Factors associated with the spread of dengue fever in Jeddah Governorate, Saudi Arabia

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العوامل المصاحبة لانتشار حمى الضنك في محافظة جدة، المملكة العربية السعودية

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الخلاصـة: انبعثَتْ حمى الضنك من مرقدها انبعاثةً عنيفة في جدة عام 2004 ليصل عدد الحالات عام 2006 إلى 1308 حالة. وتسعَى هذه الدراسة المشهَّدة إلى تحديد العوامل التي تُعزِّز انتشار الداء، تمهيداً لتحديد الخط القاعدي من القيم الوبائية والذي يساعد على مكافحة حمى الضنك. وقد كانت جميع الحالات المشتبه بإصابتها (وعددها 650 حالة) من حمى الضنك في جدة عام 2007 مؤهلة للاندراج ضمن الدراسة. وتمثَّلت الحالات المرضية في تلك الحالات التي تأكدت إصابتها بحمى الضنك بالدراسات المختبرية (وعددها 244)، في حين تمثَّلت الشواهد في الحالات التي تأكدت سلبيتها (وعددها 406). ومن بين المجموع كان هناك 129 حالة دراسة و240 شاهد أمكن للباحثين التواصل معها وأدرجت ضمن الدراسة. وقد أدرج الباحثون العوامل التي يُعتدُّ بها إحصائياً في التحليل الثنائي المتغيرات ضمن التحليل التحوُّفي اللوجستي. وتبيَّن لهم أن المحددات المستقلة للعدوى بحمى الضن (P>0.01) تتمثَّل في وجود مياه راكدة في فجوات نزح المياه داخل المباني (OR = 4.9)، ووجود اليرقات داخل المباني (OR = 2.2). ووجود مواقع للبناء قريبة (OR = 2.2)، والتقدم في العمر (OR = 1.2) كما تبيّن للدارسين أن التثقيف الصحي بالتواصل المباشر قد أنقص من خطر العدوى بحمى الضنك إنقاصاً يُعْتَدُّ به إحصائياً. وأن الحاجة ماسّة لبذل الجهود لمكافحة العوامل التي تم تحديدها في هذه الدراسة والتي هي ممكنة التعديل، مع التأكيد على التثقيف الصحي.

ABSTRACT Dengue fever resurged sharply in Jeddah in 2004 and rose to 1308 cases in 2006. This case–control study determined factors potentiating the spread of the disease to provide an epidemiological baseline to help dengue control. All (650) suspected cases of dengue in Jeddah in 2007 were eligible for inclusion. Cases were those confirmed with dengue by laboratory investigations (n = 244) and controls those confirmed negative (n = 406). Of these, 129 cases and 240 controls could be contacted and were included in the study. Variables found significant in the bivariate analysis were included in a logistic regression analysis. The presence of stagnant water in indoor drainage holes (OR = 4.9), indoor larvae (OR = 2.2), nearby construction sites (OR = 2.2), and older age (OR = 1.2) were independent determinants of dengue infection ($P < 0.01$ for all). Face-to-face health education significantly decreased the risk of dengue infection. Efforts are needed to control the modifiable factors identified in this study with emphasis on health education.

Facteurs associés à la propagation de la dengue dans le gouvernorat de Djeddah (Arabie saoudite)

RÉSUMÉ La dengue est réapparue brusquement à Djeddah en 2004 et 1308 cas ont été déclarés en 2006. La présente étude cas-témoin a identifié les facteurs potentialisateurs de la propagation de la maladie afin de créer une base épidémiologique contribuant à la lutte contre la dengue. Tous les cas suspectés de dengue (650) à Djeddah en 2007 pouvaient être inclus dans l'étude. Les cas étaient des infections de dengue confirmées par des examens de laboratoire (n = 244), alors que les témoins avaient obtenu des résultats négatifs (n = 406). Parmi ceux-ci, 129 cas et 240 témoins ont pu être contactés et inclus dans l'étude. Les variables étant apparues comme importantes à l'issue d'une analyse bivariée ont été incluses dans une analyse de régression logistique. La présence d'eau stagnante dans des trous de drainage (O.R. = 4,9) et de larves (O.R. = 2,2) à l'intérieur des habitations, de chantiers de construction à proximité (O.R. = 2,2), et un âge avancé (O.R. = 1,2) étaient des déterminants indépendants d'une infection par le virus de la dengue (P < 0,01 pour tous). L'éducation sanitaire individuelle a réduit considérablement le risque d'infection. Des efforts, en particulier des actions d'éducation sanitaire, sont nécessaires pour lutter contre les facteurs modifiables identifiés dans cette étude.

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Introduction

Vector borne disease are of public health importance and are still considered a hazard which can seriously affect human health in many parts of the world. They are increasingly reported in the majority of tropical countries [1]. The reason for this increased incidence in tropical and temperate countries are multiple and include increased rate of urbanization with changed living conditions and standards, uncontrolled vectors, virus evolution and immense international travel movement. Urbanization could be one of the most important factors of those previously mentioned and travel allows the easy spread of infection from one area to another [2]

The World Health Organization (WHO) has reported that the global prevalence of dengue fever has increased dramatically, and the disease has become endemic in more than 100 countries in Africa and America. South-east Asia and the western Pacific are seriously affected by the illness. Dengue infection can cause a variety of illness ranging from an influenza-like disease, known as dengue fever, to dengue haemorrhagic fever/dengue shock syndrome, a severe and sometimes fatal disease characterized by haemorrhage and shock [3].

On October 1993, dengue haemorrhagic fever appeared in Jeddah City. On March 1994, the Disease Control Division in Jeddah initiated surveillance of dengue haemorrhagic fever to detect any new cases. By August 1994, there were 289 classic cases; 37% of the cases were construction workers. Reported cases from 1995 to 2003 ranged between 0 and 36 cases every year with zero reported cases in 1998 and 2001. At the end of 2004, however, there was a sharp rise in reported cases which reached 291 cases followed by 305 cases in 2005. The highest episode was observed in 2006 where 1308 cases were reported with 6 deaths, giving a case fatality rate of 4.6/1000 cases [4].

Epidemiologically, the main benefits of surveillance of dengue fever are early detection and better understanding of the distribution of the disease in relation to time, place, virus serotype and severity of the disease. These data will provide better understanding of the problem of dengue fever in a certain locality and hence increase the ability to predict transmission and design and implement control measures accordingly to stop outbreaks. It is of extreme importance to link clinical surveillance with entomological surveillance data to identify the time and place of occurrence of the disease [5].

To strengthen dengue fever control measures through the provision of comprehensive epidemiological baseline data of the disease, this study was conducted to determine factors associated with the occurrence of dengue fever in Jeddah Governorate.

Methods

Study area

This study was conducted in Jeddah Governorate located in the west of Saudi Arabia, which has an area about 550 km^2. Its main border is on the Red Sea, and the weather is hot and humid with scanty rainfall most of the year. The population is estimated to be about 3 000 000 individuals; expatriates represent almost 48% of the total residents in the Governorate [6]. Jeddah Governorate is the main seaport of Saudi Arabia and is the main entry point for over 2 million pilgrims coming for haj or *umrah* annually.

Study design and population

This was a case–control study of all suspected cases of dengue fever in Jeddah in 2007 who had undergone laboratory investigations for confirmation of the diagnosis. There were 650 suspected cases, 244 (37.5%) of whom were confirmed positive for dengue fever and were categorized as cases, while 406 were confirmed negative for dengue and were categorized as controls. Of the cases, only 129 (52.9%) had known addresses and could be reached for completion of surveillance activities, while 240 (59.1%) controls could be reached. The rest had either missing addresses or gave wrong information for access. The control/case ratio was 1.9.

Data were tracked through code number and collected from the stored sheets and forms based on the results collected from the accredited regional laboratory in Jeddah Governorate.

Data collection

The study included data from different sources. The records of the Preventive Medicine Department of the General Directorate of Health in Jeddah were used to identify contact details for cases and controls recorded during the outbreak period. The centre of vector control conducted an entomological study in which data were collected about the presence of vector breeding places both inside and outside the place of residence of the case and control groups and mosquito traps were used to identify the prevailing vector species in the environment of the study groups. Data on vector abundance and meteorological conditions were collected from both the vector control department and the meteorological department in Jeddah Governorate. Personal data related to exposure to mosquito bites and exposure to health education campaigns were collected through direct interview of cases and controls. The interview was conducted at the houses of cases and controls.

Data were collected by trained interviewers recruited from health inspectors working at Preventive Medicine Affairs in Jeddah Directorate of Health who had previous experience in similar studies.

Door-to-door health education campaign

After the sharp increase of cases of dengue fever in 2006, a health education campaign was organized. The campaign was designed and implemented by Preventive Health Affairs, Jeddah Municipality, boys and girls Education Department, Department of Religious Affairs and Information Department at Jeddah Governorate as well as by King Abdul-Aziz University. The goal was to strengthen community participation in the prevention and control of dengue fever and support preventive measures conducted by the Ministry of Health and other related governmental sectors. The campaign addressed issues related to awareness-raising of the public about causes of dengue fever infection, measures of prevention and the importance of early detection and management of suspected cases. It was implemented by trained volunteers and selected schoolteachers in Jeddah and was a house-to-house campaign in areas with a high prevalence of dengue fever based on surveillance data. The campaign also included schools in the same area.

Ethical considerations

Approval letters were prepared to facilitate collection of data from different sources. The cases and controls were contacted by telephone using the number recorded in the surveillance sheets to explain the purpose of the study and to get their approval to be included in the research. They were assured of anonymity and confidentiality of handling their data. All the data would be kept confidential and would not be disclosed except for the study purpose. There were no refusals to participate. The records used in the study were coded and only the principal investigator had the keys for codes.

Statistical analysis

Collected data were organized, tabulated and statistically analysed using *SPSS*, version 17. Bivariate analyses were carried out to determine the association between dengue infection and the characteristics of the cases and controls, and the presence of vector breeding places both inside and outside the house. The chi-squared test was used as a test of significance for differences observed between categories. If the chi-squared test was not found appropriate, the Fisher exact test was used.

Binary logistic regression analysis was conducted for variables which showed a significant association with the occurrence of dengue fever in the bivariate analysis and adjusted odds ratios (OR) were calculated taking account of potential confounding by the other variables. *P*-value < 0.05 was considered statistically significant.

Results

Distribution of dengue fever cases in 2007

Cases, in general, were clustered in the south of Jeddah Governorate with a relatively higher density in districts in the vicinity of the seaport compared to districts in the north and west of the governorate.

Table 1 shows the characteristics of the cases and controls. A significantly larger proportion of cases (48.1%) were non-Saudis than controls (36.2%) (*P* = 0.027). The age distribution of cases was significantly different to that of controls, with a greater proportion of cases in the older age groups compared with controls (*P* = 0.030). There was no significant difference between cases and control in relation to sex or work environment.

Table 1 Demographic characteristics of the cases and controls

Characteristic	Cases (*n* = 129) No. (%)	Controls (*n* = 240) No. (%)	χ^2	*P*-value
Sex				
Male	84 (65.1)	161 (67.1)	0.146	0.703
Female	45 (34.9)	79 (32.9)		
Nationality				
Saudi	67 (51.9)	153 (63.8)	4.863	0.027
Non-Saudi	62 (48.1)	87 (36.2)		
Age (years)				
< 10	18 (14.0)	59 (24.6)		
10–	23 (17.8)	47 (19.6)		
20–	26 (20.2)	56 (23.3)	12.342	0.030
30–	28 (21.7)	35 (14.6)		
40–	21 (16.3)	20 (8.3)		
50+	13 (10.1)	23 (9.6)		
Work environment				
Indoor	70 (54.3)	144 (60.0)	2.297	0.317
In the street	24 (18.6)	31 (12.9)		
Not working	35 (27.1)	65 (27.1)		

Meteorological and entomological factors associated with dengue

The number of confirmed cases reported monthly was not significantly correlated with the percentage of traps positive for *Aedes aegypti* (r^2 = 0.284, *P* = 0.074) (Figure 1).

Figure 2 illustrates the correlation between meteorological and entomological factors with the dengue fever cases. Occurrence of cases was correlated with the abundance of *Aedes aegypti* mosquitoes. At the same time, the gradual increase in temperature in the first half of the year was accompanied by an increase in both the vector and the dengue cases. Moreover, the gradual decline in temperature in the third quarter (by 1 degree) was accompanied by a decline in both cases and vector. However, the continued decline in the last quarter was accompanied by an increase in cases and vector. On the other hand, the changes in cases, vector, and temperature were in the opposite direction to changes in the average humidity.

Presence of *Aedes aegypti* and indoor breeding places

Overall 18.9% of houses were positive for the presence of indoor *Aedes aegypti*. The percentage was significantly higher in houses of the cases (25%) compared to the control group (15.5%) (*P* = 0.027). *Aedes* larvae were detected in 22.2% of houses: the percentage was significantly higher in houses of the cases (33.3%) compared to houses of the controls (16.2%) (*P* < 0.001) (Table 2).

The proportion of houses in which water was stored in uncovered containers on the balcony was significantly higher in the houses of cases (5.6%) than controls (1.7%) (*P* = 0.046). Stagnant water in the drainage holes of the water circuits was significantly ore common in houses of the cases (11.1%) than controls (3%) (*P* = 0.002). In all other suspected indoor breeding places there were no significant differences between the houses of cases and controls (Table 2).

Outdoor breeding places of *Aedes aegypti*

More potential breeding places for *Aedes aegypti* were found in the vicinity of the houses of the cases than the controls, but the difference was only statistically significant in the case of the presence of buildings under construction near the houses: 71% of cases had building sites near their homes compared to 55.5% of controls (*P* = 0.004) (Table 3).

History of exposure to *Aedes aegypti*

Table 4 shows the participants' recall of being bitten by a mosquito(es) and the site of the bite(s). Significantly more cases (80.6%) remembered that they had been bitten by mosquitoes before becoming ill compared to 70.8% of controls (*P* = 0.040). Table 4 also shows that more than two-thirds of the cases (69.2%) said that they had been bitten on their legs compared to 57.1% of the controls (*P* = 0.029). Similarly, a significantly higher percentage of the cases (28.9%) compared to the controls (15.1%) indicated that they had been bitten on their face (*P* = 0.003).

Door-to-door health education

Slightly more than two-thirds of the households (69.4%) received face-to-face health education. The proportion was significantly higher among households of the controls than those of the cases: 173 (73.6%) versus 79 (62.7%) respectively (χ^2 = 4.638, *P* = 0.031). At the same time, 63.8% of households received health education materials (brochures, booklets, etc): 74 (58.7%) among households of the cases compared with 159 (67.4%) for controls' households, although this differ-

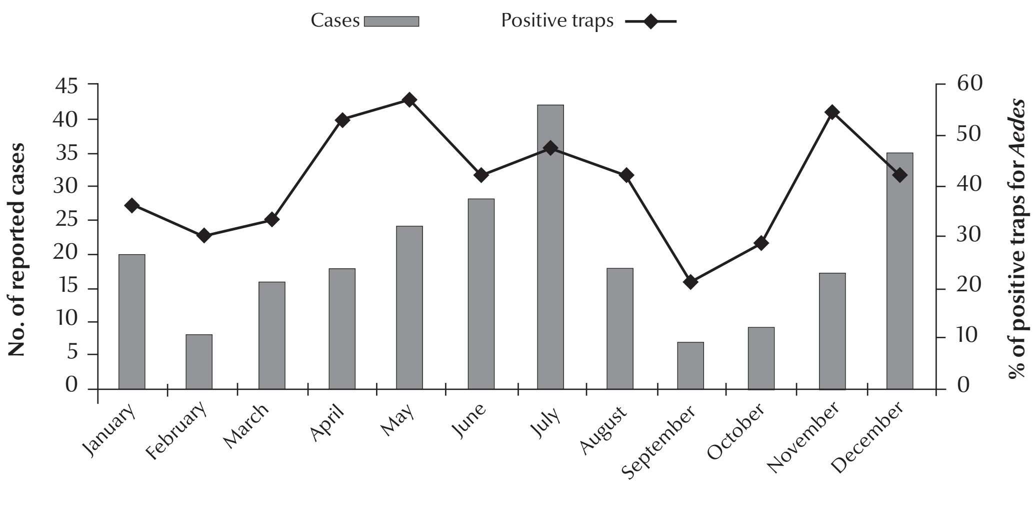

Figure 1 Relationship between reported cases and percentage of positive traps for *Aedes aegypti* in Jeddah, 2007

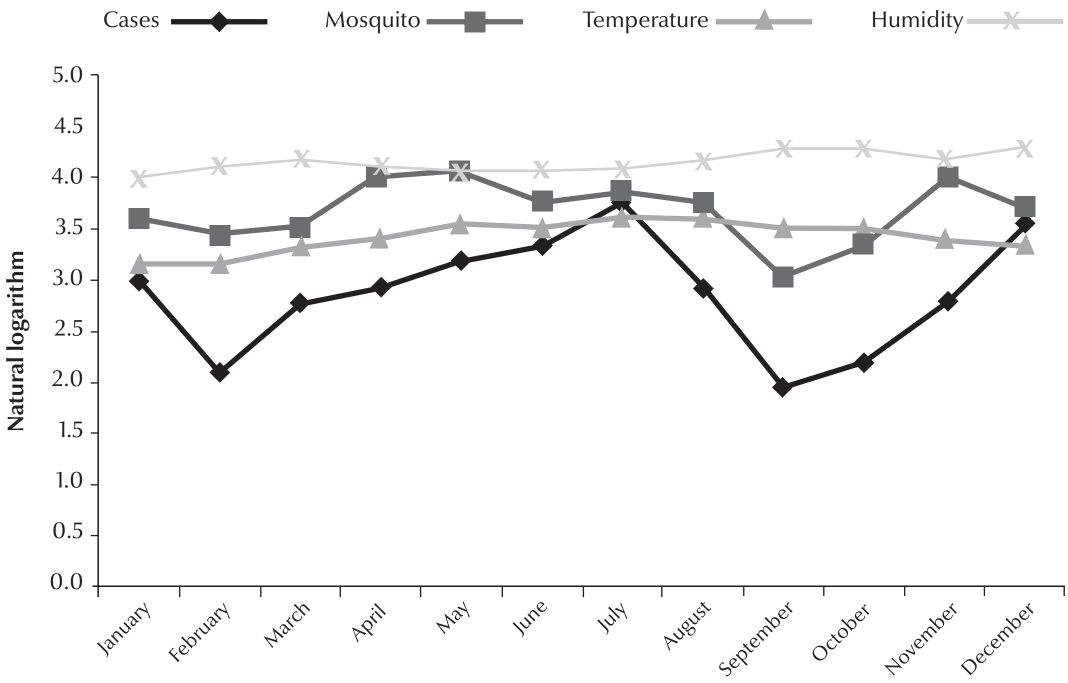

Figure 2 Correlation between the occurrence of dengue cases, abundance of *Aedes aegypti*, temperature and humidity in Jeddah, 2007

ence was not statistically significant ($\chi^2 = 2.675$, $P = 0.102$).

Risk factors for being a case

Table 5 shows that the presence of stagnant water in the indoor drainage holes significantly increased the likelihood of being a confirmed case by almost 5 fold (OR = 4.934), followed by the presence of indoor larvae (OR = 2.208) and the presence of nearby buildings under construction (OR = 2.2). Older age groups were also significantly more likely to be infected than those aged < 10 years (OR = 1.226). Nationality, presence of indoor adult mosquitoes and presence of water containers in the balcony, which were significant in the binary analysis, were no longer significant after adjustment in the regression analysis.

Discussion

Epidemiological pattern of dengue in Jeddah Governorate

The present study showed an increase in the number of reported cases of dengue fever in Jeddah during the summer months with another peak occurring in December and January. To explain this seasonal variation, it was essential to refer the epidemiological curve to the meteorological changes. It was found that the step-wise increase in cases was accompanied by an increase in the percentage of positive traps which was related to the increase in the weather temperature until the middle of the year. Thereafter, with a further increase in temperature the vector population dropped and eventually so did the number of the cases. The same findings were reported in Brazil where the peak incidence of confirmed dengue infection followed the peak larval density by nearly 1 month [7]. Our findings also concur with what was found in Thailand, where the transmission of dengue virus was at a maximum at a temperature ≥ 30 °C [8].

In Taiwan, it was documented that months with an average temperature > 18 °C and low degree of urbanization and standards of living were associated with an increase in dengue fever incidence at the township level [9]. The second minor increase disease incidence in Jeddah Governorate, which was observed in the 4th quarter of the year, could be attributed to the rains that occasionally occur at that time. Fortunately, the rainy season in Jeddah does not last long and usually it only rains once or twice during the season. The impact of rains on the breeding of *Aedes aegypti* and the spread of the dengue has been previously documented [10].

Characteristics of the participants

Our study showed that slightly more than two-thirds of dengue cases were in adults which is similar to the age distribution of cases in the epidemic in Brazil in 1995–2006, where it was found that dengue mainly affected adults [11]. The preponderance in adults could be attributed to the fact that adults are likely to be exposed both at home and at the work place and are likely to be outside the home more to perform activities such as shopping and recreation. Greater exposure will increase the risk of

Table 2 **Presence of indoor and private outdoor risk factors for dengue infection in the houses of cases and controls**

Risk factor	Cases (*n* = 129) No. (%)	Controls (*n* = 240) No. (%)	χ^2	*P*-value
Presence of indoor Aedes aegypti				
Adult mosquito	32 (24.8)	37 (15.4)	4.863	0.027
Larvae	43 (33.3)	39 (16.3)	14.167	< 0.001
Possible indoor breeding sites				
Stagnant water in the bathroom basin	4 (3.1)	10 (4.2)	FE	0.422
Uncovered water containers in the bathroom	13 (10.1)	18 (7.5)	0.781	0.244
Uncovered water containers in the kitchen	4 (3.1)	9 (3.8)	FE	0.509
Stagnant water in a water cooler	10 (7.6)	19 (8.0)	0.004	0.951
Stagnant water at the base of the refrigerator	3 (2.3)	6 (2.5)	FE	0.610
Stagnant water in the indoor drainage holes	14 (11.0)	7 (3.0)	9.830	0.002
Possible outdoor breeding sites				
Uncovered water containers on the balcony	7 (5.4)	4 (1.7)	FE	0.046
Private garden	21 (16.3)	47 (19.6)	0.423	0.516
Neglected private pool	4 (3.1)	13 (5.4)	0.911	0.340

FE = Fisher exact test.

being bitten by the vector and hence the risk of becoming infected.

Our study showed a preponderance of cases among males, almost two-thirds of the cases. An inverse situation was observed in the Brazil epidemic where it was reported that 59.3% of the cases were females [11]. Since the 1980s, many theories have been proposed to explain this phenomenon of male preponderance over female patients. Halstead pointed out as early as 1970 that males predominate among those with milder disease, but females account for more severe illness [12]. He suggested that either the immune response in females was more effective than in males, resulting in a greater production of cytokines, or the capillary bed of females was prone to increased permeability. Kaplan in Mexico suggested that an incidence bias in favour of females was related to the timing of the survey interviews [13] because the interviews were mainly made during working hours when men were mostly out of the home while women were at home and available for the interview. On the other hand Goh suggested that the low incidence among women in Singapore was because they stayed at home and were less exposed to infection to the vector [14].

Our results showed that there were more cases among non-Saudis compared to Saudi Arabian nationals. This may be attributed to differences in their socioeconomic status and lifestyles. Non-Saudis have relatively lower monthly income and often live in poorer areas with inadequately developed infrastructures. Therefore, it is not uncommon to find water collection outside and inside their houses which are suitable places for vector breeding. This explanation is borne out by a study on the Mexico–Texas border, which

Table 3 **Presence of outdoor risk factors (possible breeding sites) for dengue infection near the houses of cases and controls**

Suspected breeding site	Cases (*n* = 129) No. (%)	Controls (*n* = 240) No. (%)	χ^2	*P*-value
Nearby buildings under construction	88 (68.2)	132 (55.0)	8.222	0.004
Nearby brick manufacturers	17 (13.2)	18 (7.5)	3.428	0.064
Presence of underground water seepage	7 (5.4)	9 (3.7)	0.656	0.418
Nearby public garden	25 (19.4)	40 (16.7)	0.623	0.430
Nearby public water tap	22 (17.1)	30 (12.5)	1.664	0.197
Nearby public water cooler	11 (8.5)	16 (6.7)	0.496	0.481
Nearby solid garbage	9 (7.0)	18 (7.5)	0.011	0.917
Old used tyres	7 (5.4)	12 (5.0)	0.060	0.807
Empty cans	14 (10.9)	19 (8.0)	1.076	0.300

Table 4 **Recall of the cases and controls of being bitten by a mosquito(oes) and the sites of bite(s)**

Exposure to and site of mosquito bites	Cases (n = 129) No. (%)	Controls (n = 240) No. (%)	χ^2	P-value
Exposure to mosquito bites	104 (80.6)	240 (100.0)	4.200	0.040
On the legs	81 (62.8)	125 (52.1)	4.748	0.029
On the face	33 (25.6)	33 (15.7)	8.963	0.003
On the arms & hands	83 (64.3)	145 (60.4)	1.337	0.248

asserted that social and economic factors play an essential role in the incidence and prevalence of dengue and dengue haemorrhagic fever [15]. In addition, non-Saudis constitute the major labour force in certain jobs, e.g. construction work, and maintenance and municipal activities. All these activities are likely to bring them close to water collection sites where the vector may be prevalent.

Characteristics of the households

The presence of larval habitats has been reported as one of the most important risk factors for dengue fever [15]. More than other species of mosquito, *Aedes aegypti* need clear (non-turbid) water for breeding, which they are more likely to find indoors being used in domestic activities thus increasing the likelihood of their presence in the home.

Houses with uncovered water containers in the bathrooms, kitchens, and balconies stored water because of not having regular public water supply. Our study showed that the percentage of houses deprived from public water supply or having interrupted water supply was higher in the cases compared to the controls. Similar findings were reported in a case–control study in Havana, where it was found that a greater risk of infestation was associated with low socioeconomic status and interrupted water supply [16]. In addition, in Brazil, higher dengue incidence was associated with deficient running water and water supply [17]. The indirect relationship between interrupted water supply and increased risk of dengue fever results from the necessary storage of water in containers for domestic activities when the piped water supply stops. Moreover, with long durations of interrupted water supply, as was the situation in Jeddah Governorate in 2007, residents store water in numerous containers including pans, basins, bottles, jugs and even cups. The problem is augmented when they are not aware that these containers are likely breeding places for of the vector, and so they are left uncovered and/or not changed regularly. The same situation was reported in India, where owing to over-storage of domestic water by the inhabitants, mosquitoes and vertically transmitted viruses increase during summer season, which can proceed the active transmission season of dengue [18]. Furthermore in order to decrease over-crowding of containers in kitchens or bathrooms, residents sometimes put containers in on the balcony where they are exposed to the outdoor open air and greater risk of becoming a for breeding place for the vector.

A further risk for breeding of *Aedes aegypti* is the collection of water resulting from leakage from cracks or badly-fitted plumbing connections. This was found to be significantly more frequent in houses of the cases rather than that for controls. These sites are often in relatively humid dark places in the kitchen or bathroom and provide optimal environment for the vector [19].

Outdoor breeding places

The *Aedes aegypti* mosquito exploits peridomestic water containers as its larval habitats and human reservoir hosts are preferred for blood feeding [20]. Generally, our study showed that for almost all sites investigated as potential breeding places for *Aedes aegypti*, there were more such sites near the houses of the cases than the controls, especially construction sites. These findings raise the issue of the relationship between the outdoor and indoor mosquito indices and their impact on dengue

Table 5 **Logistic regression analysis of predictors of dengue infection**

Variable	Adjusted OR	Wald	P-value
Age category	1.226	7.36	0.007
Presence of indoor larvae	2.208	8.124	0.004
Presence of stagnant water in indoor drainage holes	4.934	9.222	0.002
Presence of nearby buildings under construction	2.200	9.523	0.002
Constant	0.012	30.379	<0.001

Adjusted for potential confounding by the other variables.

transmission and emphasize the usefulness of indoor as well as outdoor insecticide application for houses of the reported cases [21].

Benefits of health education campaign

In the absence of chemotherapy or vaccines for prevention of dengue fever, the most effective measure for preventing the disease at the individual level is still the adoption of behaviour to avoid mosquito bites and control potential breeding places at home. To reach this goal, educational campaigns on dengue fever protective and preventive measures can have a real impact on people's knowledge and practice and could reduce the risks of acquiring the disease [22]. Our study clearly illustrated the reality of this assumption; while over two-thirds of the households received face-to-face health education it was significantly higher among households of the controls compared to cases.

Limitations of the study

Despite the existence of detailed surveillance data before and during the dengue epidemic in Jeddah Governorate, which offered a unique opportunity to analyse entomological information at different times, the entomological data collected through routine systems has some limitations. First, larval prevalence was possibly slightly underestimated, blocks were inspected by different vector control technicians, procedures used may not have been completely standardized and some data were (randomly) missing.

In addition, data related to reported cases before the mid 2006 generally lacked the demographic characteristics of the patients. Therefore we focused on the demographic characteristics of the patients recorded in 2007. This could be a source of bias in results.

We were not able to trace all confirmed cases (only 57%) because of the lack of contact information for some cases and controls. This may be a source of selection bias of results due to the lack of results for the other confirmed cases which we could not trace

Conclusion

There are numerous factors that facilitate the continued existence dengue fever and its spread. The presence of stagnant water in the indoor drainage holes, the presence of indoor larvae, the presence of nearby buildings under construction and older age were independent determinants of the occurrence of dengue fever in Jeddah. Efforts should be made to control the modifiable factors identified in the current study with emphasis on health education campaigns.

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Comprehensive guidelines for prevention and control of dengue and dengue haemorrhagic fever

Dengue fever is the fastest emerging arboviral infection with major public health consequences for millions of people around the world, and in particular the South-East Asia region. *Comprehensive guidelines for prevention and control of dengue and dengue haemorrhagic fever* provides extensively revised, updated and expanded regional guidelines with the focus on new and additional topics of current relevance to the populations of the South-East Asia Region.

They are intended to provide guidance to national and local-level programme managers and public health officials, as well as stakeholders, including health practitioners, laboratory personnel and multisectoral partners, in strategic planning, implementation, monitoring and evaluation, and strengthening the response to dengue prevention and control in their countries. Scientists and researchers within and outside the Region who are involved in vaccine and antiviral drug development will also find crucial baseline information in this publication.

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