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Behavioural Determinants Associated with CHIKV Outbreak in Gouriepet, Avadi, Chennai, South India

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Abstract

Introduction: Frequent outbreaks of CHIKV infection implicate not only vectors but also risk behaviours of communities. While ample literature is available on vector biodynamics, studies on behavioural determinants are limited. We conducted a study to: (i) identify behavioural risk factors associated with CHIKV outbreak in Gouripet, Avadi, Chennai, South India and (ii) describe the association between vector indices and CHIKV infections.

Methods: Adopting a case control design, we defined households with at least one case of CHIKV as case-households and those without any case of CHIKV as control households. Using interview techniques, we collected data on behavioural risk factors at individual and household levels. By observation we ascertained information on backyard cleanliness in households. We calculated Odds Ratios, Adjusted Odds Ratios and 95% Confidence Intervals. House, Breteau and Container Indices were compared for case and control households. We used chi-square test, mid P exact test and conditional Poisson test to test the differences of these indices between case and control households.

Results: We included 279 case households and 378 control households. Not wearing clothes that fully cover the body (AOR: 4.7, 95% CI: 1.95 – 11.11), storing water (AOR: 4.6, 95% CI: 2.64 – 7.88), storing water in cement barrels/ plastic containers (AOR: 2.6, 95% CI: 1.90 – 3.78), infrequent changing of stored water (AOR: 2.6, 95% CI: 1.66 – 3.99), poor backyard cleanliness (AOR: 1.6, 95% CI: 1.10 – 2.27) were all significantly associated with risk of CHIKV infections. Vector indices in case households were double compared to control households.

Conclusion: Our study has proved that risk behaviour impacts adversely on vector indices to cause CHIKV outbreaks. We strongly advocate efficient vector control measures combined with Behavior Change Communication programmes to effectively prevent future outbreaks.

Keywords: Behavioural risk factors; Chikungunya; Vector indices

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Introduction

Chikungunya fever re-emerged in India, in 2005, causing widespread outbreaks with 22 states and Union Territories reporting cases [1]. The morbidity and disability losses due to the 2006 epidemic in India were reported to be around 45.26 DALYs lost per million population [2]. Chikungunya fever is transmitted by mosquitoes (*Aedes Aegypti* and *Aedes Albopictus*) and is caused by an arthropod borne virus (arbovirus). Chikungunya virus (CHIKV) is an enveloped, single stranded, positive RNA virus that is a member of the Togaviridae family and alphavirus genus. Alpha viruses consist of about 30 members - some of whom are highly infectious while others are non pathogenic. Most alpha virus infections in humans and domesticated animals are considered “dead - end” viruses, i.e. the virus cannot be further transmitted to a new host [3]. Although most CHIKV transmission is vector borne, maternal fetal transmissions have also been reported. A single mutation, A226E (E1) in the envelope protein of CHIKV now allows both aedes mosquito species (Aegypti and Albopictus) to transmit CHIKV [4].

Aedes aegypti, a household container breeder, is the primary vector of CHIKV *Aedes albopictus*, the Asian tiger mosquito, may also play a role in human transmission [5]. Aedes mosquito, with a short flight range of 100 – 200m, breeds on shallow water. On account of its anthropophlic and endophilic nature its bionomics is heavily reliant upon the actions of the local residents. Existence of this species throughout the year is probably due to the arid climate and subsequent behavior of local residents.

Currently vector control measures have been the key method employed to limit CHIKV infection. However risk behaviour practices of humans is perhaps equally important in rendering the local environment conducive for mosquito breeding and vector transmission. Therefore environmental consequences of risk behaviour practices of the local residents assume importance in understanding the epidemiology of CHIKV infection [6].

With no specific anti retroviral drugs and vaccines available for treatment and prevention of CHIKV infections, patients are currently treated symptomatically with analgesics, antipyretics and non steroidal anti inflammatory drugs. Many potential vaccine candidates have been tested in humans and animals. These include: whole inactivated virus preparations, live attenuated vaccines, recombinant proteins or virus like particles, DNA vaccination, MHC- 1 restricted epitopes and epitope based peptide vaccines. While several CHIKV vaccines are in different stages of development and with varying degrees of success, they are yet to be licensed [7-9]. Further, though many antiviral compounds were reported to be effective in cell culture, very few have been evaluated in animal models, suggesting the need for intensive studies to assess the impact of appropriate compounds in animal models and humans [10]. Thus in the absence of an effective vaccine and antiviral therapy, both vector control measures and Behavior Change Communication activities (BCC) assume importance.

Frequent outbreaks of CHIKV infection suggest that health system efforts for vector control alone may not be sufficient for effective control. Probably a combination of health system efforts and healthy behaviour practices by the community is essential for effective control. Although a fair amount of knowledge has been gained from the recent outbreaks and subsequent investigations about vector bionomics, studies are needed to elucidate the potential behavioural determinants in the affected area, which may promote transmission.

While ample literature is available on health system efforts to control vector borne diseases, studies on behavioural determinants are very limited. There is thus a need to understand behavioural determinants that trigger outbreaks of vector borne diseases such as CHIKV infections and Dengue. We therefore conducted a study to: (i) identify behavioural risk factors that could be associated with CHIKV outbreak in Gouripet area of Avadi municipality in Chennai, South India and (ii) describe the association between vector indices and CHIKV infections.

Methods

Study setting

During June 2006, our team conducted an epidemiological investigation and confirmed an outbreak of CHIKV infection in Gouriepet area of Avadi municipality, Chennai. All cases were clinically diagnosed by a clinician who is a specialist in internal medicine. The outbreak was laboratory confirmed with 5 out of 9 serum samples (obtained from CHIKV case patients) testing positive for IgM antibodies against CHIKV antigen [10]. During the outbreak we conducted vector survey in all the households and computed vector indices such as House Index (HI), Container Index (CI) and Breteau Index (BI) [11]. Water is a scarce commodity and most of the residents have to store water inside the houses to meet their daily needs. Municipal water is supplied once in 3-10 days. On an average households store around 8 – 12 containers of water. A government urban health post located in Gouriepet provides free outpatient care services.

Study design

We conducted a case control study to identify the behavioural factors for CHIKV infection. All households with one or more cases of CHIKV were considered as case-households. All the households in the same neighbourhood where no one was identified as a case of CHIKV during the outbreak were considered as control households.

Data collection

Using interview and observational techniques, we collected data at individual and household levels. Our respondents were cases in case households and head of household in control households. Since most risk factors of interest were operative at household level, in households with more than one case we selected only one case randomly to avoid duplication of data, because household level data are likely to be similar for individuals within the same household. If cases were children below 8 years of age then the child's mother was interviewed to get information about the child.

The individual level data we collected included information on: (i) identification particulars, (ii) clinical symptoms, (iii) individual socio demographic particulars (e.g. education and occupation), (iv) individual behaviour practices (e.g. use of personal protection measures- wearing clothes that fully cover the body, use of bed nets, mosquito repellents/ creams/ coils).

The household level data included information on: (i) Family particulars (e.g. family size, family income,) (ii) availability of water sources within the house(e.g. open well/ bore well), (iii) household level behavioural risk factors: (a) need to use public tap as a major source of water to meet household water needs, (b) water storage practices: number of containers of stored water, type of containers used for storing water, covering of water containers with a tight fitting plate/cloth, frequency of changing water in stored containers and (b)practice of environmental sanitation in and around the house (as evidenced by the presence/absence of: coconut shells, plastic plates/ containers, broken tyres and other shallow water receptacles influencing mosquito breeding).

All field investigators were trained and data collection instruments pilot tested and modified prior to commencement of data collection. Every fifth interview schedule was cross checked by an

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independent field supervisor and data were entered twice by two independent data entry operators.

Data analysis

Data were analyzed using SPSS software version 18.0. For univariate and multiple logistic regression analysis, we calculated Odds Ratios and Adjusted Odds Ratios respectively. Using the vector survey data generated during the outbreak, we compared vector indices e.g. House Index (HI), Container Index (CI), and Breteau Index (BI), for case and control households and observed differences if any. To compare House Index (HI) we performed proportion test using method of chi-square. Poisson (conditional test) method was used to test BI index. Mid P exact was used to test Container Index. P value less than 5% was considered significant.

Human subject protection

This study was conducted as an integral part of an emergency response to an outbreak of CHIKV infection and is thus covered by normal practice. This study was approved by the Technical Review Committee of the National Institute of Epidemiology, Indian Council of Medical Research (ICMR). We obtained informed consent from all the study respondents and maintained confidentiality of data generated. All respondents in need of treatment were referred to the local government health facility where necessary treatment was provided free of cost.

Results

We included all the 657 houses in Gouriepet for our study. A total of 508 CHIKV cases were identified during the outbreak in a total of 279 houses. From these 279 houses that had CHIKV patients (case households), we recruited one case randomly to yield a sample of 279 case respondents. Of the 657 houses, 378 houses did not have any CHIKV patients (control households). From these houses we selected only one member (the head of the household) from each house to yield a sample of 378 case respondents.

Profile of respondents

Salient features of respondents from case and control households are described below.

Case households

Of the 279 respondents from case households, nearly 53% were males and 77.4% educated up to or below middle school. The mean family size, income, and median age were 4.53 (SD 1.789), Rs. 4501.97 (SD 4246.078) and 32 years (IQ Range: 23-45) respectively.

Control households

Of the 378 respondents from control households, 48% were males and 68.3% educated up to or below middle school. The mean family size, income, and median age were 4.17 (SD 1.591), Rs. 5312.70 (SD 4739.612) and 28years (IQ Range: 15-38) respectively.

Univariate analysis

We considered several behavioral risk factors listed in **Table 1** for univariate analysis. The following factors were significantly associated with risk of CHIKV infection viz. (i) use of public tap water as a main source of water to meet the daily needs of the members of house, (ii) storing of water for drinking and washing/bathing, (iii) use of plastic buckets and cement barrels for storing water, (iv) changing stored water in the containers once a week, (v) not covering the water storage containers, (vi) not keeping the environment around the house clean as denoted by the presence of broken plastic cups, tyres, coconut shells, broken plastic vessels or plates in the backyard of the houses.

Wearing clothes that fully cover the body, having an open well or bore well in the home as a source of water, changing stored water daily and covering water containers were behavior practices that were found to be significant and protective.

Multivariate analysis

We performed a logistic regression analysis and observed the following behavioural factors to be significantly associated with risk CHIKV infection: (a) at the individual level: (i) not using clothes that fully cover the body, (ii) not using mosquito coil, (b) at the household level :(i) accessing water from a public tap, (ii) practice of storing water for washing/bathing to meet the daily needs of the members of house, (iii) use of cement barrels, plastic buckets for storing water, (iv) changing stored water in the containers once a week and (v) not keeping the environment around the house clean as denoted by the presence of tyres, and coconut shells, in the backyard of the houses **(Table 2)**.

Table 1 Behavioural determinants for CHIKV infection/ outbreaks among Case and Control households – Univariate analysis.

Risk behaviours	Case Households (279)		Control Households (378)		Odds Ratio	95% Confidence Interval
	Yes(+)	No(-)	Yes(+)	No(-)		
Not using mosquito coil	93	186	87	291	1.67	1.17 – 2.40
Not using fully covered cloths	272	7	345	33	3.72	1.54 – 9.36
Not using Mosquito Net	274	5	366	12	1.8	0.58 – 5.91
Source of water - Public tap	239	40	247	131	3.17	2.10 – 4.81
Source of water - Bore well	52	227	120	258	0.49	0.33 - 0.73
Water stored for Wash/ Bath	260	19	290	88	4.15	2.40 – 7.26
Water stored in Cement barrel /plastic bucket	186	93	145	233	3.21	2.29 – 4.50
Refill water once in a week	85	194	50	328	2.87	1.91 – 4.34
Water containers are not covered	132	147	115	263	2.05	1.47 – 2.87
Found Plastic cup / Coconut shells/ Used tyre / Broken plastic plates in backyard of the house	205	74	218	160	2.03	1.43 – 2.88

Vector survey in case and control households

We identified only Aedes Egypti species of mosquitoes in the Gouriepet area. The median number of containers per household in the case households was observed to be 10 containers (IQ Range: 7-13) compared to 8 containers (IQ Range: 5-11) in control households. The vector indices for all houses in the Gouriepet area were observed to be as follows: HI – 23%; BI – 35% and CI-4%. We compared the same for case and control households. For case households the vector indices levels were: HI = 30%, BI = 49% and CI = 4%. For control households the vector indices levels were: HI = 17%, BI = 24% and CI= 3%. The vector indices HI and BI were nearly double and significantly higher (p value < 0.0001) for case households compared to control households. CI was also observed to be significantly higher (p value < 0.05) for case households compared to control households **(Table 3)**.

Discussion

Using a case control study design, we have identified several behavioural risk factors that could be associated with CHIKV infections in a community. Our study findings also enabled an assessment of the impact of risk behaviour on vector indices in a community. Furthermore, we were able to identify the main factor that triggers risk behaviour among community members which in turn leads to adverse consequences, viz., increases in vector indices resulting in increases in risk of CHIKV infection/outbreaks. In fact our study findings have provided the necessary evidence that enables us explain the relationships of various inter related factors that could increase the risk of CHIKV infections/outbreaks in a community **(Figure 1)**.

Urban mosquito control has little impact on Aedes population as demonstrated in earlier studies [12,13]. Elimination of larval habitats from the domestic environment is the only approach that has some effect on mosquito control. In a complex urban setting behaviour and environment do affect the risks of Aedes borne infections particularly behavioural aspects that shape the magnitude of various exposures which are risk factors for CHIKV infections. We identified combination of household level and individual level behaviours that might be modified to prevent the CHIK infections.

Risk behaviour thus operates both at the household and individual levels **(Figure 1)**. One of the major household level risk behaviour was storage of water due to use of public taps as the main source of water. Water supply through taps was irregular and the municipal water supply through tankers was quite unreliable. Therefore residents were compelled to store around 8-10 containers of water per household. Risk behaviours associated with poor safe water storage included not covering the water storage containers and infrequent changing of water. Our finding of water storage as a risk factor is consistent with the findings of other studies [14-18]. High vector breeding observed in our setting is consistent with evidence from a similar study in Rajasthan [19]. Interestingly households with open wells or bore wells in the house as the main source of water were significantly protected from the risk of CHIKV infection.

Another important household level risk factor was poor domestic environmental sanitation practices as observed from the presence of coconut shells, broken plastic cups and discarded tyres. Our study findings corroborate with the earlier studies by Barrera et al 1993 [20]. Results from an entomological survey conducted by Lenhart et al. in 2006 [21] in the Bolivarian Republic of Venezuela reported that drums and tyres together produce almost 50% of all the pupae, suggesting thus that focusing attention on addressing these issues should be accorded high priority while planning interventions for control.

At the individual level risk behaviour refers largely to personal protection measures adopted by individuals in the community. Non use of mosquito nets was not associated with risk of CHIKV infection. This could be because most persons tend to use mosquito nets at night whereas the CHIKV mosquito is a day biting vector.

Wearing clothes that fully cover the body was found to be both significant and protective. Earlier reports suggest that wearing long sleeves and pants is one of the best ways to prevent mosquito bites [22]. More recently, the Ahmedabad Municipal Corporation (AMC), Government of Gujarat, "to safeguard school kids from mosquito bites, the health department of AMC has issued an order to the city district education office and AMC school board to allow school children to wear full sleeve shirts and trousers even if it is not part of their dress code" [23].

Our study has thus provided the epidemiological evidence that explains how water shortage and associated risk behaviour practices related to water storage along with poor domestic environmental sanitation practices and poor personal protection practices in case houses negatively affects vector indices in these households resulting in increased levels that in turn render such individuals susceptible to CHIKV infections and

Table 2 Behavioural determinants for CHIKV infection/outbreaks among case and control households – Multivariate analysis.

Risk Factors		Odds Ratio	95% Confidence Interval	Adjusted Odds Ratio	95% Confidence Interval
Mosquito Repellent	*Not using Coil*	1.7	1.17 – 2.40	1.8	1.17 – 2.61
Dress	*Not fully covered*	3.7	1.54 – 9.36	5.4	2.22 – 13.16
Water source	*Public tap*	3.2	2.10 – 4.81	2.6	1.69 – 4.13
Water stored for	*Wash / Bath*	4.2	2.40 – 7.26	3.4	1.92 – 6.02
Water stored in	*Cement barrel/ Plastic bucket*	3.2	2.29 – 4.50	2.5	1.78 – 3.61
Water refilling practice	*Refill water once in a week*	2.9	1.91 – 4.34	2.6	1.68 – 4.14
Environment	*Coconut shells, broken plastic and old tyres found*	2	1.43 – 2.88	1.5	1.05 – 2.20

Table 3 Vector indices for case and control households.

Index #	Case Households (279)	Control Households (378)	P- Value
House Index	30% (85/279)	17% (63/378)	< 0.0001
Breteau Index	49% (137/279)	24% (91/378)	< 0.0001*
Container Index	4% (137/3326)	3% (91/2803)	< 0.05

** Conditional test*

 # House Index (HI) : Percentage of houses infested with larvae and /or pupae.

HI = (Number of Houses infected / Number of Houses inspected) * 100.

Breteau Index (BI) : Number of positive containers per 100 houses inspected.

BI = (Number of positive containers / Number of houses inspected) * 100.

Container Index (CI) : Percentage of water holding containers infested with larvae or pupae.

CI = (Number of positive containers / Number of containers inspected) * 100.

Container = water storage, flower pots, fridge defrost drain tray etc

which, if left unchecked, fulminates into a CHIKV outbreak in the area.

These findings thus strongly advocate adoption of an evidence based public health practice that encompasses in its fold forging fruitful partnerships between the departments of health and civic amenities, provision of basic civic amenities such as regular water supply to populations, regular removal of domestic waste, implementation of efficient vector control measures combined with continuous and sound Behavior Change Communication programmes to effectively prevent and/ or control future outbreaks of Chikungunya in the community in a sustained manner.

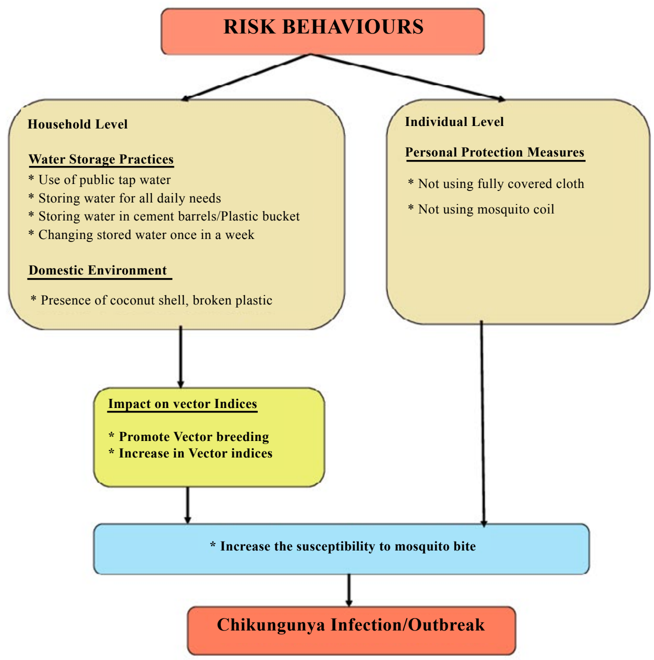

Figure 1 Risk Behaviours-Impact on vector Indices and CHIKV infections/Outbreaks.

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