

# Dengue in Grenada

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## ABSTRACT

**Objectives.** Dengue fever is endemic in the country of Grenada and is grossly underreported as a source of morbidity. The goal of this study was to assess the status of dengue fever in a representative community in Grenada.

**Methods.** Surveys were conducted in the Mont Tout/Grand Anse Valley area in the parish of St. George's from March to June 1996. The objectives of the survey were to: (1) to assess the knowledge, attitudes, and practices (KAP) of residents; (2) to determine the presence of larval and adult *Aedes aegypti* and their potential breeding sites; and (3) to identify the seroprevalence of specific immunoglobulin G (IgG) dengue antibodies in the local population.

**Results.** Out of the 102 respondents to the KAP survey, 100 of them (98%) reported never having had dengue fever. Of the 75 persons who agreed to have blood samples taken, 70 of them (93%) (95% confidence interval = 85.1%–97.8%) tested positive with the IgG enzyme-linked immunosorbent assay, indicating past exposure. In terms of water storage, 98 of 102 respondents (96%) stored fresh water in containers. The vector survey found 57 of the 102 households (56%) had *Ae. aegypti* larvae in water containers on their property, and 94 of 102 dwellings (92%) had adult *Ae. aegypti* mosquitoes indoors.

**Conclusions.** Although many people were familiar with dengue fever and mosquitoes, the 1996 survey found that their knowledge of the important relationships among mosquitoes, human behavior, and disease transmission was incomplete. Since 1996, continued education efforts have been made in the public school system and with national public health campaigns, yet little effort has been specifically targeted towards our study community. These data suggest Grenada has a need for continued community education that addresses dengue fever transmission and *Ae. aegypti* reduction.

## Key words

Dengue; *Aedes*; health knowledge, attitudes, practice; mosquito control; Grenada.

Dengue fever is a significant source of morbidity and mortality world-

wide, annually affecting millions of people. The mosquito vector, *Aedes aegypti*, is peridomestic and lays its eggs in standing fresh water, most often found in a variety of containers. There are four known serotypes of dengue virus: DEN-1, DEN-2, DEN-3, and DEN-4. These are single-stranded RNA viruses of the family *Flaviviridae*. Between 1947 and 1972 the Pan American Health Organization (PAHO) succeeded in eliminating *Ae. aegypti* from

23 countries in the American tropics, but reduced funding allowed the mosquito to reclaim its lost territory by 1993 (1). With renewed fear of a dengue epidemic, public health officials developed education programs in the school systems as well as public health media campaigns.

Clinical manifestations of dengue fever vary in severity, from generalized myalgias to the classic symptom of retro-orbital pain. Although rare,

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dengue hemorrhagic fever may result in death due to changes in the coagulation cascade (2). The primary infection is often asymptomatic or nonspecific in childhood (3), yet subsequent infections in adulthood may cause significant morbidity. This broad range of disease severity frequently creates problems in determining the true prevalence of infection in a community. The real level can be several-fold higher than official estimates, as often only the most severe cases are documented (4).

Dengue fever has been endemic in the three-island country of Grenada for decades. In 1956 a report indicated that dengue fever was prevalent in major coastal towns such as Gouyave, with fewer cases in smaller coastal communities (Grand Anse, Pearls) and with isolated cases in the interior parts of the country's main island, Grenada (5). The incidence of dengue fever in the country has waxed and waned in the past decade. In 1995, PAHO documented 74 cases of dengue fever caused by DEN-1, with one case of dengue hemorrhagic fever (DHF). Although cases decreased during the next four years, there was a resurgence in 1999, when 85 cases of DEN-2 were reported. Further increases occurred in 2002, when there were 264 cases of DEN-3 and 3 cases of DHF. As of week 39 of 2003 there had been no cases of dengue fever reported (6), and as of week 26 of 2004 there had also been no cases reported (7).

This study was undertaken in 1996 to document the knowledge, attitudes, and practices (KAP) of residents in one community in Grenada; to assess the presence of larval and adult *Ae. aegypti* and their potential breeding sites in the community; and to determine the seroprevalence of dengue-specific immunoglobulin G (IgG) antibodies in this population. This is the first study to integrate these three components in an effort to more fully understand the impact of disease, document understanding, and gauge the response of a Grenadian community to dengue fever. We also briefly discuss progress since 1996, with the development of a national dengue diagnostic capability, and setbacks such as Hurricane Ivan in 2004.

## MATERIALS AND METHODS

The KAP survey instrument used in this study was originally developed by the Ministry of Health of Grenada, the Caribbean Epidemiology Center (CAREC), and PAHO from similar surveys in the areas of Crochu and Chantimelle in Grenada. The survey questions covered dengue fever, household waste management, water supply, and household pest control.

The study was first approved through the institutional review board of the Windward Islands Research and Education Foundation. One investigator (AP) conducted all the questionnaire-based interviews. A second researcher (ERL) did yard inspections and counted potential water-collecting containers inside and outside dwellings as well as within 10–15 feet (3.0–4.6 m) of them. ERL also sampled for adult mosquitoes within the homes, using a modified Centers for Disease Control and Prevention (CDC) backpack aspirator (8). Each mosquito was frozen at  $-20^{\circ}\text{C}$  until identification was accomplished using a dissecting microscope.

The area of Mont Tout/Grand Anse Valley (National Census Enumeration District 05-5) is in St. George's parish. The area was chosen for two reasons: (1) it had one of the highest densities of residential dwellings on the island and (2) it was serviced by an unreliable water supply that consisted of several standpipes for the majority of residents, with some residences benefiting from direct water line access into the home. The area is located in the southern tip of the island, which receives less rainfall than the interior. Originally a sugar plantation, it developed, without master planning, over two generations into a community of single-family homes as new light-manufacturing facilities and tourist hotels were built within walking distance. A construction and population boom occurred in 1985, leading to inadequate capacity in the water supply. At the time of the 1996 survey the residents described the water supply as intermittent, requiring them to store water for household needs.

For our 1996 study every household within the area was surveyed. If no one was home, we returned, often several times, until we found an occupant. Everyone we approached regarding the survey was eager to participate. Surveys were conducted between the hours of 8:00 a.m. and 5:00 p.m., from March 1996 through June 1996.

The seroprevalence survey was offered voluntarily to each person in each household. With a lancet, participants had blood drawn, which was then placed into 2-mL cryotubes and placed into a cooler filled with ice. At the end of each survey day, the samples were spun down at 3 500 rpm on a benchtop centrifuge for 10 minutes and stored at  $-20^{\circ}\text{C}$  until further testing was done at the Dengue Branch of the Division of Vector-Borne Infectious Diseases of the United States Centers for Disease Control and Prevention. The Dengue Branch is located in the city of San Juan, Puerto Rico. IgG enzyme-linked immunosorbent assay tests were conducted using a previously standardized protocol (9–12).

Data were keyed and entered into SPSS statistical analysis software (SPSS Inc., Chicago, Illinois, United States). Following the testing, letters were sent to all the participants, informing them of their test results, along with educational material to help them protect themselves and their families from mosquitoes and dengue fever.

## RESULTS

During the survey period, 102 residents participated in the questionnaire, the breeding site survey, and the indoor mosquito aspiration. The KAP survey found that 93 of 102 respondents (91%) were familiar with the name of the disease, dengue fever. However, 69 of 102 (68%) were unfamiliar with the symptoms, and only 15 of 102 (15%) named fever. Two-thirds of the residents (68 of 102, or 67%) could name mosquitoes as the vector of dengue fever, yet only 3 of 102 (3%) could identify *Ae. aegypti*. The vast majority of the respondents—100 of 102

(98%)—stated that they had never had dengue fever, and 99 of 102 (97%) were not aware of an immediate family member who had ever had dengue fever.

Housing in the area of Mont Tout/Grand Anse Valley consisted of wooden homes built on wooden and/or concrete supports. Most houses lacked screens and glass windows, and many houses had large gaps between the roof and walls, allowing easy access for pests. The respondents reported that 60 of 102 households (59%) disposed of organic and nonorganic waste using the small plastic grocery bags that local supermarkets provided for free to their customers. These bags were placed into neighborhood bins that routinely overflowed before removal by a refuse service.

The most common pests were mosquitoes, reported by 63 of 102 households (62%), followed by flies, reported by 16 of 102 households (16%). Sixty-three of 102 respondents (62%) knew that mosquitoes breed in standing water.

Knowledge of the connection between mosquito control and prevention of disease was not as common as could have been hoped. Only 53 of 102 households (52%) understood the links between disease prevention and removing containers, managing water storage containers, and using insecticides. Unfortunately, 23 of 102 households (23%) reported poor understanding regarding disease prevention. The remaining respondents reported such disease prevention strategies as keeping the immediate yard or dwelling tidy and drinking clean water. Forty-three percent understood the connection between removing water from containers and decreased mosquito infestation.

Many forms of water storage were used, with 98 of 102 respondents (96%) reporting the need to store fresh water in containers. The most commonly reported containers were covered buckets, used by 42 of 102 households (40%), followed by 55-gallon drums, used by 31 of 102 households (30%).

In terms of mosquito control, a large majority of households—80 of 102

(78%)—used methods that were more expensive than source reduction. These methods included insecticides and such other chemical means as mosquito coils and bug mats (electric burners with pads that vaporize pyrethrum).

The vector survey found 57 of 102 households (56%) had *Ae. aegypti* larvae in water containers within 15 feet (4.6 m) of the dwelling. Indoors, 94 of 102 dwellings (92%) contained adult *Ae. aegypti* mosquitoes, while 81 of 102 (79%) also harbored *Culex quinquefasciatus*. The most common breeding sites found around homes were 55-gallon metal drums, which were found positive for *Ae. aegypti* in 65 of 102 (64%) yards. Relatively few tires were seen. Homes with both a negative yard survey and a negative indoor survey accounted for only 5 of 102 households (5%).

The adults in the local community were very resistant to having blood drawn. However, after the risks and benefits were discussed, 75 of the participants, including several children, agreed to provide a blood sample. The age of the persons providing a sample ranged from 7 to 70 years, with a mean of 35 years. A total of 70 of the 75 blood samples drawn (93%, 95% confidence interval = 85.1%–97.8%) were positive for dengue IgG antibodies, with 34 positive females and 36 positive males. Of the five individuals who tested negative, three were siblings under 12 years old, one was a 27-year-old who had recently arrived in the area, and one was a 1-year-old child.

## DISCUSSION

The data from our study suggest a lack of community understanding of the key interrelationships of exposure to dengue, knowledge about dengue, and information about prevention of the disease. The vast majority of the people surveyed did not expect to have been exposed to dengue fever in the past or to have had a family member who was exposed. Similar results were found in studies completed in Grenada in 1993 and in Trinidad and

Tobago in 1995 (13, 14). In our 1996 survey in Grenada, fever was the most commonly mentioned symptom, but symptoms such as retro-orbital pain and myalgias and arthralgias were rarely mentioned. Two-thirds of the respondents identified mosquitoes as the vector of dengue fever, but a noticeable portion of the respondents could not identify the species of mosquito involved in the transmission cycle or relate the causative mosquito to specific breeding sites and thus possible control measures. The most common mosquito control methods used were options that were more expensive than source reduction. This pattern was probably due to differences in source reduction among nearby households.

Water is the major factor in *Ae. aegypti* proliferation (15, 16). Barrera (17) found a correlation between the frequency of water supply problems and *Ae. aegypti* infestation. These problems were solved by using different types of water storage containers. In our 1996 Grenada survey many people used covered buckets to store small amounts of drinking water, while nearby there were often one or two covered 55-gallon drums for storing larger amounts of water for washing or other household uses. An interesting difference between the questionnaire and the vector survey was noted in terms of these 55-gallon drums. Many respondents did not recognize the drums as frequently used water containers. That was in spite of the fact that the drums were ubiquitous throughout the survey area, supplying residents with ready access to potable water that they could not obtain from the public water supply. The drums were commonly covered with corrugated tin, which did not inhibit mosquitoes but did prevent larger material from falling in.

The high seroprevalence (93%) of dengue IgG antibodies in our survey population suggests a high level of endemicity for dengue viruses. While the DEN-4 serotype has not been identified in the Grenadian population, its presence could create optimal conditions for epidemics and an increased

incidence of DHF, as has been seen in Southeast Asia (18).

The control of dengue fever in the country of Grenada is complicated by difficulty in reducing both the vector population and the number of viremic hosts. An effective, laboratory-based surveillance system for the country has been put in place, assisted primarily by the establishment in January of 2001 of a dengue diagnostic laboratory at the Windward Islands Research and Education Foundation, which is located just south of the city of St. George's, Grenada. With the capacity to quickly identify the arrival of new serotypes, the Ministry of Health of Grenada can alert the medical community and more effectively mobilize limited vector control resources to areas that are most affected. This will allow for more efficient and rapid vector and viremic host reduction (19). A stepwise approach is needed to break the cycles of epidemics that occur in Mont Tout/Grand Anse Valley. The first step of this approach requires the local population to acknowledge the presence of the pathogen.

Education has been the mainstay of local dengue fever prevention in Grenada for several decades. Andre Worme, the Acting Chief of the Department of Environment of the Ministry of Health (personal communication, 8 December 2004), noted that programs targeting schoolchildren have been the method preferred by the Ministry of Health to improve community awareness. Often, but not always, this information is communicated vertically to parents and other older members of the immediate family. Unfortunately, little community intervention has been conducted in the

Mont Tout/Grand Anse Valley survey area since the completion of our survey in 1996. This is regrettable since this community-based approach has proved successful in Puerto Rico, with a correlation between a decrease in mosquito breeding sites and increased community awareness of dengue fever and mosquito transmission (20).

On 7 September 2004 Hurricane Ivan caused widespread damage to the housing stock and infrastructure in Grenada, and the people of the country have been engaged in a Herculean cleanup effort since then. The Ministry of Health's Worme found an increase in the larval indices and a rise in the number of individuals reporting dengue-like symptoms within weeks of the hurricane, which he believes may lead to an increase in dengue fever cases for 2005 (Andre Worme, personal communication, 8 December 2004). There has not yet been a noticeable increase in the number of reported dengue fever cases, although it is important to note that this may be the result of a temporary change in surveillance priorities.

## CONCLUSIONS

This study demonstrates the very common, yet serious, problem of attempting to protect a population from a disease that is not perceived to be a threat. Similar attitudes towards a variety of infectious diseases can be found in many developing nations.

Our combined KAP, vector, and seroprevalence survey was the first to demonstrate the intimate association among mosquitoes, human behavior, and dengue fever transmission in a

community in Grenada as well as to suggest potential areas for further community education, such as increasing the residents' awareness of the mosquito species and limiting mosquito access to fresh water. Although sizable resources have been used on school-based prevention programs, local community involvement has been minimal. It is essential to work with leaders in the local community in order to create a sense of ownership and to motivate the entire community to take an active role in partnership with Government health agencies. It is commendable for individual families to work at mosquito control, such as by buying and using insecticides. However, that requires more resources than would be needed with source reduction techniques. The post-hurricane rebuilding effort will hopefully result in a critical reanalysis of the community water supply as well as a reassessment of the importance of debris around homes and of potential mosquito breeding sites. People have formed their own understanding of dengue from official Government sources, the media, and local community opinion. However, it is important to continue education programs and community involvement to prevent the cycle of transmission. This will improve the health of the community that we surveyed, the country of Grenada, and the other nations of the Caribbean basin.

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## REFERENCES

- Gubler DJ. *Aedes aegypti* and *Aedes aegypti*-borne disease control in the 1990's: top down or bottom up. *Am J Trop Med Hyg.* 1989;40: 571-8.
- Kurane I, Takahashi T. Dengue fever and dengue hemorrhagic fever: challenges of controlling an enemy still at large. *Rev Med Virol.* 2001;11:301-11.
- Lange RW, Beall B, Denny SC. Dengue fever: a resurgent risk for the international traveler. *Am Fam Physician.* 1992;45:1161-8.
- Monath TP. Dengue: the risk to developed and developing countries. *Proc Natl Acad Sci USA.* 1994;91:2395-2400.
- Down WG, Anderson CR. Arthropod-borne encephalitis viruses in the West Indies area. Part 1: serological survey of Grenada, W.I. *West Indian Med J.* 1959;8:101-9.
- Pan American Health Organization. 2003: number of reported cases of dengue & dengue hemorrhagic fever (DHF), Region of the Americas (by country and subregion), last update 3 February 2004 [Internet site]. Available from: <http://www.paho.org/english/ad/>

- dpc/cd/dengue-cases-2003.htm. Accessed 20 February 2005.
7. Pan American Health Organization. 2004: number of reported cases of dengue & dengue hemorrhagic fever (DHF), Region of the Americas (by country and subregion), last update 2 August 2004 [Internet site]. Available from: <http://www.paho.org/english/ad/dpc/cd/dengue-cases-2004.htm>. Accessed 20 February 2005.
  8. Clark GG, Seda H, Gubler DJ. Use of the "CDC back pack aspirator" for surveillance of *Aedes aegypti* in San Juan, Puerto Rico. *J Am Mosq Control Assoc.* 1994;10:119–24.
  9. Burke DS, Nisalak A, Ussery MA. Antibody capture immunoassay detection of Japanese encephalitis virus immunoglobulin M and G antibodies in cerebrospinal fluid. *J Clin Microbiol.* 1982;16:1034–42.
  10. Chungue E, Marche G, Plichart R, Boutin JP, Roux J. Comparison of immunoglobulin G enzyme-linked immunosorbent assay (IgG-ELISA) and haemagglutination inhibition (HI) test for the detection of dengue antibodies. Prevalence of dengue IgG-ELISA antibodies in Tahiti. *Trans R Soc Trop Med Hyg.* 1989;83:708–11.
  11. Gubler DJ, Sather GE. Laboratory diagnosis of dengue and dengue hemorrhagic fever. In: Homma A, Cunha JF, eds. *Proceedings of the International Symposium on Yellow Fever and Dengue*. Rio de Janeiro: Bio-Manguinhos; 1988. Pp. 291–322.
  12. United States of America, Centers for Disease Control and Prevention. *Laboratory protocols for the diagnosis of dengue*. San Juan: CDC, Division of Vector-borne Infectious Diseases; 1996.
  13. Branch-Rooke J. *Integrated vector control program: knowledge, attitudes and practices baseline survey*. St George's: Ministry of Health; 1993.
  14. Rosenbaum J, Nathan MB, Ragoonansingh R, Rawlins S, Gayle C, Chadee DD, et al. Community participation in dengue prevention and control: a survey of knowledge, attitudes, and practice in Trinidad and Tobago. *Am J Trop Med Hyg.* 1995;53:111–7.
  15. Ilkal MA, Dhanda V, Hassan MM, Mavale M, Mahadev PV, Shetty PS, et al. Entomological investigations during outbreaks of dengue fever in certain villages in Maharashtra state. *Indian J Med Res.* 1991;93:174–8.
  16. Rodríguez-Figueroa L, Rigau-Pérez JG, Suárez EL, Reiter P. Risk factors for dengue infection during an outbreak in Yanes, Puerto Rico in 1991. *Am J Trop Med Hyg.* 1995;52:496–502.
  17. Barrera R, Avila J, González-Tellez S. Unreliable supply of potable water and elevated *Ae. aegypti* larval indices: a causal relationship. *J Am Mosq Control Assoc.* 1993;9:189–95.
  18. Nisalak A, Endy TP, Nimmannitya S, Kalayanaroj S, Thisayakorn U, Scott RM, et al. Serotype-specific dengue virus circulation and dengue disease in Bangkok, Thailand from 1973 to 1999. *Am J Trop Med Hyg.* 2003;68:191–202.
  19. Gubler D, Casta-Valez A. Programa de prevención del dengue epidémico y el dengue hemorrágico en Puerto Rico y las Islas Vírgenes estadounidenses. *Bol Oficina Sanit Panam* 1992;113(2):109–20.
  20. Winch PJ, Leontsini E, Rigau-Pérez JG, Ruiz-Pérez M, Clark GG, Gubler DJ. Community-based dengue prevention programs in Puerto Rico: impact on knowledge, behavior, and residential mosquito infestation. *Am J Trop Med Hyg.* 2002;67(4):363–70.

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## RESUMEN

### El dengue en el país de Granada

**Objetivos.** La fiebre del dengue es endémica en el país caribeño de Granada y es grande su subnotificación como fuente de morbilidad. El objetivo del presente estudio fue evaluar la situación del dengue en una comunidad representativa de ese país.

**Métodos.** Se llevaron a cabo encuestas en la zona del valle de Mont Tout y de Grand Anse, en la parroquia de St. George's, de marzo a junio de 1996. Los objetivos de las encuestas fueron: 1) explorar los conocimientos, actitudes y prácticas (CAP) de los habitantes; 2) determinar la presencia de formas larvianas y adultas de *Aedes aegypti* en posibles criaderos, y 3) identificar la seroprevalencia de inmunoglobulina G (IgG) con actividad específica contra el virus del dengue en la población local.

**Resultados.** De las 102 personas que respondieron la encuesta de CAP, 100 (98%) indicaron que nunca habían padecido de fiebre del dengue. De las 75 personas que consintieron que se les sacaran muestras de sangre, 70 (93%) (intervalo de confianza de 95% = 85,1%–97,8%) tuvieron resultados positivos en la prueba de inmunoadsorción enzimática para la detección de IgG, señal de que habían tenido una exposición anterior. En lo que respecta al almacenamiento del agua, 98 de las 102 personas (96%) encuestadas almacenaban agua fresca en recipientes. La encuesta de vectores reveló que en 57 de las 102 viviendas (56%) había larvas de *Ae. Aegypti* en recipientes de agua en la propiedad, y en 94 de las 102 viviendas (92%) se encontraron mosquitos *Ae. aegypti* adultos en el interior.

**Conclusiones.** A pesar de que muchas personas estaban familiarizadas con la fiebre del dengue y el mosquito vector, la encuesta de 1996 reveló en ellas conocimientos incompletos acerca de las relaciones importantes entre los mosquitos, los hábitos del ser humano y la transmisión de la enfermedad. Desde 1996 se han puesto en marcha de continuo iniciativas educativas en las escuelas públicas y mediante campañas sanitarias a escala nacional, pero pocas han estado dirigidas específicamente a la comunidad aquí estudiada. Estos datos indican que el país de Granada necesita un sistema de educación comunitaria continua que se oriente a reducir la transmisión de la fiebre del dengue y la población de *Ae. aegypti*.

### Palabras clave

Dengue; *Aedes*; conocimientos, actitudes y prácticas en salud; control de mosquitos; Grenada.