

## Malaria in Sucre State, Venezuela

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**Abstract** *The author reviews the malaria research program in Sucre State, Venezuela, taking an ecosystem approach. The goal was to determine which methods could have been introduced at the onset that would have made the study more ecological and interdisciplinary. Neither an ecosystem approach nor integrated disease control were in place at the time of the study. This study began to introduce an ecosystem approach when two contrasting ecosystems in Sucre State were selected for study and vector control methods were implemented based on research results. The need to have a health policy in place with an eco-health approach is crucial to the success of research and control. The review suggests that sustainability is low when not all the stakeholders are involved in the design and implementation of the research and control strategy development. The lack of community involvement makes sustainability doubtful. The author concludes that there were two interdependent challenges for malaria control: development of an ecosystem approach for malaria research and control, and the implementation of an integrated disease control strategy, with malaria as one of the important health issues.*

**Key words** *Malaria; Tropical Medicine; Vector Control*

**Resumo** *O autor faz uma revisão do programa de pesquisa sobre malária no Estado de Sucre, Venezuela, à luz de uma abordagem ecossistêmica. O objetivo era determinar quais métodos poderiam ter sido introduzidos no início do estudo para torná-lo mais ecológico e interdisciplinar. A fase inicial do estudo não incluía uma abordagem ecossistêmica ou controle integrado da doença, que só foram incorporados quando dois ecossistemas contrastantes no Estado de Sucre foram selecionados para pesquisa, junto com um método de controle de vetores com base nos resultados. Uma política de saúde bem-definida com uma abordagem ecossistêmica é crucial para o sucesso de uma estratégia de pesquisa e controle. Esta revisão sugere que a sustentabilidade é baixa se todos os atores não estiverem envolvidos no desenho e implementação das estratégias de pesquisa e controle. A falta de participação comunitária coloca em cheque a sustentabilidade das intervenções. Conclui-se que havia dois desafios interdependentes para o controle da malária no Estado de Sucre: o desenvolvimento de uma abordagem ecossistêmica para pesquisa e controle da malária e a implementação de uma estratégia integrada de controle de doenças, em que a malária seria uma das principais questões sanitárias.*

**Palavras-chave** *Malária; Medicina Tropical; Controle de Vetores*

## Introduction

### Nature of the research program

This research program focused on the reintroduction of *Plasmodium vivax* malaria along the eastern coast of Venezuela in the State of Sucre. The reintroduction after more than 15 years of absence began in May 1985 and spread rapidly throughout the State. By 1990 there were 6,831 reported malaria cases. A review of the situation showed that *Anopheles aquasalis* was probably the principal vector, but no direct confirmation was made. This vector was widely distributed in the State. Its breeding sites were diverse, ranging from mangroves to temporary pools of water, but only within 10 kilometers of the coast. Adult behavior appeared to be crepuscular, but data were unavailable for Venezuela as a whole. The vector was considered responsible for refractory malaria (Gabaldón, 1978). This meant that mosquitoes did not rest on walls when they entered houses and were thus minimally impacted by residual insecticide spraying of walls. It was believed that transmission occurred indoors and possibly in the peridomicile.

Nevertheless, the government control program was based on residual house spraying once or twice a year. *Plasmodium vivax* cases were treated with a 3-day chloroquine, 14-day primaquine treatment regimen. No health education program or citizen action was present in the communities. Venezuelan malaria control at the time was a vertical program with the government responsible for all aspects of prevention and control.

After reviewing the biological, administrative, and political situation at the time it was determined that the first step was to gain a better understanding of the vector biology in order to present alternatives to the failing malaria control program. It was expected to be a difficult enough task to introduce the idea of research into the Ministry of Health's activities as they were, let alone call for more local control over the disease. The proponents of alternative measures knew that the basic problem was not just the mosquito. The situation was more complex because of the lack of *Plasmodium falciparum* malaria, the long 14-day treatment regimen for *P. vivax*, potential case relapse, poverty, and the diverse ecosystem.

There were two different ecosystems with which to deal. The first is located along the northern coast of the State and is dominated by mangroves and beaches. According to the Holdridge life zone classification, it is a very

dry tropical forest (Ewel & Madriz, 1968). However, a series of narrow valleys drop down suddenly from the coastal mountain range, dominated by lush vegetation. Rivers flow down through the valleys, with abundant springs, making for many potential mosquito breeding sites. Along the southern border of the State the slope off the coastal range is much more gradual, opening up onto broad plains with salt marshes and mangroves. According to the Holdridge life zone classification, it is a dry tropical forest (Ewel & Madriz, 1968).

The study's objectives were to determine the main vectors' ecological niche, incriminate them as vectors, and understand the adult behavior as related to host-vector contact. The study was ecological and entomological. A sub-project was initiated in order to determine whether Geographical Information Systems (GIS) and Remote Sensing (RS) might be valuable malaria control tools.

Epidemiological data indicated that all age groups and genders were equally impacted by malaria. No significant difference in risk was detected.

### **Government concern and research group**

Several groups were concerned over the resurgence of malaria, including the national malaria control program, state and local political officials, and citizen groups. The national malaria control program took the lead in solving the problem. The government's primary concern was that it was unable to eliminate malaria in this State by conventional methods. The Pan-American Health Organization (PAHO) thus offered to advise a government research team in the Rural Endemic Disease Division on how to collect baseline information through research that would lead to more effective malaria control.

### **Socioeconomic and ecological history of malaria in the area**

Malaria in this region has traditionally been caused by *P. vivax*. *Plasmodium falciparum* cases were imported from other regions of Venezuela. Sucre was one of the last States in Venezuela to eradicate malaria. The main occupations have been and continue to be fishing and subsistence agriculture. No major lifestyle changes have occurred, except the cinder block houses replacing the former mud and wattle

construction. This was a government program. Tourism recently increased in the area due to the number and quality of the beaches. However, income is still low. Although no specific studies have been done, unofficial surveys indicate that young men have migrated from Sucre State to the gold mines in Bolivar State and have returned with malaria. This may have contributed to the reintroduction of *P. vivax* malaria in Sucre State. There has also been migration between Venezuela and Trinidad and Tobago. Trinidad and Tobago has no malaria currently, but in the early 20th century the country had serious problems with the disease.

Most circulation of people is local, with social activities occurring outdoors until dark or until bedtime. This increases exposure to malaria vectors in the peridomicile. Social and ecological variables are related in several ways. The main occupation is fishing, meaning that people stay outdoors for hours before and after dark, also exposing them more to contact with malaria vectors.

Because the northern coastal valleys drop steeply down to the ocean, there is very little land available for agriculture. Livestock production is thus limited. Some households raise goats and donkeys. Along the southern coastal plain there is much more land for crop production and livestock. Ecological variables with the greatest impact on malaria risk at the time of the study were the abundance of breeding sites, persistence of *An. aquasalis*, and lack of alternative hosts (Berti et al., 1993a, 1993b). In addition, GIS and remote sensing tools were used to demonstrate that the distance between breeding sites and houses, topography, and vegetation were important malaria risk factors (Barrera et al., 1998, 1999).

Because of the vital wetlands along the coast of Sucre, it was imperative that solutions be sought that did not involve draining swamps or cutting mangroves (Zimmerman & Berti, 1994). The wetlands act as marine life breeding areas and hence a source of livelihood for the local population.

Sociological and related economic determinants appeared to be poverty, level of schooling, housing, community involvement, sewage system, and agricultural practices. These variables interacted to favor malaria transmission.

Some variables not studied in this project might have had a significant impact on malaria transmission, especially level of schooling and compliance with the 14-day treatment schedule. It was also apparent that when government insecticide spraying teams or medical staff were on strike, the malaria situation tended to get

worse. There was a basic problem with citizenry not taking full responsibility for their own health. A simultaneous socioeconomic survey should have been conducted to determine the importance of these variables, as a prerequisite for the selection and implementation of alternative sustainable malaria control.

During this study there were no major regional changes in policy. Although the Venezuelan national currency was devalued, housing projects within the region continued uninterrupted. The impact of young men migrating to the gold-mining areas did not change. However, after the project was concluded, a specific government policy curtailed independent mining activity by individual miners. There was greater control over local migration in the mining area with the potential of decreasing the number of persons arriving in Sucre with malaria. Ecological variables, including topology, vegetation, and hydrology, were basically stationary at the regional level. At the local level there was a slow trend towards deforestation and use of new insecticides in subsistence agriculture that could and eventually did increase resistance in mosquito vectors. Poor sanitary conditions increased the pollution in mangroves, bathing in rivers, and incidence of diarrhea. Malaria was a local problem, and the scale was more at the neighborhood level, with some households having more cases than others. Some communities also had more cases of malaria than others (Barrera et al., 1999). That is, there were different interacting scales of malaria transmission. No definitive studies were designed to investigate the ecological and social variables that may have contributed to the difference. Malaria intensity and vector abundance were seasonal. Mosquito abundance increased during the rainy season. Malaria increased immediately after the rainy season, but persisted as mosquito abundance declined.

### Multilevel ecosystem

If one were to define the ecosystem level on which this research was conducted, it would have been the local level. Entomological data were collected to observe the ecology and disease at the community level. They were then scaled up to the regional level for control recommendations. Malaria case data were more multilevel because one could actually stratify the data at the community, department, and regional levels. Due to manpower shortage it was difficult to examine the vector at multiple levels. One could view the ecological variables

at all levels. The disease itself should be viewed at all ecosystem levels to better understand the ecological, biological, and sociological factors that influence transmission. Malaria incidence in Venezuela differed by region, and within Sucre State the intensity differed by ecosystem and community. Within the community there were differences in intensity by neighborhood and household (Barrera et al., 1998, 1999).

It appears that the main driving force behind the reintroduction of malaria into Sucre was the economic situation that promoted migration to and from malaria areas. The ecological situation of abundant breeding sites, vector presence and behavior, and the pathogen, (i.e., *P. vivax*), made transmission possible and difficult to eliminate.

### Implications for ecosystem management

There is no doubt that if a sustainable health program including malaria control is the goal, then different organizations need to be involved from the start. These would include community organizations, political leaders, agriculture, the Ministry of the Environment, and coastal management interests. For example, agricultural interests should view the possibility of increasing economic gain by small-scale livestock production, decreased use of insecticides, and filling holes left by palm tree extraction.

Biological research showed that the main vector was *An. aquasalis*. Biting activity was greater in the peridomiciliary as compared to intradomiciliary areas (malaria-infected mosquitoes were captured biting humans both indoors and outdoors) and was crepuscular (Berti et al., 1993b). In addition, mosquitoes did not rest on inner walls of houses, but on the vegetation surrounding the houses before and after entering them. Larval breeding areas increased due to manmade breeding sites (Berti et al., 1993a). From the point of view of vector control, indoor spraying was having little or no effect. A program for biolarviciding breeding sites near houses and spraying vegetation around houses was thus initiated (Zimmerman & Berti, 1994). However, the decision to develop control policy pertains to the national malaria control program, which would have to switch from indoor spraying to the above-recommended vector control methods. This is not an easy task.

Lack of community involvement made sustainability doubtful. The community needed to be educated about the disease, the ecosystem, and malaria prevention and control. There are

many roles the community could take, from applying biolarvicides to organizing health education and treatment clinics in the neighborhoods at greatest risk. Community involvement with government support and expertise appeared to be the main challenge in the study area.

### Research implications

What this study demonstrated was that a vertical vector control program including vector and disease biology could reduce malaria, but the sustainability of alternative vector control methods appeared to be questionable.

The ideal approach to malaria control in the State of Sucre, Venezuela, is multifold. There needs to be an ecosystem approach, the premise being that the ecosystem is the template wherein human activities and diseases are acted out. One would be able to set up the appropriate hypothesis and research the malaria situation more adequately. The current study began to take this approach by selecting the two contrasting ecosystems in Sucre State. There also needs to be a parallel socioeconomic study, considering human activities and behavior as related to disease.

The initial research team would involve biologists, epidemiologists, sociologists, and educators. However, one could not rule out other specialists, such as anthropologists, geographers, and ecologists. The community could be involved in surveillance, education, surveys, and data collection.

### Ecosystem approach and integrated disease control

At the time of the study there was no direct policy promoting an ecosystem approach to malaria research or control, nor a system of broader integrated disease control. Political barriers associated with changing a traditional spray program into a more ecological program with integrated disease control need to be overcome. The challenge to one advocating an ecosystem approach for disease control is to demonstrate its advantages. One must conduct ecosystem-based studies on diseases and/or problems of concern to the local population in order to make changes. One must change disease control management methods. Communication must be opened up with all stakeholders. Leadership must be created. The dynamics of disease epidemiology and the inherent uncertain-

ty in the dynamics must be expressed properly so that all stakeholders understand the difficulties associated with controlling the disease. The need to take an ecosystem approach to integrated disease management needs to be demonstrated. In conclusion, there are two interdependent challenges for malaria control: the development of an ecosystem approach and an integrated disease control strategy, where malaria is only one of the important health issues.

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