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A GEOSTATISTICAL ANALYSIS OF THE RELATIONSHIP BETWEEN VILLAGE SIZE AND PREVALENCE OF VECTOR BORNE DISEASES IN INDIAN VILLAGES

Rajkumar Ghosh* PG Department of Population Studies, Fakir Mohan University, Balasore-756020, Odisha *Corresponding Author

Sibsankar Mal Department of Geography, S.S.M. College, Keshpur, Paschim Medinipur- 721150, West Bengal

ABSTRACT Vector borne diseases (VBDs) have emerged as a major public health problem in India. Government of India has launched various schemes to improve water and sanitation facility. This study tries to find the village factor which leads to selected diseases. Village data of District Level Household Survey 2007-08 has used for analysis. Study reveals that Prevalence of malaria is higher in east region of India and chicken pox in South and central states of India. One third of east India, villages is under poorest and richest category respectively. In South east region two fifth of villages come under poorest category. Odds ratio of vector borne disease significantly vary by size of the villages. It is concluded that with the intensified efforts toward creating a public awareness about VBDs, the measures taken to control vectors other than personal protection measures suggested that health education interventions are effective and remain a valuable tool in community-based vector prevention and control interventions.

KEYWORDS : Village, Prevalence, Households, Sanitation, Vector Borne Disease.

Introduction

Globally, Vector borne diseases (VBDs) are endemic in more than 100 countries. These diseases affect more than half of the world's population; they are difficult to predict, prevent or control and to add to the complexity, for most VBDs there is no available vaccine. In India, the Directorate of National Vector Borne Disease Control Programme is the central agency for the prevention and control of the six most common VBDs in the country, namely: malaria, dengue, lymphatic filariasis, kala-azar, japanese encephalitis and chikungunya. Although the impact of VBDs in India, which mostly affect poor populations, is linked to specific social determinants of health, we argue that the existence of an effective health system must be at the core of the efforts to successfully control these diseases (NVBDCP, 2011).

In recent years Vector borne diseases (VBDs) have emerged as a major public health problem in India, particularly dengue fever, Japanese encephalitis and malaria now occur in epidemic proportions almost on an annual basis causing considerable morbidity and mortality (WHO, 2014). The world's fastest growing VBD is dengue, with a 30-fold increase in disease incidence over last 50 years. Every year there are more than 1 billion cases and over 1 million deaths from VBDs. In India, 27% population lives in malaria high transmission area. The diseases are commonly in tropical and subtropical regions and places where access to safe drinking water and sanitation system is problematic. They are on the rise because of failure of these existing methods of control of vector and VBDs and the climate change (WHO, 2014). Almost one-tenth of the global disease burden could be prevented by improving water supply, sanitation, hygiene and management of water resources. The improvement in health and nutritional status in a sustainable way could reduce child mortality. The estimates show that about 88 percent of diarrheas are attributable to unsafe water, inadequate sanitation or insufficient hygiene (WSSCC, 2008).

Access to safe drinking water and sanitation is essential for protection and promotion of health. The safe drinking water and sanitation is a basic human right and a key component of effective public health delivery system. The lack of safe drinking water, poor sanitation and hygiene practices is attributed to substantial ill health in India. Safe and potable water is normally defined as water that is free from pathogenic agents and chemical substances, pleasant to taste and usable for domestic purposes. A daily requirement of minimum of 40 lpcd (liters per capita per day) in the rural and 70 lpcd in the urban areas is a must to lead a normal healthy life. Polluted water is the root cause of most of the water borne diseases and is caused by human activities like rapid unplanned urbanization, industrialization, agricultural pollutants like pesticides and insecticides, improper waste management in the urban areas etc. Quality of water and waste management are interdependent and has to be dealt together to ensure supply of pollution free water (SIAES, 2009).

The impact of water pollution on the public health is enormous. A number of diseases with high morbidity and mortality are wide spread in the communities specially living in unsuitable environmental conditions in urban slums and vast rural areas. The major diseases that are attributed to environment pollution and poor drinking water supply are: Diarrhoeal Diseases, Cholera, Shigellosis, Escherichia Coli Diarrhoea, Poliomyelitis, Typhoid, and Water Borne Viral Hepatitis. However, Diarrhea diseases alone cause more than 0.6 million deaths annually. Study has also shown that in slum areas in major cities prevalence of diarrhea is as high as 11 episodes per child per year on regular basis. The estimate shows that diarrheal morbidity can be reduced by an average of 6-20 percent with improvements in water supply and by 32 percent with improvements in sanitation. Approximately 73 percent of the rural population in India does not use any method of water disinfection and 74 percent does not have sanitary toilets (WHO, 2014). Open air defecation, a common practice among villagers, may lead to contamination of the water supply and result in outbreaks of Diarrhoeal disease. The practice of tethering animals close to human dwellings and the consequent proximity to animal defecation matter further enhances the risk of contamination of the drinking water. The key to providing microbiologically safe drinking water lies in understanding the various mechanisms by which water gets contaminated, and formulating interventions at critical points to decrease and prevent contamination of drinking water (Gupta *et. al.*, 2012).

One of the greatest failures of the last fifty years has been the failure to lay the foundation stones of public health in the developing world – hygiene, sanitation and water supply. It is a failure that today deprives hundreds of millions not only of health but of productivity. Despite significant progress during the last two decades, the demographic and environmental health scenario continues to be a cause of serious concern in the developing countries of South East Asia and Sub-Saharan Africa. The traditional problems of water and air-borne infections combine with malnutrition and poor environmental sanitation form a vicious cycle that increases the burden of diseases beyond the capacity of the existing health infrastructure and jeopardizing the productivity of society. Information related to disease burden due to improper hygiene practices and inadequate supply of drinking water and provision of sanitation facilities in India is lacking – currently there are no summarized snap shots available for the macro level that clearly reflects the concerns and achievements at micro-level initiatives. Therefore, the study focuses a process to summarize the disease burden situation in India due to inadequate Water Supply and Sanitation (WSS) services (SIAES, 2009).

Objectives

The proposed study is designed with the following objectives:

1. To examine the prevalence of vector born diseases among Indian villages.
2. To study the association between village size and prevalence of Vector Borne Diseases in Indian villages.

Methodology

The study used District Level Household Survey (2007-08) data conducted by International Institute for Population Sciences, Mumbai. The household survey covered 611 districts and 22825 villages. However, to address the issue of relationship between village size and prevalence of Vector Born Diseases in Indian villages, DLHS-3 raw data are analyzed. In this study, percentage distributions are calculated, data are cross-tabulated, and a logistic regression model is applied to assess the degree of associations using a computer software package – SPSS 20.0 version. Bi-variate table has constructed between zone and village size, classified on the basis of households. The logistic regression for each of the state is carried out to find if size of the village has an impact on the diseases.

For the prevalence of vector born disease Indian states has been divided into five region namely north, east, south east, central and south.

North	East	South East	Central	South
1. Jammu and Kashmir 2. Himachal Pradesh 3. Punjab 4. Chandigarh 5. Uttaranchal 6. Haryana 7. Delhi 8. Rajasthan 9. Uttar Pradesh 10. Bihar	1. Sikkim 2. Arunachal Pradesh 3. Nagaland 4. Manipur 5. Mizoram 6. Tripura 7. Meghalaya 8. Assam	1. West Bengal 2. Jharkhand 3. Orissa 4. Chhattisgarh	1. Madhya Pradesh 2. Gujarat 3. Daman and Diu 4. Dadar and Nagar Haweli 5. Maharashtra	1. Andhra Pradesh 2. Karnataka 3. Goa 4. Kerala 5. Tamil Nadu 6. Pondicherry 7. Lakshadweep 8. Andaman & Nikobar

Results and Discussion

If suitable vectors are present in adequate densities, the resurgence or recrudescence of transmission of a vector-borne disease in a given area is possible, especially if the infection was previously endemic. Recrudescence of disease transmission cannot occur if the vectors have been eradicated and changed ecological conditions preclude their reestablishment. Unfortunately, major ecological changes have often fostered vector proliferation. Such changes may result from environmental alterations induced by development projects such as dams, irrigation systems, deforestation, or urbanization (Gratz, 1999).

The prevalence of vector born: Malaria, Cholera, Kala-Azar, Dengue and Chicken pox in the village by five zones is given in table 1. Malaria was more prevalent in villages of East zone (48%) followed by South East zone (20%) and Central zone (19%). The prevalence of Cholera (10%) and Kala-Azar (5%) was higher in east zone villages. Cholera was 7 percent prevalent in the villages in South East zone followed by North India (5%). Dengue (12%) and Chicken pox (54%) was highly prevalent in South Indian villages. Indian villages from Central zone also suffered from chicken pox (27%).

Table 1: Prevalence of vector borne disease, India, 2007-08.

States	Malaria	Cholera	Kala-Azar	Dengue	Chicken Pox	N
North	8.6	5.2	2.6	1.9	9.0	8859
East	48.5	9.8	4.6	1.9	11.9	3046
South East	20.3	6.8	2.6	2.1	7.7	3594
Central	19.1	4.1	1.5	4.1	27.4	3885
South	18.7	4.9	2.7	11.9	54.2	3441

The size of the villages has an impact on the prevalence of VBDs in the community (Table 2). There are variations in the clustering of villages in the zones. The villages in the North and Central zone are clustering in the size class of 1001-2000 populations. For the east zone 38 percent of villages have 0-500 population. There South zone has large village size and 34 percent of villages have more than 5000 population.

Table 2: Size of villages of different region, India, 2007-08.

States	0-500	501-1000	1001-2000	2001-5000	5000+
North	12.3	19.7	29.3	25.1	13.7
East	38.3	20.6	23.7	13.4	4.0
South East	26.5	28.5	28.8	11.9	4.3
Central	13.1	25.4	34.5	16.7	10.3
South	7.7	13.4	22.1	23.2	33.6

There are differences in the prevalence of each of the diseases in the villages in each of the zones. The Prevalence of disease can also vary by size of the villages. The logistic regression analysis is carried out to find the size of the village according to number of households per se has an effect on each of the disease in each of the zones. The logistic regression shows that even after controlling for various village level factors in north zone prevalence of malaria increase with the size class of villages (Table 3). The prevalence of malaria decreases in the larger village in east, south east and central zone. Odds of the prevalence of the Malaria were 2 times more in villages, had more than 5000 households compare to villages had less than 500 households in north zone. There are no significant differences in the prevalence of malaria in the south zone by village size.

Table 3: Odds of prevalence of Malaria in the villages by Zones and background characteristics, India, 2007-08.

		Zones				
		North	East	South East	Central	South
Variable		Malaria Exp(β)				
Village Size						
	0-500®					
	501-1000	1.48**	0.72***	0.94	0.83	0.93
	1001-2000	1.89***	0.71***	1.04	0.73**	0.96
	2001-5000	1.86***	0.51***	0.71**	0.60***	0.77
	5000+	2.36***	0.43***	0.43***	0.65**	0.65

Note: *** = p < 0.001; ** = p < 0.005. ® Reference category.

The prevalence of cholera is found in north and central zone (Table 4). There are significant differences in the prevalence of cholera with the size of the class of the villages in the north zone. Odds of the prevalence of the Cholera were 3 times more in villages, had more than 5000 households compare to villages had less than 500 households in north zone. The differences are found to increase with the size of the villages. The prevalence of cholera is found to decrease in the village size of 501 to 1000 Households in the central zone. There is no significant difference in prevalence of cholera in other size class villages. There is not significant effect of village size in the prevalence of cholera in the east, south east and south zone.

Table 4: Odds of prevalence of Cholera in the villages by Zones and background characteristics, India, 2007-08.

		Zones				
		North	East	South East	Central	South
Variable		Cholera Exp(β)				
Village Size						
	0-500®					
	501-1000	0.98	1.03	0.70	0.60**	0.90
	1001-2000	1.50**	1.13	0.92	0.74	0.96
	2001-5000	1.31	0.70	0.88	0.66	1.13
	5000+	2.97***	0.91	0.74	0.77	1.42
Note: *** = p < 0.001; ** = p < 0.005. ® Reference category.						

The logistic regression analysis is carried out for the prevalence of Kala-Azar and village size controlled for other village indicators were main sources of water, drainage facility, underground drainage, open with outlet, open without outlet, village electrification and sources of irrigation (Table 5). The logistic regression shows that there are significant differences in the prevalence of Kala-Azar with the village size. The prevalence of Kala-Azar increases with the village size in north zone. Odds of Kala-Azar in villages had more than 5000 household had 6 times more than the reference category in north zone. There are no significant differences in the prevalence of Kala-Azar and village size in east, south east, central and south zone.

Table 5: Odds of prevalence of Kala-Azar in the villages by Zones and background characteristics, India, 2007-08.

		Zones				
		North	East	South East	Central	South
Variable		Kala-Azar Exp(β)				
Village Size						
	0-500®					
	501-1000	1.91	0.82	0.98	0.65	0.72
	1001-2000	3.43***	1.03	0.70	1.44	1.24
	2001-5000	3.10***	0.52	1.07	0.59	0.78
	5000+	6.06***	0.63	1.46	0.38	2.02
Note: *** = p < 0.001; ** = p < 0.005. ® Reference category.						

As per the prevalence of other VBDs, similar logistic regression analysis was carried for the prevalence of Dengue controlled for other village level factor (Table 6). The prevalence of Dengue is found significant only in the village size of 5000+ population in central and south zone. The prevalence increases with the size of the villages.

Table 6: Odds of prevalence of Dengue in the villages by Zones and background characteristics, India, 2007-08.

		Zones				
		North	East	South East	Central	South
Variable		Dengue Exp(β)				
Village Size						
	0-500®					
	501-1000	1.10	0.55	0.98	1.27	0.81
	1001-2000	0.84	0.54	1.40	1.50	0.93
	2001-5000	1.00	0.24	1.20	1.79	0.93
	5000+	1.54	0.82	0.00	2.59**	1.83**
Note: *** = p < 0.001; ** = p < 0.005. ® Reference category.						

Logistic regression is carried out to find the prevalence of Chicken Pox by the village size (table 7). The result shows that prevalence of Chicken Pox increase with the size of villages in north, east and central and south zone. Odds of Chicken Pox in villages had more than 5000 household had 2 times more than the reference category in north zone. The size of the village having number of households of 1001 to 2000, 2001-5000 and 5000 and above shows significant effects in north zone. For east zone the effect was significant only for the village size of 1001-2000 and 2001-5000, shows significant effect in south east zone. All the village sizes in south east zone show significant effect in south zone show significant effect in the prevalence of Chicken Pox. There is no significant effect in the prevalence of chicken pox by village in central zone.

Table 7: Odds of prevalence of Chicken Pox in the villages by Zones and background characteristics, India, 2007-08.

		Zones				
		North	East	South East	Central	South
Variable		Chicken Pox Exp(β)				
Village Size						
	0-500®					
	501-1000	1.21	1.29	1.13	1.07	1.64***
	1001-2000	1.44**	1.46**	1.57**	1.17	1.73***
	2001-5000	1.49**	0.73	1.90***	1.12	1.59***
	5000+	1.71***	1.00	1.48	1.01	3.94***
Note: *** = p < 0.001; ** = p < 0.005. ® Reference category.						

Summary and Conclusion

In this paper we provide key finding of the size of villages in relation to the vector borne disease and the prevalence of the diseases in different zones of India.

- Malaria was more prevalent in villages of eastern India and lesser in north India it might be because of densely forest.
- Cholera and Kala-Azar were also more in eastern India.
- Chicken Pox and Dengue were more prevalent in villages of south India
- Large size villages have had more odds of vector born diseases.
- Odds of Malaria, Cholera, Kala-Azar are more in larger village in north India but in eastern zone malaria is less in larger villages.
- Odds of Chicken Pox in larger villages in northern and southern zone are more.
- Malaria and cholera were more in the villages were sources of irrigation were river.

Vector is an important link in transmission of VBDs and thus, protection from vector serves as one of the best strategies for prevention in population. Environmental pollution, public health hazard, and insecticide resistant vector population indicate that the insecticides are no longer a sustainable control method of vectors and VBDs. Personal protection measures (PPMs) have become important tool against VBDs. A variety of PPMs are available including repellent creams, mosquito nets, mosquito coils, liquid repellents, electric rackets, mats, smokeless coils, intense sticks, and naphthalene balls. Under national VBD control program, government has introduced insecticide treated nets for the endemic communities (Pandit et. al., 2010). Considering the increasing problem of VBDs, it is important that the people should be aware about various measures available and how to use them correctly. Success of these measures largely depends on the access, acceptability, and proper usage by the target population (Boratne et. al., 2010).

It can be concluded that long-term vector control strategy should be based on generation of increased awareness on the disease and various methods of its control. Health-care access and administrative commitment should be increased for prosperity in resource poor settings. Participation in educational intervention program led to improved knowledge of vector ecology and disease epidemiology, and prevention. With the intensified efforts toward creating a public awareness about VBDs, the measures taken to control vectors other than PPMs suggested that health education interventions are effective and remain a valuable tool in community-based vector prevention and control interventions.

Ethical considerations

This study does not identify or affect any individual, group or society/community. This research is immensely useful for policy makers and planners. District Level Household Survey (2007-08) Data used in this study are fully available to the public without restriction.

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