An ecosystemic approach to evaluating ecological, socioeconomic and group dynamics affecting the prevalence of *Aedes aegypti* in two Colombian towns

Aproximación ecosistémica para evaluar las relaciones entre ecología, factores socioeconómicos, dinámicas sociales y la presencia del dengue en dos ciudades de Colombia

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Abstract

This article focuses on the epidemiological methods and results of a global Ecohealth study that explored the complexity of the relationship between ecological, biological, economical, social and political factors and vector presence. The study was carried out in two dengue endemic areas of Colombia. A transdisciplinary team gathered quantitative and qualitative data. A survey in randomly sampled households was applied and, simultaneously, direct observation of potential breeding sites was carried out. Logistic regressions and qualitative techniques were used. Qualitative and quantitative data were compared using triangulation. The presence of low water containers increases seven-fold the risk of finding immature forms of Aedes aegypti *in the household (OR = 7.5; 95%CI: 1.7-32.2). An inverse association between socioeconomic stratum and presence of the vector was identified (Low stratum OR = 0.9; 95%CI: 0.6-1.4; High stratum OR = 0.4; 95%CI: 0.07-1.7). Water management is a complex social dynamic associated with the presence of* Ae. aegypti. *Dengue control is a challenge for public health authorities and researchers as they should address promotion and prevention strategies that take into account cultural, behavioral, socioeconomic and health factors.*

Dengue; Ecology; Aedes aegypti*; Socioeconomic Factors*

Introduction

It is estimated that 50 million people living in tropical and subtropical regions are affected every year by dengue fever, dengue hemorrhagic fever, and dengue shock syndrome [1]. Despite government efforts, dengue is still a growing problem [2]. This is the case in urban areas, particularly in Colombia [1]. Between 2000 and 2002, the number of new cases increased to reach a total of 77,000 cases. From 2003 (16,961) to 2006 (22,205) the number of cases remained high [3]. *Aedes aegypti* has a wide distribution, found in 95% of rural areas located below 1,800 meters of altitude. From the mid-1950s three serotypes have been circulating, namely DEN-1, DEN-2 and DEN-4; however, serotype DEN-3 was re-introduced in 2001 [4].

Several problems may be related to the increase in dengue in the urban areas of large cities in Colombia. In some cities, there is a failure in the continuous supply of household piped water, which compels inhabitants to store clean water. These open water containers, along with other receptacles such as tyres, cans, and flower vases, create breeding sites for *Ae. aegypti* within and near the household.

The change in the health system in the last decade has dramatically influenced the health status of the population in Colombia. Central management of health services became decentralized, and health coverage of the popu-

lation changed from public hospitals to insurance based health services, resulting in a lack of coverage of 50% amongst the poorest [5]. Social mobility and community risk perception are also determinants of vector density and vector behavior that influence the hyperendemic situation. Dengue transmission is a complex phenomenon influenced by living conditions, poverty, social inequalities and illiteracy [6]. Therefore, an Ecohealth approach [7] was implemented to assess how the aforementioned factors interact, to describe possible causal pathways, to identify avenues for future interventions and to recommend measures for intervention at all governmental levels. The goal was to understand dengue as a bio-anthroposocial event that takes into account the interaction between biological, epidemiological, social and cultural data.

This article focuses on the epidemiological and entomological methods and findings of the research project. Therefore, the results section presents socio-demographic findings, as well as knowledge, attitudes and household environmental factors particularly towards dengue in the region. These variables together with the local knowledge and cultural practices associated with dengue gives us a complex view of the reality of dengue in this region of Colombia.

Materials and methods

Study area

The study was carried out in Girardot (Cundinamarca) and Melgar (Tolima), two municipalities located in one of the three most endemic areas of Colombia. Each belongs to a different department (state) but in ethnic, geographic, climatic, and cultural characteristics, the two municipalities are otherwise homogeneous. Girardot has a total population of 138,000 inhabitants [8] and Melgar 28,596 inhabitants. They are separated by a distance of 30 kilometres, are a 2 hour-drive from Bogotá and have a daily temperature of between 25 and 30ºC, making these cities attractive tourist destinations for residents of the capital.

Study type

A cross-sectional study was carried out to assess linkages between eco-bio-social factors and the presence of the dengue vector (considered an effect variable) by using the ecosystemic approach [7] according to the conceptual framework described elsewhere [9]. Both qualitative and quantitative techniques were used. Three groups of variables with potential links to the proposed dependent variable: (1) ecological; (2) biological; and (3) social variables were explored.

Sample size

We followed the sampling method defined by the Ministry of Health [10] that follows Pan American Health Organization (PAHO) recommendations [11]. Following this method and considering the municipality of Girardot with 24,464 households divided into 8 sectors and Melgar with 5,788 households divided into 5 sectors (South, West, Northwest, Southwest and Center), we calculated the sample size by sector (Table 1). Once the sample size was defined, an updated map was obtained and consecutive numbering of each house occurred, beginning with the block located at the far northeast. By generating a random number table on Epi Info 6.4 (Centers for Disease Control and Prevention, Atlanta, United States), the first household was chosen randomly and the rest clockwise until the total number of households was attained.

Field-based data collection

A household survey was carried out between December 2004 and February 2005 using a structured questionnaire that was delivered by a trained interviewer to the head of the household residing within the study catchment area, following informed consent.

Table 1

Sample size for Girardot and Melgar, Colombia, per sector, 2005.

Municipality	Population	Number of households per sector	Sectors	Sample size
Girardot	138,000	59	8	472
Melgar	30,000	Between 55 and 59	4	286

The questionnaire was divided into two sections. The first related to socio-demographic characteristics, knowledge, attitudes and practices towards dengue. The second consisted of a checklist that collected data on risk and protective factors within the household, including vector indices.

In order to identify positive or negative households for *Ae. aegypti*, aedic indices (house index, index of water containers, Breteau index, adulta and pupae indices) were collected based on procedures established by the *Colombian National Emergency Plan for the Elimination of the Dengue Epidemic* [10].

All potential breeding sites for *Ae. aegypti* were inspected by an entomologist or technician. This vector and other species of the Culicidaes family were collected and information recorded on survey forms designed by the Ministry of Social Protection. Pupae and larvae of *Ae. aegypti* and other mosquitoes were put into small plastic jars with 70% alcohol and labeled with the municipality, sector, neighborhood, address, block, house, collector and date. The search for adult *Ae. aegypti* was done indoors and outdoors, and the subsequent capture of the mosquitoes was completed using hand-held nets and mouth aspirators. Immature forms and adults were identified using guides recommended in the scientific literature [12,13,14].

The qualitative methodology has been described in detail elsewhere [9], but a combination of social and cultural anthropological methods (focus groups, in depth interviews with key stakeholders, and direct social observations) and methods emerging from Rapid Assessment Procedures (RAP), such as Focus Ethnographic Studies were also used. The methods applied correspond to assessments that take into consideration aspects of the local reality such as time constrains, peer pressure and type of social organization. Once the community was approached, three specific data gathering methods were implemented: (1) in-depth interviews with health promoters, key stakeholders, and community members chosen by critical case sampling and snowball referral; (2) focus group discussions with health promoters and community members; and (3) direct social observation within the cities.

Data analysis

Quantitative data was double entered into databases using Excel (Microsoft Corp., United States) and analyzed using the statistic software Stata version 8 (Stata Corp., College Station, United States). Categorical variables were described using frequencies, and continuous variables were reported as means or medians (with 95% confidence intervals and standard deviations). Logistic regression models were used to explore the association between eco-biosocial factors and the presence of *Ae. aegypti*. Three outcome variables were used to explore these associations: presence or absence of immature, adult, or any forms. We assessed three different models: (1) a socio-demographic model where the following variables were included: education (with at least one year and no education categories), number of residents per household (with categories less than or equal to 5 and more than or equal to 6 inhabitants), gender and socioeconomic stratum (with three categories: low, medium and high); (2) a household environmental model that included variables all with Yes or No categories such as having a high water container, a low water container, the use of temephos (insecticide), recycling, and the use of insecticides and bed nets; and (3) a knowledge model (hearing about dengue, source of information, knowledge on forms of dengue transmission, signs and symptoms, breeding sites and methods for dengue control and prevention). Finally, we constructed the final model with variables from the results of the former analyses.

The data obtained from the three qualitative techniques was manually sorted, entered, and systematized into the computer according to the research variables set for the project and used in the instruments. The software ATLAS.ti version 5 (Muhr T. Scientific software development GmbH, Berlin, Germany) was used in order to categorize data, following content analysis.

To carry out the transdisciplinary approach we applied a multiple triangulation analysis by combining theoretical and methodological triangulations. The theoretical triangulation analysis involved the use of multiple professional perspectives to interpret our data. In order to accomplish this process we brought together people from different disciplines and individuals within disciplines: two physician epidemiologists, a sociologist-anthropologist, an entomologist, an anthropologist and psychology student and two anthropology undergraduate students. The methodological triangulation considered quantitative (cross-sectional study), meteorological, entomological and qualitative methods (medical anthropology).

Results

751 people from the 758 eligible households (99,1%) agreed to being interviewed. The average age of respondents was 42 (SD = 16.10).

The mean number of residents per household was four (SD = 3.12). 603 were women, of which 71.6% were housewives, followed by employees (22.6%), 3% students and 2.3% retired. Of 148 males, 69.4% were employees, followed by 16.8% retired, 10.1% unemployed and 3.4% students. The entomologic indices are shown in Table 2. There were 483 infested households (64.3%) with any stage of the vector, but 243 (32.4%) of these had immature forms. Figures for Girardot (83%) and Melgar (84%) show that the most important breeding site in the two cities and all sectors is the low tank.

Bivariate analysis

• Socio-demographic characteristics

We conducted bivariate analysis to assess the association of entomologic indices and the socio-demographic characteristics of respondents as shown in Table 3. Most respondents (80.2%) were women. There is an inverse statistically significant association: the higher the socioeconomic stratum the lower the risk of having any form of vector inside the house. This trend is not only statistically significant for any form (p = 0.002) but also for vector adults (p = 0.018) and immature forms (p = 0.041).

• Knowledge about dengue

Of the 751 respondents, 8.7% had never heard of dengue. The main source of information was from the radio (86.6%) and television (86.3%) followed by information from health promoters (65.4%). The most underused source of information was the "booklet" (29.7%).The majority of participants (74.3%) had received the information six or more months before the interview.

Mosquito bites are recognized by 98.1% of the interviewees as the way dengue is transmitted. "*None of us have ever been sick from dengue* (...) *but I know it is transmitted by the mosquitoes and you have to be careful if there is fever and sickness*" (Community respondent).

Most of the respondents had knowledge when asked about the signs and symptoms of dengue and the most common answers were fever (98.9%), headache (94.4%), myalgia (93%), and hemorrhages (76%). Only four respondents were not able to give any answer.

As long as the most recognized symptoms: fever, headache, and myalgia correspond to social knowledge of the disease, these signs are considered a minor affliction and do not fall into the serious category of illness. However, if the symptoms worsen, and if there is hemorrhaging, the spectrum of dengue enlarges into a new category where hemorrhagic dengue becomes a serious possibility.

"*When people have dengue the symptoms are fever, vomit, diarrhea, and low levels of blood platelets, but when they start bleeding and the diarrhea worsens that's when they go to the hospital, there they will tell you if you have dengue or hemorrhagic dengue*" (Community respondent P23, 2005).

A statistically significant association was found between having a household infested by immature forms and some independent variables for assessing knowledge, such as knowing about the form of dengue transmission. Those who knew that dengue may be transmitted by contaminated food had a statistically significant lower risk of having a positive house for immature forms (OR = 0.7; 95%CI: 0.4-0.9), and those who knew that it may be transmitted by insects like fleas, louses or flies had a risk of 1.1 (95%CI: 0.8-1.5).

648 respondents (86.4%) knew that clean stagnant water was required for the mosquito to breed, but the same respondents had a 1.6 (95%CI: 1.0-2.4) higher risk of living in a household infested with any form of the vector. On the other hand 77.1% of respondents confirmed that mosquitoes breed in sewage water systems: "*In my case, I try to keep everything clean, to clean the tank so you can clean too, the plants, to throw away the water and not have containers 'cause that's where mosquitoes come from*" (Community respondent P33, 2005).

Most respondents possessed knowledge about ways to prevent and control the dengue

Table 2

Aedes aegypti household infestation in two Colombian municipalities, 2005.

Index	Study area
Inspected houses	751
Inspected containers	2,953
House index (%)	32.4
Deposit index (%)	9.1
Breteau index	35.8
Pupae index (%)	6.1
Adult index (%)	46.3
Number of pupae found in low containers	742
Number of pupae in high tanks	0
Number of pupae in tyres	3
Number of pupae in discarded deposits	2
Number of pupae in plants	0

Table 3

Crude association between having a household infested by *Aedes aegypti* and socio-demographic characteristics in two Colombian municipalities, 2005.

Socio-demographic characteristics	n	%	Adult forms		Immature forms (larvae and pupae)	
			OR	95%CI	OR	95%CI
Gender						
Female	603	80.3	1.0		1.0	
Male	148	19.7	0.8	0.5-1.1	0.7	0.5-1.1
Education						
No education	31	4.1	1.0		1.0	
At least one year	720	95.9	0.5	0.2-1.2	0.3	0.1-0.5
Occupation						
Employed	239	31.8	1.0		1.0	
Housewife	432	57.5	1.3	0.9-1.8	1.2	0.9-1.7
Other	80	10.2	1.4	0.8-2.4	0.9	0.5-1.6
Socioeconomic stratum						
Low	615	81.9	1.0		1.0	
Medium	117	15.6	0.7	0.5-1.0	0.8	0.5-1.2
High	19	2.5	0.5	0.2-1.2	0.2	0.05-1.0
Health insurance coverage *						
Uninsured	220	29.3	1.0		1.0	
Subsidized	163	21.7	1.0	0.7-1.5	0.6	0.4-1.0
Contributory	368	49.0	1.2	0.9-1.7	0.9	0.7-1.3
Number of residents per household						
≥ 6 residents	138	18.4	1.0		1.0	
≤ 5 residents	613	81.6	0.9	0.6-1.3	0.7	0.5-1.0

OR: odds ratio estimates and confidence interval (95%CI).

* According to the Colombian health system reform of 1993, three different categories of affiliation are established. The formally employed and independent workers whose employers and themselves pay insurance (Contributory regime); the poor and indigent who do not make any insurance contribution and are covered under the subsidized regime; and individuals who are eligible for affiliation but still uninsured, known as *vinculados*, who rely on public hospitals for care [32].

vector. The most known prevention methods were "insecticide spraying" (46.2%) and "discharging water deposits" (22.6%). Only one respondent mentioned covering stored water as a method of prevention. Of those who knew that insecticide spraying was a way of controlling the vector, the risk of finding adult forms was zero. Those who knew that source reduction was a vector control measure for dengue had a 0.37 (95%CI: 0.1-0.9) risk of finding immature forms in the households compared to those who did not have that knowledge

- **Attitudes towards dengue**

Quantitative and qualitative findings support the statement that, from the population's point of view, dengue is not and has not been a major health issue. Although the majority of respondents (59.25%; 445) considered not to be at risk of coming down with dengue, if there was a neighbor with the infection, some inhabitants thought they would be at risk: "*Well, the truth is that there is a lot of dengue around here, in fact, one of our neighbors is very ill and a relative too, we don't even go there anymore, so that we don't catch it* [the disease]… *it's right there, nearby, if you want I can show you*" (Community respondent P19, 2005).

When queried about "who should be responsible for dengue control", the majority (97.4%) considered the government's health institutions, specifically referring to the Department of Health and local health secretariats, while others cited each household (95.61%) and health institutions (94.41%). There was no statistical significance for bivariate analysis when measuring the association between having a household infested by dengue (immature form or any stage), and independent variables for assessing responsibility for the occurrence of dengue. Yet, when assessing the association for in-

fested household by dengue (adults), we found a significant association between educational institution (OR = 0.7; 95%CI: 0.5-0.9) and community (OR = 0.7; 95%CI: 0.5-0.9).

- **Practices for dengue control**

The use of water and water containers has important implications for vector indices. Those who store water in lower containers have a 9.2 (95%CI: 2.2-39.0) times greater risk of being positive for immature forms in the household when compared with those who do not store water in such a way.

Taking into consideration these results, what are the control measures reported by people from Melgar and Girardot for trying to keep low tanks clean? Survey findings give interesting quantitative outcomes: out of 751 respondents, 701 (93.3%; 93) store water at home in "low water-storage container", out of which 37 (9%) cleaned the deposit once a week. In addition, 93% adequately cleaned the deposit, as they used water, soap and brushed all the walls. In the words of the community:

"*The water tank must be cleaned every two days. I wash it with a clean brush and water*". "*They have told us to clean the tank at least once a week, but to be honest, we can't clean it weekly. We clean it, sincerely; every month or maybe even longer it takes for us to clean it*" (Community respondent P63, 2005).

Higher tanks are not cleaned as often as low-domestic tanks, perhaps because they are not used daily. The only control measure that seems to be effective- is to cover higher tanks.

"*Higher tanks are always covered, but never with a chemical to avoid animals, mosquitoes or larvae, all of that, we never do that. Maybe a spoonful of chlorine but that's not the rule here*" (Community respondent P2, 2005).

With regards to measures taken to prevent mosquito bites, 74.3% (558) of respondents used insecticides, of which 231 used them occasionally. The two most common forms of insecticides used were liquid (70.6%) and spray (26%). Additionally other measures taken to prevent mosquito bites, such as bed nets, were rarely used (17.8%).

Other prevention measures included in the questionnaire were related to the actions taken towards disposable containers and waste disposal. The majority of respondents (98.5%) gave away their *discarded containers* and their garbage to the "car garbage collector". Only a few respondents (34) recycle these discarded containers. The association between having a household infested by immature forms of dengue vector and recycling was found to be not significant (OR = 0.4; 95%CI: 0.2-1.1). But for those that recycle inside the household (23), the association between having a household infested by adult forms of dengue vector was found to be significant (OR = 5.7; 95%CI: 1.1-30.5), although the power is low as seen by the wide confidence interval.

Temephos is the main chemical used for dengue control. There was no significant association when measuring a household infested by dengue vector (any stage, immature form or adult stage) and knowledge of temephos. The acceptance of chemical control is based on the conservation of water properties, such as colour and smell. Nevertheless, people comment that temephos is good, but it remains perhaps too much time in the tanks, thereby loosing its efficacy. Supporting this finding, quantitative results illustrate that including the total number of respondents, after a detailed explanation of what temephos is, 78.2% agreed to apply it. Most of the reasons given by the non-users of temephos claim that they already have fish or other animals inside the water container, and temephos can kill them.

Multivariate analysis

The analysis of the three models, as described in the methods section shows that for socio-demographic variables, education had the strongest association with having immature forms in the household, after adjusting for other socio-demographic variables (OR = 0.3; 95%CI: 0.1-0.6). As the household's socioeconomic status improves, the risk of having the vector in the household decreases. Gender and number of residents per household were not associated with the presence of immature forms (Table 2).

After adjusting for household environmental variables, there was an association between immature forms and the practice of storing water in low containers (OR = 0.1; 95%CI: 0.03-0.5). Having high tanks, using temephos and recycling were not associated with the presence of immature forms.

After adjusting for several variables about knowledge of dengue, we found that those who answered that the Secretariat of Health is responsible for dengue control activities had a 0.6 (95%CI: 0.4-0.9) risk of being positive when compared to respondents of household who did not affirm that. On the other hand the respondents who believed that the *Aedes aegypti* breeds in stagnant sewage water had a 0.6 risk (95%CI: 0.4-0.9). Furthermore, those who answered that dengue is transmitted by contami-

nated food showed a 2.0 risk (95%CI: 1.2-3.3) of having a positive house for immature forms of the vector.

The final model with variables of the three previous models (Table 3) shows five strong associations with the presence of immature forms in the household. Having at least one year of education, receiving information about dengue from the health secretariat, knowing that the vector does not breed in sewage water and not having low water containers in the household are protective factors against the presence of immature forms of the vector. By looking at the crude and adjusted effects, a no confounding effect is observed in the association with immature forms (Table 4).

Table 4

Crude and adjusted association between having a household infested by dengue in the immature stage form and protective factors in two Colombian municipalities, 2005.

Protective factors	Crude OR	95%CI	Adjusted OR	95%CI
Education				
No education	1.0		1.0	
At least one year	0.3	0.1-0.5	0.3	0.2-0.8
Residents per household				
≥ 6	1.0		1.0	
≥ 5	0.7	0.5-1.0	0.7	0.5-1.1
Socioeconomic stratum				
Low	1.0		1.0	
Medium	0.8	0.5-1.2	0.9	0.6-1.4
High	0.2	0.05-1.0	0.4	0.07-1.7
Gender				
Female	1.0		1.0	
Male	0.7	0.5-1.1	0.7	0.6-1.3
Source of information				
Not from health institution	1.0		1.0	
From health institution	0.8	0.6-1.1	0.9	0.6-1.4
Never heard about dengue	1.6	0.9-2.7	1.3	0.6-2.8
Not from health promoter	1.0		1.0	
From health promoter	0.8	0.6-1.1	1.2	0.6-1.9
Not from health secretariat	1.0		1.0	
From local health secretariat	0.6	0.4-0.8	0.6	0.2-0.9
From community groups	1.0		1.0	
Not from community groups	0.9	0.9-3.2	0.9	0.6-1.5
Knowledge of symptoms				
Do not know hemorrhages	1.0		1.0	
Know hemorrhages	0.9	0.5-1.4	1.0	0.7-1.5
Never heard about dengue	2.0	0.3-0.9	1.8	0.2-17.5
Practices				
Having high water container	1.0		1.0	
Not having high water container	0.9	0.7-1.3	0.9	0.7-1.4
No use of temephos	1.0		1.0	
Use of temephos	0.9	0.7-1.5	0.9	0.7-1.5
Having high/low water container	1.0		1.0	
Not having low water container	0.1	0.02-0.5	0.1	0.03-0.6
Having low water container	9.2	2.2-38.7	7.5	1.7-32.2
No recycling	1.0		1.0	
Recycling	0.4	0.2-1.1	0.5	0.2-1.1
No bed nets	1.0		1.0	
Bed nets	0.7	0.6-1.3	0.9	0.6-1.4

OR: odds ratio estimates and confidence interval (95%CI).

Discussion

An ecosystemic approach proved to be a useful conceptual framework that allowed for the integration of different themes that are usually treated independently. The vector and disease were no longer separate units of analysis for each discipline but were combined to ensure an intercultural dialogue between epidemiology, entomology and medical anthropology.

From an ecosystemic perspective, different links associated with the situation of the dengue vector were observed. Socio-demographic characteristics (especially socioeconomic stratum and education) are related to the presence of the vector. Those households where interviewees had at least one year of schooling showed a significantly lower risk of harboring vector forms than those with zero years of schooling. In Southern Mexico households with family heads with low education levels accumulate more containers that favor *Ae. aegypti* breeding [15].

Sanitation and control measures are simultaneously influenced by social equity and gender roles. 80 percent of respondents were women in charge of household care and hygiene. Their *savoir-faire* (when effectively transmitted to other members of the household) may influence whether others adopt these measures. A recent dengue project carried out in Puerto Rico established a prevention strategy that relies on community health workers known as promoters. Local women, who were nominated by fellow community members to be leaders, received training to help promote behavior change within the community. The strategy resulted in positive behavior change: 20 percent more households turned containers upside-down to prevent larval infestation in the intervention community than did those in other communities [16].

Biological and ecological variables also had a direct influence on the presence of the dengue vector. It was possible to see that low water tanks were the most common breeding site in the study area. Similar observations were made in other parts of Colombia and Latin America [17,18,19]. Girardot and Melgar are lowland regions whose residents have historically given water a particular status, therefore water management is central to their daily functioning. A lack of water has been a continuous problem in this region. In order to deal with this reality, people have developed social dynamics that have allowed them to store and keep water in a manner that keeps it clean. The evident result is ownership and proliferation of the low tank, which is an essential commodity that everybody must possess within their households.

The information shows that people from lower socioeconomic strata had considerably more risk of having dengue vector forms in their homes. The common characteristic in these areas was not having a house-built tank, but instead a plastic or metal container filled with water was used for laundry and storing drinking water. Higher socioeconomic strata areas used washing machines and their own water supply system. This situation enhances the invisibility of dengue for higher classes. For example, because of the presence of washing machines, people do not see why they have to take extra control measures of water deposits. Health promotion personnel see this perception as a limitation, and acknowledge that most control measures are based on the tanks; in their absence, it was difficult for them to present the link between any kind of water deposit and breeding site.

Quantitative results clearly show that the presence of the dengue vector was lower in places with higher socioeconomic stratum and education. These meaningful results can be associated with qualitative information regarding everyday perceptions of people from different socioeconomic stratum in relationship to dengue control. An entomological technician from the region states that higher class sectors present a low vector presence compared to lower stratum.

If we use the pupae index, which represents the number of pupae per 100 houses, in order to compare the relative importance of the different breeding sites, the only breeding site relevant in the production of adults were the low tanks (742 pupae collected in inspected houses) as only three pupae where collected from tyres. Our results are consistent with findings from other researchers that report that the contribution to the total number of *Ae. aegypti* larvae positive containers was high for grounded level tanks (56%) [20,21,22]. On the other hand, if we compare the immature infestation indices with adult indices, the highest infestation was found among adults, rather than larvae. These results are consistent with observations in Guaduas, Cundinamarca [17]. It is also important to note that those knowing that bed nets are a measure of prevention and those having bed nets had a lower risk of having adult vectors in their households. But when we assessed having bed nets and the presence of immature forms the risk increased, although not significantly. In this sense immature forms are not perceived as a menace, as either they are not readily visible or they are just one more element to deal with in the interviewees' daily lives.

As it was possible to observe that those who responded that dengue may be transmitted by contaminated food or by insects like fleas or

lice, or flies have a statistically significant lower risk of being positive for any stage or for adults. These results also indicate that there is a clear discrepancy between knowledge and social dynamics concerning dengue, therefore implying that knowledge does not necessarily lead to behavioral change incorporating recommended practices. Even though individuals have scientific knowledge about dengue, there is a wide array of perceptions about the disease. This fact means that there is a wide diversity of disease definitions and therapeutic itineraries used to cope with the symptoms, and these lead to social actors drifting away from public health measures. The weak relation between dengue knowledge and practice observed in our study is consistent with results from studies carried out in Grenada [23], Thailand [24] and Puerto Rico [25].

The word dengue covers a wide spectrum of definitions that vary from a mild flu to a bone breaking fever. Dengue can be controlled with cold medicine available over the counter, or, by taking care of the ill person at home, without any need for a medical consultation. Previous research carried out in Colombia [26], Mexico [27,28] and Puerto Rico [25] demonstrates that dengue is not considered a serious condition. While having a common flu-dengue or diarrhoea is not associated with being sick, the new symptomatology that involves bleeding is associated with trauma, and is given the category of illness.

Furthermore the community within the two municipalities asserted that dengue prevention should be the responsibility of government institutions, specifically referring to the Department of Health and local health secretariat, as well as the responsibilities of each household and health institution. In this sense everyone is responsible. But as the perception of dengue as a problem arises only when it is linked to one's neighbor (other than having a negative health impact) responsibility is no longer shared.

The consequence of perceiving dengue not as a major burden, and acknowledging that dengue prevention is not a joint responsibility may be associated with two issues: one related to vertically organized control programs and the second with incomplete implementation of community based programs. In the case of the latter, the community has been placed at the center, as a full time partner in the construction of programs for disease prevention and vector control [29], but as the same time it has become a policy token to legitimate and validate health interventions [30,31].

Conclusion

Alternative pathways are required to control dengue. Colombian health plans have followed the strategies of international health programs that have quickly turned sour due to social realities and global development. Although these programs are important, complementing alternative methods of intervention that incorporate models based on multidisciplinary approaches may be equally beneficial.

Resumen

Este artículo se enfoca en los métodos epidemiológicos y resultados de una investigación global en Ecosalud que exploró la complejidad de la relación entre factores ecológicos, biológicos, económicos, sociales y políticos y la presencia de Aedes aegypti. *El estudio se llevó acabo en dos áreas endémicas de Colombia. Un equipo transdisciplinario recogió y analizó información, tanto cualitativa como cuantitativa. Se aplicó una encuesta en una muestra de casas escogidas aleatoriamente. Simultáneamente, se realizó observación directa de criaderos potenciales. La articulación entre los datos cuantitativos y cualitativos se efectuó mediante triangulación. La presencia de tanques bajos aumentó el riesgo siete veces (OR = 7,5; IC95%: 1,7-32,2). Se identificó una asociación inversa entre el estrato socioeconómico y la presencia del vector (Estrato bajo OR = 0,9; IC95%: 0,6-1,4; Estrato alto OR = 0,4; IC95%: 0,07-1,7). El manejo del agua es una dinámica social compleja, asociada con la presencia de* Ae aegypti. *El control de dengue se convierte en un reto para las autoridades en salud y para los investigadores, puesto que deben desarrollarse estrategias de prevención y promoción que tengan en cuenta aspectos culturales, socioeconómicos y de comportamiento.*

Dengue; Ecología; Aedes aegypti*; Factores Socioeconómicos*

Contributors

J. Quintero, G. Carrasquilla, R. Suárez and C. González participated in the overall study concept and design, data collection and data analysis. V. A. Olano is an entomologist who participated in the identification/confirmation of *Aedes aegypti* forms and in the discussion of the results. G. Carrasquilla and J. Quintero led the design and drafting of all sections of this paper as well as the statistical analysis.

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