GEO-INFORMATICS BASED APPROACH FOR EVALUATION OF TRENDS IN DENGUE OUTBREAKS WITHIN DOLUWA MOH AREA IN CENTRAL PROVINCE OF SRI LANKA

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Introduction

Dengue has emerged as one of the prominent health issues in Sri Lanka. The average number of dengue cases recorded within the recent years remains increasing over time due to recent outbreaks throughout the country, despite of the immense efforts taken by the relevant authorities to reduce the rate of mortality. Investigation of the trends in spatial and temporal distribution patterns of dengue is often treasured in drafting and implementation of management/ action plans to ensure effective management of dengue epidemics at the regional scale. Furthermore, such efforts are also useful in evaluating the efficacy of the already implemented control measures in restricting the outbreaks of dengue. Thus, a statistical and geo-informatics based analysis of the recent trends in dengue distribution was carried out to identify spatial and temporal trends in distribution patterns of dengue and to determine the susceptibility of population to dengue infection in Doluwa Medical Officer of Health (MOH) area in order to facilitate the effective regulation of dengue outbreaks, while evaluating the role of vector controlling agencies in controlling dengue.

Methodology

Monthly records of reported dengue cases from 2009 to 2014 of the Doluwa MOH area were collected from the Doluwa MOH. Spatial maps of the recorded dengue case distribution were prepared by using Arc GIS (version 10.2) to identify the spatial variations in dengue transmission within the Doluwa MOH area at the GND level. The number of recorded dengue cases of each year from each *Grama Niladhari* Division (GND) belonging to Doluwa MOH, were subjected to a Paired- Chi square statistical analysis to investigate the significance of spatial variations in dengue outbreaks at the GND level throughout the study period. The temporal trends in dengue outbreaks within the Doluwa MOH were analyzed by using visual time series analytical techniques. The Percentage Infected Male: Female Ratio (PIMFR) was calculated for each year and the significance in the variations was evaluated by devising Chi square test and Paired-Chi square test. Furthermore, the Paired-Chi square test was utilized to investigate the statistical significance of the temporal variations in the percentage of dengue patients belonging to each age group in different years, while maintaining eight predefined age groups together as subcategories.

Results and Discussion

The Figure 1 shows the temporal variation of the recorded dengue cases throughout the study period at the GND level where Panvilathenna GND indicates the highest susceptibility for dengue outbreaks followed by Palle Delthota and Doluwa GNDs that indicate a moderate risk. The rest of the GNDs indicate less (Atuwewatta, Gampolawatta, Gurukele, Haloya, Inguruwatta, Kahawatta, Megoda Kalugamuwa, Millagahamulla, Legumdeniya, Nillamba, Pupuressa, Thundeniya, and Naranvita) and null (Galoya, Ganegoda, Godawela, Gonatuwela, Hunugala, Masgolla, Mulgama, Nawa Nillamba, Nawa Gurukele, Orayanwatta, Pabadeniya, Pitawala, Rajathalawa, Thupelawaka, Wewathenna, Wariyagala and Ududeniya) vulnerabilities to dengue outbreaks throughout the study period. Significant variations in the emergence of dengue outbreaks within the Doluwa MOH could be recognized, throughout the study period at both spatial (at the GND level) and temporal (annual) scales in accordance with the statistics of the Paired-Chi square test (Table 1). The highest number of dengue cases in Doluwa MOH (at the GND level) has been reported in 2011, while 2014 reports the least number of recorded dengue cases within the studied period of 2009 – 2014. Based on the statistics of the Paired Chi-Square test, the number of recorded dengue cases at the GND level vary significantly throughout the years, denoting a significantly declining trend of reported dengue cases (after the peaking of dengue cases in 2011) in all of the GNDs, except for Pupuressa GND that indicate an opposing trend during the recent years. Thus, the implemented management and control measures seem to be effective in terms of dengue outbreak restriction within the Doluwa MOH.

Table 1. Summarized results of the Paired Chi-Square test for analysis of significance in temporal variations in dengue outbreaks in the Doluwa MOH

Year	2009	2010	2011	2012	2013	2014
2009		+	+	+	+	+
2010	+		+	+	+	+
2011	+	+		+	+	+
2012	+	+	+		+	+
2013	+	+	+	+		+
2014	+	+	+	+	+	

+ denote significant variations [$>X^2_{(32, 0.95)} = 46.17$] among the number of annual recorded dengue cases at the GND level in accordance with the Paired Chi-Square test

In accordance with the results of the normal Chi square, the Percentage Infected Male: Female Ratio (PIMFR) remains significantly altered throughout the period of study (p = 0.00 < 0.05 at 95% level of confidence). Males tend to indicate relatively high susceptibility for dengue infection than females (with 56.3: 43.7 of average PIMFER).

As suggested by Table 2, the age group of 21 - 30 indicates the highest vulnerability to dengue infection, while groups of 11 – 20, 31 – 40 and 41 – 50 indicate moderate levels of vulnerability. The age group of over 61, indicate the least vulnerability to dengue while rest of the groups indicate less susceptibility to dengue in the Doluwa MOH area.

However, according to the Paired-Chi square test, the vulnerability of age groups tends to shift significantly throughout the study period [$>X^2$ (7, 0.95) = 14.067].
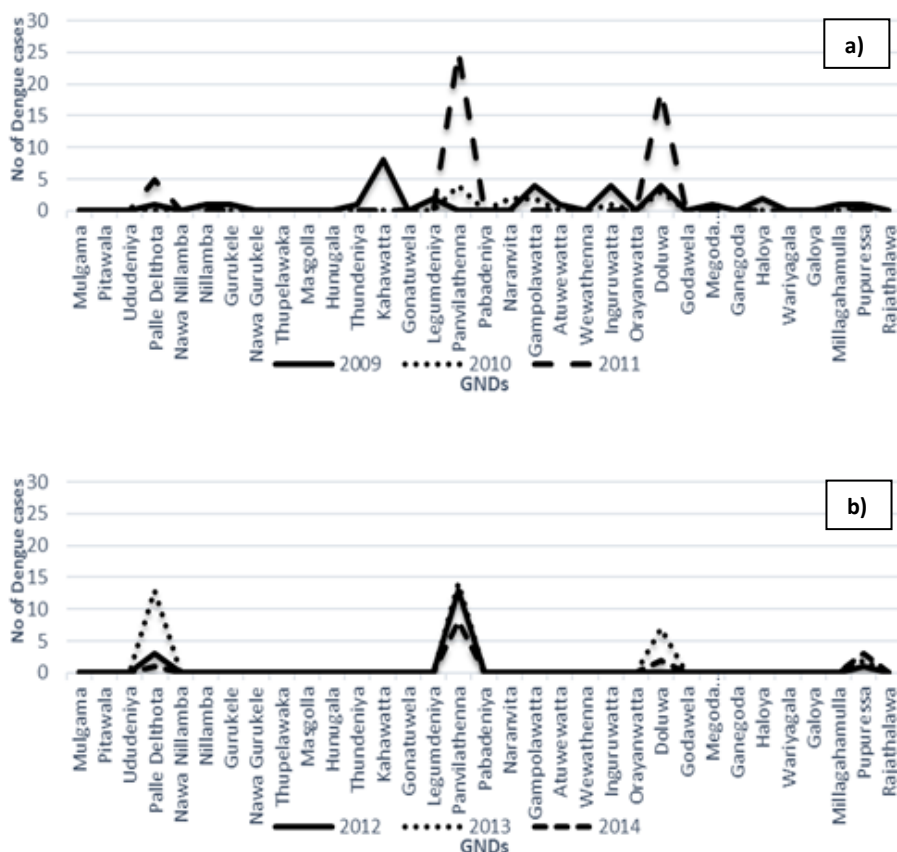

Figure 1. Temporal variation of the recorded dengue cases throughout the studied years, a) 2009 – 2011 and b) 2012 - 2014 at the GND of the Doluwa MOH area.

Table 2: Summarized average annual percentages of dengue patients belonging to each target age group for Doluwa MOH area for the period of 2009 – 2014

Year	Annual Percentage (%)							
	0 - 5	6 -10	11 - 20	21 - 30	31 - 40	41 - 50	51 - 60	> 61
2009	1.01	1.01	11.11	14.14	7.07	1.01	2.02	0.00
2011	4.17	2.08	10.42	6.25	6.25	4.17	2.08	0.00
2011	5.26	10.53	42.11	39.47	7.89	10.53	10.53	7.89
2012	0.00	0.72	0.72	6.47	1.44	1.44	0.72	0.00

2013	5.26	0.00	18.42	42.11	13.16	7.89	2.63	5.26
2014	0.00	0.00	2.02	7.07	2.02	2.02	1.01	0.00
Average Annual Percentage (%)	3.14	2.87	16.55	21.69	7.16	5.01	3.60	2.63

Conclusions and Recommendations

Significant variations in dengue outbreak incidence could be noted in Doluwa MOH at both spatial and temporal scales. Panvilathenna GND indicates the highest susceptibility for dengue outbreaks, while most of the GNDs tend to indicate less (13 GNDs) or null (17 GNDs) susceptibilities for incidence of dengue. Males tend to indicate relatively high susceptibility to dengue. Age group of 21 - 30 tend to indicate the highest vulnerability to dengue, while the age group of over 61 emerged as the least vulnerable group. Except Pupuressa, all the other GNDs indicate a declining trend of reported dengue cases, suggesting that the attempts of the relevant dengue vector controlling agencies are effective in controlling dengue incidence within the recent years in Doluwa MOH area. The evaluation of the trends in temporal and spatial distribution of dengue outbreaks at the localized level, could be recommended in further planning and implementation of action plans to control the rise of dengue at regional scale by the government sector and other relevant entities.

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