Spatial and Temporal Analysis of Vector Borne Disease Epidemics for Mapping the Hotspot Region, Risk Assessment, and Control for Sustainable Health

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Abstract

Vector borne diseases are having increasing trend in both vertical and horizontal structure of the disease epidemics in India for the recent decades. Filariasis, Japanese Encephalitis, Dengue, Chikungunya, Leishmaniases, and Malaria are the major vector borne diseases in India for several decades. The increasing trend of both spatial distribution and magnitude of the disease makes public health challenging problem in India, especially, for the recent decades. The both spatial extent and magnitude of vector borne disease outbreaks have been increasingly reported and it has been found ubiquitous across the country. The geographical extent of endemic regions, the frequency of outbreaks in both urban and rural, and the spatial and temporal aspects of vector borne disease epidemics were analyzed across the nation for the past 30 years, in order to assess the probability of potential risk of the VBD outbreaks in the country using GIS, accordingly, the appropriate control strategy will be prepared to manage the future epidemic situations in a site specific areas of high risk hotspot regions. Spatial and temporal dynamics of vector-borne disease epidemics across the country have been evidently associated with land use / land cover changes including the agriculture practices, urban dynamics, industrial growths, population movements, manmade environmental transition, etc., and have been acted upon the epidemic scenarios change the indigenous territories, and also intrusion into the non-endemic areas. The concept of control activities of vector borne disease sudden occurrence could not be achieved with no single intervention will be sufficient to control epidemic diseases, and therefore, prevention measures and control strategy must have to be advantageously applied during the intermittent outbreaks situations regularly, so as to move towards the achievement of erratic transmission control and prevent acceleration in epidemic transmission early in advance successfully.

Key words: *vector borne diseases, spatial and temporal analysis, risk assessment, epidemics, malaria, dengue, chikungunya, Japanese encephalitis, leishmaniasis, filariasis*

Introduction

The epidemics of vector borne diseases, viz; Filariasis, malaria, Dengue, Chikungunya, Japanese Encephalitis, and Leishmaniases have been occurred across the nation for several decades[1-45]. Spatial and temporal analysis of vector borne diseases epidemic transmission in India with a retrospective view has shown the accelerated trend for the recent decades[1,2,9,10,16]. The unplanned urban agglomeration, increasing transportation, globalization, irrigation and power projects, and industrial developments are causing the land use /land cover dynamics[6]. Increasing temperature, irregular and uncertainty of rainfall[17,19,20], and the environmental transition[9,10,20] are brought multiplier effect on micro climate change[5], landscape changes[34,39], and change in micro organism including the vector mosquitoes[9]. It has influence on the variations VBD vector mosquitoes (*Aedes, Anopheles and, Culex sp.*) life cycle, particularly, on the fecundity, fertility

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and survival of the vector mosquitoes[3,20,21,23],are created conducing environment for mosquito breeding[3,14,23], and moreover, landscape changes, unplanned developmental activities, lack of knowledge[18], socio-economic factors, are responsible for increase or decrease of vector mosquitoes profusion, administrative breakdown of vector control strategy and disease prevention measures collectively have been permitted for the increase of vector borne diseases both in vertical and horizontal structures in India for the recent decades[1-5,12]. The present study is made for mapping hot spot epidemic regions as well as risk assessment with the geo-environmental variables, and thus, the geographical distribution and the longitudinal spread of VBD transmission risk patterns have been predicted[22,24], using remote sensing and GIS[6,7,34,41,45,48], as a result, the health officials of the national VBD controlling authority could be made the appropriate control strategy in a site specific hotspot high risk region.

Study area: India has awfully diverse with its natural landscapes, viz; mountain ranges, hills, plateaus, deserts, and plains. She has a coastline of over 7,000 km (4,300 miles), most of India lies on a peninsula in Southern Asia. She has the extensive fertile landscape namely, Indo-Gangetic plain occupies most of Central, Northern, and Eastern India, the Deccan Plateau in the Southern India, and the desert in the west of the country. Climate ranges from Tundra in the Himalayan ranges to equatorial in the far south. India has divided into 27 States and 9 Union Territories for the administrative purpose. India is geographically lies between the 8^0 4' N and 37^0 6 'N latitudes, and 68^0 7' E and 97^0 25'E longitude. It is the seventh-largest country in the world, with a total geographical area of 3,287,590 km² (1,269,219 square miles), and has the population about 135.26 Crores (2018).

Materials and Methods

The epidemic data pertains to vector borne diseases (VBD) were collected from various sources including the WHO, 2019, National Vector Borne Disease Control Programme (NVBDCP), India, 2019, research and review reports available in the public domain. MS Excel software was used to develop a database in the Dbase format for analyse the spatial and temporal aspects of vector borne diseases, mapping hotspot epidemic regions, and VBD transmission risk assessment for the past 30 years, using ARC GIS version 10.0. The detailed information on urban landscape dynamics, land use / land cover changes, climate determinant variables (temperature, relative humidity, rainfall, water features, floods) along with vector borne disease epidemics data were analysed using geo-statistical software SPSS 10.0. The geo-climate, landscape, manmade and environmental risk variables associated with the occurrences of epidemic transmissions were critically analyzed to make a conclusion on the dimension of the extension of longitudinal geographical patterns as well as enormity of the periodical transmission across the country.

Results and Discussion

Malaria: Malaria cases were estimated about 251 million, 231 million, 228 million cases, deaths were estimated 585, 000, 416, 000, and 405, 000 caused by malaria globally, during 2010, 2017, and 2018 respectively[1-3]. Children aged below 5 years old are the most susceptible group affected by malaria[2], account to 67% worldwide, during 2018. According to the WHO report 2018, 19 nations in the Sub-Saharan Africa region, and India were affected 85% of the global malaria burden[12]. In Asia, 75% of malaria cases have been reported from India[1,12.] The facts of malaria is the most important public health problem in the country[2], is transmitted by nine *Anopheles species* in diverse geo-ecological paradigms[2], however, *An. culicifacies, An. fluviatilis, An. stephensi, An. minimus, An. dirus, An.Annularis*, are contributing higher level[1], among these mosquitoes, *Anopheles culicifacies* is the main rural malaria vector, followed by *Anopheles stephensi* is the major urban malaria vector, and *Anopheles fluviatilis* is the hilly or tribal region malaria vector of Indian sub-continent[1-3,5,12]. The average confirmed malaria incidence of *P.falciparum* 63 %, *P.vivax* 37 %, and estimated death about 16,700 were reported in India[12], during 2017. The spatial and temporal analysis of malaria clusters were investigated at the country level, the results shows that the high transmissions of malaria were occurred (>1 *falciparum* cases per 1000 population) across the nation with affected 162.5 million people 12% of the total population, and low transmission (0-1 cases/1000 population) was about 1.1 billion people 81% of total population, and free from malaria is 87.9 million people accounted 7% of total population in India[12], during 2017. The map illustrates that clusters of malaria transmission hotspot regions has been occurred in the Eastern and North Eastern regions[1-3,12], and followed by western part, central and northern regions in India[1-3,12]. The wetland cultivation of irrigated rice fields provides the ideal ground for abundance of malaria vector mosquito's larval habitats[7,10,14], across the country, and remote sensing and GIS were used for mapping the epidemics and risk assessment[9,10] and demarcate the hotspot endemic regions[3-8,11]. Climate factors are completely determined the abundance of *Anopheles species* malaria vector mosquitoes[3], and the mean annual temperature between 20°C to 30°C determine the vector's fecundity, however, the transmission of *Plasmodium vivax* could be sufficient with a minimum mean temperature of 15°C, and transmission of *Pf* is possible with a minimum temperature of 19°C. In India, the *P.vivax* requires 15 to 25 days to complete its cycle in the vectors, provided, the temperature must be within 15°C to 20°C, the relative humidity (RH) for both parasites between 55 to 80% , and the high incidence of malaria cases were reported 68±5% mainly during the monsoon period[1-3,10], with 95% statistically significant p value <0.001, mostly associated with people those who are occupied in the agriculture activities in the 14 States and Union territories 80% of plain and plateau regions. North Eastern States and other part of hilly tribal regions of India are reported 20 % about 2 million cases, 1000 deaths annually. However, the confirmed malaria cases by Slide Positivity Rate (SPR) method were reduced from 3.50 to 0.26, during in 1995 and 2019 respectively[1]. The *Plasmodium Falciparum* (*Pf*) cases were reduced from 1.14 million in 1995 to 0.16 million cases in 2019. But, the imported cases were gradually increased from 39% in 1995 to 46.55% in 2019, mainly due to the population mass movements on occupations during the period 2001-2010, nevertheless, the both incidence of confirmed malaria cases and deaths rate has been progressively reduced across the country[1-3,12], since 2006 (Fig.1, and 2).

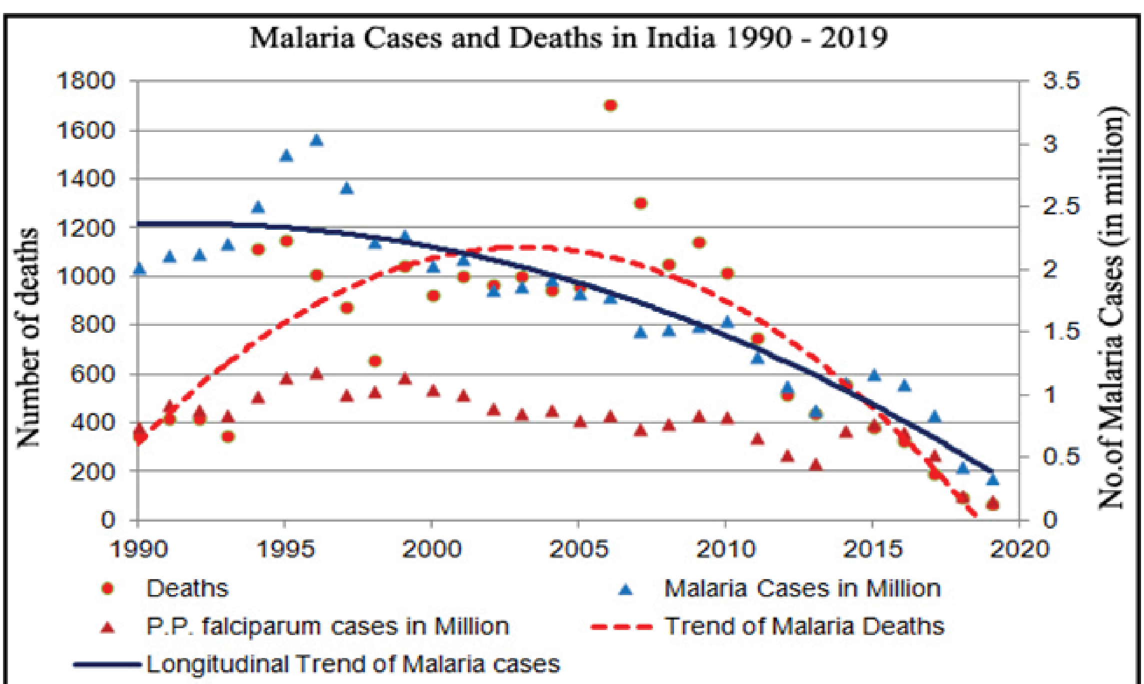

Fig. 1. Malaria cases and deaths reported in India (1990-2019), the trend line shows the longitudinal vertical dimension of cases and death over a period of 30 years

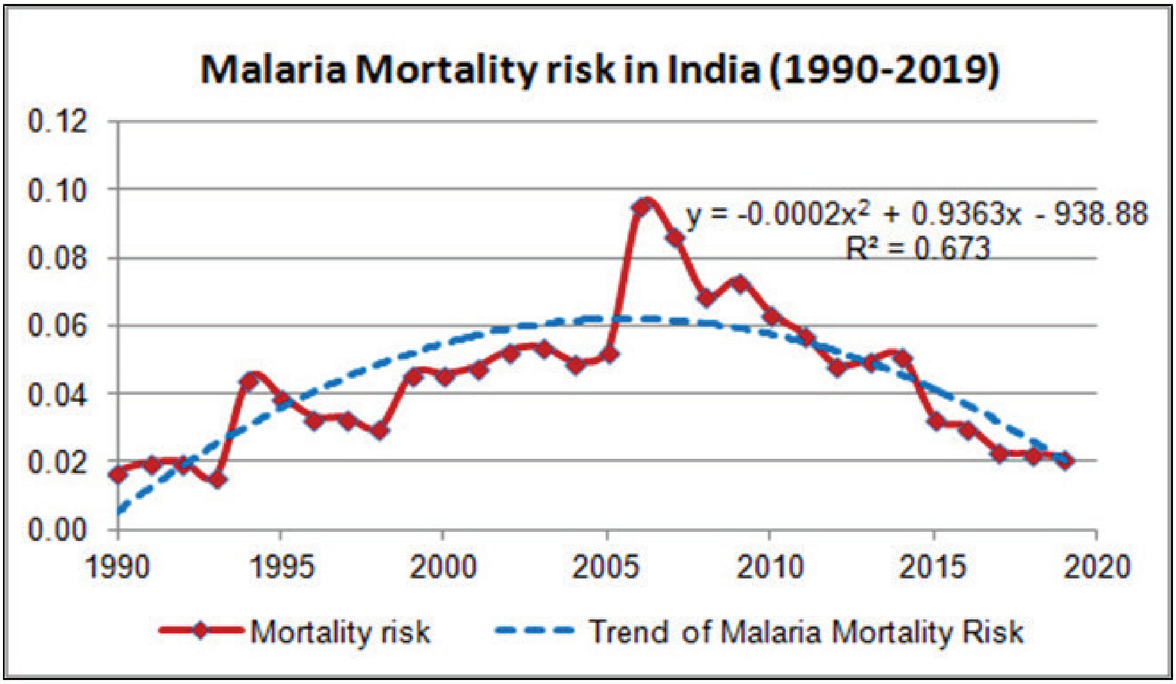

Fig. 2. Malaria Mortality Risk in India (1990-2019), the trend line shows the longitudinal vertical dimension of mortality risk is reduced 67% over a period of 30 years

Table.1. Vector borne diseases in India (1990-2019)

Years	Malaria Cases (in Million)	Malaria Deaths	Malaria Mortality Risk	Dengue Cases	Deaths	Dengue Incidence	Dengue Mortality Risk	Dengue Epidemic Risk	VL Cases	VL Incidence/ 1000
1990	2.02	353	0.02	NA	NA	-	-	-	57742	57.74
1991	2.12	421	0.02	NA	NA	-	-	-	61670	61.67
1992	2.13	422	0.02	NA	NA	-	-	-	77102	77.10
1993	2.21	354	0.02	NA	NA	-	-	-	45459	45.46
1994	2.51	1122	0.04	7494	4	7.494	0.05	0.793	25652	25.65
1995	2.93	1151	0.04	7847	10	7.847	0.13	0.814	22625	22.63
1996	3.04	1010	0.03	16517	545	16.517	3.30	1.681	27049	27.05
1997	2.66	879	0.03	1177	36	1.177	3.06	0.118	17429	17.43
1998	2.22	664	0.03	717	18	0.717	2.51	0.070	13627	13.63
1999	2.28	1048	0.05	944	17	0.944	1.80	0.091	12886	12.89
2000	2.03	932	0.05	650	7	0.65	1.08	0.062	14753	14.75
2001	2.09	1005	0.05	3306	53	3.306	1.60	0.308	12239	12.24
2002	1.84	973	0.05	1926	33	1.926	1.71	0.176	12140	12.14
2003	1.87	1006	0.05	12754	215	12.754	1.69	1.147	18214	18.21
2004	1.92	949	0.05	4153	45	4.153	1.08	0.368	24479	24.48
2005	1.82	963	0.05	11985	157	11.985	1.31	1.044	32803	32.80
2006	1.79	1707	0.10	12317	184	12.317	1.49	1.057	39173	39.17
2007	1.51	1311	0.09	5023	62	5.023	1.23	0.425	44533	44.53

***Cont...* Table.1. Vector borne diseases in India (1990-2019)**

2008	1.53	1055	0.07	12561	80	12.561	0.64	1.046	33598	33.60
2009	1.56	1144	0.07	15535	96	15.535	0.62	1.276	24213	24.21
2010	1.6	1018	0.06	28292	110	28.292	0.39	2.292	28382	28.38
2011	1.31	754	0.06	18860	169	18.86	0.90	1.508	25000	25.00
2012	1.07	519	0.05	50222	242	50.222	0.48	3.968	21000	21.00
2013	0.88	440	0.05	75808	195	75.808	0.26	5.919	13869	13.87
2014	1.1	562	0.05	40571	137	40.571	0.34	3.131	9241	9.24
2015	1.17	384	0.03	99913	220	99.913	0.22	7.626	8500	8.50
2016	1.09	331	0.03	129166	245	129.166	0.19	9.752	6249	6.25
2017	0.84	194	0.02	188401	325	188.401	0.17	14.074	5758	5.76
2018	0.43	96	0.02	101192	172	101.192	0.17	7.481	4380	4.38
2019	0.34	73	0.02	136422	132	136.422	0.10	9.984	3143	3.14

Data Source: WHO – South East Asia, 2019, and 2) NVBDCP, Ministry of Health and Family Welfare, Government of India-2019

NA- Not Available

Dengue: India is known for dengue endemic country and the epidemics are reported from 24 States and 3 Union Territories of 34 States / Union Territories in India[12], and highest report was recorded in 5 major States[13] (Tamil Nadu, Kerala, Karnataka, Punjab and West Bengal) during 2019. *Aedes aegypti* mosquitoes are transmitting the dengue epidemics in India[1,15,18], followed by *Ae.albopictus* is contributed to epidemics in India[12-16]. The First case of dengue virus DENV1 was clinically confirmed in Vellore in Tamil Nadu State of India, during 1956. The geographical extent of occurrences of dengue DENV1 virus epidemics in India during 1963-1964, subsequently, all the four types of DENV1-4 were reported in various parts of the country, followed by major outbreaks were occurred, during 1967-1968, and the epidemics were occurred in major cities of India, during years 1983, 1985, 1990, 2003, 2004, 2005, 2006, 2010. Subsequently, dengue epidemics have been increased in India, since 2010. As the result, dengue epidemic areas has been changed its scenario into endemic situation during the recent decades[12-16]. Dengue epidemics in India (1994-2019), have shown the linear trend of three fold outbreaks across the country[13,18]. The exponential model tend to have the trend of epidemics across the nation with increasing average risk of infection rate 3.75 per 100,000 population, and is the alarming and warning to the public health. However, the mortality risk has been drastically reduced with 1.02 %. The probability of predicted epidemic trend is increasing 68% by the year 2025, and the longitudinal trend of dengue epidemics pattern in India illustrates that the steady increase of dengue epidemics with 68% during 2012–2019 (Fig.3). Drinking water for the domestic purpose was intermittently supplied or once in a week, consequence of that storing water in the big plastic containers / metal vessels and cement containers makes ideal breeding grounds for the *Aedes* mosquito population, was significant with $\chi 2$ test, (P value <0.05). The NDVI values of remote sensing data <0.4 was spatially correlated with vector profusion in the presence of actively photosynthesizing vegetation viz., pineapple, rubber plantation, and forest covers. Climate variables viz. temperature, relative humidity, saturation deficiency, and rainfall, are fuelled for conducing environment for the vector abundance and dengue virus incubations[17,19-21] Temperature ranges between > 21 and < 34, and relative humidity $>70\%$ and $<90\%$ has influence on the impact of variations on the fecundity, fertility and longevity of female *Aedes species,* and flying capacity and egg laying capacities are reduced with temperature < 10 ^{0}C, and mean temperature >35 ^{0}C, respectively[17,20,21]. The hot spot dengue epidemics patterns are spatially correlated with mean annual rainfall between 300 mm to 1200 mm, and tend to have seasonal patterns, particularly, during and after the monsoon[17,20,21,23].

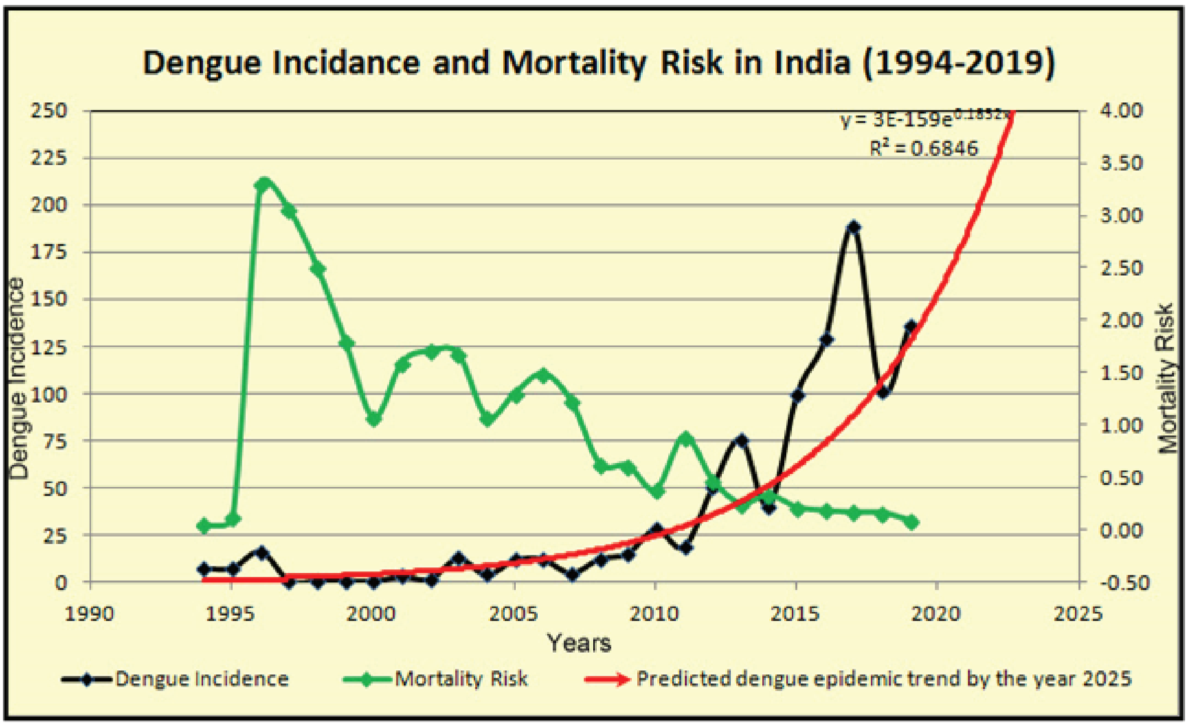

Fig.3. Illustrate the trend of dengue epidemics and mortality risk in India during the period of 1994-2020

Chikungunya:

Chikungunya fever (CHIKF) is caused by a virus belongs to the *Alphavirus* genus of the family *Togaviridae*, transmitted by the infected *Aedes genus* female mosquitoes[1,13,16]. It is deteriorating human soft tissues and weakening bone with joint pain, but non-fatal, however, it causes many behavioural changes in the human body including irritability, attention disorders, and memory issues, febrile seizures, isolated cranial nerve palsies, stroke, and hearing loss, and probably chronic fatigue syndrome[25]. The first confirmed report of chikungunya was recorded in 1963 (Kolkata), and followed by Pondicherry in 1965, Tamil Nadu, Andhra Pradesh, Madhya Pradesh, and Maharashtra[1,18,20] during 1973, and subsequently, sporadic cases were recorded in Maharasthra[1,18,20], during 1983 and 2000. A major outbreak of chikungunya was occurred in the 213 districts from the states of South India viz Maharasthra, Gujarat, Madhya Pradesh, Andhra Pradesh, Karnataka, Tamil Nadu, and Kerala[1,18,20], during 2006, and it was happened after the 25 years period, and subsequently, it has been reported with considerable cases every year[1]. The ecology and climate conditions of the chikungunya vector are the same of dengue vector mosquitoes[20]. But, the occurrences of epidemic cases are drastically reduced after the major outbreaks[1, 12] across the country during, 2006.

Japanese Encephalitis:

Japanese Encephalitis (JE) is a viral disease caused by a *flavivirus* virus affected approximately 50,000 cases, and 10,000 deaths every year all over the epidemic countries in the Asiatic region[1,12], and in India, 1,500 - 4500 cases have been reported in all the year[1,12,26].

Most of the infected JE cases are asymptomatic, but later on, it causes considerable morbidity and mortality in the age group of children below 15 years[1, 12]. The first report of confirmed cases was registered during 1955, subsequently, 6 districts were affected with JE cases during 1956-1965, followed by 6 districts were recorded during 1965-1975, it was highly increased and reported from 81 districts. JE cases were spread across the country with high magnitude in both vertically and horizontally during 1975-1985, magnitude of the cases were reported from 43 districts during 1985-1995, the cases were recorded in 18 districts, it was gradually reduced during 1996-2015 (Fig.4), however, problem is still continued in the 16 districts of 12 states, namely, Assam, Meghalaya, Tripura, Arunachal Pradesh, Bihar, Karnataka, Jharkhand, Uttar Pradesh, Odisha, West Bengal, Telangana, Tamil Nadu[26], since 2013. Totally, 154 districts of 21 States / Union Territories in the country were reported JE outbreaks[26] during 1956-2019, but it was reported in 15 states / UT, during 1998-2019. The most difficulty for the public health department that controlling the outbreaks are challenging problems in the endemic regions where it persist every year due to the complex of phenomenon including nature and man-made. In India, the JE outbreaks have been mostly correlated with construction of mega water resource irrigation projects brings extensive land use / land cover changes in many parts of the nation[10,26]. The change in agriculture cultivation practice from dry land to wet land have been probably creating the conducing environments for fecundity of JE vector mosquitoes i.e. *Culline* mosquitoes mainly *Cx. vishnui* species (*Cx. Vishnui, Cx tritaeniorhynchus, Cx. pseudovishnui, Cx. whitmorei, Cx.epidesmus, Cx.fuscocephala, Cx.gelidus, and Cx. bitaeniorhynchus*). The spatial and temporal analysis shows that the clusters of geographical hotspot region of JE JE epidemics in India for the past 65 years, has significant spatial auto correlation with wet irrigation cultivation and alluvial soil. The profusion of vector mosquito populations are directly changing the epidemiology of disease transmission in the country[26-29], and the results has spatially significance r^2 value 0.63, and p value < 0.05. Remote Sensing and GIS were used for the mapping JE hotspot regions by the researchers for the recent decades, and the similar study was conducted by the author gives the clear pictures of susceptible province of JE epidemics as well as endemic hotspot regions in India, could be used as the datum of baseline for the site specific target for control[47].

Leishmaniases:

Leishmaniasis is a neglected tropical disease which has been spread to humans by the infected female *phlebotomine* 90 species of sand flies[1,12,30]. Leismaniasis are classified in to 4 major groups, namely; Visceral Leishmaniasis (VL), otherwise known as (Kala-azar), Post-Kala-azar Dermal Leishmaniasis (PKDL), Cutaneous Leishmaniasis (CL), and Mucocutaneous Leishmaniasis (MCL), and are caused by a protozoa parasite account to more than 20 *Leishmania* species[12]. The clinical syndromes are characterized by fever, weight loss, splenomegaly, hepatomegaly, and anemia. The incidences of leishmaniasis are reported from 102 countries in the world[12]. The annual incidence of CL is estimated about 1.5 million cases, and VL is estimated 500,000 cases from 98 countries with 310 million people at risk of infection cross the world[12]. The leishmainasis are endemic in the 119 districts/counties of four major countries in South Asia, namely; India, Bhutan, Nepal, and Bangladesh, and 90% of the global burden of VL cases are reported from Brazil, Ethiopia, India, Somalia, South Sudan and Sudan[12].

India is known for endemics of visceral leishmaniases and cutaneous leishmaniases, from very early period, and the first outbreaks of visceral leishmaniasis (VL)/ Kala-azar was occurred during 1824–1825 in Jessore district of India, present day Bangladesh[30-38]. VL is caused by the protozoan Leishmania parasites *L. donovani* are being spread by the bite of infected female *phlebotomine* sandflies, namely; *P. argentipes, P. papatasi* are died before laying eggs at the minimum temperature <15 °C, however, the lifespan of the female adult *P. papatasi* is increased with decreasing temperature within a range of 18–32 °C, and the immature *phlebotomines* are ecologically sensitive insects[34,37-39], and highly abundance in the cool and moist areas with high organic matter that serve as food for larvae[37,38,40]. During the southwest monsoon (July-October) in India, there was a increasing of irrigation sources leads to extensive areas of cultivation with edible crops and agricultural plants in the alluvial soil regions, is dark coloured alkaline in nature (pH 7.2– 8.5), calcareous with chief inorganic constituents of silicon, iron and aluminium, and its capability of retaining water, and thus, flourishing growth and wealth of edible crops, and agricultural plants[34]. Mostly, the houses in the endemic regions are mud plastered roof tops with crack and crevices on the walls have been supported for the effective day-resting habitats[30-36, 39].

The VL cases are reported from 54 districts of endemic region in India[1,12,34], and the most endemic states are namely; Bihar, West Bengal, Jharkhand, Uttar Pradesh, Gujarat, Kerala, and foothills of the Himalayan mountain range in the North Western sector of India[1,12,34]. Visceral leishmaniasis transmission hotspots clusters were identified using the universal spatial autocorrelation analyses, the result illustrates that Bihar state alone is at the risk of infection account to reported 80 % of the cases in India where 90% of the population lives in extreme poverty[1,12], currently represents 50% of the global burden of VL, and it has the co-incidence with HIV infected cases are increasingly reported among migrant workers[1,12]. CL by *L. tropica* and *L. major* occur in the West and North-western states of India[34-36] viz; Rajasthan, Punjab, and Bikaner district in Rajasthan, and cases reported from other districts are mostly migrants from Bikaner district. It has been affected severely in the poor economic groups who have lack of knowledge and poor access to free treatment, and because of the lack of government hospitals, many of them are focused to use the private hospital for the immediate recovery from the illness. The present analysis shows that it has the declining trend of 48 % (Fig.4) over the period of 30 years (1990 to 2020).

Filariasis:

In India, filariasis is caused by the parasite species namely; *Wuchereria Bancroft* 99.4 % and *Brugia malayi* 0.6%, and are spread by the bites of infected female *Culex quinquefasciatus*, and *Mansonia annulifera/ M.uniformis* species vector mosquitoes respectively[1,12,40-43]. The *Bancroft* vector mosquitoes are found ubiquitous across the country[40-43] throughout the year due to the huge urban agglomeration and settlements growths, whereas the districts are located in the filariasis hotspot endemic regions along the coastal districts, and the districts of major perennial river belts all over the country[40-44], and *Mansonia annulifera/ M.uniformis* species mosquitoes have been densely occurred in the Kerala state of western coastal region[40-43]. India is known for the filariasis endemic country in the world representation for more than 100 years[1,12], and 257 districts are affected with filariasis endemic spatially distributed in the 21 States and Union Territories of India [1,12, 40-43]. India has Filariasis 0 mF prevalence in 50 districts, < 1.0 mF prevalence in the 221 districts, and > 1.0 mF prevalence in the 172 districts across the country, and remaining districts are predicted as free from filariasis[1, 40-43]. The national health policy was aimed to eliminate the filariasis in the country by the year 2015, and it was extended to 2017, and again it was postponed to 2020. In India, the Elimination of Lymphatic Filariasis (ELF) was started in 2004 to cover 202 endemic districts in the 20 states and Union territories[1,43], and subsequently, it was extended to cover 257 endemic districts in the 21 states and UTs with 650 million population[1]. The ELF was started with single drug DEC, and later during 2006, and the main constrain of the NFCP is that it is distributed in the urban areas and does not cover the total population at risk of infection in the rural areas[43-46] combination of DEC and Albendazole was distributed. After 10 years, the validation of drug administration was carried out during 2013. The Global Alliance Elimination of Lymphatic Filariasis (GAELF) was organised during 2018, accordingly, in India, the Integrated Drug Administration (IDA) was launched with combination of 3 drugs (DEC + Albendazole + Ivermectin) [1,12] in 2019. IDA was started in 1 district of Bihar state during 2018, and followed by 16 districts in the 16 endemic states, during 2019, and 21 districts in the 20 endemic states during 2020. The IDA has been implemented in the filariasis endemic districts, and among the endemic districts, all the 257 districts were surveyed in very earlier in different localities at point of time period[40], and as of now, it is outdated, and therefore, resurvey must be conducted constructively in all the districts all over the country where mF prevalence was positive in the earlier period, make a plan accordingly, and distribute the IDA in the hotspot endemic districts across the nation, otherwise, the elimination of filariasis in the country by 2020 will be a utopian illusion.

Conclusion

India is resourceful country and naturally diverse. On other side, whole country has been suffered from major vector borne diseases and the hundreds of million people at risk of infection. The national health policy of the Government of India has been planned to operate the appropriate control strategy and prevention measures periodically, as the result, the VBD namely; malaria, filariasis, and chikungunya are drastically reduced across the nation, on the contrary, quite a few of the VBD number of cases have been increased for the recent decades. The longitudinal epidemics pictorial representation illustrates that the outbreaks have been upward trend, and have been increased spatially and vertically, paradigm; dengue have been steadily increased in both horizontal and vertical dimension across the nation for the recent decades. Malaria is still highly challenging problems in the Eastern, and North Eastern states, followed by northern, central regions, and western part of India. Japanese encephalitis epidemics are uncontrollable in the wetland rice cultivation regions of India. Leishmaniasis have been challenging public health problem for the very long period, particularly, in Uttar Pradesh, West Bengal, Bihar, Jharkhand, Assam, i.e. Gangetic river plain and Brahmaputra river plain. The public health authority must have to pool the base line information on the VBD hotspot regions across the nation, and accordingly, make a control plan and the prevention measures in a right place and right period.

Conflict of Interest: Nil

Source of Funding: Self

Ethical Clearance: Not applicable

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