▮▮ RESEARCH PAPER ▮

Hospital Seroprevalence of Dengue Virus Infection among Adults of Urban Dhaka

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Abstract

Background: Global incidence of dengue has increased dramatically over the last few decades. In Bangladesh, there is a high transmission of Dengue in urban and peri-urban areas of Dhaka and other major cities. Seasonal variation, improper surveillance, underreporting of dengue infection have made difficult to estimate disease burden of dengue.

Objective: This study was aimed to observe the rate of seropositivity by ELISA for Dengue IgG patients presenting to hospital.

Methods: This is a cross-sectional study done in seven medical college hospital in urban Dhaka from January 2018 to March 2018. A small amount of blood was taken obtaining informed written consent in patients selected by purposive sampling during presenting to hospitals and a pre-tested questionnaire was fill to gather socio-demographic and relevant epidemiological data.

Results: A total of 695 patients were included in this study with a mean age 34.9±16.49. Dengue IgG was positive in 349 (51.2%), positivity was found highest (70%) in Shahabuddin Medical College Hospital and lowest (25%) in Uttara Adhunik Medical College. Dengue IgG positive patients were more literate (82% vs 74.2%), more from urban setting (51.2% vs 41.8%), had more monthly income, had more garden (26.8% vs 23.3%) and stagnant water (25.5% vs 23%) in comparison to IgG negative patients.

Conclusion: This study revealed that high seroprevalence posing risk to develop severe dengue and indicating high disease burden which warranted large scale well design population-based study.

Keywords: Dengue sero-prevalence, Dengue transmission, Dengue IgG, Urban Dhaka

Introduction

Dengue is an arboviral infection i.e. viral disease transmitted by arthropod Aedes mosquitoes. Dengue infection may cause febrile illness varying from undifferentiated viral-like illness to potentially life-threatening condition called severe dengue. Dengue is widespread throughout the tropic and subtropics in urban and semi-urban areas. Global incidence of dengue infection has increased dramatically that over a few decades half of the population at risk of dengue infection and today dengue virus poses a major threat to global public health.[1] The actual number of dengue infection is under-reported due to variable severity and diverse presentation and many cases are misclassified. It is estimated about 390 million dengue infection occurs per year worldwide of which 96 million people manifest with dengue fever and 3.9 billion people in 128 countries are at risk of dengue infection.[2-3]

The first dengue case was reported from Dhaka in 1964 then sporadic cases also reported during 1997-78 and 1996-97 but true transmission and prevalence were not known.[4-5] The first identified epidemic of DF and dengue hemorrhagic fever (DHF) in Bangladesh, took place during the monsoon season of 2000 and resulted in 5,521 officially reported cases with admission having 93 fatalities.[6] With the predominance of DEN-3, all four dengue serotypes have been found in circulation in recent years.[7-10] From 2000–2009, ninety one percent of all reported dengue cases were from Dhaka making it the most endemic urban area of the country.[11] Though secondary infection with different serotype (mostly DEN-2, DEN-3) is associated with severe dengue, sometimes primary infection with DEN-3 causes severe dengue in this region.[12] As dengue case reporting relies on dengue seropositive cases presented to hospitals which mainly includes

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severe dengue, reported dengue cases over two-decade did not reflected the true image of magnitude of infection and current status is probably only the 'tip of iceberg'. It has been well documented that passive surveillance involving case notifications does not accurately reflect the burden of dengue in such a geographical location.[13]

There is seasonal distribution and incidence correlates with rainfall.[14] During 2000 - 2017 data showed that 49.73% cases occurred during the monsoon (May to August) and 49.22% of cases occurred during post-monsoon (September to December) and since 2014 pre-monsoon transmission has been observed which is more than seven times than before.[15] Climatic change such as average rainfall, humidity, temperature, rapid unplanned urbanisation, poor waste management are the strong predictor of change of ecology leading to rapid increase of dengue cases and first-time massive Chikungunya outbreak in 1917 in Dhaka.[15] Given the absence of adequate surveillance, variability of transmission and seasonal distribution of incidence make the estimation of disease burden difficult. The validity of the existing incidence data is unclear because notification and surveillance were not extensively done. A notionally representative study of seroprevalence from 70 communities indicated seroprevalence ranged from 3% in the northern part of Bangladesh to more than 80% in Dhaka city.[16] High population density and ecological conditions in the urban and semi-urban areas of Dhaka city have been favourable for dengue transmission for the last 15 years, suggesting a rather stable endemic transmission pattern. However, the real infection pressure and household and environmental risk factors are not known accurately. High seroprevalence is probably associated with high transmission in young age and peri-urban area and severe dengue. Hospital seroprevalence will help to estimate disease burden, to know the risk factor associated with transmission and to identify vulnerable groups having infection and severe disease; thus to help to intervene for prevention appropriately. In this descriptive study seroprevalence for dengue was estimated testing IgG antibody and risk factors for dengue transmission were documented in afebrile patients presented inpatient and outpatient department of seven medical college hospital in Dhaka city.

Materials and Methods

This cross-sectional observational study was conducted during January, 2018 to March, 2018 at the department of Medicine of Dhaka Medical College. Seven medical college hospitals were selected from arbitrary four main quadrant of Dhaka city (figure I).

Figure 1: Study site in the Dhaka city map. 1. Uttara Adhunik Medical Colloge 2. Shahabuddin Medical College Hospital 3. Shaheed Suhrawardy Medical College Hospital 4. Mugda Medical College Hospital 5. Dhaka Medical College Hospital 6. Sir Salimullar Medical College Hospital. N.B. Enam Medical College Hospital is not present in the picture

From southern part and old Dhaka we selected Dhaka Medical College Hospital and Sir Salimullar Medical College Hospital. From eastern part of Dhaka we selected Mugda Medical College Hospital; from western and middle part of Dhaka we selected Shaheed Suhrawardy Medical College Hospital. From northern part Uttara Adhunik Medical Colloge; northern-middle part Shahabuddin Medical College Hospital. Enam Medical College Hospital was selected as satellite urban and peri-urban area. Patients presenting outpatient for any cause were chosen for convenient sampling and after selecting the first responder, every 3rd patient was taken. After every male responder enrolled, one female responder was tried to be enroll to reduce gender gap. One hundred patient from each hospital was selected and total 700 patients was

selected which was about three times of calculated sample size of 247. A pretested questionnaire was used to gather socio-demographical and relevant epidemiological data. A sample, 3 ml of whole blood without anti-coagulant was drawn taking all aseptic measures from each respondent. The blood samples was transported to Department of Virology in Dhaka Medical College maintaining cold chain and serum was separated and kept in 4ºC until test for detection of Anti-Dengue IgG was done. Five blood sample was spoiled and discarded; hence total 695 sample was considered for analysis.

Results

Demographic profile: The range of age of respondents was wide who were included in the study. Mean age was 34.9±15.4 years; 17.8% (n=107) of patients were under 20 year of age, 52.2 % (n=314) and 23.3% (n=140) were between age group 21 - 40, 41 -60 respectively. Among the respondents 51.6 % (n=353) of population was male and female was 48.4% (n=331). Most of the participants were Muslim (93.0%, n=646) rest were Hindu. About 58.0% (n=403) of participants were married, 21.7% (n=111) of participants were illiterate, 68.3 % (n=400) of participants were literate among them 30 % (n=120) had higher education. About 44.0% of participants have monthly income 10,000 to 25000 taka. Most of respondents presented from urban (47.0%, n=246), semi-urban setting (25.9%, n=180) and only 13.7% (n=95) respondents presented from rural area.

Factors associated with Dengue infection: Among respondents, 14.8% (n=86) of patients had family history of dengue and 20% (n=136) patients had past history of dengue which was confirmed laboratory in 83% (n=113). Mosquito net use was used in 74.1% (n=500) of respondents in their residence and spraying activity for mosquito control was observed by 37.4% (n=154) of respondents. Most of the respondents are from 'Paka' type housing (68.8%, n=364), 27.4% and

3.8% of respondents from 'Semipaka' and 'Kacha' housing respectively. 90.6 % (n=567) of patients used to use sleep on bed and 9.4% (n=59) sleep on floor. Among respondents 25.3 % mentioned garden was present in their residence and 34% (140) also mentioned stagnant water was present in their vicinity.

Dengue IgG positive patients: A total of 349 patients was positive for Anti Dengue IgG which was 51.2% (table I).

Table I: Test result of Dengue IgG antibody (n=695)

Test result	Frequency	Percentage	Valid Percentage
Positive	349	50.2	51.2
Negative	332	47.8	48.8
Undetermined	14	2	
Total	695	100.0	

The highest number of patients positive for dengue IgG was found in Shabuddin Medical College Hospital while lowest was found in Uttara Adhunik Medical College (figure 2).

The literacy rate was higher in dengue IgG seropositive than in seronegative patients (82.8 vs 74.2) (table II). The proportion of highly educated patients was markedly higher in Dengue higher in seropositive patients than seronegative patients. In dengue IgG seropositive patients 51.0% presented from urban setting which was higher than that of seronegative patients. A good number of seropositive patients presented from semi-urban and rural setting. Thirty-three percent (n=30) of patient positive for IgG had monthly income BDT >25000, 44.0% and 23.0% of positive IgG patients had monthly income BDT 10,000-Taka 25,000 and BDT< 10,000 respectively. Mosquito net use rate was higher in seropositive patients than
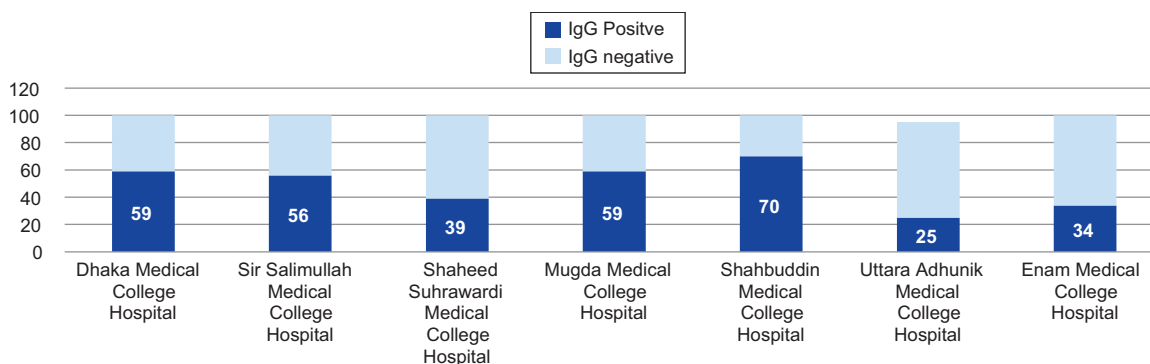

Figure 2: IgG positivity according to Medical College Hospital

Table II: Association of education, residence, economic status and mosquito net use with Dengue prevalence.

Variable	Dengue IgG		p value
	Present n (%)	Absent n (%)	
Literacy			
Illiterate	41 (17.2)	68 (25.8)	0.023
Literate	197 (82.8)	196 (74.2)	
Education Level			
Educated	124 (62.9)	152 (77.6)	0.002
Highly Educated	73 (37.1)	44 (22.4)	
Residence			
Urban	131 (51.2)	105 (41.8)	<0.068
Semi-urban	85 (33.2)	91 (36.3)	
Rural	40 (15.6)	55 (21.9)	
Monthly Income, BDT			
<10,000	21 (23.)	18 (18.6)	0.134
10000 – 25000	40 (44.0)	44 (45.4)	
>25000	30 (33.0)	35 (36.1)	
Mosquito Net			
Yes	253 (75.1)	238 (73.5)	0.279
No	84 (24.9)	86 (26.5)	
Mosquito Spraying			
Yes	86 (41.5)	62 (31.5)	0.023
No	121 (58.5)	135 (68.5)	
Sleeping practice, n (%)			
Bed	262 (87.9)	291 (92.7)	0.046
Floor	36 (12.1)	23 (7.3)	
Presence of garden, n (%)			
Yes	77 (26.8)	67 (23.3)	0.324
No	210 (73.2)	221 (76.7)	
Presence of stagnant water, n (%)			
Yes	73 (25.5)	66 (23)	0.480
No	213 (74.5)	221 (77)	

seronegative patients (75.15 vs 73.5). Mosquito spraying activity and use of repellent was higher in dengue IgG positive patients than negative patients (41.5% vs 31.5%). Sleeping practice on the floor observed at a higher rate in patients with Dengue IgG positive than that of Dengue IgG negative (12.1 vs 7.3). The presence of the garden was more observed in Dengue IgG positive patients than IgG negative patients (26.8 vs 23.8). The presence of stagnant water around the vicinity was more Dengue IgG positive patients than negative patients (25.5 vs 23).

Discussion

In this hospital-based study, seropositivity rate for dengue IgG among patients was high which was 51.2% (n=349). True seroprevalence of Dengue infection of Dhaka is not known. A population-based cross-sectional serosurvey of anti-dengue antibody in 12 of 90 wards of Dhaka city was done by Dhar et al in 2012 and showed very high seroprevalence which was 80% and 83.3% for pre-monsoon and post-monsoon respectively.[17] Rahman et al analysed retrospectively in 225 samples of blood from patients presenting the Diabetic Association of Bangladesh Hospital, which showed 69.33% was positive for Anti Dengue IgG and IgM and 38.22% positive for dengue IgG.[8] In our study seropositivity is lower than other studies mentioned above. As various patients of urban, semi-urban, slum and rural patients from different part

of the country presents those medical college hospitals as highest level referral. In the present study, only 47.0% of patients were from urban setting, rest from semi-urban, rural setting. Among seropositive patients 84.2 presented from urban and semi-urban areas, only 15.6% of patients from rural setting. If total participants were from urban setting then seropositivity would have even been higher.

This high seroprevalence in Dhaka should also be regarded as an indicator of significant under-reporting of dengue virus-associated illness. In recent years predominant serotypes of dengue virus in metropolitan Dhaka were DEN3 but all for serotypes are present in this region.[11] High seroprevalence of dengue poses a major risk factor for secondary dengue infections and more severe diseases, such as dengue hemorrhagic fever, expanded dengue syndrome if a new dengue serotype to which there has been limited prior exposure is introduced in the existing other seropositive areas.

The positive relationship between the presence of antibodies and increasing age is indicative of cumulative dengue infection. Many other studies have reported that dengue antibody prevalence increases with age and on-going virus transmission, over many years, is often cited as the reason for this pattern.[20] Only 11.1% of seropositive patients under 20 years of age. Although dengue has been known to be a disease of children previously, the current trends in Bangladesh and also in surrounding countries experiencing increased incidence of elderly dengue.

Socioeconomic characteristics found in this study is important. Patients with dengue IgG positive tended to be more literate, more highly educated and more economically affluent in comparison to patients to patients with dengue IgG negative. Most of the seropositive patients were from urban area. It has been observed that there is variation in the spatial distribution of dengue transmission; the highest transmission occurs in densely populated and urban area and moderate transmission occurs in the peri-urban area.[18] In the present study high proportion of seropositivity in patients from 'Paka' (well-structured building) type house in urban area indicate presence environment helpful for mosquito breeding and dengue transmission and presence of garden and stagnant water were more marked in patients with dengue IgG positive than dengue IgG negative patients. In the case of Bangladesh, improving financial capability has

resulted in changes in social values, taste such as keeping ornamental plants indoors has become a custom. This trend has become more prevalent among the middle and upper-middle socio-economic class, which was reflected in the high proportion of dengue cases among this demographic cohorts during the 2000 epidemic.[19]

The presence of the garden was found in 26.8% of patients with seropositive for dengue. Unplanned urbanisation has lead densely populated Dhaka city with scarcity of parks and gardens in residential areas. There is also tendency to do roof garden with the conception of green Dhaka which is unplanned and not regulated by any authority. The high seroprevalence may be also due to these inappropriate roof garden in Dhaka city. In the present, 25.5% of patients reported stagnant water in and around their house. Low socioeconomic residential area risk factor may be attributed to poor settlement and housing structures, high population density, presence of inter-domiciliary potential mosquito breeding sites such as plastic bucket, plastic drum, clay pot, tire dub, and coconut shell, cans, vehicle tires in such urban zones.[15] Further multi-scale research is necessary to investigate risk factors encompassing both socioeconomic status, indoor and outdoor environment.

Conclusion

This study revealed a high seroprevalence of Dengue infection which may provoke further larger-scale population-based study. High prevalence poses a risk for high incidence of severe Dengue disease which is a major public health concern for local and regional public health authority. Formulation of an active DENV surveillance system is urgently warranted, particularly to estimate the impact of Dengue disease burden in the city of Dhaka and other areas of the country.

Acknowledgements

References

1. World Health Orgamization [Internet]. [cited 2019 November 4] url:https://www.who.int/news-room/fact-sheets/detail/dengue-and-severe-dengue

2. Bhatt S, Gething PW, Brady OJ, Messina JP, Farlow AW, Moyes CL, et al. The global distribution and burden of dengue. Nature. Springer Science and Business Media LLC; 2013; 496:504–7. DOI: 10.1038/nature12060

3. Brady OJ, Gething PW, Bhatt S, Messina JP, Brownstein JS, Hoen AG, et al. Refining the Global Spatial Limits of Dengue Virus Transmission by Evidence-Based Consensus. Reithinger R, editor. PLoS Neglected Tropical Diseases. Public Library of Science (PLoS); 2012 ;6: e1760. DOI: 10.1371/journal.pntd.0001760

4. Sharmin S, Viennet E, Glass K, Harley D. The emergence of dengue in Bangladesh: epidemiology, challenges and future disease risk. Transactions of The Royal Society of Tropical Medicine and Hygiene. Oxford University Press (OUP); 2015;109:619–27. DOI: 10.1093/trstmh/trv067

5. Karim MN, Munshi SU, Anwar N, Alam MS. Climatic factors influencing dengue cases in Dhaka city: a model for dengue prediction. Indian J Med Res. 2012;136:32–39.

6. Banu S, Hu W, Hurst C, Guo Y, Islam MZ, Tong S. Space-time clusters of dengue fever in Bangladesh. Tropical Medicine & International Health. Wiley; 2012;17:1086–91. DOI: 10.1111/j.1365-3156.2012.03038.x

7. Aziz MM, Hasan KN, Hasanat MA, Siddiqui MA, Salimullah M, Chowdhury AK, et al. Predominance of the DEN-3 genotype during the recent dengue outbreak in Bangladesh. Southeast Asian J Trop Med Public Health. 2002 ;33 :42–8.

8. Rahman MT, Tahmin HA, Mannan T, Sultana R. Seropositivity and pattern of dengue infection in Dhaka city. Mymensingh Med J. 2007;16:204–8.

9. Podder G, Breiman RF, Azim T, Thu HM, Velathanthiri N, Mai LEQ, et al. Short report/ : origin of dengue type 3 viruses associated with the dengue outbreak in dhaka , bangladesh , in 2000 and 2001. Am J Trop Med Hyg. 2006;74:263–5.

10. Muraduzzaman AKM, Alam AN, Sultana S, Siddiqua M, Khan MH, Akram A, et al. Circulating dengue virus serotypes in Bangladesh from 2013 to 2016. VirusDisease. Springer Science and Business Media LLC; 2018; 29:303–7. DOI: 10.1007/s13337-018-0469-x

11. Sharmin S, Viennet E, Glass K, Harley D. The emergence of dengue in Bangladesh: epidemiology, challenges and future disease risk. Transactions of The Royal Society of Tropical Medicine and Hygiene. Oxford University Press (OUP); 2015 ;109 :619–27. DOI:10.1093/trstmh/trv067

12. Soo K-M, Khalid B, Ching S-M, Chee H-Y. Meta-Analysis of Dengue Severity during Infection by Different Dengue Virus Serotypes in Primary and Secondary Infections. Huy NT, editor. PLOS ONE. Public Library of Science (PLoS); 2016 23;11:e0154760. DOI: org/10.1371/journal.pone.0154760

13. Low S-L, Lam S, Wong W-Y, Teo D, Ng L-C, Tan L-K. Dengue Seroprevalence of Healthy Adults in Singapore: Serosurvey Among Blood Donors, 2009. The American Journal of Tropical Medicine and Hygiene. American Society of Tropical Medicine and Hygiene; 2015 8; 93: 40–5. DOI:10.4269/ajtmh.14-0671

14. Morales I, Salje H, Gurley ES, Saha S. Seasonal Distribution and Climatic Correlates of Dengue Disease in Dhaka, Bangladesh. The American Journal of Tropical Medicine and Hygiene. American Society of Tropical Medicine and Hygiene; 2016;94:1359–61. DOI: 10.4269/ajtmh.15-0846

15. Mutsuddy P, Tahmina Jhora S, Shamsuzzaman AKM, Kaisar SMG, Khan MNA. Dengue Situation in Bangladesh: An Epidemiological Shift in terms of Morbidity and Mortality. Canadian Journal of Infectious Diseases and Medical Microbiology [Internet]. Hindawi Limited; 2019; 2019:1–12. DOI: 10.1155/2019/3516284

16. Salje H, Paul KK, Paul R, Rodriguez-Barraquer I, Rahman Z, Alam MS, et al. Author response: Nationally-representative serostudy of dengue in Bangladesh allows generalizable disease burden estimates. eLife Sciences Publications, Ltd; 2019 20; DOI:10.7554/elife.42869.020

17. Dhar-Chowdhury P, Paul KK, Haque CE, Hossain S, Lindsay LR, Dibernardo A, et al. Dengue seroprevalence, seroconversion and risk factors in Dhaka, Bangladesh. Williams M, editor. PLOS Neglected Tropical Diseases. Public Library of Science (PLoS); 2017 23;11:e0005475. DOI.: 10.1371/journal.pntd.0005475

18. Paul KK, Dhar-Chowdhury P, Haque CE, Al-Amin HM, Goswami DR, Kafi MAH, et al. Risk factors for the presence of dengue vector mosquitoes, and determinants of their prevalence and larval site selection in Dhaka, Bangladesh. Terenius O, editor. PLOS ONE. Public Library of Science (PLoS); 2018;13:e0199457. DOI:10.1371/journal.pone.0199457

19. Seroprevalence of dengue virus infection in Dhaka, Bangladesh, 2012. Heal Sci Bull. 2014;12:1–6.