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Thanh Toan, Do Thi, Luu Ngoc, Hoat, Hu, Wenbiao, Wright, Pamela, & Martens, Pim
(2015)
Risk factors associated with an outbreak of dengue fever/dengue haemorrhagic fever in Hanoi, Vietnam.
Epidemiology and Infection, *143*(8), pp. 1594-1598.

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https://doi.org/10.1017/S0950268814002647

Epidemiol. Infect., Page 1 of 5. © Cambridge University Press 2014
doi:10.1017/S0950268814002647

Risk factors associated with an outbreak of dengue fever/dengue haemorrhagic fever in Hanoi, Vietnam

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Received 17 June 2014; Accepted 15 September 2014

SUMMARY

Dengue fever/dengue haemorrhagic fever (DF/DHF) appears to be emerging in Hanoi in recent years. A case-control study was performed to investigate risk factors for the development of DF/DHF in Hanoi. A total of 73 patients with DF/DHF and 73 control patients were included in the study. The risk factor analysis indicated that living in rented housing, living near uncovered sewers, and living in a house discharging sewage directly into to ponds were all significantly associated with DF/DHF. People living in rented houses were 2·2 times more at risk of DF/DHF than those living in their own homes [adjusted odds ratio (aOR) 2·2, 95% confidence interval (CI) 1·1–4·6]. People living in an unhygienic house, or in a house discharging sewage directly to the ponds were 3·4 times and 4·3 times, respectively, more likely to be associated with DF/DHF (aOR 3·4, 95% CI 1–11·7; aOR 4·3, 95% CI 1·1–16·9). These results contribute to the understanding of the dynamics of dengue transmission in Hanoi, which is needed to implement dengue prevention and control programmes effectively and efficiently.

Key words: Dengue fever, dengue haemorrhagic fever, risk factors, Hanoi.

INTRODUCTION

Dengue fever/dengue haemorrhagic fever (DF/DHF) is a fast-spreading vector-borne disease associated with a significant public health impact. Dengue is receiving attention all over the world for its epidemic expansion and high mortality rate [1]. Before 1970, DF/DHF was detected in only nine countries but has now spread to over 100 countries. The global number of reported DF/DHF infections has been stated to be around 96 million per year. However, many cases go unreported and it is estimated that the real number could be as high as 390 million (95% confidence interval 284–528) cases [2].

Vietnam is located in the heart of the endemic area for DF/DHF. It is recognized as a major cause of mortality and morbidity in Vietnam and ranks among the top ten communicable disease in terms of overall health burden [3]. In 1958, the first DHF case was described in Vietnam and the first reported outbreak occurred in southern Vietnam in 1963, resulting in 116 deaths [4]. The estimated morbidity and mortality rates between 1979 and 2005 were

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33–462/100 000 and 0·1–2·7/100 000, respectively, per year. Although dengue transmission occurs in both rural and urban areas in Vietnam, 73% of the population live in rural areas and therefore the majority of DF/DHF cases and deaths are from these areas [5].

Hanoi in Northern Vietnam is a large city where DF/DHF appears to be emerging as a major public health concern. In 2009, Hanoi experienced its largest ever recorded outbreak. In this study we set out to investigate which risk factors are associated with DF/DHF in patients admitted to hospitals in Hanoi. Identifying the risk factors can help to design and apply effective preventive and control strategies.

MATERIALS AND METHODS

This study was performed in Hanoi at the National Hospital of Tropical Diseases, the Hospital of Hanoi Medical University and the Infectious Diseases Department of Bach Mai Hospital, from August 2009 to March 2010. Approval from the hospital administration was obtained before approaching the patients. We performed a prospective matched case-control study on patients who were diagnosed with DF/DHF; control patients were from the same hospital but negative for DF/DHF. The criteria for notification of DF were based on the guidelines of the Ministry of Health, 1999, on surveillance, diagnosis and treatment of dengue. The guidelines stipulate that individuals are suspected to have dengue when they have acute febrile illness (⩾38 °C) of 2–7 days' duration, with ⩾2 of the following non-specific manifestations of DF: headache, retro-orbital pain, myalgia, arthralgia, rash, haemorrhagic manifestations, and leucopenia [6]. The control group was matched to the study group for sex and age (±5 years). The characteristics of the 73 DF/DHF patients and the 73 control patients are shown in Table 1.

All cases and control patients were interviewed during their period of hospitalization by two specially trained interviewers who administered a standard questionnaire. The questionnaire included information on demographic characteristics of the patients such as age, education level and occupation as well as variables related to their residence: location of house, type of house, source of water supply, and type of water containers in the house. The questionnaire had been pre-tested before being used in the study.

χ^2 and Mann–Whitney tests were used to test for differences in demographic characteristics between DF/DHF patients and control patients. A multivariable backward stepwise logistic regression model was applied to identify the risk factors for DF/DHF. The independent variables consisted of: age, education, occupation, having been in an epidemic area within past 6 months; place of living: in urban or rural area, in a rented house or near an open sewer; and living conditions such as unhygienic environment, other family member had DF/DHF during past 6 months, presence of mosquitoes, presence of larvae in water containers, directly discharging sewage to ponds, and being flooded during the rainy season. The significance level was set at $P < 0·2$. Associations are expressed in terms of odds ratios (ORs) with 95% confidence intervals (CIs). All analyses were performed using Stata statistical software, v. 12.1 (StataCorp., USA).

RESULTS

The characteristics of the 73 DF/DHF patients and 73 control patients are shown in Table 1. The mean age of the case group and the control group were comparable. The distribution of education level and occupation were quite similar between the case and control groups; most individuals had college education and many were students.

Table 2 displays variables related to the residence of the study population. In both groups, three quarters resided in the inner districts of Hanoi. More than half of the participants in the case group were living in rented houses, significantly higher than in the control group, with only one third. People in the DF/DHF group were living in smaller houses with a larger household size compared with those in the control group. In particular, a significantly higher proportion of people in the case group were living in homes near suitable breeding areas for mosquitoes, such as open sewers.

Table 3 presents the adjusted and unadjusted ORs and CIs of variables affecting DF/DHF included in the final logistic regression model. The analysis revealed that living in a rented house, living near open sewers and untreated water discharging directly into nearby ponds/lakes were all significantly associated with DF/DHF. Living in a rented house increased risk by 2·2 times (aOR 2·2, 95% CI 1·1–4·6). Living in an unhygienic house or one directly discharging sewage into ponds increased risk by 3·4 times and 4·3 times, respectively (aOR 3·4, 95% CI 1–11·7; aOR 4·3, 95% CI 1·1–16·9). Detecting mosquitoes in the house or living near an open sewer constituted a very high risk (aOR 6·3, 95% CI 0·7–59; aOR 6·9,

Table 1. *Demographic characteristics of dengue fever/dengue haemorrhagic fever (DF/DHF) and control patients*

Characteristic		DF/DHF ($n = 73$)	Controls ($n = 73$)	P
Sex	Male	36 (49·32%)	36 (49·32%)	
	Female	37 (50·68%)	37 (50·68%)	>0·05*
Age (years)	Mean ± s.d.	28·1 ± 9·4	27·4 ± 9·9	>0·05†
	Range	17–75	18–78	
Education	Elementary school	9 (12·3%)	10 (13·7%)	
	Middle school	10 (13·7%)	4 (5·5%)	>0·05*
	High school	11 (15·1%)	6 (8·2%)	
	University/college	43 (58·9%)	53 (72·6%)	
Occupation	Office worker	17 (23·3%)	24 (32·9%)	>0·05*
	Business person	7 (9·6%)	12 (16·4%)	
	Home worker	4 (5·5%)	7 (9·6%)	
	Pupil/student	36 (49·3%)	22 (30·1%)	
	Other	9 (12·3%)	8 (11·0%)	

* By χ^2 test.
† By Mann–Whitney test.

Table 2. *Housing variables of dengue fever/dengue haemorrhagic fever (DF/DHF) and control patients*

Variables		DF/DHF ($n = 73$)	Controls ($n = 73$)	P
Living area	Inner district	54 (74·0%)	55 (75·3%)	>0·05*
	Outer district	19 (26·0%)	18 (24·7%)	
Accommodation status	Rented	41 (56·2%)	25 (34·3%)	<0·05*
	Owned	32 (43·8%)	48 (65·7%)	
Type of housing	Brick construction	43 (58·9%)	35 (47·9%)	
	Temporary house	7 (9·6%)	7 (9·6%)	
	Old condominium	11 (15·1%)	15 (20·6%)	>0·05*
	New condominium	0 (0·0%)	3 (4·1%)	
	Other	12 (16·4%)	13 (17·8%)	
Area of household (m^2)	Mean ± s.d.	54·1 ± 47·1	68·2 ± 69·9	>0·05†
	Range	8–200	9–350	
Number of people in household	Mean ± s.d.	4·2 ± 2·3	4·9 ± 4·3	>0·05†
	Range	1–10	1–19	
House with water storage containers	Yes (water tank without cover)	22 (10·7%)	21 (1·3%)	>0·05*
	No	53 (70·8%)	54 (72·0%)	
House with water storage containers infested with larvae and/or pupae	Yes	11 (15·1%)	13 (17·8%)	>0·05*
	No	52 (71·2%)	56 (76·7%)	
	Don't know	10 (13·7%)	4 (5·5%)	
House environment	Pond/lake/river	16 (19·3%)	21 (24·1%)	>0·05*
	Open sewer	33 (39·7%)	13 (14·9%)	<0·01*
	Garbage collection point	7 (36·8%)	12 (63·2%)	>0·05*

* By χ^2 test.
† By Mann–Whitney test.

95% CI 0·9–71·9, respectively), but the difference between the case and control groups was not significant.

DISCUSSION

The results of this study revealed that DF/DHF in Hanoi appeared mainly in downtown districts and much less frequently in suburban districts, which is consistent with the statistical reports on the DF epidemic in 2009. The highest morbidity rate was found in the 15–30 years age group; at higher ages the rate became very low. Dung & Cam reported in 2003 that more than 90% of dengue morbidity was in individuals aged between 15 and 25 years [7]. This could

Table 3. *Crude and adjusted logistic regression odds ratios on selected variables*

Independent variables	Grouping	Crude OR (95% CI)	Logistic regression aOR (95% CI)
Living in rented house	Yes	2·2 (1·1–4·8)	2·2 (1·1–4·6)
Other family member had DF/DHF during past 6 months	Yes	2 (0·9–4·6)	1·96 (0·9–4·3)
Unhygienic house	Yes	3·3 (0·9–12)	3·4 (1–11·7)
Mosquitoes in house	Yes	6·8 (0·7–64·2)	6·3 (0·7–59·5)
Near open sewer	Yes	6·9 (0·7–67·1)	7·9 (0·9–71·9)
Discharging sewage directly into ponds	Yes	5·9 (1·3–26·4)	4·3 (1·1–16·9)

aOR, Adjusted odds ratio; CI, confidence interval; DF, dengue fever; DHF, dengue haemorrhagic fever.

be related to differences in lifestyle, time spent outdoors near vectors, sleeping without mosquito nets or other aspects of inadequate disease prevention among the young. Another explanation could be that the disease can create lifelong immunity for the individual, so that older persons who have been exposed more often may have more resistance, decreasing the morbidity rate.

Considering how many cases were young people, it is perhaps not surprising that around half of the positive cases were students. The second dominant group was office workers. This result differs from the result of a study in Kamphaeng Phet, Thailand [8] where 65% of the patients were farmers. The discrepancy is probably due to a different job distribution in the two regions studied. Students may also be prominent in the cases in our study because many students live in rented accommodation, which was another risk factor for dengue. The combination of cramped rented living accommodation, an unsanitary environment, infrequent cleaning, little knowledge of DF, and little interest in prevention activities may explain why the morbidity rate in the rental group is rising.

People living near stagnant water like ponds, lakes and rivers or open sewers, or favourable mosquito breeding places like garbage collection points, had higher rates of morbidity. This is consistent with other national and international studies [9–17]. In Brazil [10] the epidemic was associated with proximity to uncontrolled waterways and stagnant water in tanks, gutters, and cans. In Pakistan, poor condition of the house, such as uncovered toilet water tank or leaking water pipes, was a highly significant risk factor for the presence of *Aedes* foci [10]. In Vietnam, a study in Binh Thanh, Dong Thap [11] found that while most families stored their drinking water, only three quarters of them covered their water storage containers. Nowadays, although Hanoi residents seldom use water storage containers like jars or pots, the large area of natural water surfaces available makes an annual epidemic almost unavoidable [12]. Because dengue-spreading mosquitoes spend three stages of their life-cycle in water, it is recommended to reduce mosquito living sites, e.g. long-term stagnant water storage inside and outside the house, open sewers, and natural water surfaces.

According to around half of the respondents, their homes and the surrounding environment are not really clean. Although the difference between case and control groups was not statistically significant, it did reflect how the unsanitary, polluted living environment in the modern environment of the capital is favourable for the vector and the disease.

Environmental factors have a powerful influence on the appearance of DF/DHF. Simple interventions could help; in our study, people living in houses with uncovered water tanks were 7·9 times more likely to get DF. Those in houses discharging sewage directly into ponds had a 5·9 times higher risk than those in houses with sanitary sewage systems. For civil authorities it is important to note that people who stay in rented accommodation had double the risk of those owning their homes. These influences of the environmental factors have also been found in other studies. A 2001 study in Brazil revealed that people living in a slum area had a nearly 10 times higher risk of DF [10]. In An Giang, Vietnam, people living in homes with gardens or water tanks had a threefold higher risk [12].

This study was conducted soon after Hanoi had experienced heavy flooding in August 2009 which reduced the selection and recall bias often found in a case-control study. However, our data came from the three major hospitals for infectious diseases in Hanoi, and may have missed factors related to cases that did not present to these hospitals. Our logistic regression model was set up to identify factors that may influence dengue transmission dynamics. In a complex epidemiological setting, transmission dynamics involve interactions among people, dengue viruses, vectors and ecosystems, where biotic and abiotic determinants have both direct and indirect influences on transmission. Our model cannot account for all possible variables. More information is needed to further unravel the predictors of dengue transmission in Hanoi, which will help to inform planning of prevention and control measures.

CONCLUSIONS

This integrated analysis of the eco-social determinants of DF transmission risk contributes to improved understanding of the dynamics of dengue transmission in Hanoi. Our study shows various well-known risk factors of DF which are components of human behaviour, can be addressed through modifications of municipal services. The social and demographical contexts and lifestyles of people in Hanoi will significantly influence transmission and all information on this population will support dengue prevention and control programmes.

ACKNOWLEDGEMENTS

We thank Dr Nguyen Nhat Cam, Vice-Director of Hanoi Preventive Medicine Center and his staff for the assistance on collecting the epidemiological data. This study was funded by the Netherlands Higher Education (NPT) project on 'Strengthening teaching and research capacity in preventive medicine in Vietnam'.

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