

INTESTINAL HELMINTHIASES IN ECUADOR: THE RELATIONSHIP BETWEEN PREVALENCE, GENETIC, AND SOCIOECONOMIC FACTORS

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Prevalence of infection with the intestinal helminths, Ascaris lumbricoides, Trichuris trichiura, Ancylostoma duodenale and Strongyloides stercoralis was examined in 632 residents of communities in Esmeraldas province of Ecuador. These communities were divided into two groups according to area of habitation which reflected different socioeconomic circumstances. Attempts were made to correlate infection status with race and ABO blood group phenotype. The racial groups included blacks, Chachi amerindians, and mixed-race mestizos. Greater prevalences of infection were seen in the area of lower socioeconomic status. No racial or blood group associations with helminth infection were seen controlling for socioeconomic status.

Key-words: Helminth parasites. Race. ABO blood group phenotypes. Socioeconomic status.

Gastrointestinal helminthiasis are an important cause of morbidity worldwide and affect a large proportion of mankind³. The factors that control susceptibility to geohelminthiasis in man are poorly understood but include host behaviour, immunity, genetics, and nutrition.

The evidence for a role for genetic factors in determining susceptibility to intestinal helminth infections is largely epidemiological. For example, there is some evidence of a familial predisposition to high or low worm burdens⁶. Genetic associations with infection status may be examined at the population level using simple genetic markers such as race and blood group.

Racial differences in the prevalence, and the course and outcome of disease have been documented in infections with hookworm¹³, pinworm⁵, onchocerciasis¹⁵, and leishmaniasis¹⁴. Many such studies suffer from the disadvantages of comparing populations from different geographical regions, making it impossible to control for confounding factors such as level of exposure and nutritional status.

There has been renewed interest in the role of the ABO blood group system in determining susceptibility to parasitic and bacterial infections.

Individual ABO phenotypes have been associated with susceptibility to lymphatic filariasis¹¹, giardiasis¹, cholera⁴, and malaria¹².

An opportunity to study the relative importance of genetic and socioeconomic factors in intestinal helminthiasis exists in the Santiago river basin of Esmeraldas province in Ecuador. Here, three racial groups inhabit a rain forest area in close proximity to each other; indigenous Chachi amerindians, blacks (of African descent), and mixed-race mestizos. Racial differences in disease prevalence between Chachilla and blacks have already been reported in malaria¹⁰, yaws⁸, and onchocerciasis⁷.

This study was performed to investigate the importance of genetics, using the markers of race and blood group, and socioeconomic status in determining the prevalence of intestinal helminthiasis in the Santiago river basin.

MATERIAL AND METHODS

Study area and population

The province of Esmeraldas (latitude 1°96 S to 1°43 W and longitude 78°48 W to 80°9 W) is the northwestern coastal province of Ecuador. This region where the elevation ranges approximately 0-200 metres, occupies 14,710 km² and has a population of 285,600 (1982 census).

The Santiago river basin is composed of several large rivers and their tributaries in the northern

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coastal part of the province, municipal of Eloy Alfaro. The area is primarily equatorial rain forest.

The study was conducted in communities living in this area. These communities include; indigenous amerindians, the Chachilla; blacks (of african descent); and mestizos of mixed european, indian, and african ancestry. Most families in this region are engaged in agriculture, logging, or fishing. The ethnographic features of these communities have been described elsewhere⁹.

The study area included Borbon (the principal town at the confluence of the rivers that form the Santiago River Basin) and rural villages which were accessible by either river or dirt road. The study area was divided into two: Area 1 (higher socioeconomic status) was Borbon and area 2 (lower socioeconomic status) included a total of 56 villages. Inhabitants of Borbon were wealthier than those from area 2 and had access to education and health facilities. Most households in Borbon had rudimentary sanitary facilities, electricity, and access to clean water. These were absent in area 2.

Sample collection and analysis

A single blood sample and stool sample were obtained from individuals in the study communities. To obtain and analyse these samples laboratories were set up at health centres in Borbon for area 1 and Zapallo Grande for area 2. A total of 296 were selected in area 1 and 336 in area 2. A field team spent a total of 3 weeks in area 1 followed by 3 weeks in area 2 collecting and analysis samples. In Borbon, members of the community were encouraged to attend the health centre where samples were taken and examined immediately. In area 2, the team visited the villages by canoe and brought back approximately 50 volunteers daily (selected randomly) to Zapallo Grande where samples were taken and examined fresh. A data sheet was filled in for each patient which included information on age, sex, race, and address.

Stool suspensions were examined in saline and lugol's iodine by direct microscopy using low and high power. Three smears (each for saline and iodine) were examined from each individual for the presence of eggs or larvae of intestinal helminths. The direct method of stool examination was used as

the formalin-ether concentration method¹⁵ offers little advantage in sensitivity over this method in areas of high helminth prevalence (Guevara, unpublished data).

Only infection with the 4 commonly found intestinal helminths were reported in this study. These were *Ascaris lumbricoides*, *Trichuris trichiura*, hookworm, and *Strongyloides stercoralis*. The hookworm species identified in this study according to egg size was *Ancylostoma duodenale*. This is the dominant species found along the west coast of South America². All individuals infected with intestinal helminths were offered appropriate antihelminthic treatment.

Blood samples were obtained by venepuncture of antecubital veins using sterile vacutainer (Becton Dickinson, New Jersey, USA) sets. Red cells were tested for ABO blood group antigens using the test tube method.

Consent

Ethical consent for this study was obtained by consultation of community leaders and the Chachi Federation and also from the Ethical Committee, Hospital Vozandes, Quito.

Statistical analysis

Statistical analysis was performed using Minitab statistics programme on an Apple-Macintosh computer. Individuals with missing data were excluded from the analysis. Statistical associations were measured using Pearson's Chi-square. Statistical significance was taken as a probability of less than 0.05.

RESULTS

Population characteristics

A total of 632 participants were included in the analysis. These comprised 398 (63.8%) blacks, 67 (10.6%) mestizos, and 167 (26.4%) Chachilla. The study population was composed of 314 (49.7%) males and 318 (50.3%) females. The age range was 4-88 years.

Population distribution

There was a skew in the racial distribution of the study population between the two study areas. Most blacks lived in area 1 (60.3%) and the mestizos (68.7%) and Chachilla (79.0%) lived mainly in area 2.

Blood group phenotypes

This is best examined according to race. The distribution of blood group phenotypes was similar between blacks and mestizos with 70.6% and 62.7% respectively being blood group O, 14.6% and 19.4% group A, 13.1% and 14.9% group B, and 1.8% and 3.0% group AB. Almost all the Chachilla (98.8%) were blood group O with only 2 (1.2%) being group B. There were no Chachilla with groups A or AB.

Helminth prevalence

A total of 480 (75.9%) of the study population were infected with at least one helminth species. Infection rates for individual helminth species were as follows; *A. lumbricoides* 368 (58.2%) infected, *T. trichiura* 320 (50.6%), *A. duodenale* 158 (25.0%), and *S. stercoralis* 37 (5.9%).

Race and helminth prevalence

Prevalence rates tended to be higher in mestizos and Chachilla than in blacks (Table 1). This was true of combined infection ($\chi^2=11.5$ df=2, $p<0.01$) and infection with *A. lumbricoides* ($\chi^2=9.1$ df=2, $p<0.05$) and *A. duodenale* ($\chi^2=21.3$ df=2, $p<0.001$). These racial differences were not statistically significant in infections with *T. trichiura*. In the case of *S. stercoralis*, prevalences were too low to detect any differences.

Blood group and helminth prevalence

Blood group associations were seen in infection with *A. duodenale*. Groups O and AB were seen more commonly in infected individuals ($\chi^2=9.7$ df=3, $p<0.05$). Infection rates with this parasite according to blood group are shown in Table 2. Only 9 individuals were group AB.

Area and helminth prevalence

Prevalence rates were higher in area 2 than area 1 (Table 1). This was true of combined infection ($\chi^2=66.8$ df=1, $p<0.001$), *A. lumbricoides* ($\chi^2=7.0$ df=1, $p<0.01$), *T. trichiura* ($\chi^2=25.8$ df=1, $p<0.001$), and *A. duodenale* ($\chi^2=21.3$ df=1, $p<0.001$). *S. stercoralis* was more prevalent in area 1 (not significant).

Area, race, and helminth prevalence

Analysis of helminth prevalence by race in the two areas showed markedly higher prevalences in all races in area 2 (Table 1). These differences were not statistically significant in infections with *A. lumbricoides*. *S. stercoralis* was more prevalent in area 1 in blacks and mestizos (not significant).

There were no inter-racial differences in helminth prevalence in neither area 1 nor area 2 (Table 1). This was true for combined and individual helminth infections.

Area, blood group, and helminth prevalence

The blood group O and AB associations with *A. duodenale* infection were confounded by area. If the prevalence of *A. duodenale* infection is examined according to blood group in areas 1 and 2, the associations disappear (Table 2). The finding of 100% prevalence in individuals with group AB in area 2 is difficult to interpret as only 2 individuals had this blood group.

DISCUSSION

Area of habitation was the major factor determining helminth prevalence. Infection rates for most helminths were higher in area 2 than area 1. These findings were very strongly statistically significant. *Gut helminth transmission is likely to be greater in area 2 as this area is characterised by poor access to health care and education, and by the absence of clean water and sanitation and the irregular use of footwear. The study participants were and sanitation and the irregular use of footwear. The study participants were not questioned about antiparasitic medication which might account for some reduced prevalence in area 1 due to better*

Table 1 - Helminth infection prevalence according to racial group and area of habitation.

Race	Area	Number	Combined	Al	Tt	Ad	Ss
All groups							
	1	296	61.2	52.7	39.9	8.8	7.1
	2	336	89.4 ***	63.1 **	60.1 ***	39.3 ***	4.8
	T	632	76.0	58.2	50.6	25.0	5.9
Blacks							
	1	240	60.8	50.8	40.8	8.3	6.3
	2	158	88.0 ***	58.2	59.5 ***	36.1 ***	2.5
	T	398	71.6	53.8	48.2	19.4	4.8
Mestizos							
	1	21	57.1	57.1	28.6	4.8	19.1
	2	46	91.3 **	73.9	60.9 *	37.0 **	8.7
	T	67	80.6	68.7	50.8	26.9	11.9
Chachis							
	1	35	65.7	62.9	40.0	14.3	5.7
	2	132	89.4 ***	65.2	60.6 *	44.0 **	6.1
	T	167	84.4	64.7	56.3	37.7	6.0

T = total; Combined = all 4 helminths; Al = *A. lumbricoides*; Tt = *T. trichiura*; Ad = *A. duodenale*; Ss = *S. stercoralis*
 Test statistic of comparison of prevalences between areas 1 and 2 are shown
 (1 degree of freedom): * p < 0.05 ** p < 0.01 *** p < 0.001

Table 2 - Prevalence of *A. duodenale* infection according to blood group and area.

Blood group	Both areas		Both areas		Both areas	
	n°	%	n°	%	n°	%
O	135/488	27.7	17/198	8.6	118/290	40.7
A	11./71	15.5	5./44	11.4	6./27	22.2
B	9./64	14.1	3./47	6.4	6./17	35.3
AB	3./9	33.3	1./7	14.3	2./2	100.0
Total	158/632	25.5	26/296	8.8	132/336	39.3

access to health facilities.

Populations surveys have provided empirical data relating to racial differences in prevalence of a number of helminths^{5 7 13 15}. Racial differences in disease prevalence has often been cited as evidence for genetic control of susceptibility. Interpretation of such data is complicated by the many environmental differences that may influence these such as level of exposure, nutrition, and intercurrent infection. In this study these factors were controlled as well as possible. In each area, the 3 racial groups shared the same environment and were of similar nutritional status and were likely to be exposed to similar levels of infection with gut helminths as

well as other infectious diseases.

The apparent racial differences in helminth prevalence seen in this study were strongly confounded by area of habitation. For example, prevalence rates were higher in mestizos and Chacilla than in blacks for combined infection, *A. lumbricoides*, and *A. duodenale*. However, when analysed by area, all racial differences were lost.

A number of studies have looked for broad disease associations between disease prevalence and outcome and blood group phenotypes at the population level in parasitic infectious^{1 11}. Our results showed possible associations of blood groups O and AB with infection with *A. duodenale*. It is

possible that the group AB association is valid but numbers were too small to exclude an area effect. The group O association was strongly confounded by area: The proportion of individuals with blood group O was higher in all races in area 2 where *A. duodenale* prevalence was much higher. In addition, the Chachis, who lived predominantly in area 2, had the highest prevalence of *A. duodenale* and were almost exclusively group O.

This study illustrates the importance of controlling for socioeconomic circumstances in epidemiological investigations of geohelminthiasis. Area of habitation was a good indicator of both socioeconomic factors and the level of geohelminth transmission and prevalence. If the study area had not been divided into two to reflect these differences, a number of spurious associations between race and blood group and helminth prevalence would have been seen.

These findings do not preclude a role for genetics in susceptibility to gut helminths. The use of prevalence studies to detect racial and genetic determinants of infection status with helminths, though useful, may be of limited power in revealing such associations. The use of simple genetic markers such as race and blood group may be too crude to detect valid genetic associations. Alternatively, the very strong influence of environment demonstrated in this study may have masked weaker associations of race or blood group.

RESUMO

A prevalência de infecções com helmintos Ascaris lumbricoides, Trichuris trichiura, Ancylostoma duodenale e Strongyloides stercoralis foi examinada em 632 pessoas em diferentes comunidades na Região de Esmeraldas no Equador. Estas comunidades foram divididas em dois grupos conforme a área na qual residem, o que reflete diferentes circunstâncias sócio-econômicas. Intentou-se correlacionar os tipos de infecção com a raça e os grupos sanguíneos ABO. Nestes grupos raciais estão incluídos negros, ameríndios Chachi, e mestiços. Notou-se a prevalência de infecções nas áreas sócio-econômicas mais baixas. Não se encontrou nenhuma relação com a infecção helmíntica e raça ou grupo sanguíneo depois de controlar-se o status sócio-econômico.

Palavras-chaves: Parasitos helmintos. Raça. Grupo sanguíneo ABO fenótipo. Status sócio-econômico.

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