LEISHMANIASIS CONTROL STRATEGIES
A CRITICAL EVALUATION OF IDRC-SUPPORTED RESEARCH

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CIID
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This series includes meeting documents, internal reports, and preliminary technical documents that may later form the basis of a formal publication. A Manuscript Report is given a small distribution to a highly specialized audience.

La présente série est réservée aux documents issus de colloques, aux rapports internes et aux documents techniques susceptibles d'être publiés plus tard dans une série de publications plus soignées. D'un tirage restreint, le rapport manuscrit est destiné à un public très spécialisé.

Esta serie incluye ponencias de reuniones, informes internos y documentos técnicos que pueden posteriormente conformar la base de una publicación formal. El informe recibe distribución limitada entre una audiencia altamente especializada.
Leishmaniasis control strategies
Leishmaniasis control strategies: A critical evaluation of IDRC-supported research

Proceedings of a workshop held in Mérida, Mexico, November 25–29, 1991, sponsored by the International Development Research Centre, in collaboration with the Universidad Autónoma de Yucatán (UADY) and the Universidad Peruana Cayetano Heredia (UPCH)

Edited by
Pandu Wijeyaratne, Tracey Goodman
and Carlos Espinal
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Risk Factors and Leishmaniasis: Possible Contributions for Control Strategies

J. Calmet Böhme

Introduction

The risk factors originating from or represented by "classical biomedical factors" are rather easily identified in our minds, but some risk factors and their contributions are not so obvious and further work is required for their clarification. The latter are more related with social, cultural, and economic factors. The identification of these risk factors can especially contribute to the design of appropriate control strategies.

Our work has been carried out in a province of Cuzco, whose inhabitants are mainly peasants. They live at altitudes over 3,000 m.a.s.l., where there is no primary transmission of leishmaniasis. However, due to economic problems they need to go to the nearby amazon region to work in the gold mines. It is here that they are exposed to the disease. In the national context, leishmaniasis from Cuzco has historically represented near 50% of all the disease reported in Peru (Graph 1).

As a conceptual framework, we have tried to understand disease or the lack of health not only as a biological problem of individuals. We have attempted to explore leishmaniasis in its real dimension as a health problem, and particularly how society and social conditions influence the epidemiology of the disease and vice versa.

With this analytical approach, we are trying to construct an comprehensive and diachronic exploration of the epidemiology of leishmaniasis. Although schematic, such an epidemiological model can help to summarize the complex mechanisms through which the different elements and categories (both social and biological) interact and can be used to compare each reality. A complex methodological design has been needed for this approach. Different quantitative and qualitative techniques, from distinct disciplines, are to be used.

Methods and Results

This paper presents the results of the first tool we have applied in Ocongate, a district in Cuzco. After a meeting with the community presidents or their representatives in which they agreed to participate in a community survey, a community assembly was

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1 This document was originally prepared in spanish for the workshop. This translated version is a summary of the original document thanks to the invaluable collaboration of Dr. Jaime Chang Neyra of the IMT "A.von Humboldt".

2 Centro de Investigacion y Promocion Amazonica (CIPA), Av. Ricardo Palma 666 D. Miraflores, Lima 18, Peru.
GRAPH 1
OFFICIAL STATS. LEISHMANIASIS

ANNUAL REPORT RATE

YEAR

--- Leish. National  --- Leish. Cuzco
scheduled for each visit. We visited 37 communities and between 50-80% of all adults in every community came to the meetings. Each adult was asked for their migratory experience and leishmaniasis history.

In trying to make a concrete contribution to control strategies, our work aims to define the principal elements that explain and predict the epidemiology of leishmaniasis, particularly its transmission, based on the past epidemiological behaviour of the disease in this population. It also seeks to define the structure and demand for health services currently and in the future. Our team believes that the successful control of health problems must result in a balance between the demand for health services and the response to this demand by the health services.

Scheme 1 summarizes the principal hypothesis we are using for studying the epidemiology of leishmaniasis in the Ocongate region. This model was originally developed by other Peruvian researcher, Dr. Miguel Campos, and we have adapted it to the specific context of the South Andean region. Box S represents the susceptible population; people who have never had the disease or been infected, and that reside in the highland where no primary transmission of the disease occurs. Box E represents the exposed population; the people that in accordance to a migration rate go to the jungle and get exposed to leishmaniasis transmission. The migration rate depends on the economic, social and cultural factors of the highland population which is migrating. Box I (and CA) represent the population that become infected and develop cutaneous disease when they go to the jungle. They get infected in accordance to a rate we call risk for prime infection, in last instance this depends on the specific activity undertake in the jungle. Box C represents the people that suffered the cutaneous disease and, as it usually occurs, heal spontaneously in accordance to a specified recovery rate. Finally, box MA represents the population that develops mucous disease; in most cases people who have a cutaneous scar and develop the mucous form of the disease in accordance to a specific conversion rate.

The results we are presenting are gathered in relation to these hypotheses. First, we will present the conventional indicators of leishmaniasis, the incidence and prevalence of the different clinical forms of leishmaniasis found in Ocongate. This will be followed by a discussion of the direct determinants of these conventional indicators. In the case of cutaneous disease incidence, the determinants which seem to be the most important are the migration rate to the amazon region and the risks of primary infection. In the case of mucous disease incidence, it seems to depend principally on the conversion rate.

Finally we will present some advances in the identification of the indirect determinants of the epidemiology of leishmaniasis. Particularly, some socio economic factors that trigger and influence the magnitude of the variable that in some way initiates the epidemiological chain, that is, the migration rate to the jungle. We will try to identify what are the economic, social and cultural factors which characterize the migrants to the jungle.
**Scheme 1**

- **S**: Population
- **E**: Exposed Population
- **I**: Infected Population
- **CA**: Population Infected with Cutaneous Disease
- **C**: Population which heal spontaneously
- **MA**: Population with Conversion to Mucous Disease
- **F**: Death

**Characteristics of S**: Migration

**Characteristics of E**: Individual risk of primary infection

**Characteristics of I**: Characteristics of sending environment

**Characteristics of MA**: Characteristics of receiving environment

**Recovery rate**: Cutaneous disease

**Conversion rate**: Mucous
Conventional Indicators of the Epidemiology of Leishmaniasis

As anticipated from official statistics, leishmaniasis is an important health problem. Nearly one out of every six men in Ocongate has suffered the cutaneous form of the disease sometime during his life. This proportion increases to one out of every three in the group between the second and the fourth decades of life. Almost 80% of cases occurred in men between 15 and 35 years of age. On average, more than 5% of the people that were free from disease in 1985 were found to have the disease at the time of this survey and this proportion increases to 20% among men in the second and third decade of their lives.

The case of mucous leishmaniasis is no less important. Almost 5% of all men interviewed had mucous involvement sometime during their life and when men reach the fifth decade of their life, 10% of them have already had mucous disease.

Leishmaniasis in its different clinical forms is extremely rare among women. Less than 2% of the women surveyed had suffered cutaneous disease, and only two out of 1,300 women interviewed had mucous involvement.

Direct Determinants of Epidemiological Indicators

As we mentioned before, two very important determinants have been identified in relation to cutaneous leishmaniasis. The first is the migration rate, since there is no primary transmission in Ocongate. Second, the risk of primary infection, that is the probability of becoming infected or sick while remaining in the jungle. Both factors were explored in our survey in Ocongate in order to explain the epidemiology of cutaneous leishmaniasis.

Migration to the jungle from Ocongate is a very frequent event among the male population. On average more than 50% of the men have gone to the jungle at least once in their lives. This proportion increases to 80% among the population in the second and third decade of life. The male population of Ocongate, on average has migrated three times to the jungle and, currently, by the time a male reaches the fifth decade of life at which point their migratory life has probably ended, they have on average undertaken five migratory episodes to the jungle.

There are two prominent features in this migration. First, working in the gold mines is the principal reason for migration among all age groups, accounting for more than 80% of the episodes. Second, the temporal character of the migration is such that 75% of the episodes last three months or less, and another additional 20% last less than 12 months.

The history of more recent migrations indicates that one third of the male population has travelled to the jungle during the period 1985-1990, and that for some age
groups that proportion increases to two thirds. Many of the males interviewed referred to at least one migratory episode for the same quinquennium, which represents an annual migration rate close to 20%. For those aged 10-29 years that value increases steeply, reaching an annual migration rate of nearly 40%.

As it was mentioned before, the risk of primary infection (i.e. the chance of each susceptible person to get the infection/disease in a migratory event) is the other crucial direct determinant of cutaneous disease incidence. This seems to depend on the type of activities that the migrant undertakes in the jungle and on the nature of the exposure of the individual to the primary forest, the best ecological habitat for the reproduction of the zoonosis.

We have estimated the risk for primary infection for the population of Ocongate. However, we have not done a differential analysis for each attraction context. Graph 2 we present a global value of risk for primary infection for the total migratory experience of Ocongate peasants. As the mean survival curve for this variable demonstrates, when migrants reach an average of 10 migratory events the prevalence of cutaneous disease reaches 50%. That might mean a 5% probability of acquiring the disease for each migratory event.

In the case of the mucous form of leishmaniasis, the crucial direct determinant seems to be the conversion rate from cutaneous to mucous disease. Typically, after one year of disease, most of cutaneous lesions heal spontaneously. Nevertheless, after healing a proportion of healed patients develop mucous disease, basically as a metastasis of the primary lesion. The annual proportion of the infected population converting is what we call mucous conversion rate; a variable that seems to depend on the biological specificity of each ethnic group involved.

The mucous conversion rate has been calculated for the sample studied by our team in Ocongate. As it can be seen in Graph 3, the mean survival curve shows that when ten years have passed from primary infection, the accumulated prevalence of mucous leishmaniasis reaches 20%. That means that with a short confidence interval, the annual mucous conversion rate is a little more than 2%.

Interesting associations can be made relating the direct determinants with the epidemiological indicators of disease found in Ocongate. Additionally, the values found permit us to predict what are the expectations for prevalence and incidence of the different clinical forms of leishmaniasis. The most important relationships found can be seen between migration rates and the epidemiological indicators of leishmaniasis disease. In summary the age groups that have the higher values for migrants and migratory episodes over the last quinquennium are the same as those which have the higher incidence of cutaneous leishmaniasis. Therefore a strong association between both phenomenons is indicated.
GRAPH 2
TOTAL RIPLEISH

INVERSE CUTANEOUS PREVALENCE

MIGRATORY EPISODES
Graph 3
MUCOUS CONVERSION RATE

INVERSE MUCOUS PREVALENCE

0 0.2 0.4 0.6 0.8 1 1.2

0 4 8 12 16 20
YEARS
Nevertheless, the distribution by age of the accumulated prevalence of cutaneous disease calls attention. It would be logical to expect that most of the migrants to the jungle begin their migratory experience while young, i.e. with enough physical strength to tackle the hard labour conditions of gold mining. But, if young people are the most important age group that acquires the infection or disease, some explanation is needed for the fact that older age groups have a lower accumulated prevalence of leishmaniasis, a condition that by definition is not reversible.

We think that changes in the migration rate can take account for this observation. The 20% migration rate that we see today is the final result of a dynamic process over time. Men that today are aged 40 years and older were exposed to lower migration rates and therefore prevalence of disease among this group is lower. Because migration rates have been increasing over time, the younger generations have been exposed to greater migration and as a consequence have a higher accumulated prevalence of cutaneous disease.

Acceleration of the migration rate seems then to be the most important risk factor that by itself can modify the accumulated prevalence of cutaneous disease and also the accumulated prevalence of mucous disease, which depends on the former.

Accordingly, it should be expected that a higher acceleration of the migration rate will condition the occurrence (within a certain period afterwards) of higher incidences of the different forms of disease and higher accumulated prevalences, thus increasing and concentrating the impact of disease on people and the health system.

We have tried to demonstrate this effect with a mathematical simulation done in a personal computer. Stable values have been used for the principal direct determinants of both clinical forms: the maximum migration rate, the risk of primary infection, and the mucous conversion rate. We introduce different accelerations, one the double of the other. When higher accelerations of migration rates are used the slope of the curve changes, shifting left and upwards (Graphs 4 and 5).

Graphs 6 and 7 show the additional proportion of cases of leishmaniasis observed with changes in the acceleration of migration rates. When the population reaches a maximum annual migration rate of 20% in 15 years instead of in 30, the proportion of additional cases (and then the increase of disease impact and its recuperative costs) grows between 20% and 100% for cutaneous leishmaniasis and between 40% and 100% for the mucous form of the disease.

Although the principal direct determinants could remain stable in the future, including the acceleration of migration rates, the forecast for the future epidemiological situation of the disease is extremely worrying. The average number of migratory events for the male population approaching the fifth decade of life, is rapidly reaching a value which corresponds with a 50% rate of prevalence of cutaneous lesion on the mean
GRAPH 4
CUTANEOUS PREV. AND ACCELERATION

CUTANEOUS PREVALENCE

0%  10%  15%  20%

1960  1980  2000

YEAR

GRAPH 5
MUCOUS PREV. AND ACCELERATION

MUCOUS PREVALENCE

0%  1%  2%  3%  4%  5%

1960  1980  2000

YEAR
GRAPH 6
EFFECT OF ACCELERATION
CUTANEOUS CASES

GRAPH 7
EFFECT OF ACCELERATION
MUCOUS CASES
survival curve. As a result we expect that in a short time the prevalence of cutaneous disease for this age group will be 50%, meaning that one out every two peasant families will have to assume the health impact and costs of disease within their households.

The situation for the mucous form of leishmaniasis, which has a enormous social impact and recuperative costs, has a similarly bad prognosis. Almost 10% of the male population will suffer from mucous leishmaniasis by the time they reach the fourth decade of life. This means that one of every 10 peasants families will have to assume the high impact and costs of mucous leishmaniasis in their households.

**Indirect Determinants of Epidemiological Indicators**

Migration as a social process, is the result of the cross action effect of a variety of economic, social and cultural factors that in a generic way we called indirect determinants of epidemiological indicators of the disease. It is principally the historical context of South Andean societies that explains the appearance of the migratory phenomenon, and its modification over time.

In the most strict economic sense, for the migration of the Andean peasant population to the Amazon expresses the need for individuals to sell their manual labour because of the unequal terms of their access to the market economy. It is ultimately the final result of a broad range of unequal exchange relationships that denies the peasant society the benefits of urban centers, firstly of the cities in the region, then in the capital of the Republic, and finally, in the profit of the industrialized northern hemisphere.

The peasant migrates because he or she needs the salary to subsist and sustain his family. The migrant peasant is pushed to sell scarce crops at very low prices and to buy expensive manufactured goods which are needed. The generated deficit must be covered with the only asset the peasant still retains, their manual labour.

Some of the results of our research reinforce our hypothesis. The variation in migration rates that can be observed in Ocongate can be explained by the increasing deterioration in the terms of exchange for the peasant society of the region. A group of the peasant communities located in the areas of higher altitude and especially dedicated to cattle, are migrating more recently with higher rates because of the abrupt decrease in the international prices of their principal cash product: alpaca wool.

To understand the difference in migration rates and the incidence of cutaneous leishmaniasis in Ocongate we divided the community in three ecological and socio-economic habitats. Each one has some unique characteristics as shown in Table 1. The characteristics range between two extremes. On one side there are the communities of the higher elevations, which occupy the "puna" ecological levels over 4,000 m.a.s.l., dedicated to cattle, with "traditional" socio-cultural patterns, with "scattered settlement" patterns, and recent articulation with the official health service. On the other
<table>
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<th>Altitude</th>
<th>Principal Productive Activity</th>
<th>Predominant Ecological Pattern</th>
<th>Predominant Conomical Pattern</th>
<th>Predominant Socio-Cultural Pattern</th>
<th>Predominant Settling Pattern</th>
<th>Predominant Sanitary Pattern</th>
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<td>4,000-4,800 m.s.n.m.</td>
<td>Cattle: Auguenids (Alpaca)</td>
<td>Ecological floor: - Suni alto/puna</td>
<td>Principal Productive Activity:</td>
<td>- In general, more &quot;traditional&quot;</td>
<td>- Of scattered type, rural</td>
<td>- Recent articulation with official health services</td>
</tr>
<tr>
<td>3,700-4,000 m.s.n.m.</td>
<td>Combine: - Cattle (auquenid, sheep) - Agriculture (potatoe)</td>
<td>Ecological Floor: - Suni bajo</td>
<td>Intermediate pattern</td>
<td>- Intermediate pattern</td>
<td>- Combine type, semiurban and rural</td>
<td>- Intermediate pattern</td>
</tr>
<tr>
<td>3,300-3,700 m.s.n.m.</td>
<td>- Maize - Barley</td>
<td>Ecological Floor: - Quechua</td>
<td>Principal Productive Activity:</td>
<td>- In general more &quot;modern&quot;</td>
<td>- Concentrated type, semiurban</td>
<td>- Old articulation with official health services</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Agriculture:</td>
<td>- Little emphasis in production for &quot;self-consumption&quot;</td>
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SUMMARY OF GRAPHS No. 9
JUNGLE MIGRANTS 85-90

PROPORTION OF MIGRANTS

CUTANEOUS INCIDENCE

PROPORTION CUTANEOUS LESION
GRAPH 10
WOMEN MIGRANTS 85-90

PROPORTION WOMEN MIGRANTS 85-90

AGES

Comunidades altas
Comunidades medias
Comunidades bajas
extreme, there are the communities of lower elevations, which occupy the "suni" ecological levels, above 3,000 m.a.s.l., dedicated to agriculture (especially to maize and potato production), with "modern" social-cultural patterns, concentrated or semi-urban settlement patterns, and an established articulation with official health services.

In the summary Graphs 9 we first present the age distributions of the recent migratory experience. Although, on average the three groups of communities exhibit the same values for recent migrants, it can be early noticed that in the case of the communities of high elevation the average age of migrants seems to be lower. That is, age groups that because of their youth could only migrate in the last period. From this we can say, that the configuration of the curves of recent migration suggest that the communities of higher elevation will be migrating more intensely than the other groups of communities. The fact seems to be confirmed in the last graph of this summary where we can clearly see the higher incidence of cutaneous disease among communities of higher elevations, especially among their younger inhabitants.

The similarities in the recent migration experience (curves) and incidence of disease for the different groups of communities, seems to be related to economic changes that occurred recently. Usually the group of communities which had greater migration rates were the ones from the lower elevation due to the low prices of their cash crops. In the past, the good price of alpaca wool used to protect communities of the higher elevations from the need to migrate. However, the abrupt fall of alpaca wool prices has recently push the latter community group to migrate to the jungle. We expect that this change will cause a rapid increase of the incidence and prevalence of leishmaniasis, creating a need for specific control measures.

Graph 10 shows the distribution by age of female migrants in the three group of communities. The proportion of female migrants is considerable higher for the low and medium altitude communities. It appears that some kind of limit to male migration is being reached in some communities. Since these communities cannot expel more male population to the jungle and still sustain vital agricultural activities in the highlands, they instead expel women and youngsters, even children, to get the income their families need.

Conclusions

Some preliminary conclusions can be made from the results presented regarding to control strategies for leishmaniasis in the South Andean region of Peru.

1. In the first place, leishmaniasis has been demonstrated to be a major public health problem in the region, especially among the male population of economically active age. In the short term, about one out of every two households will have suffered the impact of cutaneous disease and one out of every ten households will have suffered the effect of mucocutaneous disease.
Specific control strategies for solving the problem should be developed promptly, because both the social impact and the recuperative cost of the disease are cumulative.

2. Temporal migration for gold mining is the direct determinant most closely related to incidence of the disease. The magnitude of this migratory phenomena is huge, reaching annual migration rates of 20% in Ocongate with the migrants being predominantly young males. Any sustained positive modification of leishmaniasis incidence will depend upon improving social and economical opportunities, which require specific political decisions. Changes in migration rates occur differently for different communities, and as a consequence the occurrence of leishmaniasis is greater in some communities in which both the impact of disease and its recuperative costs tend to concentrate over time.

3. Sanitary education should be a vital part of any control strategy in order to develop a collective awareness of the problem, and also to create a collective willingness to change the conditions that make the problem occur, including those factors which are social and economic. For this, an active and horizontal exchange of knowledge and experiences between the different social actors, community members and leaders, health and social scientists, authorities, etc. needs to be stimulated.

4. It is urgent to establish control interventions which diminish the expected incidence of disease with high efficiency and efficacy if the overall impact of leishmaniasis is to be reduced, taking into account social and economic factors.