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Original Work

Assessing the sustainability of individual behavior change against mosquitoes after the outbreak of a vector-borne disease in Mauritius: a case study

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ABSTRACT: The island of Mauritius had not experienced any mosquito-borne diseases since the last malaria outbreak in the early 1980s. When the chikungunya fever epidemic affected the island in 2005-2006, the local population was unprepared against this mosquito-borne infection and officially 11, 000 people were affected. Authorities promptly set up public health campaigns and actively encouraged the public to take preventive actions against the mosquito vector. This study has been carried out to investigate whether the individual preventive interventions adopted to combat mosquitoes during the outbreak have been sustained two years following the outbreak in a specific rural locality. Ethical clearance was obtained from the Research Ethics Committee of the University of Mauritius. Data was collected using a door-to-door household survey in a small rural locality of Mauritius in December 2008 and January 2009. One person per household was interviewed and the sample size was 172. Sustainability of individual preventive interventions was determined by assessing the preventive measures adopted by people against mosquitoes prior to, during, and two years following the outbreak. Elimination of mosquito breeding places was the most practiced preventive measure adopted by people in all outbreak periods as compared to preventive measures against mosquito bites within and outside the house. An increase in all individual preventive measures was observed during the outbreak followed by a slow decline two years following the outbreak. An important finding was that all post-outbreak preventive measures were sustained above the pre-outbreak levels, especially so in the case of source reduction interventions. Individual efforts in the inter-epidemic period are important to mitigate the spread of a mosquito-borne infection and it is encouraging to observe in this case study that although individual preventive measures decline with time after an outbreak they are still being sustained above the pre-outbreak levels.

KEY WORDS: ***Sustainability of behavior change; Vector-borne disease; Preventive measures; Post-outbreak period***

INTRODUCTION

In the island of Mauritius, the chikungunya fever outbreaks in 2005-2006 were significant public health challenges, as this vector borne disease had not been encountered before. Chikungunya fever is a viral illness, which causes fever with marked arthralgia. It was locally transmitted by the *Aedes albopictus* mosquito. Since there are no curative treatments for this condition, vector control and prevention of mosquito bites are the main public health interventions. The first appearance of chikungunya fever in Mauritius occurred in 2005, with a small-localized outbreak of around 3,500 suspected cases, in the capital city Port Louis, followed by a second more severe and more extensive outbreak from the start of February 2006. Officially around 11,000 out of 1.23 million inhabitants of the country were affected during the second outbreak. Districts of the island most

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affected by the disease were coastal districts namely Port Louis, Rivière du Rempart, Pamplemousses, Flacq and Black River[1]. Since 2006, there has not been any vector borne diseases in Mauritius, except for a short-lived dengue outbreak localized in the capital city of Port Louis in 2009[2]. Currently there are no endemic vector-borne diseases in the country. In the past, Mauritius had successfully eradicated malaria, with the last malaria outbreak occurring in the early 1980s.[3]

Right from the start of the first chikungunya fever outbreak, authorities took immediate actions to prevent spread of the infection. During the second outbreak, more massive and intensive public health education campaigns backed by government authorities were carried out to raise awareness of the disease amongst the population. Specific measures were nationwide health promotion and education campaigns in the local dialect such as the "Pik Li Avan Li Pik ou" campaign, which is translated as "Kill it (the mosquito) before it kills you".[4] These were aimed to raise awareness of the threat of mosquitoes among the population and to encourage source reduction measures and the prevention of mosquito bites by the use of long sleeved and other protective clothes and by the use of bed nets and other mosquito repellents in the home. There was also the free distribution of mosquito repellents amongst the public. Regarding the reduction of mosquito breeding sites, there were home visits by sanitary officers to inform and advise people as well as the clearing of unoccupied and abandoned lands, riverbeds, and gutters and general cleaning up around the island. Talks on chikungunya fever were carried out in many localities. Regarding measures taken to reduce the mosquito vector, there was the fumigation by insecticides carried out especially near hotels, guesthouses and areas affected by chikungunya. Authorities screened domestic and international travelers at the airport and port (mainly for those coming from affected countries) and all hotels and medical practitioners were requested to notify any suspected case to the health authorities. Amongst a wide palette of measures adopted, some were more successful than others and measures had to be adopted flexibly according to circumstances. The co-operation of the public was crucial to complement the efforts from authorities and professionals in the field of public health. Since the outbreaks, it appeared that people had generally become more aware of diseases caused by mosquitoes and had adopted new behavioral patterns to combat mosquito proliferation and mosquito bites. However evidence regarding the pattern and sustainability of this behavior change has not been clearly established.

The outcome of public health interventions is greatly influenced by individual behavioral change to result in positive action, which promotes health. Without appropriate and timely individual action, public health measures will not be successfully implemented. There are several models, which attempt to explain and predict individual health behaviors. One such model is the widely used health belief model[5] which could be applied in this case to the individual's readiness to take action to avoid chikungunya fever: namely the perceived susceptibility to the disease ("I am at risk of chikungunya fever") and the perceived severity of the disease ("I could be seriously ill if I contract the infection"); outcome expectations namely the perceived benefits of performing a behavior ("if I prevent stagnant water collection, I can prevent chikungunya fever"), the perceived barriers of performing the behavior ("I have no time to clean the yard") and the belief that the benefits of performing a behavior outweigh the consequences of not performing it ("I'd rather use mosquito repellents than get chikungunya fever") and finally the belief of self-efficacy knowing that one can perform a behavior even under difficult circumstances ("I am confident that I can do it"). This model has also been advocated for use in many vector borne diseases, for instance in dengue health education.[6] Other models to explain the determinants of behavior change (theory of reasoned action)[7] as well as the stages of behavior change (transtheoretical model of behavior change)[8] also exist. However two important points to be considered from these models are that continuous motivation is a crucial factor and that behavioral change takes time to become established.

In addition to the individual's readiness to take action, it is also important to determine the sustainability of this desirable action over time for optimal use of resources devoted to health promotion programs. Sustainability in public health programs and sustainability of behavioral change are complex topics. A recent paper[9] analyzing the concept of sustainability in community based health proposed a useful framework to look at sustainability factors which were classified into: "project design and implementation factors", "factors within the organizational setting" and "factors in the broader community environment." In this paper, we focus on individual behavior which impacts on community involvement and especially on how the behavior changes in different periods (pre-outbreak, outbreak and post-outbreak periods).

Specific determinants of sustainability at the individual level are still being explored. Regarding individual change, it is argued that information alters knowledge, attitudes and behavior and this precedes behavior change though other factors impact on the maintenance of the changed behavior[10]. In communicable diseases programs, research has shown again that disease knowledge

and perception at the individual level, as well as, the design of locally-appropriate health education messages taking into consideration cultural elements; regular health messages delivered through established networks as well as through house-to-house visits; community participation, ownership and responsibility and non-monetary incentives of the program are amongst the significant factors promoting sustainability[11]. Issues that research have not sufficiently addressed, so far, include quantitative assessments of sustainability of individual interventions over time and the rate of decline of appropriate individual behaviors, once the immediate threat to health has been removed. However, a recent paper[12] investigating the value of educational messages embedded in a community-based approach to combat dengue fever, concluded that there was a reduction in larval indices after educational interventions, but the value of the interventions declined after a period eighteen months to two years.

In order to obtain a clearer picture of how individual interventions designed to combat mosquitoes, vary from the pre-outbreak through the outbreak to the post-outbreak period, we investigated a small community and questioned its inhabitants through the use of a questionnaire survey. Individual interventions aimed to tackle mosquito-breeding sites, and protective interventions against mosquito bites within and outside the home were studied. This was against a background of continuing community interventions and regular public health campaigns in the media. Our results show that there the level of individual interventions vary in different outbreak periods and according to the mode of intervention.

METHODOLOGY

Ethical policy

The research protocol was approved by the local ethical committee (the University of Mauritius Research Ethics Committee) in November 2008 and informed consent was obtained from each subject prior to inclusion in the study.

Participants

Data was collected in a door-to-door survey in the small rural locality of Queen Victoria (20.22^{o}S and 57.71^{o}E) situated in the Flacq district (one of the nine districts) of Mauritius (20.17^{o}S and 57.33^{o}E) through a questionnaire in December 2008 and January 2009, more than two years after the end of the last chikungunya outbreak. This specific locality was selected because of its convenient size which made a door-to-door survey possible and also because a significant portion of the population had been previously affected with chikungunya fever in 2006. Temperatures in the locality vary between 16^{o}C and 28^{o}C. Rainy seasons are usually between December and April. Most of the houses in the locality are built of concrete and have flat roofs. This locality also has an average relative development index which is a measure of its development.

One adult per household was requested to participate in the study and an information sheet was also provided. Written consent was obtained from participants. The same interviewer conducted all interviews with a mean interview time of thirty minutes. Out of the 177 households situated in the main village, one adult from 172 households participated in the study.

Design of questionnaire

Previous studies conducted on aspects of perceptions, knowledge, awareness and practices regarding vector borne diseases[13,14] were used as guides to design the questionnaire. Individual interventions were determined by assessing the preventive measures adopted by people in the pre-outbreak, during the outbreak and in the post-outbreak periods. We assessed three modes of individual interventions namely "reduction of mosquito breeding sites", "preventive practices against mosquito bites within the home" and "preventive practices against mosquito bites when going out". These modes of interventions were selected based on health promotion leaflets published by the Ministry of Health and Quality of Life during the national campaign "Pik Li Avan Li Pik Ou".[4] This campaign had focused on source reduction and protection against mosquito bites. "Reduction of mosquito breeding sites" measures included cleaning the yard and disposing of any article that can collect rain water such as empty cans and rubber tyres, installing good drainage for any place susceptible to collect water such as flat roofs, turning or covering water collection recipients such as buckets, putting only the required amounts of water in plant pots, removing stagnant water in plant pots and scrubbing inside vases or other recipients susceptible to contain mosquito eggs or changing the water weekly. "Preventive practices against mosquito bites at home" measures included the use of mosquito repellents, coils or vapor mats at home, use of mosquito nets near beds, windows and doors, closure of windows and doors to prevent mosquito entry at appropriate times, use of curtains treated with insecticides at windows and doors, wearing long-sleeved shirts and long trousers or other useful measure. "Preventive practices against mosquito bites when going out" measures included the use of mosquito repellents and wearing long-sleeved shirts and long trousers. The questionnaire also included questions

regarding the background and level of education of the participants, whether the participants had suffered from chikungunya fever, their level of knowledge of vector borne diseases especially chikungunya fever, their source of information, motivating factors which sustained their actions and measures being taken at locality level against mosquito proliferation.

Data analysis

Data was analyzed using Epi Info and Microsoft Excel. Figures were generated to show the frequency of each mode of individual preventive practices in each period. The total number of practices in pre-, post- and outbreak periods were calculated by multiplying the number of participants by the number of practices for each mode of practice.

RESULT

Profile of participants

The age group of the participants was as follows: 18-30: 29.1%, 31-40: 20.3%, 41-50: 23.3%, 51-60: 18% and above 60: 9.3%. The mean age of participants was 41 years. Males comprised 33% of the sample and females 67%. Of the people interviewed, 12.8% had not received any schooling, 19.8% had received primary education, 61.6% had received secondary education and 5.8% had received tertiary education. Hence most participants had received secondary education. Regarding chikungunya status, 40.1% of the sample had been affected by chikungunya fever. 77% knew that chikungunya fever was transmitted by means of a mosquito vector. Their knowledge source was as follows: television (98%), radio (92%), other people (81%), newspapers (79%), posters (62%), talks (49%), pamphlets (47%), billboards (25%) and finally the internet (8%). 95% of the participants said that they were motivated to take precautions against mosquitoes. Main motivating factors were as follows: fear of catching chikungunya (30%), to prevent re-emergence of chikungunya (23%) and to protect self and family against mosquito-borne diseases (23%).

Profile of interventions at locality level

There were regular visits of scavengers in both the pre-outbreak and post-outbreak periods. Clearing of rivers, gutters and wastelands continued at the same levels. However in the outbreak and immediate post-outbreak periods there were in addition regular visits of sanitary officers and distribution of mosquito repellents.

Profile of individual interventions

As shown in **Figure 1**, a substantial 19% of the sample was not practicing any interventions to prevent the collection of stagnant water prior to the outbreak. However, during the outbreak, every participant practiced at least one measure to reduce mosquito-breeding sites. It was also observed that during the outbreak the intervention curve increased steeply and there was a considerable increase in participants who took at least six measures to drain stagnant water and tackle mosquito-breeding sites. In the post-outbreak period there was a decrease in the maximum number of individual interventions; most people were practicing between 2 to 5 interventions. It was also noted that 5% of the sample had discontinued all precautions for source reduction post-outbreak. However the post-outbreak intervention levels remained higher than pre-outbreak levels with a substantial 25% of participants persevering with 6 interventions. Numbers of interventions practiced for source reduction were as follows: pre-outbreak (Total 447, Average 2.6), outbreak (Total 807, Average 4.7) and post-outbreak (Total 621, Average 3.6).

Figure 2 demonstrates that in the pre-outbreak period, participants were most frequently implementing one measure to protect themselves against mosquito bites at home but this increased to three measures practiced during the outbreak. In the post-outbreak period the level of interventions remained higher than pre-outbreak levels though less than outbreak levels. It is to be noted that the number of participants practicing 6 measures remained low throughout. Hence interventions against mosquito bites were less practiced than interventions for source reduction. Numbers of interventions practiced for prevention against mosquito bites at home were as follows: pre-outbreak (Total 275, Average 1.6), outbreak (Total 490, Average 2.9) and post-outbreak (Total 363, Average 2.1).

From **Figure 3**, it is observed that 71% of participants were not taking any precautionary measures against mosquito bites outside the home prior to the outbreak, 38% were still not taking any similar protective measures during the outbreak and a significant 65% were not practicing any protective intervention against mosquito bites when going out. Post-outbreak, there had been only a slight increase in individual interventions against mosquito bites outside the home as opposed to the pre-outbreak period. Numbers of interventions practiced against mosquito bites outside the home were as follows: pre-outbreak (Total 64, Average 0.4), outbreak (Total 157, Average 0.9) and post-outbreak (Total 74, Average 0.4).

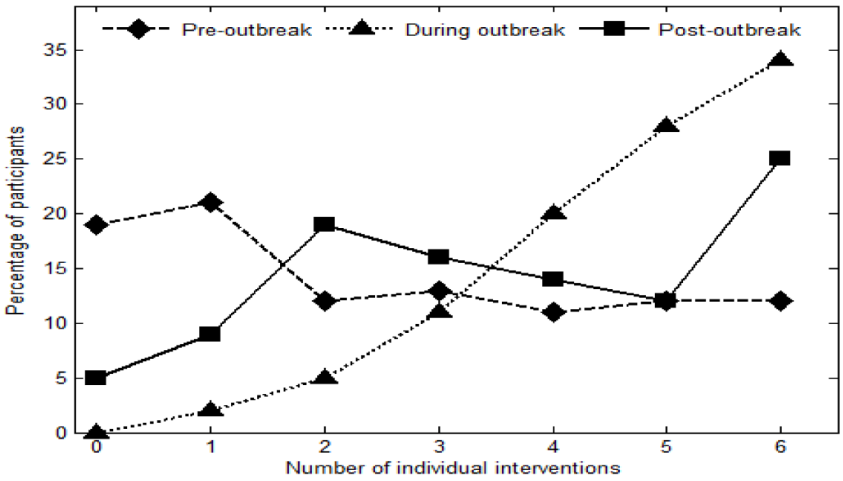

Figure 1: Individual interventions for the reduction of mosquito breeding sites in different outbreak periods

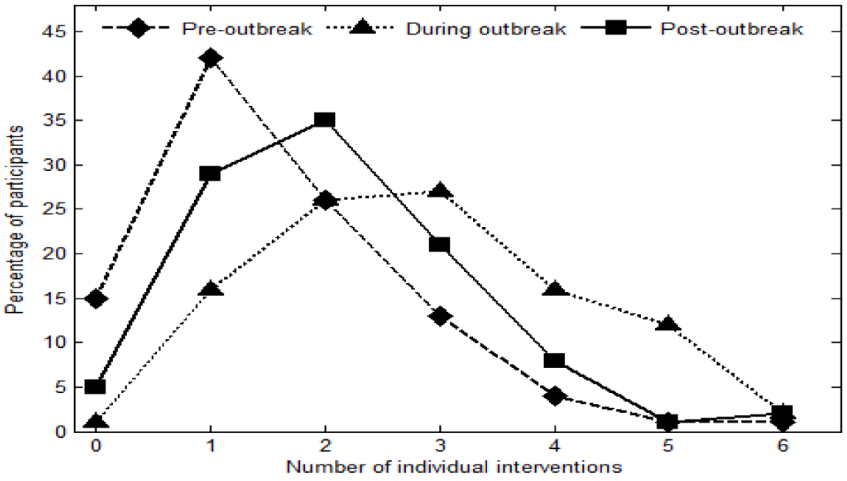

Figure 2: Individual interventions for the prevention of mosquito bites within the home in the different outbreak periods

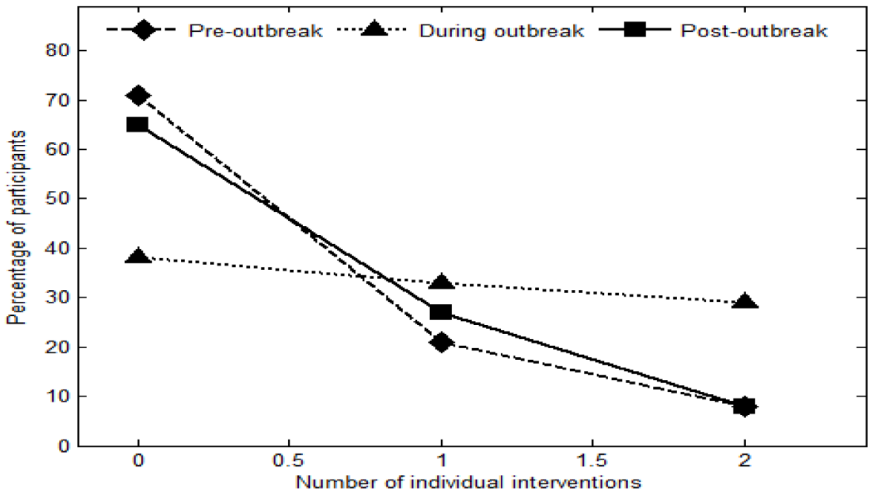

Figure 3: Individual interventions for the prevention of mosquito bites outside the home in the different outbreak periods

DISCUSSION

The main findings of this study are that individual preventive practices with respect to mosquito source reduction and prevention of mosquito bites in and outside the home increased from the pre-outbreak period to the outbreak period and then declined 2 years after the outbreak. In the post-outbreak period, the average number of preventive practices in all three modes of individual interventions continued to remain above the pre-outbreak levels. Out of the three types of preventive practices studied, prevention of mosquito breeding sites showed the most substantial and sharp increase during the outbreak period and was also the measure that was the most commonly sustained. In addition, a significant 25% of the participants were still carrying out 6 source reduction interventions 2 years after the outbreak.

This study was limited to a specific small rural locality. Hence the results from this study may not be representative of the whole Mauritian population as different people adopt different behavioral measures according to their specific circumstances and they are also influenced by other factors in their environment. Regarding accuracy of data, it may be possible that respondents had given socially desirable answers, though the interviewer specifically ensured crosschecking of answers through an in-depth interview. Respondents may also have been using effective measures other than those being studied, but these were not taken into account in this study. The frequency of preventive practices is also an important factor. For preventive practices to be truly effective, they should be carried out at regular well-determined periods. For instance source reduction measures should be carried out at least once weekly to prevent the emergence of adult mosquitoes. Similar preventive practices against mosquito bites in the home and outside the home must be carried out at least once daily if not more often. In this study, although the frequency of the preventive practices was not specified, it was assumed that respondents were performing them at a reasonable frequency. In addition, the variation of mosquito larval counts and adult mosquito counts in the pre-outbreak, outbreak and post-outbreak periods would have been useful to complement the findings of this study, but this data was not available to us.

Knowledge of chikungunya fever was high in the sample. 77% knew that this was transmitted by a mosquito vector. As discussed previously, an individual's disease knowledge and perception is an important factor in a communicable disease program and a high level of knowledge influences positive individual action against the vector. A high level of knowledge also creates favorable conditions for sustainability. Television and radio played a crucial role in the transmission of public health information and this also reflects that most people had access to a television and a radio. Surprisingly billboards and the Internet was the least effective route whereby people in this locality accessed health information. This is an important finding, which could be used in future health promotion campaigns.

In the pre-outbreak period, it was observed that although 81% of the respondents were practicing at least one source reduction preventive measure, 85% were using at least one preventive measure against mosquito bites at home and 29% were practicing at least one preventive measure against mosquito bites when going out, these measures had not been sufficient to prevent an outbreak of chikungunya fever which caused the infection of 40.1% of the sample. This figure is comparable to that obtained mathematically from a study carried out in 2008[1] which showed that an estimated 39% of the population in the district of Flacq could have been infected by the chikungunya virus.

During the outbreak, preventive measures had increased substantially. All respondents were practicing at least one measure for tackling mosquito-breeding sites and 34% were even practicing 6 measures. Regarding prevention against mosquito bites at home, 99% of participants were practicing at least one measure and three measures were most frequently practiced by 27%. 62% were practicing at least one measure for prevention of mosquito bites when going out. Hence it was clear that participants were mostly aware of the threat of being infected by mosquito bites and of contracting the disease. In a study investigating knowledge, awareness and practices regarding dengue fever during a recent period of dengue outbreak[14], findings showed that the most common preventive practice was the use of mosquito sprays in 48.1 % of the sample whilst prevention of water stagnation was a measure used by 20.9%. In another study evaluating the West Nile Virus campaign[15], it was observed that 54.1% of respondents took measures to eliminate standing water whilst 27.5% used repellents and 36.9% wore long clothes. Thus preventive practices vary widely according to specific circumstances. In Mauritius, public health authorities have long stressed on mosquito source reduction given its history of malaria whilst preventive practices against mosquito bites are less emphasized. Hence our results reflect this tendency, which could also be influenced by health messages concentrating more on environmental management measures than on personal protection measures. Indeed, even fewer people were taking protective measures against mosquito bites outside the home in all outbreak periods. Whether the availability and cost of mosquito repellents and mosquito barriers have influenced the findings of this study remains to be investigated.

Post-outbreak levels of preventive practices remained higher than pre-outbreak levels at 2 years. Thus we can deduce that there has been a measure of sustainability. Preventive practices have been widely studied in the context of knowledge, attitude and practices surveys but sustainability of these preventive practiced have been poorly documented.

Sustainability of individual behavioral change in public health is a difficult measure to quantify whether in communicable or non-communicable conditions. In fact, what qualifies as sustainability has not been explicitly described. In this study, sustainability was taken as the presence of interventions in the post-outbreak period, which was greater than those taken during the pre-outbreak period. Other studies may choose different values to define sustainability depending on the condition being studied. So far, research has not quantified the number of measures, which need to be sustained in the post-outbreak period of a vector-borne disease in order to prevent another outbreak in future. In addition, the duration over which the interventions need to be sustained has not been determined. In practice, it is often observed that individual interventions gradually decrease with time as people become less vigilant and less motivated to carry on with vector control activities. The fact that people were still sustaining such efforts at such levels more than two years after the last chikungunya outbreak is promising and a credit to the health promotion efforts at all levels.

Although this study has shed some light into sustainable behavioral change in the case of a vector-borne disease, future research work could further refine the concept of sustainability and explore the factors, which promote sustainable health behaviors to prevent outbreaks of mosquito borne diseases. What is the minimum desirable level of individual interventions during inter-epidemic periods and what constitutes the best combination of individual preventive practices need to be explored. There may be need for the formulation of an index for optimal preventive practices for mosquito control.

Another important question which needs to be addressed is determining the threshold of sufficient practice to block disease transmission. Hence there are many interesting questions in this field of research, which need to be investigated further.

CONCLUSION

For successful public health programs, individual interventions as well as their sustainability over time need to be taken into account. As Mauritius still remains at risk of mosquito-borne infections, it is important to determine individual efforts and behavior patterns in relation to the mosquito vector in the inter-epidemic period and to ensure that these preventive interventions are being sustained at appropriate levels so that the introduction of a mosquito-borne disease in the island is not followed by rapid propagation.

REFERENCES

1. Ramchurn SK, Goorah SS, Makhan M, et al. Excess mortality as an epidemic intelligence tool in chikungunya mapping. *Euro Surveill*. 2008 Feb 14;13(7). pii: 8039.
2. Ramchurn SK, Moheeput K, Goorah SS. An analysis of a short-lived outbreak of dengue fever in Mauritius. *Euro Surveill*. 2009 Aug 27;14(34). pii: 19314.
3. Communicable diseases control unit. Malaria in Mauritius, 2008. Available: http://www.gov.mu/portal/goc/moh/file/mal-history.pdf Accessed 25 Dec 2011.
4. Government of Mauritius. Cabinet decisions of 15 December 2006. Available: http://www.gov.mu/portal/site/?content_id=a0b194de88aaf010VgnVCM1000000a04a8c0RCRD Accessed 25 Dec 2011.
5. Strecher VJ, Rosentock IM. The health belief model. In: Glanz K, Lewis FM, Rimer BK, editors. *Health behavior and health education: theory, research and practice*. 2nd edition. San Francisco: Jossey-Bass. 1997;41-59.
6. Lennon JL. The use of the health belief model in dengue health education. *Dengue Bulletin*. 2005;29:217-9.
7. Fishbein M, Ajzen I. *Belief, attitude, intention, and behavior: An introduction to theory and research*. Reading, MA: Addison-Wesley 1975. Available: http://people.umass.edu/aizen/f&a1975.html Accessed 26 Dec 2011.
8. Prochaska JO, DiClemente CC. Toward a comprehensive model of change. In: Miller WR, Heather N editors. *Treating addictive behaviors: processes of change*. New York: Plenum Press. 1986;3-27.
9. Shediac-Rizkallah MC, Bone LR. Planning for the sustainability of community-based health programs: conceptual frameworks and future directions for research, practice and policy. *Health Educ Res.* 1998 Mar;13(1):87-108.
10. Swerissen H, Crisp BR. The sustainability of health promotion interventions for different levels of social organization. *Health Promot Int.* 2004 Mar;19(1):123-30.
11. Atkinson JA, Vallely A, Fitzgerald L, et al. The architecture and effect of participation: a systematic review of community participation for communicable disease control and elimination. Implications for malaria elimination. *Malar J.* 2011 Aug 4;10:225.
12. Al-Muhandis N, Hunter PR. The value of educational messages embedded in a

community-based approach to combat dengue fever: a systematic review and meta regression analysis. *PLoS Negl Trop Dis.* 2011 Aug;5(8):e1278.

13. Lennon JL. Students' perceptions about mosquito larval control in a dengue endemic Philippine city. *Dengue Bulletin*. 2004;28:196-206.
14. Itrat A, Khan A, Javaid S, et al. Knowledge, awareness and practices regarding dengue fever among the adult population of dengue hit cosmopolitan. *PLoS One*. 2008 Jul;3(7): e2620.
15. Averett E, Neuberger JS, Hansen G, et al. Evaluation of West Nile virus education campaign. *Emerg Infect Dis*. 2005 Nov;11(11):1751-3.