SHORT REPORT

Forecasting incidence of dengue and selecting best method for prevention

Muhammad Sabir, Yousaf Ali, Noor Muhammad

Abstract

This study forecast future infected patients from dengue and also sought optimum solution for its prevention. Previous years' data of dengue patients was used for forecasting numbers of infected patients in 2017. The novelty of the study is the application of Analytical Hierarchy Process (AHP) technique in application of dengue control. We employed AHP to rank the alternative for dengue prevention using perception of general public collected via questioners from 100 respondents across Pakistan. The results show that public considered not to let the water accumulate inside their homes as the most economical, effective, efficient and less labour intensive alternative to combat dengue.

Keywords: Viral Diseases, Dengue, MCDM, AHP

Introduction

Dengue is an infectious disease caused by virus that transmit between humans via Aedes aegypti mosquitoes. Globally around 390 million individuals get dengue infections per year out of which 96 million manifest apparently. Additionally, about 70 percent infected of dengue globally are from Asia with India being the most infected country.[1] The disease is mostly under reported in Pakistan and globally.[2] Dengue vector is an urbanized mosquito and breeds in stored water. Dengue outbreaks are interlinked with monsoon seasons.

Pakistan gets major annual rainfalls during the monsoons, which is coupled with poor drainage systems and poor infrastructure; water retained on rooftops and containers thus becoming an ideal breeding spot for Aedes. Floods followed by monsoon fuel the problem (e.g., after flood of 2010 there was a significant spike in the number of recorded cases.[3] In the Year 2011 there were about 20,000 dengue cases reported in Pakistan.[3,4]

Government of Pakistan pursues various policies to combat dengue during its outbreak. This includes: installing new wards in hospitals, extensive fumigation of susceptible areas and potential breeding grounds. But there are negligible endeavours on basic prevention measures, which include, full body apparel, different forms of traplights, mosquito repellent lotions and fumigation. Fumigation can be counterproductive as the aegis are forced indoors, potentially increasing the risk of dengue infections. Efforts are more focused on treatment of infected patients rather than reducing spread. Efficient and better control on spread can be achieved by ensuring control through chemical, biological and public awareness campaigns.[2]

This study incorporates the public opinion to find best strategy in dengue control through usage of modern decision making tools. The novelty of the study is the application of advance multi criterion decision making tools for control of infectious diseases. Recent literature of such kind is focused on Zika virus that is similar to dengue in sign, symptoms and spread. A semi-quantitative risk assessment of the Zika virus was done in the Guangdong province of China.[5]

Methods and Results

The study employed simple regression to forecast dengue patients for year 2017 using data presented in

APPENDIX: A

Table-A1: Historic data of dengue infections.

Year	No. of Infected
2003	3500
2004	25
2005	500
2006	5400
2007	2700
2008	1800
2009	570
2010	5000
2011	20000
2012	840
2013	20890
2014	275
2015	10000

Department of Management Sciences, Ghulam Ishaq Khan Institute, Topi, Swabi, KP, Pakistan.
Correspondence: Muhammad Sabir. Email: sabir.m@giki.edu.pk

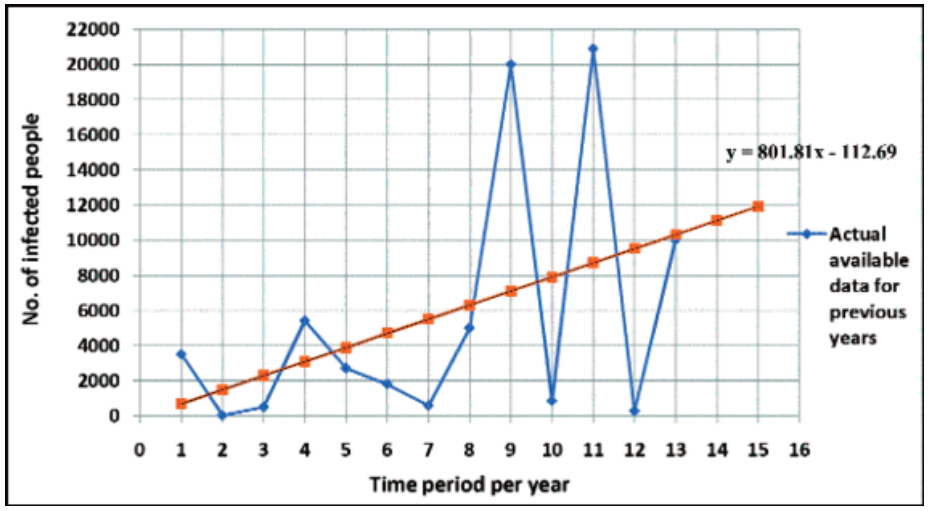

Figure-1: Regression analysis.

Table-A1 in appendix.[2] It also used field survey to gauge public opinion about various dengue prevention measures and its effectiveness. Multi criteria decision-making tools called Analytic Hierarchy Process (AHP) was used for ranking. AHP process consists of five steps starting with selection of alternatives, criteria's for making a choice decision and then based on that decision, all available alternatives are compared and a priority ranking is assigned. Finally, best alternative is picked. AHP is a powerful tool for multi criteria decision analysis.[6]

Figure-1 presents results of regression analysis. Approximately 11,200 people in Pakistan are expected to be infected by dengue in 2017. In 2015 the number of infected were nearly 10,000.

AHP is applied on the basis of the following list of alternatives and criteria presented in Table-1. Alternatives selection is done by going through: media broadcast about the virus, medical personnel involved in treating dengue during outbreak season, journals and online information from dengue control authorities of Pakistan, India, Sri Lanka and Philippines. The list of alternatives includes, actions that can save individuals and people around, and eliminate the source of disease.

AHP application requires priority vectors, for which a survey was conducted among different demographics across Pakistan from around 100 respondents during 2017 using google docs. We employed slightly tailored AHP 9 scales intervals to 5 intervals where 1 represents equally preferred choices and 9 represents extremely preferred, respectively. Responded rated different alternatives in preferences to each other (on five interval scale), and these were further used to assign weightage for AHP, with respect to each selecting criteria. In Figure-2 below a bar chart shows rating of each alternative with respect to effectiveness criteria.

The individual scores for each alternative were multiplied with number of respondents to get weighted average rating, and then were added together. Final values were dividing by number of responses for each alternative with respect to each criterion. Weighted

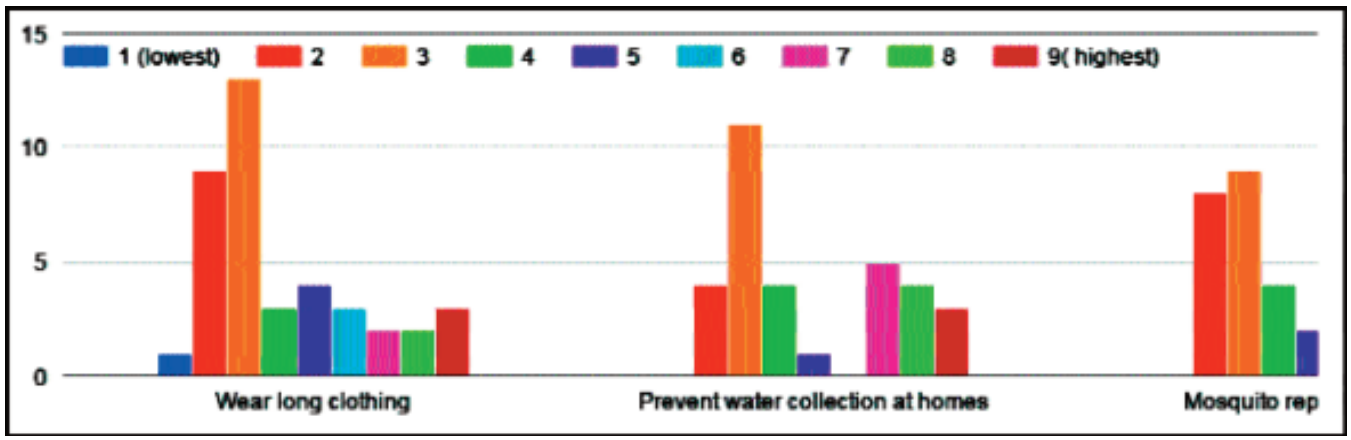

Figure-2: Public Rating Public for each Alternative against each Criterion.

Table-1: List of Alternatives and Selection Criteria's.

List of Alternatives	
i.	Full body clothing
ii.	Preventing accumulation of water in outdoor spaces
iii.	Application of mosquito repellent
iv.	Extensive fumigation of homes and commercial buildings
v.	Proper and systematic storage of discarded and new tyres
vi.	Improving the drainage and sewerage system , in order to provide a hostile environment for vector breeding
vii.	Spraying of larvicides on large stagnant water bodies
viii.	Containment through enforcement of quarantine (Segregation of patients in wards).
List of Selection Criteria's	
i.	Cost of performing the alternative
ii.	Manpower required for implementation
iii.	Ease of alternate implementation
iv.	Timely responses for alternative step to counter the spread
v.	Effectiveness of the alternative

Table-2: Overall Priority Vector (%).

Alternatives	Overall priority vector	New Priority Vector
Long clothes	0.1305	0.1553
Water collection	0.2449	0.1847
Mosquito repellent	0.1698	0.1351
Fumigation	0.0831	0.0907
Tire disposal	0.0564	0.1158
Larvacides Spray	0.1670	0.2115
Drain covering	0.1195	0.0733
Quarantine	0.0289	0.0302

averages for each criterion was compared with weighted average of each alternative and ratings were assigned accordingly. Final results as presented in Table-2 were calculated by rating criterion with respect to their importance to each other.

The best alternative for dengue control was not to let the water collect at various spots inside the homes with value of 0.2449. Use of mosquito repellent and larvicides spray were a close second and third with values 0.1698 and 0.1670, respectively. Quarantine was least preferred method to control dengue.

Another AHP was performed assigning different weightages after studying different alternatives in various dengue-affected countries, to check sensitivity of results. Last column in Table-2 shows the new priority vector with ranking being consistent with earlier findings.

Public considered not to let the water accumulate inside their homes as the best measure for dengue control.[7] It is rational because this alternative is least labour intensive and most economical. Moreover, people preferred fumigation as the second last because of the discomfort it may cause.

The survey had outlier value in the form of quarantine, which displays the lack of knowledge that the general public has regarding various modes of disease transmission. Quarantine despite being a very effective measure was not well represented in the public responses.[8] Mosquito repellent and larvicides spray came up very close to one another. Survey highlighted that the public were not fully cognizant of the endemic nature of the disease and their focus was primarily on micro managing the disease.

Conclusions

The results show that people preferred conventional methods of dengue control that are less labour intensive and economical. Quarantine is an effective measure but not preferred by the public.

Disclaimer: None.

Conflict of Interest: None.

Source of Funding: None.

References

1. Bhatt S, Gething PW, Brady OJ, Messina JP, Farlow AW, Moyes CL, et al. The global distribution and burden of dengue. Nature 2013; 496: 504-7.
2. Khanani MR, Arif A, Shaikh R. Dengue in Pakistan: Journey from a Disease Free to a Hyper Endemic Nation. J Dow Uni Health Sci 2011; 5: 81-4.
3. Rasheed SB, Butlin RK, Boots M. A Review of Dengue as an Emerging Disease in Pakistan. Public Health 2013; 127: 11-7.
4. Altaf A. Factors Associated With Spread of Dengue Fever in Urban Lahore, Punjab, Pakistan, 2013. Lancet Global Health 2015; 3: S27.
5. Li X, Liu T, Lin L, Song T, Du X, Lin H, et al. Application of the Analytic Hierarchy Approach to the Risk Assessment of Zika Virus Disease Transmission in Guangdong Province, China. BMC Infect Dis 2017; 17: 65.
6. Lolli F, Ishizaka A, Gambereni R. New AHP-Based Approaches For Multi-Criteria Inventory Classification. Int J Production Economics 2014; 156: 62-74.
7. Lyod SL, Winch P, Ortega-Canto J, Kendall C. Results of a Community-Based Aedes Aegypti Control Program in Merida, Yucatan, Mexico. Am J Trop Med Hyg 1992; 46: 635-42.
8. Masui H, Kakitani I, Ujiyama S, Hashidate K, Shiono M, Kudo K. Assessing Potential Countermeasures Against The Dengue Epidemic In Non-Tropical Urban Cities. Theoretical Biol Med Modelling 2016; 13: 12.