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A case-control study to determine the risk factors of dengue fever in Chattogram, Bangladesh

Md Sahidur Rahman [a,*], Fatema Mehejabin [a,b], Mohammad Arafat Rahman [c], Rumana Rashid [d]

[a] One Health Center for Research and Action, Akbarshah, Chattogram, Bangladesh
[b] Public Health, Asian University for Women, Chattogram, Bangladesh
[c] Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh
[d] Bangladesh Institute of Tropical and Infectious Diseases, Faujdarhat, Chattogram, Bangladesh

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ABSTRACT

Objectives: In a tropical country like Bangladesh, where the climatic condition favors the growth of *Aedes* mosquito vectors, the success of dengue prevention depends largely on the proper identification and control of risk factors. Therefore this study was aimed to explore the potential risk factors and their association with dengue infection.
Study design: A case-control study including 150 cases and 150 controls was conducted in Chattogram district of Bangladesh. Cases were confirmed dengue patients admitted in Chattogram medical college hospital and Bangladesh institute of tropical and infectious diseases during August and September 2019. On the other hand, controls were non-dengue patients admitted in other departments of the same hospitals through gender, age, and location matching.
Methods: The questionnaire data were collected through telephone-based interviews, which included general demography, daily life activities, housing and surrounding environment of participants. Chi-square and binary logistic regression were performed to identify potential risk factors.
Results: The study found that travel history to the high incidence area, staying most of the daytime in office (AOR = 18.10), living in 21–40 years old houses (AOR = 9.74), and the temporary residency in the city (AOR = 10.20) were statistically significant risk factors for getting dengue infection. However, day time sleep, house type and structure, number of family members, morning and evening walk, plant in resident, and junk yard around 250 m of the house were also showed a significant effect in chi square test.
Conclusions: Results strengthen our understanding regarding the role of factors associated with daily lifestyle and living environment of people in the development of dengue and hence support the dengue control program in Bangladesh. The study will provide a basis for future extended research covering different parts of the country.

1. Introduction

Dengue fever (DF) is one of the most common and rapidly spreading vector-borne tropical diseases throughout the world. It is a *Aedes* mosquito-borne infection caused by the dengue virus-a member of the Flaviviridae family, which produces flu-like illnesses in humans [1]. The two most common forms of the disease affecting people are comparatively less severe dengue fever and the more severe dengue hemorrhagic fever. *Aedes aegypti* and *Aedes albopictus* are the two most important mosquito vectors in transmitting the disease to people through the bite [2]. The virus has four antigenically distinct serotypes which are closely related to each other. Therefore, infection with one serotype increases the risk of subsequent infection by other serotypes and develops a severe form of dengue. Almost half of the world's population is now at risk of dengue infection and approximately 390 million people get infected every year [1]. Though the majority of them live in urban and semi-urban areas, a proportion has also been reported in rural areas [3]. The transmission rate has expanded nearly 30 times in the last half of the century [4]. The case fatality rate of dengue is significantly higher than 1% in world, however the disease is preventable [5].

Globally, the incidence of dengue fever is mostly found in 128 countries, including Southeast Asia, Eastern Mediterranean, and the Western Pacific. Asian countries represent 70% of the global burden of dengue disease [6]. The incidence of dengue fever is found

* Corresponding author.
E-mail address: sahid.dvm@gmail.com (M.S. Rahman).

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comparatively higher in Southeast Asia, where dengue has been endemic in 12 countries, including Bangladesh [3]. Alike other tropical and sub-tropical countries, dengue fever is a serious public health concern in Bangladesh. Although it was first introduced in 1964, yearly outbreaks have occurred since 2000 [7]. In 2019, the country witnessed an unprecedented dengue outbreak with a total of 101,354 hospitalizations and 164 deaths of people recorded by the Directorate General of Health Services (DGHS) across the country [8]. Population growth, rural-urban migration, the inadequacy of basic urban infrastructure, and exponential growth of consumerism are responsible for highly favorable conditions for viral transmission by the main mosquito vector, *Aedes aegypti* [9]. Since Bangladesh is a densely populated developing country, rapid urbanization, unregulated infrastructure development, poor sewerage system in cities, and monsoon rains provided a suitable condition for the dengue virus to replicate at a higher rate which ultimately increases the risk of dengue transmission among the people [10]. A local survey found that households of Chattogram city were infested with *Aedes* mosquito larvae [11].

Along with environmental conditions, different biological factors such as age, blood group, geographical location, stagnant water, occupation, comorbidities, gender, etc., also influence the development of dengue infection in humans [2]. Moreover, household conditions such as house structure, room construction, water-storing system, occupants' behavior, and sanitation play a role in transmitting dengue fever [12]. The previous study about risk factor analysis showed that residents in rented houses are more at risk of dengue than those who live in their own houses (AOR = 2.2, $p < 0.05$) [13]. A better and extensive understanding of the socio-demographic and individual risk factors is important for dengue prevention [14]. However, these issues remain neglected and less focused in previous studies in Bangladesh, and to our knowledge, it is the first study in its nature in the country.

In this regard, we aimed to reveal the possible associations of dengue infection with different socio-demographic, individual lifestyles, and household factors through a community-based case-control study design. The study findings could help policymakers execute more comprehensive strategies for preventing dengue outbreaks, especially in countries where. It also facilitates to increase community awareness to avoid that may reduce the morbidity and mortality rate in the country.

2. Methods

2.1. Study setting

This case-control study was carried out at Chattogram district of Bangladesh during July to December 2019 when an unprecedented dengue epidemic occurred throughout the country. Chattogram is the 2nd largest city as well as port the city of Bangladesh. Most dengue patient records were collected from Chattogram medical college hospital (CMCH) - A tertiary care government hospital in the city that was the referenced hospital for dengue patients. Therefore, many dengue patients were admitted to that hospital and were targeted for our study. Moreover, a small number of cases were also recorded from the Bangladesh Institute of tropical and infectious diseases (BITID), which is a specialized hospital and research center situated in Chattogram.

2.2. Case and control selection

The study was designed for a total of 300 patients' data, 150 cases, and 150 controls to compare the variables aimed to explore the possible risk factors associated with dengue fever. All cases were confirmed dengue patients diagnosed by antigen (NS1) test and were admitted in a hospital (CMCH and BITID) during August and September 2019. Whereas 150 controls were non-dengue patients admitted to the other departments of the same hospitals and selected through frequency matching by age, gender, and geographic locations.

2.3. Questionnaire design and data collection

A structured questionnaire composed of 24 variables was designed to obtain information from case and control groups. The questionnaire possessed a range of demographic, travel history, daily life activities, family status, house, and surrounding environment. Two specialists revised the preliminary version of the questionnaire from the medicine and epidemiological sector to finalize it (Additional file 1). Though the questionnaire was developed in English, it has been translated into the Bengali-mother tongue of participants during the interview.

Lists of dengue patients and non-dengue control participants with their demographic and contact information were collected from the patient record sheet of CMCH and BITID. Due to the higher burden of patients with increasing morality rate hospitals imposed restrictions on dedicated dengue wards. Therefore, the questionnaire was filled through phone interviews conducted by the trained investigator's One Health Center for Research and Action team. To ensure reliability, the team members were thoroughly discussed the questionnaire and had pre-tested it before starting the final data collection. Verbal informed consent was taken from all the respondents, and confidentiality was ensured throughout the study. Participation in this study was voluntary, and no incentive was given to any respondent. Due to the telephone interview, the response rate was a bit lower- 77.47%. Few contact numbers were found wrong, out of service, unresponsive, and/or the number holder was the patient's relatives. Moreover, participants who failed to respond to all questions properly or left without completing the interview were excluded from the study.

2.4. Data analysis

All responses were put in excel and verified for completeness and consistency. Then the final dataset was transferred into Statistical package for social sciences (SPSS) software version 26.0 and coded for analyses. At first, we performed Chi-square ($\chi2$) test for all the variables in order to test the significant differences of variables between cases and controls as well as screened the variables of interest. Later, a binary logistic regression analysis was employed by stepwise procedure to analyze further the statistically significant variables found in the chi square test affecting dengue incidence. $P < 0.05$ value was set for the significance level of the $\chi2$ test and logistic regression. In addition, odd ratio (OR) with 95% confidence intervals (CIs) were used to express the degree of associations and determine the risk and protective factors.

The Hosmer-Lemeshow test was chosen to test the goodness of fit for the logistic regression model. We found that the full model containing all predictors had statistically significant through the Omnibus test (Chi = 316.48, $p = 0.000$) and Hosmer and Lemeshow test ($p = 0.81$). The model as a whole could explain between 65.2% (Cox and Snell R square) and 86.9% (Nagelkerke R square) of the independent variable. Additionally, the classification table was made, which shows that the model has correctly classified 93.7% of dengue cases. Moreover, we have calculated the predicted value and plotted it against observed ones. It showed the model's success in predicting with most cases around the mean prediction line in close conjugation with observed ones.

3. Results

Our study population was 300 with an equal number of cases (150) and controls (150). Between case and control groups, the male and female ratio was 1:1, and frequencies of age categories and geographic locations were also matched in both groups. The higher proportion of cases was male (70%, n = 105) and were belonged to 16–30 years of age (63.3%, n = 95). Most of the dengue patients had lived in the urban area (60.7%, n = 91) and were permanent residents of the city (77.3%, n = 116). Among demographic factors, no significant differences were found among age ($p = 0.99$), gender ($p = 1$), and geographic location ($p = 0.9$) between case and control groups. On the other hand, the patient's occupation, residential status, and travel to capital Dhaka, and the presence of comorbidities have shown statistically significant differences between the groups. Table 1 depicts comparative demographic characteristics of case and control groups.

Moreover, various housing and living environment-related factors also showed a significant impact to be a risk factor for dengue infection. The person living or working with a dengue patient; the place we're staying for more time of the day, walking outside especially in morning and evening time, the habit of daytime sleep was found important for dengue cases. In addition, housing type, structure, age of the house, number of family members, and the average no of the person living in a room revealed significant differences within the case and control groups of the participants (See Table 2). However, the indoor daylight and ventilation status of a house and the presence of a bus stand or garage, stagnant water, and construction site within 250 m surrounding the house were not statistically significant factors for the spread of dengue infection.

Study participants acknowledged the presence of different manmade structures considered as *Aedes* mosquito breeding in and around their house. They mostly recognized stagnant water (61%) followed by junkyard (34%) and plant into the house (32%) (See Fig. 1).

Logistic regression analyses show that travel to capital Dhaka, spending most of the time in the office, living in 21–40 years old house, and floating residents living temporarily in a rented house acted as significant risk factors (OR>1) for dengue infection in the study area (See Table 3). However, living or working with dengue patients, daytime sleep, living in a single house, staying with more than one person per room, and plantation in home reveals a non-significant risk for dengue infection. On the other hand, patient occupation (business, private service), structure or materials of a house-made by, and the number of family members have a significant association with dengue fever (OR< 1).

4. Discussion

The study investigated the risk and protective factors associated with the dengue virus infection in Chattogram, Bangladesh. In view of the study findings, dengue virus infection was higher among the younger people (16–45 years) living in urban and semi-urban areas supported by previous studies [7,15]. Higher incidence among the young people could be due to their over activities and less concern for health and diseases.

In this study, most of the cases were living in urban and semi-urban areas. Previous studies done in Hanoi city of Vietnam found that people living in highly populated central cities had a 3.2 times higher chance of contracting dengue fever than those who live in peri-urban districts [4, 13]. A meta-analysis also showed that 50% of the dengue outbreaks were reported in urban areas, followed by 28.6% in rural areas from

Table 1
Comparing the demographic characteristics of the case and control groups.

Variables	Case (%)	Control (%)	P-Value
Age			
≤15 years old	14 (9.3)	12 (8)	0.991
16–30 years old	95 (63.3)	96 (64)	
31–45 years old	25 (16.6)	27 (18)	
46–60 years old	12 (8)	11 (7.3)	
≥61 years old	4 (2.7)	4 (2.7)	
Gender			
Male	105 (70.0)	105 (70.0)	1.00
Female	45 (30.0)	45 (30.0)	
Patient occupation			
Unemployed	14 (9.3)	32 (21.3)	<0.001
Business	10 (6.7)	21 (14.0)	
Government service	28 (18.7)	11 (6.3)	
House wife	19 (12.7)	28 (18.7)	
Private service	12 (8.0)	12 (8.0)	
Student	47 (31.3)	23 (15.3)	
Worker	20 (13.3)	23 (15.3)	
Residential Status			
Permanent residents	116 (77.3)	138 (92.2)	<0.001
Floating residents	34 (22.7)	12 (8.0)	
Geographic Location			
Rural	10 (6.7)	12 (8.0)	0.906
Semi-Urban	49 (32.7)	48 (32.0)	
Urban	91 (60.7)	90 (60.0)	
Travel to capital Dhaka			
Yes	57 (38)	8 (5.3)	<0.001
No	93 (62)	142 (94.7)	
Comorbidities			
Yes	30 (20)	73 (48.7)	<0.001
No	120 (80)	77 (51.3)	

Table 2
Comparing the housing and living factors between the groups.

Variables	Case (%)	Control (%)	P value
Lived/worked with dengue patient			
Yes	42 (28)	9 (6)	<0.001
No	108 (72)	141 (94)	
Spent most of the time			
Home	69 (46)	113 (75.3)	<0.001
Office	55 (36.7)	26 (17.3)	
School/college	26 (17.3)	11 (7.3)	
Morning/evening walk in outside			
Yes	11 (7.3)	27 (18)	0.005
No	139 (92.7)	123 (82)	
Daytime sleep			
Everyday	55	82	<0.001
Frequently	6 (4)	26 (17.3)	
Occasionally	41 (27.3)	23 (15.3)	
Never	48 (32)	19 (12.7)	
House type			
Commercial flat	75 (50)	26 (17.3)	<0.001
Single house	68 (45.3)	116 (77.3)	
Hostel/quarter	7 (4.7)	8 (5.3)	
Structure of the house			
Tin shed	6 (4)	55 (36.7)	<0.001
Semi paka	31 (20.7)	35 (23.3)	
Building	37 (36.7)	55 (24.7)	
Other	76 (50.7)	5 (3.3)	
Age of the house			
<10 years	91 (60.7)	45 (30)	<0.001
10–20 years	4 (2.7)	49 (32.7)	
21–40 years	16 (10.7)	16 (10.7)	
>40 years	39 (26)	40 (26.7)	
Number of family member			
2–3 person	109 (72.7)	15 (10)	<0.001
4–5 person	37 (24.7)	86 (57.3)	
≥6 person	4 (2.7)	49 (32.7)	
Average no of person per room			
1 person	17 (11.3)	6 (4)	0.041
2 persons	61 (40.7)	59 (39.3)	
≥3 persons	72 (52.3)	85 (56.7)	
Quality of indoor daylight			
Poor	12 (8)	12 (8)	0.971
Moderate	65 (43.3)	67 (44.7)	
Good	73 (48.7)	71 (47.3)	
Ventilation			
Poor	11 (7.3)	18 (12)	0.308
Moderate	68 (45.3)	59 (39.3)	
Good	71 (47.3)	73 (48.7)	
Plant in residence			
Yes	37 (24.7)	59 (39.3)	0.006
No	113 (75.3)	91 (60.7)	
Bus stand/garage within 250 m around your housing			
Yes	27 (18)	37 (24.7)	0.159
No	123 (82)	113 (75.3)	
Junk yard within 250 m around your housing			
Yes	30 (20)	72 (48)	<0.001
No	120 (80)	78 (52)	
Stagnant water within 250 m around your housing			
Yes	87 (58)	96 (64)	0.287
No	63 (42)	54 (36)	
Construction site within 250 m around your housing			
Yes	36 (24)	36 (24)	1.00
No	114 (76)	114 (76)	

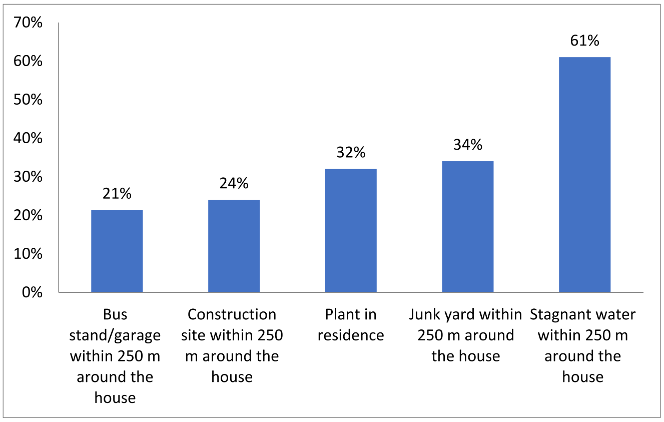

Fig. 1. Presence of mosquito breeding sources in and around the houses.

1990 to 2015 [16]. Hence, urbanization has been considered as one of the drivers of dengue fever dynamics. However, in recent times, dengue has been transmitted in urban settings and spread in rural villages by secondary vector *Aedes albopictus* which has been found available in the study area [11].

We found that the proportion of dengue fever was higher in men than in women, which is concordant with the published literature [15]. On the contrary, a study in Cameroon found the opposite result (Tchuandom et al., 2019) and perhaps the difference between males and females because males are more exposed to mosquitoes at the workplace and outside activities. However, literature has also shown no significant association between gender and dengue in a study done in Saudi Arabia [17].

Results of the Chi-square test revealed that patient occupation has a significant association (p = 0.00) with the outcome of dengue infection. A study in India-neighboring country also found a strong association of occupation with dengue fever and reported that occupation could be a major factor in developing dengue fever in humans [14]. The participants whose status was a businessman and private service holder had a significantly lower risk of getting infected with dengue fever (OR = 0.05 and OR = 0.02, respectively). On the other hand, homemakers were at a higher risk of infection (OR = 2.29), although the relation was non-significant. It indicates that house status and environment play a role in dengue transmission may be due to *Aedes* mosquito larvae and breeding sites in and around the houses of the study area found by an entomological survey [11]. On the other hand, government employees and students were significantly associated with protection against dengue virus infection. Nevertheless, the finding was found to be inconsistent with a study conducted in Saudi Arabia which found no significant association between the dengue infection and patient occupation [17].

Effect of comorbidities was found significant only in Chi-square analysis (p = 0.00). However, similar studies evident the increased risk of getting dengue fever due to the presence of different comorbidities of a patient, particularly diabetes and hypertension [17,18]. On the contrary, a study conducted in Pakistan showed a different result where no association was found between the comorbidity and the dengue fever [19]. Of significance, living or working with dengue patients was found as strongly associated with dengue infection (p-value 0.00). The binary regression showed the two times increase in the risk of infection for living or working with an infected person, which was supported by previous literature [20]. Likewise, studies also reported that people living with dengue patients remained at higher risk [21,22]. The reason could be an infected person can act as a viral carrier throughout its replication, and mosquito could transmit the virus from an infected person to healthier people by biting.

The patient's travel history was revealed as a significant risk factor for the dengue infection in this study as described by others [23]. A portion of our cases (n = 57) visited the capital Dhaka which was the hotspot of outbreaks and circulated infection throughout the year [24]. A study in India found that 70% of cases traveled to neighboring cities and expressed the signs of infection within the following 7 days [14]. There is clear evidence on the travel history and dengue infections at

Table 3
Binary logistic regressions analysis of predictors of dengue fever.

Variable name	Coefficient	Standard error	P-value	Odds ratio	95% CI
Travel to Dhaka					
No (Ref)	Ref	–	–	–	–
Yes	4.34	1.22	0.000	76.62	6.99–840.18
Patient occupation					
Unemployed	−0.32	1.27	0.79	0.72	0.06–8.72
Business	−3.06	1.43	0.03	0.05	0.003–0.77
Government service	−2.47	1.96	0.21	0.09	0.002–3.92
House wife	0.83	1.31	0.53	2.29	0.18–29.51
Private service	−4.02	1.79	0.03	0.02	0.001–0.6
Student	−0.35	1.24	0.78	0.71	0.06–7.99
Worker (Ref)	Ref	–	–	–	–
Comorbidities					
No (Ref)	Ref	–	–	–	–
Yes	−0.59	0.76	0.43	0.55	0.12–2.43
Lived or worked with dengue patient					
No (Ref)	Ref	–	–	–	–
Yes	1.08	0.87	0.21	2.97	0.54–16.4
Spent most of the time					
Home (Ref)	Ref	–	–	–	–
Office	2.89	1.26	0.02	18.10	1.54–212.14
School/college	0.68	1.05	0.52	1.98	0.25–15.51
Morning or evening walk in outside					
No (Ref)	Ref	–	–	–	–
Yes	−1.25	1.14	0.27	0.29	0.03–2.7
Daytime sleep					
Everyday	0.46	1.06	0.66	1.59	0.19–12.74
Frequently	−0.40	1.35	0.77	0.67	0.05–9.45
Occasionally	1.157	1.12	0.30	3.18	0.35–28.67
Never (Ref)	Ref	–	–	–	–
House structure					
Tin shed	−7.10	1.70	0.000	0.00	0.00–0.02
Semi-paka	−3.75	1.28	0.003	0.02	0.00–0.02
Building	−3.80	0.95	0.000	0.02	0.00–0.15
Other (Ref)	Ref	–	–	–	–
House type					
Commercial flat (Ref)	Ref	–	–	–	–
Single house	0.91	1.17	0.44	2.49	0.25–24.9
Hotel/quarter	−3.13	1.72	0.07	0.04	0.00–1.26
Age of the house					
<10years (Ref)	Ref	–	–	–	–
10–20 years	−3.57	1.27	0.005	0.02	0.00–0.34
21–40 years old	2.27	1.15	0.047	9.74	1.03–91.99
>40 years old	0.13	0.85	0.882	1.13	0.21–6.03
Residential status					
Permanent resident (Ref)	Ref	–	–	–	–
Floating resident	2.32	1.09	0.03	10.20	1.2–86.61
Number of family member					
2–3 persons (Ref)	Ref	–	–	–	–
4–5 persons	−4.33	0.87	0.000	0.01	0.002–0.07
≥ 6 persons	−3.96	1.07	0.000	0.02	0.002–0.15
Average no of person per room					
1 person (Ref)	Ref	–	–	–	–
2 persons	1.24	1.46	0.39	3.47	0.19–60.79
≥3 persons	1.08	1.44	0.45	2.95	0.17–50.05
Plant in house					
No (Ref)	Ref	–	–	–	–
Yes	0.05	0.65	0.94	1.05	0.29–3.76
Junk yards within 250 m around your housing					
No (Ref)	Ref	–	–	–	–
Yes	−0.86	0.74	0.25	0.43	0.09–1.82

both national and international levels [25]. Increased travel in the twentieth century has resulted in a 40-fold increase in dengue. It is evidenced that; dengue fever has increased 40-fold due to increased travel over the twentieth century [26]. The majority of patients who got infected with dengue infection (87.7%) had traveled to different places [27].

Our study revealed that sleeping in the daytime and walking outside like a park during morning and evening was significant for contracting dengue fever. A study was done in the Guangdong city of China also stated that park activities can significantly increase the risk of dengue infection by 1.70 times [28]. Likewise, another study showed a positive association where it was stated that parks can be a major source of dengue incidence [29]. This could be because people who walk in the parks, roads, and open grounds may be bitten by Aedes albopictus mosquito, which is the secondary vector for dengue transmission and usually live in green vegetation. Logistic regression proved the increased risk of dengue due to sleep in the daytime every day (OR = 1.59) and occasionally (OR = 3.18). Late risers and evening sleepers are more prone to infection as *Aedes* mosquitoes mostly bite in the morning and afternoon [10].

Our logistic analysis shows that temporary/floating residents possessed a significant and prominent risk of dengue infection (p = 0.03, OR = 10.2) than the permanent residents. Similar literature also stated that the rented houses were possessed a higher risk of spreading dengue [30]. Single houses presented higher odds (2.49) for occupants' infection, which may be due to high densities of *Aedes* larvae recorded in single independent houses of the study area [11]. Single houses are small buildings or semi Paka structure inhabitants of one or two families. This type of house, usually surrounded by gardens and open places, provided more suitable breeding sites for *Aedes* mosquitoes, especially *Aedes albopictus.* The commonly found structures and building materials of houses acted as a significant protective factor against the dengue infection in this study. However, a similar study in India found that living in a thatched house causes three times increased risk of dengue fever [14]. Another prominent risk factor found in this study was living in a 21–40 years old house which was concordant with the findings of another case-control study which also stated that living in an old flat and sheds increases the risk of dengue infection [31]. A multivariate analysis found seven times higher risk of dengue infection in persons who live in poorly built houses [32].

Results also revealed a strong association between the size of the family and the transmission of dengue infection. Additionally, the number of persons per room had represented a higher risk in logistic regression with the odds ratio of 3.47 and 2.95 for two persons in one room and three or more persons, respectively, compared to a single person per room. A cross-sectional study conducted in Venezuela found an average of 1.5 persons living together was identified a major risk (OR = 1.4, P = 0.046) for dengue progression [32]. On the other hand, multivariate analysis in China showed that two occupants in one room had a lower risk (OR = 0.43) than $\geq$3 occupants [2]. The status of ventilation and daylight into the house did not significantly influence the infection. However, literature described that the artificially dry atmosphere lowers their survival rate, and the cool temperature extends the extrinsic incubation period, reducing the likelihood of transmission [33].

The presence of stagnant water around the 250 m of the house was proved not to be a responsible factor in increasing the risk of dengue transmission in our current study. Similar findings were also observed in a study conducted in Vietnam which did not find a strong connection between stagnant water and dengue transmission [4]. Unlike this study, stagnant water acted as a significant risk factor in a study conducted in Ethiopia which concluded that the people living near the stagnant water source had 3.6 times more risk of infection than others [20]. Apart from that, the presence of other factors which could facilitate the mosquito breeding process, such as having construction sites, bus stands, and junkyards around the household and plant in residents,s were also investigated in this study. However, only the effect of junk yard and plant inside the home was recorded as significant (p = 0.00) in chi-square test. Junk yard may contain different discarded household plastic containers, food packets, coconut shells, and machinery, all of which can provide a good habitat for *Aedes* larvae [11]. The odds of more than one plantation in the home indicated the risk of spreading dengue among the residents. Flower tub and tray were recorded as a productive source of Aedes mosquito breeding, and a local study measured that 8.16% flower tube with the tray was infested with immature *Aedes* (larvae and/or pupae) [11].

One of the main limitations was the phone-based data collection which causes a poor and incomplete response. Due to the absence of large sample size, some of the associations had not shown significant results. Environmental parameters, the water storage system in the home, and knowledge and awareness of the house head could alternate the course and severity of the dengue infection, which were not considered in this study. We interviewed within one week after the patient's release from the hospital during the outbreak period, which ensured less chance of recall biases. We analyzed and presented both the risk and protective factors. The study findings were also supported by the previous studies regarding the associated risk factors of the dengue virus.

5. Conclusions

The study elucidated the association of various risk factors for dengue transmission. Traveling to a dengue prevalent area, staying most of the time in the office, living in the old houses of over 20 years, and temporarily live in rented houses in various parts of the city have significantly increased the risk of getting dengue infection. Dengue outbreak could be influenced by an individual lifestyle and the structures in and around the house enhancing mosquito breeding and survival. Therefore, sustainable dengue control strategies should be prioritized for mass awareness programs for promoting safe housing and a healthy lifestyle among communities.

Statements of ethical approval

This study was carried out in accordance with the recommendations of the Chattogram Veterinary and Animal Sciences University's Ethics Committee. The protocol was approved by the ethics committee with Memo no- CVASU/Dir(R&E)EC/2020/169/10, Date: 21/07/2020.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.

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