INAP Report #2 – Vulnerability Analysis

Judy Omumbo, IRI

ABSTRACT

Discussions and comments on the malaria and Climate Change vulnerability analysis in high malaria risk areas conducted on behalf of the INAP project
Ms. Viviana Ceron, consultant at the INS for the INAP project, visited the IRI in June, 2008. During her visit she participated in the IRI’s Summer Institute on Climate information for Public Health applications. The baseline surveys for the INAP study areas were completed by this time and Ms. Ceron had the opportunity to discuss some results of the descriptive analyses with colleagues at the IRI. The comments presented in this report were discussed with Ms. Ceron during 2 visits to the IRI and also during monthly teleconference calls between the IRI and the INAP team during 2009.

The aims of the descriptive analyses were:

a) To assess the baseline malaria prevalence and estimate the incidence by municipality.
b) To map the spatial and temporal distribution of cases by municipality.
c) To identify municipalities, neighborhoods and individual households that was associated with the most frequent outbreaks of infection based upon historical records.
d) To define selection criteria and parameters to be incorporated into a malaria transmission model that was under development by Dr. Daniel Ruiz.

Discussions with Judy Omumbo (Epidemiologist at IRI) focused on the epidemiological methods and analysis aspects of the investigation. The following conclusions and recommendations were made:

1. The populations at risk of *P. falciparum* and *P. vivax* have been defined well at the municipality level. Malaria incidence was highly focal and even within neighborhoods, outbreaks tend to recur within the same household clusters. This finding is in keeping with field observations made by the INAP survey team and led to the conclusion that local breeding site factors play a key role in maintaining transmission foci. The early warning system aims to identify potential outbreaks at the neighborhood level.

2. *P. vivax* is more prevalent than *P. falciparum* in most of the study sites. This is an important consideration for the development of a climate based transmission model\(^1\) as the relationship between climatic drivers and *P. vivax* transmission is not clear.

---

\(^1\) The often prolonged duration of infection with *P. vivax* makes the diagnosis of new cases of infection unreliable. Studies of the relationship between *P. vivax* incidence and and environmental variable are therefore unreliable. Few such studies are found in the literature and several have suggested a lack of association between rainfall and vivax (*e.g.* Han E-T. *et al.*, (2006). Re-emerging *vivax* malaria: changing patterns of annual incidence and control programs in the Republic of Korea. *Korean Journal of Parasitology*, 44: 285-294), and climatic variables and the main vectors of malaria in this region (*e.g.* Pveda G. *et al.*, (2001). Coupling between annual and ENSO time scales in the malaria-climate association in Colombia. *Environmental Health Perspectives*, 109: 489-493).
3. Prevalence of *P. vivax* always remains below 10% and of *P. falciparum* <2% - in general this is an area of low endemicity with a poorly defined seasonal cycle and a predisposition to epidemic outbreaks.

4. A well-coordinated active and passive surveillance system is already in place. However, epidemic outbreaks continue to be a problem. A need to evaluate the performance of the control program was also identified.

5. The Early Warning System needs to be able to detect and monitor localized foci of infection. It was suggested that a vulnerability analysis at the household level would be necessary to identify susceptible households.

**Summary of the vulnerability analysis:**

4 INAP pilot municipalities were selected for the vulnerability study and the indicators to measure the severity or magnitude of the impact included:

- level of immunity
- capacity for organized social response (awareness)
- prevalence of under nutrition or malnutrition
- level of drug resistance
- population migration and displacement

Analyses and tools available:

1. Cluster analysis using historical data that identified municipalities with the highest risk of infection.

2. A classification of endemicity for the pilot municipalities based on cross-sectional prevalence surveys (Table 1). (Note: It is not clear from the data why San Jose del Guaviare is classified as having stable transmission compared with the other municipalities while the data show a pattern of low transmission with intermittent spikes in incidence (See Panel 1: Graph 2)).

<table>
<thead>
<tr>
<th>Dominant parasite species</th>
<th>Buenaventura</th>
<th>San Jose del Guaviare</th>
<th>Puerto Libertador</th>
<th>Montelíbano</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>P. falciparum</em></td>
<td><em>P. vivax</em></td>
<td><em>P. vivax</em></td>
<td><em>P. vivax</em></td>
<td></td>
</tr>
<tr>
<td>Rainy season prevalence</td>
<td>0%</td>
<td>3.7%</td>
<td>5.7%</td>
<td>2.8%</td>
</tr>
<tr>
<td>Dry season prevalence</td>
<td>1.8%</td>
<td>5.8%</td>
<td>4%</td>
<td>6.8%</td>
</tr>
<tr>
<td>Endemicity</td>
<td>Unstable, Hypoendemic</td>
<td>Stable, hypoendemic</td>
<td>Unstable, Hypoendemic</td>
<td>Unstable, Hypoendemic</td>
</tr>
</tbody>
</table>
3. A more detailed analysis of risk conducted in the 4 study municipalities located in three different eco-epidemiological regions: San Jose del Guaviare, Buenaventura, Montelibano and Puerto Libertador. Involved an analysis of the Annual Parasite Index (API)* time series over 2001-2008 (4 week time scale based on epidemiological weeks) to develop a risk map. *API=total cases/population at risk by endemic municipality (N=19) and age.

4. High prevalence individuals and household clusters (with high prevalence based on historical records) were selected during a cross sectional study and mapped. (High prevalence in population >15 years old).

Panel 1: Time series of malaria cases 2000-2009

Vulnerability indicators measured included coverage of interventions (IEC materials, IRS, participation in and exposure to environmental control measures, bed net use and treatment seeking behavior), socio-economic status indicators (quality of housing, education level, availability of sanitation).
Main conclusions:

- Malaria is a very localized problem in Colombia making a strong case for a control program that can incorporate very focal targets for interventions, in this case, the municipality and neighborhood level. An early warning system (EWS) in support of such a program would need to be able to identify focal outbreaks as soon after infection as possible. The program would focus on monitoring of already identified recurrent disease foci and early detection of infections within these foci. A well developed active and passive surveillance system is already in place and such an early detection system can be incorporated into this.

- Epidemiological studies conducted by INAP to date have been intended to provide baseline information for the development of an EWS and a mathematical model to aid the understanding of transmission dynamics. The model under development is climate driven and consideration is also given to the impact of the vulnerability indicators that have been included in this analysis. As described above, the interpretation of climate driven models for the transmission of vivax malaria needs to be done with caution. Ecological and epidemiological studies may still be needed to assess the true impact of climatic variables on malaria outbreaks in the country.