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Original Article

The prevalence of *Hymenolepis nana* in schoolchildren in a bicultural community

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ABSTRACT

The aim of this study was to detect the presence of *hymenolepis* in a sample of 150 schoolchildren between 6 and 14 years of age and establish the relationship between the infection and (i) their nutritional state and (ii) availability of basic services in the child's dwelling.

Materials and Methods. The consent of the parents was obtained. The coprological specimens were analyzed by the zinc sulphate method at 1: 180. A questionnaire was completed to discover the services available in their dwellings. The children were weighed and measured to calculate their BMI (Body Mass Index).

Results. Thirty five children (23.3%) were infected with *Hymenolepis*. Thirty four (22.6%) presented *H. Nana*, one (0.7%) *H. diminuta*. The association between *H. nana* and school grade was significant ($p > 0.027$). The Odds Ratio (OR) of having *H. nana* and being undernourished was 1.4 (a 60% probability). Having *H. nana* and lacking basic services showed an OR of 2. Having *H. nana* together with I. Buestchlii and being underweight was significant ($p< 0.035$). Other findings: 112 children presented parasites, sixty nine (74.7%) presented multiparasitism. School grade showed a significant association with *Entamoeba histolytic* ($p< 0.006$) and *Escherichia coli* ($p< 0.014$).

Conclusions. The prevalence of *H. nana* was high. The correlation between school grade and the disease was very significant. Enteroparasites (*E. Histolytica*, *E. coli*, *I. buestchlii*) associated with *H. nana* affected the BMI. The underweight children indicated nutrition problems. The lack of basic services, together with makeshift dwellings, favours infections. All these factors predispose children for deficient development and high morbidity-mortality.

Key Words: *Hymenolepis nana*, nutrition, basic services

RESUMEN

La prevalencia de *Hymenolepis nana* en alumnos de una comunidad bicultural

Objetivo. Detectar la presencia de *Hymenolepis nana* en una muestra de 150 niños, entre 6 y 14 años, y buscar la relación entre la infección y 1) su estado nutricional y 2) la presencia de servicios básicos en la vivienda.

Materiales y Métodos. Se obtuvo el consentimiento de los padres. Se analizaron las muestras de materia fecal mediante la técnica de sulfato de zinc 1:180. Se aplicó un cuestionario sobre los servicios disponibles en la vivienda. Se obtuvieron peso y talla para calcular el índice de masa corporal (IMC).

Resultados. Los niños infectados con *Hymenolepis* fueron 35 (23.3%): 34 (22.6%) por *H. nana* y 1(0.7%) por *H. diminuta*. La asociación entre

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H. nana y grado escolar resultó significativa p<0.027. Odds ratio (OR) de tener malnutrición e *H. nana* fue 1.4 (probabilidad de 60%). La falta de servicios básicos y tener la infección mostró OR de 2. El bajo peso e infección con *H. nana* y *I. büestchlii* resultó significativo (p< 0.035). Otros hallazgos: 112 niños presentaron parásitos, 69 (74.7%) multiparasitismo. Las asociaciones del grado escolar con *E. histolytica* (p <0.006) y *E. coli* (p <0.014) fueron significativas

Conclusiones. Hubo alta prevalencia de *H. nana*. La correlación entre grado escolar y la infección fue significativa. Enteroparásitos como *E. histolytica, E. coli* y *I. buestchlii* asociadas con *H. nana* afectaron el IMC. El bajo peso de los niños en estudio indica un problema de nutrición. La falta de servicios básicos, junto con condiciones precarias de vivienda, favorecen la transmisión de las infecciones. Lo anterior predispone a un deficiente desarrollo y alto índice de morbi-mortalidad infantil.

Palabras clave: *Hymenolepis nana,* nutrición, servicios

INTRODUCTION

Intestinal infections caused by enteroparasites continue to be a public health problem in Mexico, especially in the child populations of rural areas. They are the cause of chronic and acute diseases which can be fatal. In Mexico State they are fourth most important cause of infant mortality (1). *Hymenolepis nana* (*H. nana)* is one such. This is a cestod which flourishes in temperate and warm areas and is frequently found in children living in closed institutions (2). However, it has not received much attention, despite being the most common cestod infection. Internationally, reported frequencies vary from country to country: 9.9% in India, (3) 7.2% in Morocco, (4) 0.1% in Libya, (5) 11.3% in Ecuador (6) and 13.1% in Thailand (2). The parasite has been little studied in Mexico, as the few epidemiological reports demonstrate. Recently, frequencies from 10 % to 23 % (7, 8) have been noted.

H. nana is the only cestod which does not require an intermediate host. Man is both the final and the intermediate host simultaneously. That is, both the larva phase and the adult tapeworm are to be found in the same host. The infection is acquired by ingesting *H. nana* eggs from food, the hands and fomites.

H. nana is a flat worm measuring from 30 to 40 mm. in length by 1mm. wide. The head or scolex measures about 300µ. It is equipped with 4 suction pads and a retractable rostellum having 30 or 40 hooks in the crown. After this come the immature, mature and gravid proglottids. When these disintegrate in the intestine, the eggs are liberated. These are spherical, measuring from 30 to 45 µm, with a thick, translucent membranous shell which contains a hexacanthic embryo in its interior. This is surrounded by an internal membrane with thickenings at each end from which 4 to 8 polar filaments emerge. The eggs are infectious from the moment that they are liberated and can survive in the outside environment for more than 10 days. The accidental ingestion of the egg liberates the oncosphere in the intestine. This penetrates the vellus where it converts into a cysticercoid larva which reaches its adult state in about 18 days. The eggs hatch in the intestine, originating new infections. Clinically, *H. nana* infection is usually asymptomatic and chronic. The symptoms are more frequent in preschool and primary schoolchildren. These symptoms include abdominal pain (colic), meteorism, nausea, vomiting, and diarrhoea, loss of appetite (anorexia), itching, irritability, sleeplessness and enuresis. In severe infections, diarrhoea is more frequent, associated with malabsorption syndrome which results in weight loss (9). Recently Mohammad (10) reported that the presence of the cestod reduced the intestinal absorption of vitamin B12 and folic acid which resulted in the development of anaemia. Diagnosis is based on the isolation of the eggs in excrement.

The aim of this study was to detect the presence of one kind of taeniasis (*Hymenolepis*) in a population of 150 apparently healthy

schoolchildren in a bicultural community and analyze the relationship between infection, the nutritional state of the child and the availability of basic services in the child's dwelling.

MATERIALS AND METHODS

The study area

Ixtlahuaca, the administrative centre of the municipality of the same name, lies in the north-west of Mexico State. It is 32 km north of Toluca, between 19°28´06´´ / 19°44´03´´ of the northern latitude and 99°40´43´´ / 99°54´59´´ longitude west. The municipality has an area of 336.48 km^2, a temperate humid climate, an average annual temperature of 14.8° and average precipitation of 828.4 mm. The number of schoolchildren between the ages of 6 and 14 is 1042, of which 539 are males y 503 females (11). A high proportion of the population belong to the Masahua indigenous group and are thus either bicultural or have only a marginal insertion in the majority Spanish-speaking culture, one fifth (20.6%) of the population speak mazahua as their first language. Pregnancies in this area are characterized by slow foetal growth, gestation problems and low birth weight (1). Only 40.6% of the population have access to main drainage.

The study design

During March 2007 a cross-sectional descriptive study aimed to search for *H. nana* in a sample of 150 schoolchildren from the Venustiano Carranza Primary School between the ages of 6 and 14 was carried out. Not one of these children had been the subject of a previous coproparasitic analysis. A questionnaire was applied which included some sections on the general data of the children and others on aspects associated with the infection by *H. nana*. Thus, included were: identification number, name, age, gender, school grade, characteristics of dwelling and the presence or absence of drinking water, main drainage and latrines. The study was based on the results of a preliminary sample.

Ethical considerations

Meetings were held with the parents, teachers and pupils in which they were informed of the health risks associated with parasites. The protocol of the investigation was explained to them and they were invited to participate. They were informed of its aims and benefits (a free diagnosis for the child). The consent of the parents was obtained to carry out the study. They were instructed in the way to obtain the faecal material and given the materials necessary for its collection. The treatment was to be the responsibility of the parents and the health centre.

Evaluation of the nutritional state of the child

This was established by finding the weight/height relationship of each child. The parameters of Quetelet (12) and the World Health Organization (13) (WHO) were used.

The Body Mass Index (BMI) was obtained on the premises of the school by the authors, who have been trained to measure these traits.

BMI. This correlates the weight of an individual to his /her height, using the following equation: The index of Quetelet= Weight in kilos/ height in meters

The child was placed in the centre of the platform of the (height and weight measuring) scale (Toledo) and not permitted to move. A new piece of paper was placed on the platform for each child. He/she was weighed in light clothing, without shoes, with his/her heels and back touching the vertical bar behind them, feet together and legs straight. The external auditory conduit and the lower edge of the orbit were parallel to the ground. The horizontal bar rested on the scalp. Height was determined to the nearest centimeter. Weight was taken to the nearest 100 grams. The machine was calibrated after every fifth child.

Collection of samples

A clean wide-mouthed flask with a screw top was given to each participant. This was labelled with the name and grade of the child and contained

50 ml. of formol at a dilution of 10% in an isotonic saline solution at 0.85%. The parents collected the samples of faecal material in the home using plastic spatulas. The samples were placed in portable ice boxes to take them to the laboratories of the Universidad Autónoma Metropolitana: Xochimilco in Mexico City.

Coprological analysis

In the Human Parasitology Laboratory each sample of faecal material was analysed individually using the zinc sulphate method at 1:180. Preparations were made directly from the sample of supernatant and stained with lugol´s solution for their analysis using optical microscopes at 100 and 400 magnifications. The parasites were identified by their morphology (9).

Statistical analysis

The information was organized and codified using SPSS V15.0 (Statistical Package for the Social Sciences). Fisher´s exact test was used when associating the variables. These were: age, gender, school grade, nutritional state and presence or absence of parasites. Others were materials of dwelling (mud brick, brick, wood, plastic sheeting for roofs, earthen or cement floors), defecation (external earth latrine, in the open air on the ground or W.C) and sources of drinking water (wells, shared taps, piped water). Correlations, graphs and tables were constructed which permitted a quantitative description of the study population. The calculation of Odds Ratio (OR) (14) was used to complement the other statistical analyses. This allowed us to calculate the probability of being infected with *H. nana* and (I) the nutritional state of the child and (II) the basic service variables of drinking water, latrines and characteristics of dwelling.

RESULTS

The sample consisted of 150 schoolchildren between the ages of 6 and 14 (14.4% of the population of this age group, a representative sample) of which 87 (58%) were female and 63 (42%) male. The average age was 8.3 years. The study sample was divided into 5 groups according to school grade and age. The 5th and 6th grade were taken together as there was no significant difference in their ages ($p>0.05$)

Figure 1 shows the association between the school grade and the age of the children ($p=0.0000$).

The prevalence of *H. nana* was high. Thirty five subjects presented *Hymenolepis* (23.4%). Of these, thirty four (22.7%) presented infection by *H. nana* and one (0.7%) infection by *H. diminuta.*

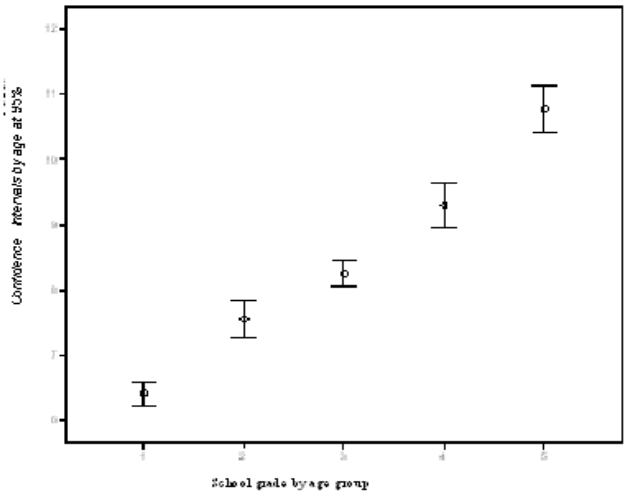

Figure 1. Age distribution of the children by school grade. School grade and age show a significant association (p=0.0000)

In Figure 2 it can be seen that there is an association between the presence of *H. nana* and school grade in children between the ages of 6 and 8 ($p<0.027$).

Table 1 shows that 121 children (80.6%) presented a BMI below the parameter of 18.50 which the WHO establishes as normal. Hence various degrees of malnutrition are present. Only one fifth of the children can be considered to have a normal BMI. The risk of being infected with *H. nana* and being undernourished shows an OR=1.4.

Table 2 shows that, of the 24 children infected by *H. nana and* other parasites, 21 were underweight. Being underweight and being infected with *H. nana* and *I. buestchlii* was significant ($p<0.035$).

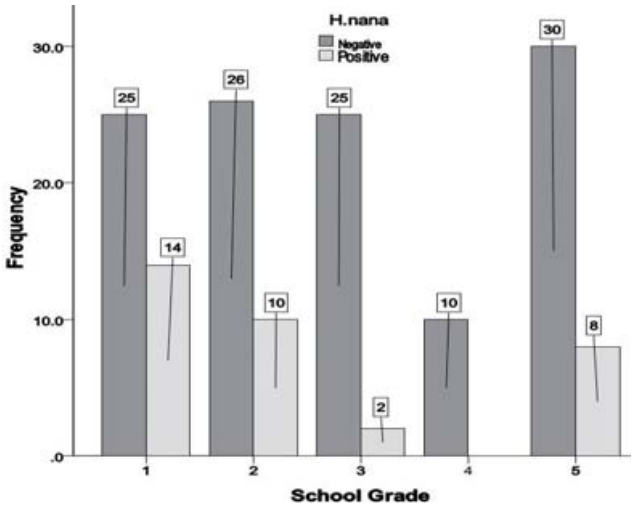

Figure 2. Age, school grade and presence of *H. nana*. Statistical association p < 0.027

Table 2
BMI of 24 children with *H.nana* and other parasites. Ixtlahuaca, Mexico State 2007

Classification	BMI (kg/m²)	*H. nana* and other parasites
Severe thinness	<16.00*	14
Moderate thinness	16.00-16.99*	3
Mild thinness	17.00-18.49*	4
Normal range	18.50-22.99	3
Total		24

Source: Adapted from WHO.
*BMI less than 18.5 indicates undernourishment or health problems

Table 3 shows the rate of infection of parasites and comensals by school grade together with the presence of *H. nana*. It can be seen that the relationship with the other enteroparasites was also significant (*Entamoeba histolytica* p<0.006, and *E. coli* p<0.014).

Figure 3 shows the total number of children infected by parasites: 112. Of these, 69 (61%) showed poliparasitism and 43 (38.4%) monoparasitism.

The OR of being infected by *Hymenolepis* and lacking basic services is 2. This means that the children who do not possess these services have twice the possibility of being infected. Of the 34 infected with *H. nana*, eight lack all the basic services (including drinking water and latrines). Moreover, they live in ramshackle dwellings. On the other hand, of those children who were free from parasites, 36 of the 38 had all of the basic services.

DISCUSSION

Despite the high prevalence of *H. nana* obtained in this study, the cases of infection were, clinically meagre. In the infected children the symptoms were slight and unspecific. They could not, therefore, be attributed to any parasite in particular. The main symptoms were: anal itching, abdominal pain, diahorrea, anorexia, headaches and dizziness. None were statistically significant.

Table 1
BMI of 150 children, Ixtlahuaca, Mexico State 2007

Classification	BMI (kg/m²)	No	Percentage	Undernourishment
Severe thinness	<16.00*	54	36	80.6%
Moderate thinness	16.00 - 16.99*	32	21.3	
Mild thinness	17.00 - 18.49*	35	23.3	
Normal range	18.50 - 22.99	29	19.4	
Total		150	100	

Source: Adapted from WHO
*BMI less than 18.5 indicates undernourishment or health problems

Table 3
Rate of infection of parasites and comensals of a population of 150 children with the statistical results.

Species	Frequency	Percentage	p
Giardia lamblia	64	42.7	>0.211
E. histolytica	31	20.7	<0.006
E. coli	67	44.7	<0.014
I. büestchlii	36	24	>0.158
Enteromonas	11	7.3	>0.094
Endolimax nana	2	1.3	>0.170
H. nana	34	22.7	<0.027
H. diminuta	1	0.7%	>0.581
A. lumbricoides	1	0.7%	>0.563

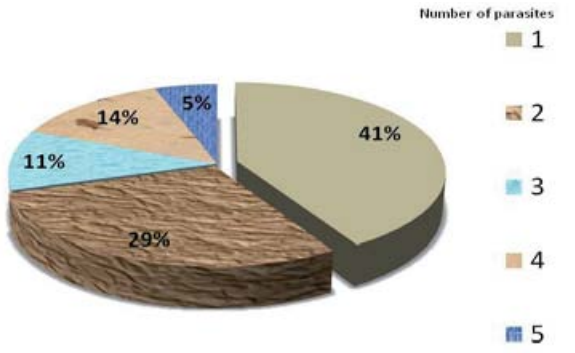

Figure 3. Frequency and percentage of parasites in 112 children from Ixtlahuaca, Mexico State 2007

The frequency of *H. nana* reported here (23.4%) is similar to that found in child populations of the same age group such as the 24.1% reported by Romani (San Lorenzo de Quinti, Lima) (15). It is higher than the 15.4% reported by Guevara (16) in his study of children from an indigenous group in the mountains of Nayarit, México. It is, however, much higher than the 0.008% reported by Suarez (17) in Ciego de Avila, Cuba and the 3.2% reported by Amin in Saudi Arabia (18). This wide range of frequencies might be related to the seasons of the year or to the local socio-economic conditions. If the figures obtained in this study (23.4%) and those obtained in Perú (24.1%) are compared, both socio-economic conditions and altitude (Ixtlahuaca and San Lorenzo lie at 2,500 and 2,700m. above sea level respectively) are seen to be comparable.

A major problem in spreading infection is lack of hygiene. Mason (19) mentions the presence of the cestod in close family members such as cousins and siblings. The school itself, which the children in this study attended, was seriously deficient in this aspect: lack of adequate drinking water, soap and towels and the presence of the faecal material of animals in the playground. One particular case which is worthy of attention is that of a 7 year old boy infected by *H. diminuta.* This is a cestod common in rats and mice. The infections are acquired from time to time by the accidental ingestion of an arthropod infected by the cysticercoid larvae of *H. diminuta* (20,21). The parasitosis is usually asymptomatic but it can cause abdominal pain, diahorrea, anorexia, dizziness and irritability (22). The infection is usually to be found where small children are in close contact with dogs or rodents (23).The eggs found in the excrement of rats and mice need an intermediate host. This may be a beetle (*Tenebrio monitor*), fleas (*Pulex irritans, Nosopsylus fasciatus*), the larva of a fly or arthropods which swallow the eggs and permit the cysticercoid larvae to develop (24). Children and rodents accidentally swallow the infected arthropods and develop the adult form of the helminths (20,21).

The high level of infection by parasites and comensals (112: 74.7% of the children) detected in this study, when added to the precarious diet, resulted in 121 (80.6%) of the children being underweight (25) (**Table 2**).

CONCLUSIONS

From the clinical point of view, epidemiological studies such as this one are important because they reveal the risks associated with helminthiasis. The high prevalence of *H. nana* found here is very serious. It is statistically significant in the younger children who are at a critical moment in their development and suffer from malnutrition.

The poliparasitism also affects their nutritional state. Ramshackle dwellings favour the transmission of infections. All these factors predispose for deficient development and high morbi-mortality. The inclusion of comensals in antiparasitic treatments is recommended.

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