A LONGITUDINAL STUDY OF INFANTILE HELMINTHIASIS IN AN INDIGENOUS GUATEMALAN HIGHLAND VILLAGE

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ABSTRACT

Thirty-two infants from a highland Indian village in Guatemala were observed for two years (1967-1969) to ascertain the initiation and subsequent history of intestinal helminthiasis, to evaluate the role of environmental and dietary factors, and to determine the relationship between seasonal variation and the levels of intensity of helminthiasis. The relationship of diarrheic intervals and ontogeny to parasitosis were observed.

INTRODUCTION

In most pre- and in some highly-industrialized societies intestinal helminthiasis remains a major health problem. The effects of adult helminthiasis in tropical areas are relatively well known yet few data exist relative to the course of the disease and its effects in infants and children. The prevalence of helminthiasis within a given tropical population does not necessarily indicate the actual levels of parasitosis since many individuals rarely exhibit symptoms (Biaggi, 1963), and remaining untreated, constitute a significant reservoir for continuing infection. The prevailing socio-economic conditions in under-developed countries also favor the propagation and transmission of infectious organisms (de Rodriguez and Portillo, 1960; Arce Paiz, 1967; DeWitt and Weinstein, 1964).

Wide-spread malnutrition, characteristic of impoverished populations, diminishes host-resistance (Scrimshaw et al., 1959). The significant demographic increase among the lower socio-economic groups has also contributed to the increased incidence of helminthiasis (Meneghelli and Razzarini, 1967). In certain tropical zones intestinal helminthiasis is of common occurrence in both urban and rural environments.

Most published reports on intestinal helminthiasis in Guatemala are the results of qualitative and quantitative surveys or field projects designed to test the efficacy of specific anthelmintics (Garcia, 1929; Santa Cruz, 1933; Erdmenger, 1959; Aguilar, 1958, 1963; Aguilar and Cifuentes, 1962; Aguilar et al., 1959; Melgar, 1960; Pierce et al., 1962). These studies have been complemented by others of a national scope (INCAP, 1969). Recent investigators, however, have attempted to define the role of environmental and cultural factors in the perpetuation of helminthiasis (Mata et al., 1969).

In the current study 32 infants from a highland indigenious village, Santa María Cauqué, were observed for two years (1967 through 1969) to ascertain the initiation and subsequent history of helminthiasis, to evaluate the role of environmental and dietary factors in the course of the disease, and to determine the relationship between seasonal variation (dry and wet) and the levels of intensity of parasitosis. A review of the literature indicates that previous studies were either single or multiple surveys (temporal or transverse). To my knowledge the present investigation is the first longitudinal (time-depth) analysis of infantile intestinal parasitosis.

HELMINTHOLOGICAL STUDIES IN GUATEMALA

Muniz (1902), obtaining data from governmental sources, reported 167 (1900) and 260 (1901) deaths attributable to Ascaris lumbricoides, the higher mortalities occurring in the rainy seasons. Garcia (1929) determined the order of frequency in Guatemala as: Ancylostoma duodenale and Necator americanus, Trichurus trichiura, A. lumbricoides, Enterobius vermicularis, Taenia saginata, and T. solium.

Shattuck (in Aguire, 1952) reported 94% of the inhabitants of the Department of Petén infected, the more common species being T. trichiura, A. lumbricoides, and N. americanus. Nationally, 6,858 juvenile deaths were attributable to intestinal parasites. Wyss (1946), determining the country-wide frequency of E. vermicularis in two temporal surveys, obtained incidence levels of 57% and 67%. The highest incidence (70%) occurred in children six to 14 years old.

Valenzuela (1948) reported the frequency of taeniais for a two-month period as: Hymenolepis nana (67.7%), T. saginata (31.8%), and T. solium (6.9%). Taenia solium and T. saginata were more common in adults, H. nana in children. Aguillar (1952), examining school-age children in five Indian villages, reported the following distribution: A. lumbricoides (84%) T. trichiura (35%), E. vermicularis (0.6%), N. americanus (2%), T. saginata (1%), H. nana (1%), and Strongyloides stercoralis (0.6%). Aguillar (1958) determined that 80% of the rural and 22% to 48% of the urban population harbored A. lumbricoides.

A recent survey (INCAP, 1969) revealed that 14% of the inhabitants of Guatemala City were infected with A. lumbricoides, 3% with T. trichiura, and 2% with unciniaisis. In rural areas infections were significantly higher: A. lumbricoides (50%), T. trichiura (18%), and unciniaisis (10%). The intensity of infection was low in both groups. The highest intensities occurred at altitudes of 600 to 870 and 1,200 to 1,470 meters. The greatest intensities of unciniaisis were encountered under 900 meters. Unciniaisis, trichiuralis, and ascarias decreased in frequency and intensity with increasing altitude. Infections of A. lumbricoides decreased markedly above 1,800 meters.

* Translated from Spanish and edited by Charles M. Fugler, Department of Biology, University of North Carolina at Wilmington, Wilmington, North Carolina 28401.
* Translator's note: This contribution is illustrative of current research undertaken in certain scientific institutions in Latin America. They should be brought to the attention of investigators not conversant with Spanish-language scientific publications and Latin American research institutions.
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The infants were scantily clothed, often without lower garments, and were invariably shirtless. The diet, quantitatively deficient in protein, consisted of taro, coffee and small quantities of fresh vegetables.

The fecal samples collected in half-joint containers were, for an hour of evacuation, preliminary processed by personnel of the Division of Microbiology, INCAP, and quantitative analyses were made in INCAP laboratories.

Ova were quantified by the Stoll-Haascher method (Stoll and Haascher, 1926). The intensity of infection (worm burden) of ascariasis and trichuriasis were arbitrarily classified according to the number of ova per gram weight of fresh feces (Table 2).

### TABLE 2: Intensity of Infection

<table>
<thead>
<tr>
<th>Species</th>
<th>Light</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. lumbricoides</td>
<td>100-9,900</td>
<td>10,000-39,900</td>
<td>40,000-99,900</td>
</tr>
<tr>
<td>T. trichiura</td>
<td>10-2,900</td>
<td>3,000-9,900</td>
<td>10,000-29,900</td>
</tr>
</tbody>
</table>

Three intestinal helminths were identified in the fecal samples: A. lumbricoides, T. trichiura, and H. nana.

The intensity of infection of A. lumbricoides and T. trichiura, based on the analysis of 384 samples, are shown in Table 3. Because the Stoll-Haascher method proved quantitatively inadequate, similar evaluation of H. nana was deleted (Belding, 1965). Light and moderate infections of A. lumbricoides were more frequent in the samples examined. Severe were seen. Of the 62 samples positive for T. trichiura all were classified as light infections.

### TABLE 3: Intensity of Infection of Two Helminth Species Based on the Analysis of 384 Fecal Samples

<table>
<thead>
<tr>
<th>Species</th>
<th>Light</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. lumbricoides</td>
<td>156 (41.6%)</td>
<td>118 (31.6%)</td>
<td>79 (20.1%)</td>
</tr>
<tr>
<td>T. trichiura</td>
<td>62 (16.5%)</td>
<td>8 (2.1%)</td>
<td>4 (1.1%)</td>
</tr>
</tbody>
</table>

To analyze the intensity of infection by age and to permit continued observations throughout the study the following age-month cohorts were arbitrarily established: 12-23 (I), 24-35 (II), 36-47 (III), and 48-59 (IV). To analyze possible seasonal variation of infection and intensity in relation to age increments the following monthly subdivisions were arbitrarily established: May-August (A), September-December (B), and January-April (C). The variation in the intensity of infection of A. lumbricoides, based on the month-cohort and seasonal variations, is shown in Table 4.

In I light (12%) and moderate (40%) levels were most frequent. Seasonal variation was not observable because the month-cohort included only during A and B of 1967. In II light and moderate infections were approximately equal. Seasonal variation was slight except in A, 1968, in which light infections increased significantly (27%). Severe infections, although of low order, were present in all month-groups except A, 1968. In III light parasitism dominated although severe infections occurred. The maximum severe infection (36%) occurred in C, 1968. Light infections were most frequent in IV and moderate infections decreased.

The frequency of positive samples increased with age, in I, 24% of the samples were positive; in II, 75% to 80%; in III, 80% to 95%; and, in IV, 82% to 87%. The highest seasonal frequency occurred in C, 1968.

Light infections of T. trichiura were quantified during the period of observation (Table 4). In I infections were not diagnosed. In II the highest levels obtained in A, 1967, and 1969, the frequency of infection rose to 35% in III, C, 1968.

In IV variation was slight: 36% in C, 1969.

During the observational period all infants were intermittently infected. There was no apparent correlation between periods of diarrhea and intensity of infection. The history of an infant with frequent diarrhea and an intensity of infection varying from light to severe is charted in figure 1.
The onset and subsequent history of ascariasis was observed in two groups of three infants whose ages varied from 17 to 23. The course of infection is shown in figures 3 and 4. Similar histories of infection are compiled in figure 5. Table 7 shows the observed incidence and seasonal variation of *H. nana*.

Antihelmintics (dirate of piperazine) were administered to nine infants, six being given single dosages and three single dosages on two occasions. The results varied widely (Table 6). Infant II experienced a decrease and infant 79 an increase in intensity of infection. Six infants were negative prior to treatment.

**TABLE 6:** Intensity of Infection of *A. lumbricoides* Before and After Administration of Antihelmintics

<table>
<thead>
<tr>
<th>Infant Number</th>
<th>Before Treatment</th>
<th>After Treatment*</th>
<th>2 months post-treatment</th>
<th>4 months post-treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Severe</td>
<td>Light</td>
<td>Light</td>
<td>Moderate</td>
</tr>
<tr>
<td>12</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Severe</td>
</tr>
<tr>
<td>18</td>
<td>Light</td>
<td>Negative</td>
<td>Negative</td>
<td>Light</td>
</tr>
<tr>
<td>24</td>
<td>Negative</td>
<td>Negative</td>
<td>Moderate</td>
<td>Negative</td>
</tr>
<tr>
<td>32</td>
<td>Negative</td>
<td>Negative</td>
<td>Negative</td>
<td>Light</td>
</tr>
<tr>
<td>59</td>
<td>Light</td>
<td>Moderate</td>
<td>Negative</td>
<td>Moderate</td>
</tr>
<tr>
<td>69</td>
<td>Negative</td>
<td>Negative</td>
<td>Negative</td>
<td>Negative</td>
</tr>
<tr>
<td>88</td>
<td>Light</td>
<td>Negative</td>
<td>Negative</td>
<td>Light</td>
</tr>
<tr>
<td>88</td>
<td>Light</td>
<td>Negative</td>
<td>Negative</td>
<td>Negative</td>
</tr>
</tbody>
</table>

* Antihelmintics administered by parents outside of dosage regimen

**TABLE 7:** Levels of Intensity of Infections of *Hymenolepis nana*

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>12-23</td>
<td>0/24</td>
<td>0/7</td>
<td>0/6</td>
<td>2/24</td>
<td>0/41</td>
<td>0/36</td>
<td>2/24</td>
<td>48</td>
</tr>
<tr>
<td>24-35</td>
<td>1/37</td>
<td>0/41</td>
<td>0/36</td>
<td>2/24</td>
<td>0/41</td>
<td>0/36</td>
<td>2/24</td>
<td>48</td>
</tr>
<tr>
<td>36-47</td>
<td>0/16</td>
<td>0/28</td>
<td>0/37</td>
<td>0/37</td>
<td>0/41</td>
<td>3/36</td>
<td>0/37</td>
<td>0/37</td>
</tr>
<tr>
<td>48-59</td>
<td>1/10</td>
<td>1/12</td>
<td>1/12</td>
<td>1/16</td>
<td>1/16</td>
<td>5/28</td>
<td>1/16</td>
<td>1/16</td>
</tr>
</tbody>
</table>

The number indicates the number of infants diagnosed positively, the denominator the number of infants examined. The figure beneath the fraction, multiplied by 100, indicates the variation in the ova count per 100 grams of fresh feces.

**FIG. 2:**

Relationship of body weight and levels of intensity of infection. Solid line indicates variation in the intensities of infection; the dashed line body weight and the interrupted line the standard weight gain anticipated.

**FIG. 3:**

Case histories of three infants illustrating the relationship of age increments and severity of infection of *A. lumbricoides*. The interrupted line represents infant 3-376-24-09, solid line infant 3-376-23-08, and dashed line infant 3-376-24-09.

**FIG. 4:**

Case histories of three infants illustrating the relationships of age increment and intensity of infection of *A. lumbricoides*. Interrupted line represents infant 3-376-23-10, solid line infant 3-376-23-10, and dashed line infant 3-376-24-08.

**FIG. 5:**

Case histories of three infants illustrating the relationships of age increment and intensity of infection of *T. trichura*. Interrupted line represents infant 3-376-24-08, dashed line infant 3-376-23-10, and solid line infant 3-376-24-07.

**DISCUSSION**

The Stoll-Hausheer technique, permitting a longitudinal study of variation of the level of intensity of helmintiasis, contains inherent deficiencies. It excludes infections of less than 100 ova per gram weight of fresh feces, and the presence of young adults, males and non-reproductive females. A second methodological deficiency is that the worm-burden can only be approximated (Ben-Ari, 1926). Antihelmintics and environmental factors may induce changes in the ova-producing cycles not detectable by this technique. This method does not permit identification of *S. stercoralis* and *E. vermicularis*.

A high frequency of *A. lumbricoides* (79%) and a relatively low frequency *T. trichura* (16%) and *H. nana* (4.6%) were recorded. The absence of Necator and Ancylostoma may be attributable to ecological factors. Optimal temperatures for embryonation (22°C to 27°C) are not attained at the study site, the daily temperature varying from 10°C to 25°C. Temperatures of 20°C may be briefly reached at mid-day. Embryonation and development of the infective larvae require high humidity and specific soil conditions not present at the study site. Annual rainfall is low and the soil is usually dry and powdery. The infrequent consumption of pork, rare in the indigenous diet, may account for the absence of teniasis.

Melvin and Mata (1971) demonstrated almost 100% infection of *A. lumbricoides* and *T. trichura* among all age groups in Santa Maria Cauqué (Stoll-Hausheer method). Two months after the cessation of the rainy season severe levels of ascariasis were found in 32% of the population. In spite of the environmental severity apparently suitable ecological conditions exist during the most rigorous seasonal variant for the perpetuation of the ascarid and trichurid life cycles.

A transverse (temporal) survey of 39 rural communities demonstrated that the frequency of ascariasis decreases above 1,800 meters (INCAP, 1969). At this altitude and above only light infections of trichuriasis were found. The frequency of infection was relatively high (18%) in Guatemala City (1,350 meters approximately), its low frequency in Santa Maria Cauqué may be related to low humidity and temperature and to other factors.

For reasons as yet uncertain the magnitude of infection in infants of the same month-coboth varied widely. The ova counts from individual infants varied widely. The variations are apparently unrelated to age increments, month-coboths, or population sample, although some variation is attributable to methodology (Santa Cruz, 1933). The observed variation may reflect successive infections or increased host resistance. Infections tend to decrease in intensity at four years of age, after which 85% are classified as light, perhaps indicating a certain level of immunity (Olliver-Conebales, 1960). In that no correlation between diarrhea and number of ova is indicated, it is conceivable that some infants, having survived nutritional risks between the ages of one and four years, resist and subsequently diminish the intensity of infection through acquired immunity.

Antihelmintics did not effect the course of the disease, possibly because of inadequate dosages or frequent reinfestation.

**ACKNOWLEDGMENTS**

Appreciation is extended to Dr. Leonardo Mata, Director of the Division of Microbiology, INCAP, under whose direction this study was undertaken. His continued advice and criticisms permitted the study to be concluded satisfactorily. Appreciation is also due to the personnel of the Division of Microbiology, INCAP, Dr. Julián Urbina, Seta, Bertha García and Sen. Joaquin de Hernández, Dr. Raúl Fernández and Dr. Roberto Rosales, whose assistance in this study was invaluable.
LITERATURE CITED


TAS EXECUTIVE COMMITTEE TO MEET FEBRUARY 7

The executive committee of the Tennessee Academy of Science will meet Friday, February 7, 1975, at 7:00 p.m. in the Walnut Room of Hill Student Center, George Peabody College for Teachers. Parking space is provided behind Hill Center off 18th Ave., South.