%
	Malaria			
		Chhatarpur	258	37%
		Chhindwara	112	16%
		Dindori	159	23%
		Hoshangabad	56	8%
		Mahasamund	108	16%
	Malaria Total		693	100%
	PUO			
		Burhanpur	85	33%
		Guna	76	30%
		Khandwa	20	8%
		Tikamgarh	75	29%
	PUO Total		256	100%
East				

	Acute Diarrhoeal Disease			
		Bankura	936	49%
		Gaya	123	6%
		Howrah	493	26%
		Nawada	168	9%
		Purulia	206	11%
	Acute Diarrhoeal Disease Total		1926	100%
	Cholera			
		Bankura	73	17%
		Birbhum	254	59%
		Kolkata	27	6%
		North 24 Parganas	78	18%
	Cholera Total		432	100%
	Dengue & Chikungunya			
		East Singhbhum	135	13%
		Howrah	903	85%
		West Singhbhum	22	2%
	Dengue & Chikungunya Total		1060	100%
	Food Poisoning			
		Bankura	727	45%
		Dibrugarh	188	12%
		Nadia	283	17%
		Purba Medinipur	325	20%
		South 24 Parganas	110	7%
	Food Poisoning Total		1633	100%
	Malaria			
		Malda	148	34%
		Malkangiri	76	17%
		Munger	86	20%
		Rohtas	80	18%
		West Singhbhum	51	12%
	Malaria Total		441	100%
North				
	Acute Diarrhoeal Disease			
		Badgum	1657	77%
		Ganderbal	78	4%
		Gurgaon	139	6%
		Kapurthala	121	6%
		Palwal	159	7%
	Acute Diarrhoeal Disease Total		2154	100%
	Cholera			
		Chandigarh	5	3%
		Jalandhar	163	91%
		Ludhiana	7	4%
		Panchkula	5	3%
	Cholera Total		180	100%
	Food Poisoning			
		Anantnag	106	57%
		Pratapgarh	45	24%
		Rudraprayag	10	5%
		Uttarkashi	25	13%
	Food Poisoning Total		186	100%
	PUO			
		Chamoli	128	19%
		Gurgaon	247	36%
		Jalaun	87	13%
		Tehri Garhwal	121	18%
		Unnao	101	15%
	PUO Total		684	100%
	Viral Hepatitis			
		Amritsar	15	9%
		Barnala	119	72%
		Pulwama	31	19%
	Viral Hepatitis Total		165	100%
South				
	Acute Diarrhoeal Disease			

		Belgaum	105	19%
		Bidar	129	24%
		Hassan	73	14%
		Kurnool	142	26%
		Warangal	91	17%
	Acute Diarrhoeal Disease Total		540	100%
	Dengue & Chikungunya			
		Bijapur	39	11%
		Dharmapuri	118	34%
		Krishna	45	13%
		Mahbubnagar	114	32%
		Thiruvallur	35	10%
	Dengue & Chikungunya Total		351	100%
	Food Poisoning			
		Devanagere	67	15%
		Mysore	55	12%
		Nellore	52	12%
		Thiruvallur	136	31%
		Trivandrum	135	30%
	Food Poisoning Total		445	100%
	Malaria			
		Gadag	10	7%
		Udupi	130	93%
	Malaria Total		140	100%
	PUO			
		Chamarajanagar	36	10%
		Pudukkottai	66	19%
		Salem	58	17%
		Thanjavur	140	41%
		Warangal	45	13%
	PUO Total		345	100%
West				
	Acute Diarrhoeal Disease			
		Dholpur	113	21%
		Nanded	83	15%
		Nashik	62	11%
		Raigad	231	42%
		Thane	56	10%
	Acute Diarrhoeal Disease Total		545	100%
	Cholera			
		Alwar	211	50%
		Navsari	46	11%
		Pune	53	13%
		Raigad	67	16%
		Rajkot	44	10%
	Cholera Total		421	100%
	Dengue & Chikungunya			
		Akola	98	22%
		Beed	174	39%
		Gadchiroli	72	16%
		Parbhani	57	13%
		Thane	43	10%
	Dengue & Chikungunya Total		444	100%
	Food Poisoning			
		Jalore	102	19%
		Jamnagar	82	15%
		Nashik	208	39%
		Pune	125	23%
		Sabarkantha	17	3%
	Food Poisoning Total		534	100%
	PUO			
		Bhandara	84	11%
		Gadchiroli	58	7%
		Jalgaon	419	54%
		Karauli	121	16%
		Nanded	98	13%
	PUO Total		780	100%

TABLE 2 (b) Incidence of the top 5 diseases per region in India in the Second quarter of 2012

Region	Disease	District	Number	Percent
Central				
	Acute Diarrhoeal Disease			
		Dhamtari	202	13%
		Janjgir	333	22%
		Mahasamund	588	38%
		Raigarh	184	12%
		Raipur	222	15%
	Acute Diarrhoeal Disease Total		1529	100%
	Dengue & Chikungunya			
		Koriya	304	100%
	Dengue & Chikungunya Total		304	100%
	Food Poisoning			
		Narsinghpur	186	23%
		Raigarh	75	9%
		Raipur	354	44%
		Rewa	32	4%
		Ujjain	157	20%
	Food Poisoning Total		804	100%
	Malaria			
		Janjgir	21	100%
	Malaria Total		21	100%
East				
	Acute Diarrhoeal Disease			
		Garhwa	140	16%
		Gaya	143	16%
		Hooghly	323	37%
		Lakhisarai	135	15%
		Nalanda	138	16%
	Acute Diarrhoeal Disease Total		879	100%
	Cholera			
		Bankura	217	36%
		Birbhum	93	15%
		Hooghly	126	21%
		Jorhat	84	14%
		Malda	87	14%
	Cholera Total		607	100%
	Dengue & Chikungunya			
		Baleswar	310	31%
		Hooghly	22	2%
		Muzaffarpur	123	12%
		Nadia	264	27%
		Patna	272	27%
	Dengue & Chikungunya Total		991	100%
	Food Poisoning			
		Barpeta	200	17%
		Buxar	168	14%
		Dhemaji	90	8%
		East Champaran	93	8%
		North 24 Parganas	629	53%
	Food Poisoning Total		1180	100%
	PUO			
		Dakshin Dinajpur	193	93%
		West Singhbhum	15	7%
	PUO Total		208	100%
North				
	Acute Diarrhoeal Disease			
		Baramulla	392	24%
		Budgam	140	9%
		Ganderbal	105	6%
		Kurukshetra	694	43%
		Lucknow	105	6%
		Unnao	186	11%
	Acute Diarrhoeal Disease Total		1622	100%

	Cholera			
		Baramulla	238	41%
		Gurdaspur	50	9%
		Hosiarpur	125	21%
		Jind	119	20%
		Patiala	52	9%
	Cholera Total		584	100%
	Dengue & Chikungunya			
		Chandigarh	579	27%
		Kanpur Nagar	348	16%
		Papum Pare	544	26%
		Upper Siang	278	13%
		West Siang	363	17%
	Dengue & Chikungunya Total		2112	100%
	Food Poisoning			
		Anantnag	512	76%
		Hosiarpur	30	4%
		Kulgam	25	4%
		Raebareli	17	3%
		Sirmaur	90	13%
	Food Poisoning Total		674	100%
	PUO			
		Auraiya	50	19%
		Jalaun	32	12%
		Raebareli	86	33%
		Rudraprayag	36	14%
		Tehri Garhwal	58	22%
	PUO Total		262	100%
South				
	Acute Diarrhoeal Disease			
		Chittoor	70	19%
		Madurai	61	16%
		Nalgonda	64	17%
		Salem	86	23%
		Warangal	92	25%
	Acute Diarrhoeal Disease Total		373	100%
	Cholera			
		Belgaum	17	6%
		Bijapur	117	44%
		Chickmagalur	19	7%
		Tirunelveli	27	10%
		Uttara Kannada	86	32%
	Cholera Total		266	100%
	Dengue & Chikungunya			
		Madurai	79	9%
		Mahbubnagar	448	51%
		Ramanathapuram	144	16%
		Salem	87	10%
		Tiruchirappalli	116	13%
	Dengue & Chikungunya Total		874	100%
	Food Poisoning			
		Chitradurga	54	14%
		Coimbatore	49	13%
		Nalgonda	52	14%
		Tumkur	128	34%
		Villupuram	93	25%
	Food Poisoning Total		376	100%
	PUO			
		Chitradurga	53	6%
		Nalgonda	541	60%
		Ramanathapuram	42	5%
		Thanjavur	205	23%
		Virudhunagar	66	7%
	PUO Total		907	100%
West				
	Acute Diarrhoeal Disease			
		Ahmedabad	136	17%
		Banswara	125	15%

	Gadchiroli	94	11%
	Gondia	172	21%
	Nanded	296	36%
Acute Diarrhoeal Disease Total		823	100%
Cholera			
	Anand	52	6%
	Banaskantha	468	50%
	Nagpur	161	17%
	Navsari	87	9%
	Parbhani	174	18%
Cholera Total		942	100%
Dengue & Chikungunya			
	Ahmednagar	37	2%
	Beed	145	6%
	Jalgaon	130	5%
	Kota	2103	85%
	Panchmahal	50	2%
Dengue & Chikungunya Total		2465	100%
Food Poisoning			
	Ahmedabad	76	25%
	Jhalawar	150	49%
	Nashik	30	10%
	Porbandar	30	10%
	Rajsamand	19	6%
Food Poisoning Total		305	100%
PUO			
	Ahmednagar	222	19%
	Amravati	152	13%
	Jalgaon	382	33%
	Osmanabad	171	15%
	Thane	248	21%
PUO Total		1175	100%

TABLE 2 (c) Incidence of top 5 diseases per region in India in the second quarter of 2013

Region	Disease	District	Number	Percent
Central				
	Acute Diarrhoeal Disease			
		Balod	409	46%
		Bhopal	97	11%
		Khargone	135	15%
		Narsinghpur	92	10%
		Raigarh	155	17%
	Acute Diarrhoeal Disease Total		888	100%
	Cholera			
		Narayanpur	66	100%
	Cholera Total		66	100%
	Food Poisoning			
		Balaghat	33	7%
		Bastar	40	9%
		Janjgir	179	39%
		Mahasamund	54	12%
		Ujjain	150	33%
	Food Poisoning Total		456	100%
	Malaria			
		Damoh	62	6%
		Janjgir	97	9%
		Korba	49	4%
		Shivpuri	278	25%
		Sidhi	627	56%
	Malaria Total		1113	100%
	PUO			
		Guna	125	19%
		Khandwa	183	28%
		Shahdol	95	15%
		Sheopur	95	15%
		Shivpuri	146	23%
	PUO Total		644	100%

East				
	Acute Diarrhoeal Disease			
		Bankura	485	20%
		Birbhum	980	40%
		Burdwan	359	15%
		North 24 Parganas	357	15%
		Paschim Medinipur	277	11%
	Acute Diarrhoeal Disease Total		2458	100%
	Cholera			
		Bankura	121	16%
		Hooghly	39	5%
		Howrah	164	22%
		North 24 Parganas	340	46%
		Purulia	81	11%
	Cholera Total		745	100%
	Dengue & Chikungunya			
		Burdwan	103	7%
		Darjeeling	530	38%
		East Sikkim	103	7%
		Jalpaiguri	189	13%
		Kamrup Metropolitan	130	9%
		Rohtas	346	25%
	Dengue & Chikungunya Total		1401	100%
	Diphtheria			
		Kishanganj	229	100%
	Diphtheria Total		229	100%
	Food Poisoning			
		Bankura	221	21%
		Jalpaiguri	142	13%
		Jorhat	198	19%
		Nadia	322	30%
		South 24 Parganas	177	17%
	Food Poisoning Total		1060	100%
North				
	Acute Diarrhoeal Disease			
		Azamgarh	369	36%
		Badgum	137	13%
		Reasi	201	19%
		Shopian	128	12%
		Una	196	19%
	Acute Diarrhoeal Disease Total		1031	100%
	Cholera			
		Kurukshetra	74	21%
		Mohali	46	13%
		New Delhi	50	14%
		South West District	50	14%
		Yamuna Nagar	133	38%
	Cholera Total		353	100%
	Dengue & Chikungunya			
		Haridwar	50	4%
		North Delhi	1345	96%
	Dengue & Chikungunya Total		1395	100%
	Mumps			
		Bandipora	16	7%
		Ganderbal	28	12%
		Pulwama	29	13%
		SAS Nagar	30	13%
		Shopian	122	54%

	Mumps Total		225	100%
	PUO			
		Firozabad	92	29%
		Jalaun	63	20%
		Pauri Garhwal	62	19%
		Srinagar	28	9%
		Udhampur	76	24%
	PUO Total		321	100%
South				
	Acute Diarrhoeal Disease			
		Gulbarga	119	17%
		Koppal	121	17%
		Kurnool	149	21%
		Ranga Reddy	227	32%
		Yadgiri	100	14%
	Acute Diarrhoeal Disease Total		716	100%
	Cholera			
		Chikkaballapur	24	9%
		Devanagere	57	22%
		Koppal	50	19%
		Medak	93	36%
		Tumkur	34	13%
	Cholera Total		258	100%
	Dengue & Chikungunya			
		Chamarajanagar	30	9%
		Kolar	66	20%
		Mysore	30	9%
		Raichur	101	31%
		Tiruvarur	53	16%
		Vellore	45	14%
	Dengue & Chikungunya Total		325	100%
	Food Poisoning			
		Belgaum	89	13%
		Cuddalore	300	42%
		Karimnagar	79	11%
		Perambalur	167	24%
		Ranga Reddy	71	10%
	Food Poisoning Total		706	100%
	PUO			
		Chitradurga	100	21%
		Kolar	89	18%
		Nalgonda	123	25%
		Villupuram	79	16%
		West Godavari	93	19%
	PUO Total		484	100%
West				
	Acute Diarrhoeal Disease			
		Jalna	59	19%
		Kheda	68	22%
		Nashik	62	20%
		Parbhani	59	19%
		Raigad	67	21%
	Acute Diarrhoeal Disease Total		315	100%
	Dengue & Chikungunya			
		Ahmednagar	54	14%
		Jalgaon	163	42%
		Nashik	54	14%
		Patan	49	13%
		Raigad	70	18%
	Dengue & Chikungunya Total		390	100%
	Food Poisoning			
		Bhilwara	119	38%
		Jaipur	31	10%
		Kutch	50	16%
		North Goa	66	21%

	Vadodara	49	16%
Food Poisoning Total		315	100%
PUO			
	Amravati	340	37%
	Chandrapur	115	12%
	Gadchiroli	163	18%
	Thane	212	23%
	Washim	93	10%
PUO Total		923	100%
Scrub Typhus			
	Jaipur	357	100%
Scrub Typhus Total		357	100%

TABLE 3(a). Reoccurrence of Diseases in the Districts of India during the peak incidence quarters of 2011, 2012, and 2013

District	Disease	Year	Number of Cases
Ahmednagar	Dengue & Chikungunya	2012	37
		2013	54
Amravati	PUO	2012	152
		2013	340
Anantnag	Food Poisoning	2011	106
		2012	512
Bankura	Cholera	2011	73
		2012	217
		2013	121
Beed	Dengue & Chikungunya	2011	174
		2012	145
Birbhum	Cholera	2011	254
		2012	93
Chitradurga	PUO	2012	53
		2013	100
Dhamtari	Acute Diarrhoeal Disease	2011	118
		2012	202
Ganderbal	Acute Diarrhoeal Disease	2011	78
		2012	105
Gaya	Acute Diarrhoeal Disease	2011	123
		2012	143
Hooghly	Cholera	2012	126
		2013	39
Jalaun	PUO	2011	87
		2012	32
		2013	63
Jalgaon	PUO	2011	419
		2012	382
	Dengue & Chikungunya	2012	130
		2013	163
Janjgir	Malaria	2012	21
		2013	97
Mahbubnagar	Dengue & Chikungunya	2011	114
		2012	448
Nalgonda	PUO	2012	541
		2013	123
Nanded	Acute Diarrhoeal Disease	2011	83
		2012	296
Nashik	Food Poisoning	2011	208
		2012	30
Navsari	Cholera	2011	46
		2012	87
Raigarh	Acute Diarrhoeal Disease	2012	184
		2013	155
Raipur	Food Poisoning	2011	46
		2012	354
	Acute Diarrhoeal Disease	2011	322
		2012	222
Tehri Garhwal	PUO	2011	121
		2012	58
Thane	PUO	2012	248
		2013	212
Thanjavur	PUO	2011	140

		2012	205
Ujjain	Food Poisoning	2012	157
		2013	150
Warangal	Acute Diarrhoeal Disease	2011	91
		2012	92

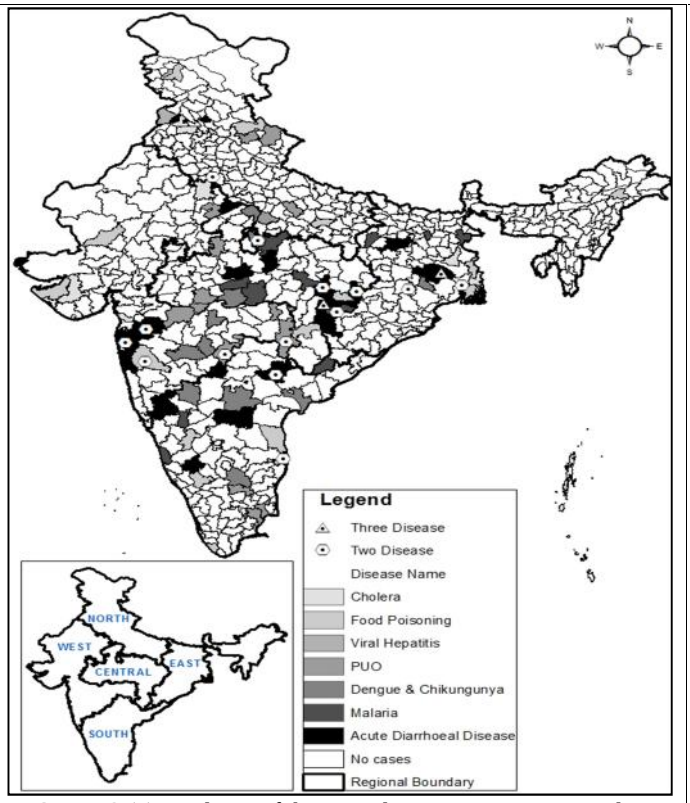

FIGURE 2 (a) Incidence of the top 5 diseases per region in India in the second quarter of 2011

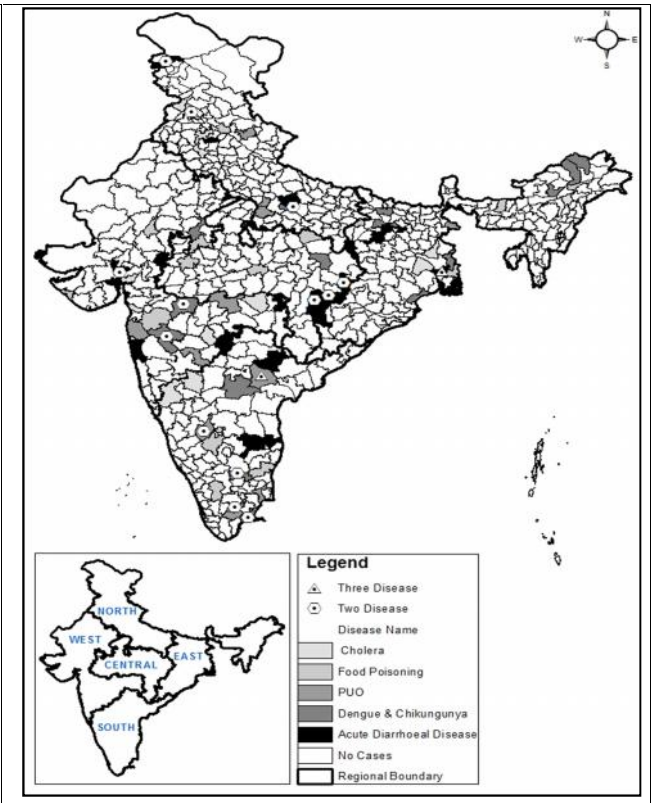

FIGURE 2 (b) Incidence of the top 5 diseases per region in India in the second quarter of 2012

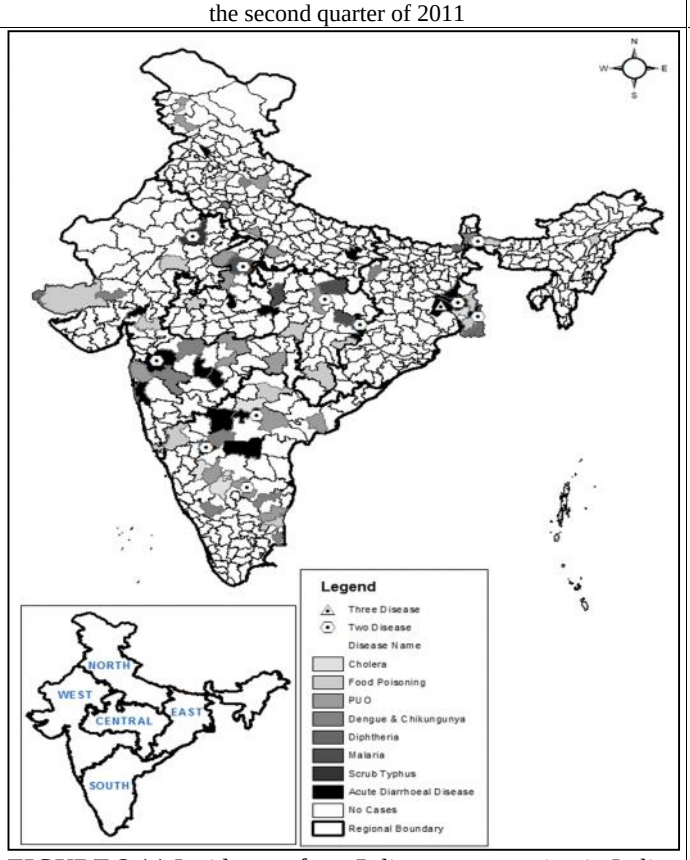

FIGURE 2 (c) Incidence of top 5 diseases per region in India in the second quarter of 2013

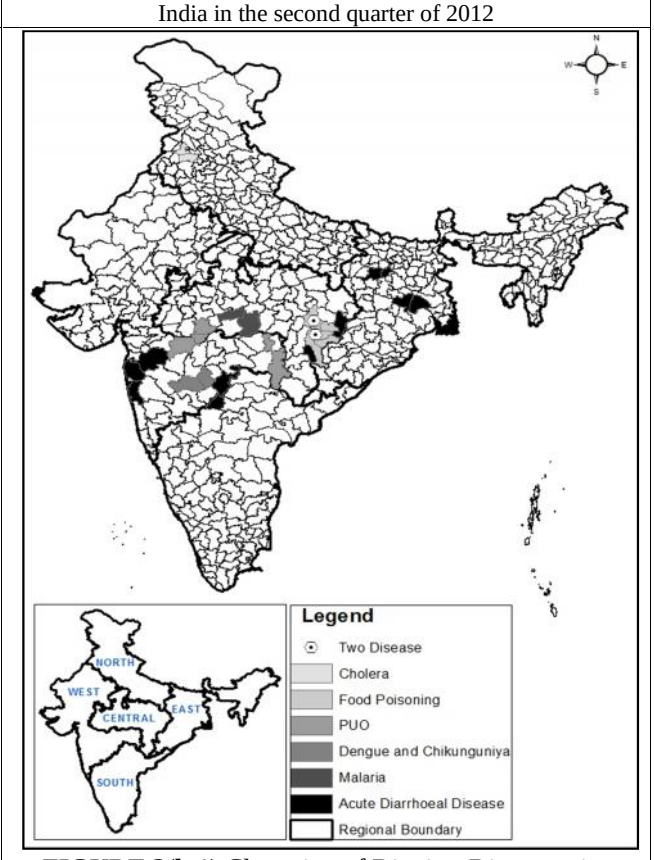

FIGURE 3(b.1) Clustering of Districts Disease-wise during the Second Quarter of 2011.

TABLE 3(b.1) Clustering of Districts Disease-wise during the second quarter of 2011

Disease	Number of Clusters
Acute Diarrhoeal Disease	5
PUO	2
Malaria	1
Cholera	1
Food Poisoning	1
Dengue and Chickungunya	1

TABLE 3(b.2) Clustering of Districts Disease-wise during the second quarter of 2012

Disease	Number of Clusters
Acute Diarrhoeal Disease	4
Cholera	3
Dengue and Chickungunya	2
Food Poisoning	1
PUO	1

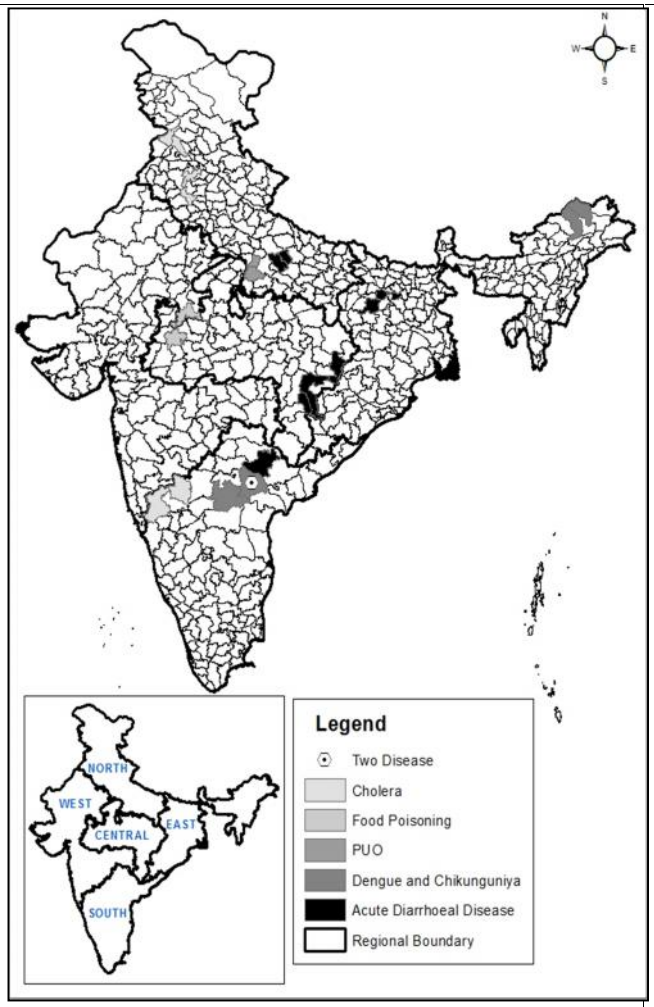

FIGURE 3(b.2) Clustering of Districts Disease-wise during the second quarter of 2012

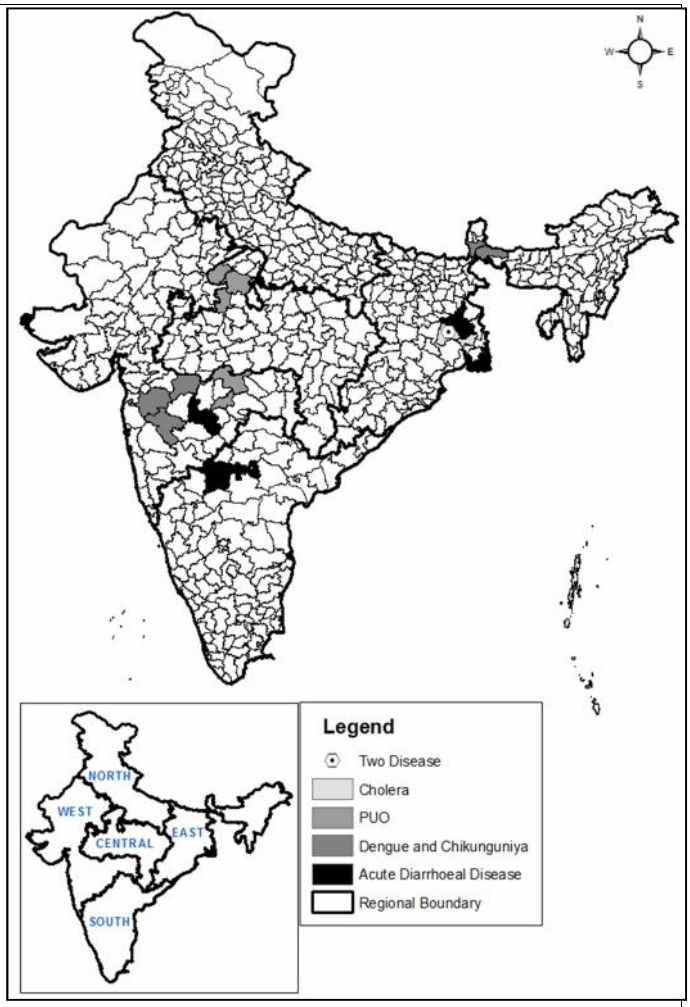

FIGURE 3(b.3) Clustering of Districts Disease-wise during the second quarter of 2013

TABLE 3(b.3) Clustering of Districts Disease-wise during the second quarter of 2013

Disease	Number of Clusters
Acute Diarrhoeal Disease	3
Dengue and Chickungunya	2
PUO	2
Cholera	2

However, despite the shortcomings in IDSP the following results were obtained from the reported disease outbreak data during 2011 – 2013: In the North region of India, no particular state had a clear majority in the number of disease outbreaks. The Badgum district of Jammu and Kashmir reported the highest incidence of Acute Diarrhoeal Disease (77%) during the second quarter of 2011. In the second quarter of 2013, North Delhi reported

the highest incidence of Dengue and Chikungunya (96%). Ganderbal and Anantnag districts of Jammu and Kashmir reported repeated outbreaks of Acute Diarrhoeal Disease and Food Poisoning respectively during the second quarters of 2011 and 2012. The districts of West Bengal reported the majority of disease outbreaks during the incidence peak quarters of 2011 to 2013. Bankura district of West Bengal observed the highest incidence of Acute Diarrhoeal Disease (49%), Food Poisoning (45%) in 2011 and Cholera (17%) in 2012. There were repeated outbreaks of Acute Diarrhoeal Disease, Food Poisoning, and Cholera over the years in Bankura. Apart from Bankura reporting the majority of disease outbreaks, the Howrah district of West Bengal had the highest incidence of Dengue and Chikungunya (85%) in 2011. Maharashtra state in the West region of India accounted for the highest number of reported disease outbreaks over the years. In the second quarter of 2012, Kota district of Rajasthan observed the highest incidence of Dengue and Chikungunya (85%). Many districts of Maharashtra and Gujarat, namely, Nanded, Ahmednagar, Beed, and Jalgaon faced a reoccurrence of Dengue and Chikungunya contributing to the peak incidence quarters of 2011, 2012, and 2013. Multiple outbreaks of Acute Diarrhoeal Disease (35%), Food Poisoning (20%) and Dengue and Chikungunya (1%) were reported in Raipur in the second quarter of 2011. Raipur also observed a repeated outbreak of Acute Diarrhoeal Disease (15%) and Food Poisoning (44%) in the second quarter of 2012.

DISCUSSION

The states in India face a skewed distribution of healthcare expenditure. While Bihar spends the least on healthcare, Himachal Pradesh spends the most. Also, most of the expenditure on healthcare is skewed towards providing curative services in urban areas. This results in expenditure on primary healthcare being minimal. The healthcare infrastructure in rural areas is non-existent and the problem is exacerbated by out-of-pocket payments and poor paying capacity of the people. India produces nearly 30,000 doctors, 18,000 specialists, 30,000 AYUSH graduates, 54,000 nurses, 15,000 ANMs, and 36,000 pharmacists annually [3]. The doctor-to-patient ratio in India is 6 for 10,000 people (0.7 for 1,000 people), way below developed countries [4]. The average global ratio stands at almost 3 doctors per 1,000 people in 2013-2014 [4]. The distribution of these doctors is uneven with low ratio in states like Chhattisgarh and Jharkhand – just two doctors for every 100,000 people. Over the past few years, the Union Health Ministry has paid special attention to states such as Bihar, Uttar Pradesh, and Madhya Pradesh that face a major shortage of specialized doctors and other healthcare manpower.

Acute Diarrhoeal Disease accounts for one of the major health problems of India affecting children. Lack of safe water supply, poor environmental sanitation, and poor personal hygiene are the driving factors for the spread of diarrhoeal disease. Despite the National Diarrhoeal Disease Program, Ganga Action Plan, and the National River Action Plan, the incidence of Acute Diarrhoeal Disease is on a rise in Northern India, especially during July to September months of the year as reported by IDSP. According to IDSP, Budgam district and its neighboring districts of Jammu and Kashmir, many districts of West Bengal, Mahasamund of Chhattisgarh are the most affected by Acute Diarrhoeal Disease. In West Bengal, Cholera is almost always present in a sporadic form, and sometimes becomes epidemic. The reported occurrence rate of Cholera in West Bengal is higher during the summer and rainy season when compared to winter and spring. Owing to the loopholes in the existing reporting structure of IDSP, further investigation is needed to validate the incidence numbers being reported. Moreover, the shortcomings of the surveillance system does not allow for an unambiguous analysis of the benefits achieved from various development programs across the Nation.

However, inferences about the missing positive impact of certain development programs can be ascertained by the increase in the reported number of outbreaks of diseases in especially the North-eastern region of India. The main source of Cholera is the bad supply of drinking water in some places. The common practice of the people of Bankura District of West Bengal is to obtain their drinking water from tanks which are unprotected and are frequently polluted, open area defecation along the banks of the river [8]. The rate of use of Oral Rehydration Salt (ORS) solution and Oral Rehydration Therapy (ORT) remain suboptimal in India. The allocated budget for 2013-2014 for the working of the Ministry of Drinking Water and Sanitation was 15,260 Crore INR [9]. To accelerate the progress of sanitation in rural areas, the Government of India launched the Total Sanitation Campaign (Nirmal Bharat Abhiyan) to bring about a revolution in village life providing unpolluted living environment [12]. Attempts are being made to provide individual household latrines, community latrines, institutional latrines, women complexes and Rural Sanitation Marts. 71% of rural India has been covered under this project till date. To encourage the successful working of the panchayats, the Ministry of drinking water and sanitation has launched an incentive scheme called Nirmal Gram Puraskar (NGP) and 13 district panchayats have received this award in the past 7 years. Government of India's major intervention in Drinking Water and Sanitation is the National Rural Drinking Water Program (NRDWP). More than 155,000 crore INR have been invested in the sector by the Central and State Governments since the beginning of the plan periods [9]. 10% of the overall NRDWP funds are earmarked for the North-Eastern states [9]. Despite the allocation of special funds for the North-Eastern States, the incidence of Acute Diarrhoeal Disease has increased from 2011 to 2013, whereas IDSP has reported reduced incidence numbers of Cholera over the years. Along with Acute Diarrhoeal Disease, Food Poisoning remains as a grave problem in India. Intensive Behavioral Change Communication Programs need to be implemented in order to educate the common man about basic know-how of food and hygiene. Viral hepatitis caused by Hepatitis Virus A through E. HAV and HEV both enterically transmitted are highly endemic in India [14]. Lack of safe water supply, poor environmental sanitation and poor personal hygiene are the driving factors for the spread of viral hepatitis disease in Northern India, especially during the second quarter of the year 2011. It is a vaccine preventable disease but according to Coverage Evaluation Survey of 2009, the sad reality is the immunization

coverage among children in few states of India evaluated to be only 58.9% [15].

The National Vector Borne Disease Control Programme (NVBDCP) is an umbrella programme for the prevention and control of vector borne diseases like Dengue, Chikungunya, Malaria and so on. The various States are responsible for implementation of the programme while the Directorate of NVBDCP, Delhi provides with assistance in the form of cash and commodity and technical support as per approved pattern [16]. Malaria is one of the major public health problems of India. Due to lack of efficiency in diagnosis and reporting at the Primary Health Centre and Sub center levels, people suffering from Fever most of the time are categorized as PUO (Fever of Unknown Origin) and go unnoticed as any other potential disease like Malaria, Dengue or Chikungunya. Around 50% of the total malaria cases reported is due to *P. falciparum.* One of the reasons attributed to the rise in *P. falciparum* cases is the resistance to chloroquine, which was used for a long time as the first line treatment of malaria cases. The incidence of Malaria is the highest among the districts of the Central region of India. The global fund supported 'Intensified Malaria Control Project – Phase 2' is being implemented since October 2010 for a period of 5 years in 7 North-Eastern States. The strategies of the project are early diagnosis and complete treatment, integrated vector control including promotion of Insecticide Treated Bed Net (Long-Lasting Insecticidal Nets), through intensive IEC and capacity building & training of the health workers & community volunteers. These project activities have resulted in a sharp decline in the number of Malaria cases reported over the years. Implementation of the World Bank Supported Project on Malaria Control in states namely Andhra Pradesh, Chhattisgarh, Gujarat, Jharkhand, Madhya Pradesh, Maharashtra, Orissa, Karnataka, and West Bengal has stabilized the reported incidence of Malaria from 2011 to 2013.The global incidence of Dengue has grown dramatically in recent decades. Dengue is found in tropical and sub-tropical climates worldwide, mostly in urban and semi-urban areas. There is no specific treatment for dengue or severe dengue, but early detection and access to proper medical care lowers fatality rates to below 1%. The prevention and control of Dengue solely depends on effective vector control measures. The incidence of Dengue has been on a rise from 2011 to 2013, with the highest number of Dengue cases being reported during the second quarter of 2012, similar is the case with Chikungunya. The month of July is observed as Anti Dengue Month when states are undertaking widespread campaigns for community awareness and mobilization, inter-personal communication, etc. in addition to regular Information Education and Communication (IEC)/ Behavior Change Communication (BCC) activities. In the case of Chikungunya, the Government of India is monitoring the situation regularly, sending guidelines and advisories for the prevention and control of Chikungunya fever to states. For the prevention and control of Dengue and Chikungunya the government of India has launched a comprehensive Mid Term Plan [18]. Focused resource allocation to the North Eastern states through the various disease control national programmes has indeed brought about a significant reduction in the incidence of Cholera in these states over the years. Having learnt from this experience, attention needs to be given to the Northern India states and West Bengal to curb the incidence of communicable diseases.

The analysis drawn from the disease outbreak data reported under IDSP is only half-baked due to a variety of shortcomings in the surveillance system. Quoting the implementation challenges documented in the IDSP Joint Implementation Review in January 2009, inefficiency of IDSP surround the issues of non-availability of skilled workforce to analyze the IDSP data and mount appropriate local response, poor participation of private health providers and public hospitals in reporting, lack of clear guidelines for diagnosis of certain communicable diseases, lack of an indicator-based surveillance and delayed reporting of disease outbreaks.

Along with improving the efficiency in resource mobilization and allocation, the government of India needs to increase the investment in mobile health technologies. Mobile technologies have played a key role in keeping people healthy, managing diseases, and lowering healthcare costs. The disease profile in the country is complex considering the high incidence of communicable and non-communicable diseases. The growing private and public expenditure on healthcare is ensuring a greater focus on technology-based healthcare delivery solutions in the country. For India, the mobile health initiative will impact many stakeholders including patients, doctors, technology companies, pharmaceutical companies, hospitals and will also benefit the entire public healthcare system of the country. Moreover, having an indicator-based disease surveillance system integrated in an event-based disease surveillance system allows for early detection of disease outbreaks and calls for urgent attention of the required authorities. There is a need to integrate social media and new media as potential sources of public health happenings of a nation. The exchange of health information on the Internet by users of social media could lead to faster recognition of cases of communicable diseases. Access to such data can help in detecting potential public health threats that are rare, new diseases or early-level warnings for epidemics. Integration of such varied sources of public health information will not only require an efficient development of the surveillance system to handle this real time data feed, but also requires an adequate validation and regulation of disease surveillance data in order to allow for the efficient data conversion into meaningful and timely information. This will also help in evaluating the benefits achieved through investments in various development programs in the most needed parts of India. Further, we will then be in a better position to advocate for the efficient use of limited resources to allow for sustainable development of India. The challenges for implementation that include resource availability, technical understanding and requirements, acceptability to public health workforce and policymakers will have wide-reaching implications for public health surveillance in India.

CONCLUSION

The study highlights the time, disease and district that

need to be prioritized for better focus of resources. Also the more critical question of "why" regarding the disease incidence should be further researched up on. The government of India needs to shift the focus of resources from the North-Eastern States to the Northern States, West Bengal, Maharashtra, and Rajasthan. This will result in reducing the incidence of communicable diseases in these states. In the next few years, the mobile health market in India will be led by diagnosis and monitoring services and it is expected to bridge India's health deficit, particularly in rural areas. Moreover, there is an urgent need to develop an indicator based disease surveillance system which consists of social media as a potential source of public health happenings of a nation.

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