Zoonoses and Climate Variability

The Example of Leishmaniasis in Southern Departments of Colombia

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Leishmaniasis in the Americas is transmitted by *Lutzomyia* spp., which have many animal reservoirs. Previous studies indicated potential changes in vectors of climate-related distribution, but impact outcomes need to be further studied. We report climatic and El Niño events during 1985–2002 that may have had an impact on leishmaniasis in 11 southern departments of Colombia: Amazonas, Caquetá, Cauca (Ca), Huila, Meta (Mt), Nariño, Putumayo (Py), Tolima, Valle (Va), Vaupes (Vp), and Vichada. Climatic data were obtained by satellite and epidemiologic data were obtained from the Health Ministry. NOAA climatic classification and SOI/ONI indexes were used as indicators of global climate variability. Yearly variation comparisons and median trend deviations were made for disease incidence and climatic variability. During this period there was considerable climatic variability, with a strong El Niño for 6 years and a strong La Niña for 8. During this period, 19,212 cases of leishmaniasis were registered, for a mean of 4756.83 cases/year. Disease in the whole region increased (mean of 4.98%) during the El Niño years in comparison to the La Niña years, but there were differences between departments with increases during El Niño (Mt 6.95%, Vp 4.84%), but the rest showed an increase during La Niña (1.61%–64.41%). Differences were significant in Va ($P = 0.0092$), Py ($P = 0.0001$), Ca ($P = 0.0313$), and for the whole region ($P = 0.0023$), but not in the rest of the departments. The importance of climate change is shown by shifts in insect and animal distributions. These data reflect the importance of climate on transmission of leishmaniasis and open further investigations related to forecasting and monitoring systems, where understanding the relationship between zoonoses and climate variability could help to improve the management of these emerging and reemerging diseases.

Key words: **leishmaniasis; vectors; reservoirs; transmission; climate variability**

Introduction

Leishmaniasis is a complex of protozoan diseases caused by species of the genus *Leishmania*. These parasites are transmitted in the Americas by *Lutzomyia* spp., mostly in endemic zones, involving many animal reservoirs.[1–3] These diseases have two main clinical types: visceral and tegumentary. Tegumentary leishmaniasis is caused by at least 14 different species of parasites belonging to the subgenera *Viannia* and *Leishmania*.[4]

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Previous Asian, European, and South American studies have indicated potential changes in climate-related vectors,[2,5–7] because vector density can be correlated to climate variables, producing seasonal patterns that have been widely described.[8–10] Vector density has been correlated with numbers of cases,[8,10] transmission is restricted to wet and forested areas,[11] and vector density diminishes with altitude.[11] Additionally it has been suggested that climate variability could influence the reservoir distribution for this disease.[2,3] Recently in northeastern Colombia we have reported that cases of leishmaniasis increased during El Niño event years, whereas they decreased during the La Niña phases.[2] However, these results, compared with others from our group in Venezuela,[11] show geographical differences (or spatial heterogeneity) in the impact of climatic changes even within geographically close areas in northeastern Colombia or northeastern Venezuela. In any case, the impact outcomes still need to be further studied and specifically characterized according to each geographic and temporal epidemiologic setting.

Materials and Methods

For this reason we compared possible climatic impacts and El Niño events during 1985–2002 on the incidence of leishmaniasis (cutaneous and visceral forms) in 11 departments in the southern region of Colombia, South America (Fig. 1). These departments were Amazonas (Az), Caquetá (Cq), Cauca (Ca), Huila (Hu), Meta (Mt), Nariño (Na), Putumayo (Py), Tolima (To), Valle (Va), Vaupes (Vp), and Vichada (Vi) (Fig. 1). All of these departments have at least one municipality with a high incidence of leishmaniasis.

Climatic data were obtained by satellite and epidemiologic data from the Health Ministry. NOAA climatic classification and SOI/ONI indexes were used as global climate variability indicators. Yearly variation comparisons and median trend deviations for disease incidence

Figure 1. Map of Colombia with the relative position and the departments included in this study.

and climatic variability were made. Linear regression models were done to assess the temporal leishmaniasis incidence variability; the effects of SOI and ONI on leishmaniasis were also studied. Statistical analyses were made with SPSS 10.0 (SPSS Inc., Chicago, IL) and GraphPad Prism 4.0 (GraphPad Software, San Diego, CA), with 95% confidence (P significance <0.05).

Results

During this period there was considerable climatic variability: strong El Niño events occurred for 6 years and there was a strong La Niña phase for 8.

In this period, 19,212 cases of leishmaniasis cases were registered in the southern departments of Columbia (Nariño 18%, Caquetá 18%, Tolima 16%, Valle 16%, Huila 11%, Meta 8%), with a mean of 4756.83 cases/year (ranging in these departments from 6.89 to 192.5 cases/year), with an increase in trend ($r^2 = 0.1866$, $F = 3.72$, $P = 0.072$) (Fig. 2).

During the El Niño years, there was a mean disease increase of 4.98% (for the whole region) in comparison to that of the La Niña years,

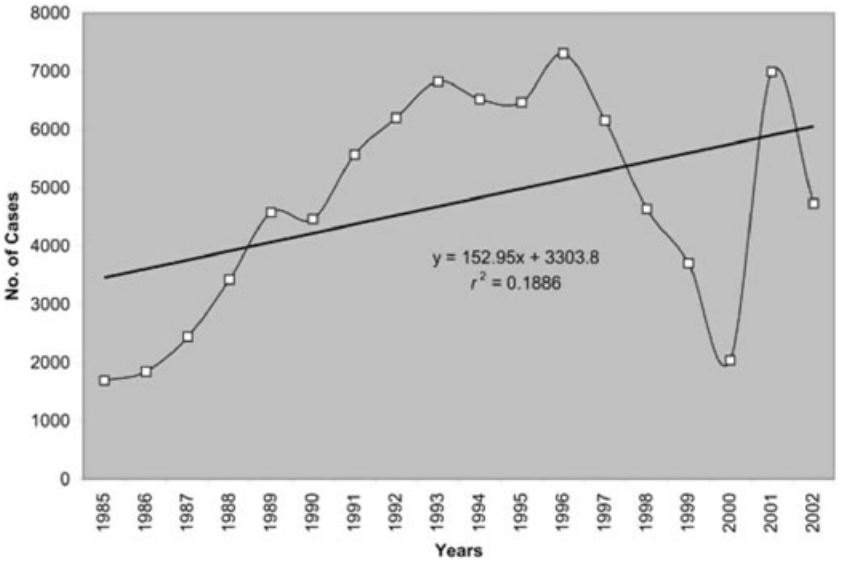

Figure 2. Trends in the incidence of leishmaniasis in Colombia during 1985–2002.

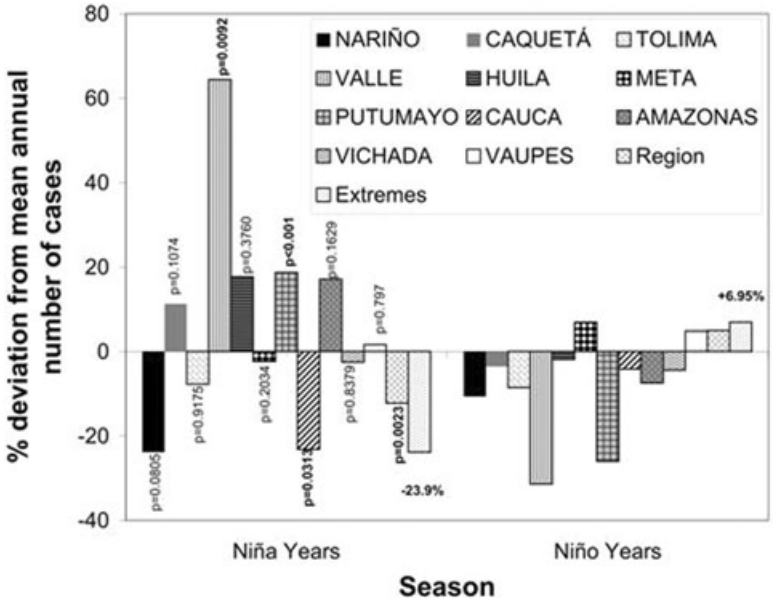

Figure 3. Comparisons of the effects of El Niño Southern Oscillation seasons on the incidence of leishmaniasis in southern departments of Colombia, 1985–2002.

but this was spatially heterogeneous with two departments showing increases during El Niño (Meta 6.95% and Vaupes 4.84%), but the rest had an increase during La Niña (ranging from 1.61% to 64.41%) (Fig. 3).

These differences were significant in Valle ($P = 0.0092$), Putumayo ($P = 0.0001$), Cauca ($P = 0.0313$), and for the whole region ($P = 0.0023$), but not in the rest of the departments ($P > 0.05$) (Fig. 3).

Discussion

Climate is changing at an unprecedented registered rate.[2,5] Shifts in insect and animal distribution indicate the importance of these changes. Climate is a relevant temporospatial vector and determinant of reservoir distribution.[5] These and other data previously presented by our group reflect the importance of climate on transmission of leishmaniasis in different areas of Colombia.[2] Additionally other authors have shown that a strong association between climate and incidence of leishmaniasis is further supported by the finding that linear models can satisfactorily forecast the incidence of this disease in some countries with an accuracy >70%. In particular, the Multivariate ENSO Index and temperature are identified as useful variables sustaining predictability for a window of 1 year[12]; this should be further studied. This is a limitation of our study in that it did not include the temperature. Longer-term data are needed to evaluate forecasting accuracy further in time.

The World Health Organization estimates that the warming and precipitation trends due to anthropogenic climate change of the past 30 years already claim more than 150,000 lives annually. Many prevalent human diseases are linked to climate fluctuations, from cardiovascular mortality and respiratory illnesses due to heat waves, to altered transmission of infectious diseases and malnutrition from crop failures.[5–7] However, now zoonotic diseases such as leishmaniasis seem to be strongly influenced in different parts of the world by climate variability.[5–10] Uncertainty remains in attributing the expansion or resurgence of diseases to climate change on account of lack of long-term, high-quality data sets as well as the large influence of socioeconomic factors and changes in immunity and drug resistance.[1,3,5,12] Day by day, the evidence grows that climate changes will pose increasing health risks and that the warming trend over recent decades has already contributed to increased morbidity and mortality in many regions of the world.

Conclusions

We and others argue for the need for more research to reduce the potential impact of climate change on human and animal health, including the development of improved methods for quantitative risk assessment,[1,7,8,10] particularly in the field of zoonotic diseases. These new epidemiologic approaches pave the way for further investigations into forecasting and monitoring systems in public health programs, where increasing knowledge of the relationship between zoonoses and climate variability could help veterinarians and other health professionals to improve the management of these emerging and reemerging diseases.[4,6,11,12]

Conflicts of Interest

The authors declare no conflicts of interest.

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