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A LONGITUDINAL STUDY OF INFANTILE HELMINTHIASIS IN AN INDIGENEOUS 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 helminhiasis, 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 prevalance of helminthiasis within a given tropical population does not necessarily indicate the actual levels of parasitosis since many individuals rarely exhibit symptoms (Biagi, 1963), and remaining untreated, constitute a significant reservoir for continuing infection. The prevailing socio-economic conditions in under-developed countries also favor the propogation and transmission of infectuous organisms (de Rodriguez and Portillo, 1960; Arce Paíz, 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 (Meneghello and Rhizzardini, 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 antihelminthics (García, 1929; Santa Cruz, 1933; Erdminger, 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 indigeneous 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 betwen 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

Muníz (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. García (1929) determined the order of frequency in Guatemala as: *Ancyostoma duodenale* and *Necator americanus, Trichiurus trichiura, A. lumbricoides, Enterobius vermicularis, Taenia saginata,* and *T. solium.*

Shattuck (in Aguirre, 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 taeniasis for a two-month period as: *Hymenolepis nana* (67.7%), *T. saginata* (31.8%), and *T. solium* (0.9%). *Taenia solium* and *T. saginata* were more common in adults, *H. nana* in children. Aguirre (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%). Aguilar (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 infested with *A. lumbricoides,* 3% with *T. trichiura,* and 2% with uncinariasis. In rural areas infections were significantly higher: *A. lumbricoides* (50%), *T. trichiura* (18%), and uncinariasis (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 uncinariasis were encountered under 900 meters. Uncinariasis, trichiuriasis, and ascariasis decreased in frequency and intensity with increasing altitude. Infections of *A. lumbricoides* decreased markedly above 1,800 meters.

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† 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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PROCEDURE

The study site selected was the village of Santa María Cauqué, Department of Sacatepéquez, whose 1,200 inhabitants belong to the Maya-Cakchiquel linguistic family (Mata et. al., 1969). The village was chosen because it presented certain characteristics requisite to the success of the investigation: (1) environmental factors apparently favoring the prevalence and dispersion of helminthic infections; (2) relative physical and social isolation from other indigenous and Ladino villages; (3) absence of significant migration from the village to the western tropical lowlands at harvest times; (4) high level of cooperation through previous exposure to programs administered by the Instituto de Nutrición de Centro América y Panamá.

The villagers are subsistance agriculturalists, whose primary crops are maize (*Zea*) and species of frijol (*Phaseolus*). Dwellings characteristically consist of one or two small, poorly-ventilated, rooms, the floors of which are hard-packed earth. Water for cooking, drinking, and bathing is drawn from communal wells. Few houses possess indoor sanitary facilities, infants and children normally urinating and defecating within the house, near the single entrance, or at the rear of the dwelling.

Santa María Cauqué, 37 kilometers north by road of Guatemala City, is at an elevation of 1,870 meters. In the immediate area rainfall averages 27.5 centimeters per year; the daily temperature ranges from 0°C to approximately 25°C; and the relatively humidity varies from 46% to 64% annually.

Two groups of infants were chosen randomly for the study (Table 1). The first groups (14 infants) ranged from 17 to 23 months and the second group (18 infants) from 24 to 35 months at the initiation of the investigation. At the termination of the study the ages varied from 39 to 45 and from 46 to 57 months.

TABLE 1:

Age and Sex of the Infant Population Sample at Santa Maria Cauqué

Number of Infants		Age in Months	
Sex		Initiation of Study	Termination of Study
Female	Male		
5	9	17-23	39-45
7	11	24-35	46-57

The infants were scantily clothed, often without lower garments, and were invariably shoeless. The diet, qualitatively and quantitatively deficient in protein, consisted of tortillas, coffee, beans, atole (an indigeneous drink of hot pulped corn) and small quantities of fresh vegetables.

The fecal samples, collected in half-pint containers within an hour of evacuation, were preliminarily processed by clinical personnel of the Division of Microbiology, INCAP. Qualitative and quantitative analyses were made in INCAP laboratories.

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

TABLE 2:

Intensity of Infection

Species	*Light*	*Moderate*	*Severe*
A. lumbricoides	100-9,900	10-15,000	50,000+
T. trichiura	100-2,400	2,500-2,900	3,000+

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

The intensities of infection of *A. lumbricoides* and *T. trichiura*, based on the analysis of 384 samples, are shown in Table 3. Because the Stoll-Hausheer method proved quantitatively inadequate, similar evaluation of *H. nana* was deleted (Belding, 1965). Light and moderate infections of *A. lumbricoides* were most frequent in the samples examined; 7% were severe. Of the 62 samples positive for *T. trichiura* all were classified as light infections.

TABLE 3:

Intensities of Infection of Two Helminth Species Based on the Analysis of 384 Fecal Samples

Species	Number and Percentage of Positive Samples*			Total Percentage
	Light	Moderate	Severe	
A. lumbricoides	156 (41%	118 (31%)	29 (7%)	79%
T. trichiura	62 (16%)	8	0	16%

* 29 samples negative

TABLE 4:

Age and seasonal variations in the intensity of Infections of A. lumbricoides

	1967 May-Aug. (A)	Sept.-Dec. (B)	Jan.-April (C)	1968 May-Aug. (A)	Sept.-Dec. (B)	1969 Jan.-April (C)
			12-23 months (I)			
Light	11(46%)	1(14%)				
Moderate	3(12%)					
Severe	0	0				
Total	14(58%)	1(14%)				
Samples Examined	24	7				
			24-35 months (II)			
Light	12(32%)	15(37%)	14(39%)	16(67%)		
Moderate	13(35%)	15(37%)	12(33%)	1(8%)		
Severe	3(8%)	1(2%)	3(8%)	0		
Total	28(75%)	31(76%3	29(80%)	18(75%)		
Samples Examined	37	41	36	24		
			36-47 months (III)			
Light		9(56%)	8(29%)	14(38%)	18(44%)	12(33%)
Moderate		2(12%)	9(32%)	4(11%)	3(7%)	2(5%)
Severe		4(25%)	10(36%)	12(32%)	12(29%)	16(44%)
Total		15(93%)	27(97%)	30(81%)	33(80%)	30(82%)
Samples Examined		16	28	37	41	32
			48-59 months (IV)			
Light					9(56%)	13(46%)
Moderate					0	1(4%)
Severe					5(31%)	9(32%)
Total					14(87%)	23(82%)
Samples Examined					16	28

TABLE 5:

Age and Seasonal Variation in the Intensity and Infections of T. trichiura

	1967 May-Aug. (A)	Sept.-Dec. (B)	Jan.-April (C)	1968 May-Aug. (A)	Sept.-Dec. (B)	1969 Jan.-April (C)
			12-23 months (I)			
Light	0	0				
Moderate	0	0				
Severe	0	0				
Total	0	0				
Number of Infants	24	7				
			24-35 months (II)			
Light	5(14%)	2(5%)	4(11%)	3(13%)		
Moderate	0	0	0	0		
Severe	0	0	0	0		
Total	5(14%)	2(5%)	4(11%)	3(13%)		
Number of Infants	37	41	36	24		
			36-47 months (III)			
Light		1(6%)	10(35%)	9(24%)	9(22%)	5(14%)
Moderate		0	0	0	0	0
Severe		0	0	0	0	0
Total		1(6%)	10(35%)	9(24%)	9(22%)	5(14%)
Number of Infants		16	28	37	41	36
			48-59 months (IV)			
Light					2(13%)	10(36%)
Moderate					0	0
Severe					0	0
Total					2(13%)	10(36%)
Number of Infants					16	28

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 (46%) levels were most frequent. Seasonal variation was not observable because the month-cohort occurred 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 (67%). Severe infections, although of low order, were present in all month-groups except A, 1968. In III light parasitoses 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, 58% of the samples were positive; in II, 75% to 80%; in III, 80% to 93%; in IV, 82% to 87%. The highest seasonal frequency occurred in C, 1968.

Light infestations of *T. trichiura* were quantified during the period of observation (Table 4). In I trichiurids were not diagnosed. In II the highest levels obtained in A, 1967, and 1968. 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 intermittantly diarrheic. 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.

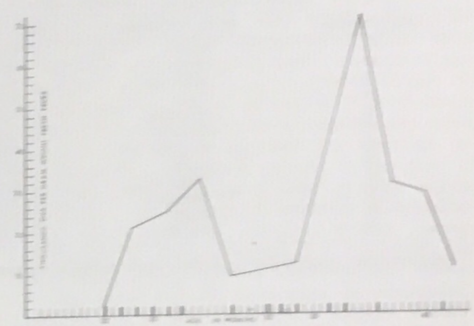

FIG. 1:

Intensity of A. lumbricoides and the occurrence of diarrheic episodes. Periods of diarrhea represented by black bar on abscissa. Less than 10,000 ova per gram weight of fresh feces indicate light infestations; 10-50,000, moderate; more than 50,000, severe. Solid line connects intensities of infection.

No apparent relationship exists between the intensity of infection and general body weight. An individual history in which the severity of infection varied greatly is shown in figure 2. Body weight increased gradually although the infant suffered intermittant episodes of diarrhea.

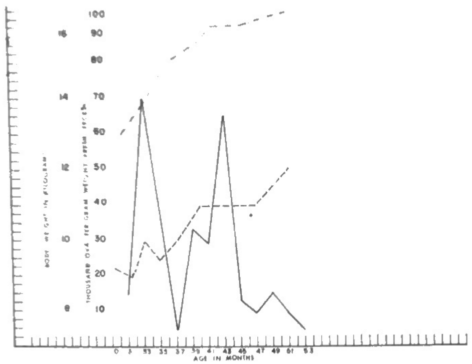

FIG. 2:

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.

Antihelminthics (citrate 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 59 an increase in intensity of infection. Six infants were negative prior to treatment.

The onset and subsequent history of ascariasis was observed in two groups of three infants whose ages varied from 17 to 23 and from 24 to 35 months. The course of infection is shown in figures 3 and 4. Similar histories of trichuriasis are composited in figure 5. Table 7 shows the observed incidence and seasonal variation of *H. nana*.

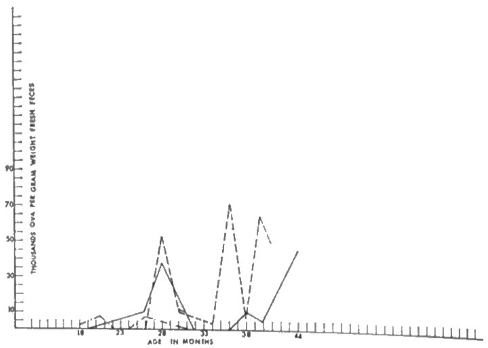

FIG. 3:

Case histories of three infants illustrating the relation of age increments and intensity of infection of A. lumbricoides. The interrupted line represents infant 3-176-24-09, solid line infant 3-193-01-13, and dashed line infant 3-069-08-09.

TABLE 6:

Intensity of Infection of A. lumbricoides Before and After Administration of Antihelminthics

Infant Number	Before Treatment	After Treatment*	2 months post-treatment	4 months post-treatment
11	Severe	Light	Light	Moderate
12	Moderate	Severe	Severe	Severe
12	Moderate	Negative	Light	Moderate
18	Light	Negative		
24	Negative	Negative		
42	Negative	Light	Moderate	
52	Negative	Negative	Negative	Light
59	Light	Moderate		
69	Negative	Light	Negative	
69	Negative	Negative	Moderate	
88	Light	Negative	Negative	Negative
88	Negative	Light		

* Antihelminthics administered by parents outside of dosage regimen

TABLE 7:

Levels of Intensity of Infections of Hymenolepis nana

Age in Months	1967 May-Aug.	Sept.-Dec.	Jan.-April	1968 May-Aug.	Sept.-Dec.	1969 Jan.-April
12-23	0/24	0/7				
24-35	1/37	0/41				
	162		0/36	2/24		
36-47		0/16	0/28			
48-59				0/37	0/41	3/36
					1-10	1-1.2
					1/16	5/28
					48	1-175

The numerator 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.

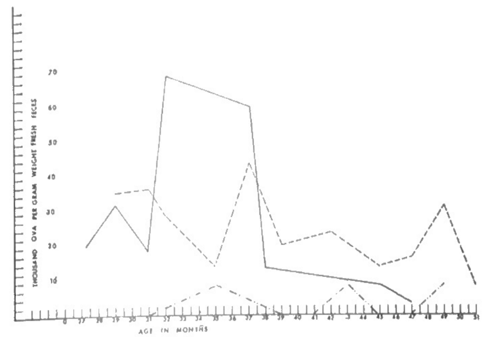

FIG. 4:

Case histories of three infants illustrating the relationships of age increment and intensity of infection of A. lumbricoides. Interrupted line represents infant 3-051-10-12, solid line infant 3-139-1710, and dashed line infant 3-079-08-08.

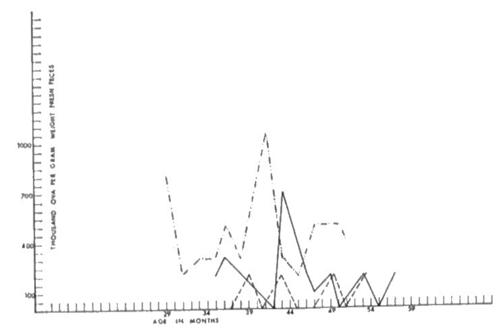

FIG. 5:

Case histories of three infants illustrating the relationship of age increments and the levels of intensity of infection of T. trichiura. Interrupted line represents infant 3-079-08-08, dashed line infant 3-122-13-06, and solid line infant 111-24-07.

DISCUSSION

The Stoll-Hausheer technique, permitting a longitudinal study of variation of the level of intensity of helminthiasis, 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). Antihelminthics 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. trichiura* (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 37° 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 indigeneous diet, may account for the absence of taeniasis.

Melvin and Mata (1971) demonstrated almost 100% infection of *A. lumbricoides* and *T. trichiura* among all age groups in Santa María 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 trichiurid 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 trichiuriasis were found. The frequency of infection was relatively high (18%) in Guatemala City (1,350 meters approximately), its low frequency in Santa María Cauqué may be related to low humidity and temperature and to other factors.

For reasons as yet unascertained the magnitude of infection in infants of the same month-cohort varied widely. The ova counts from individual infants varied widely. The variations are apparently unrelated to age-increments, month-cohorts, 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 (Oliver-Gonbales, 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.

Antihelminthics did not effect the course of the disease, possibly because of inadequate dosages or frequent reinfection.

ACKNOWLEDGEMENTS

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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.