Relative prevalence of the human hookworm species, *Necator americanus* and *Ancylostoma duodenale* in an urban community in Ogun State, Nigeria

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In order to estimate the proportion of hookworm infections represented by *Necator americanus* and *Ancylostoma duodenale*, the 2 major species of human hookworms in Nigeria, stool samples from 1253 hookworm-positive schoolchildren were cultured to the third-stage (L₃), filariform larvae, using the Harada-Mori test-tube method. *N. americanus* larvae were recovered from a total of 1177 (93.9%) coprocultures while *A. duodenale* larvae were recovered from a total of 274 (21.9%) stool cultures. 58.2% of the hookworm infections were due solely to *N. americanus*, 6.1% solely to *A. duodenale* and 25.8% were mixed infections with both species. In all mixed infections, much higher number of *N. americanus* larvae were recorded compared with those of *A. duodenale*.

**Key words:** Hookworm species, *Necator americanus*, *Ancylostoma duodenale*, filariform larvae.

**INTRODUCTION**

Despite considerable advances in chemotherapy and control, hookworms rank amongst the most widespread of soil-transmitted intestinal helminth parasites and affect a significant proportion of the world population (approximately 900 million people) mainly in the tropics and sub-tropics (Bundy et al., 1991). Adult hookworms attach to the mucosa of the small intestine, feed on blood and are an important cause of anaemia in school-aged and adult populations in the tropics (Olsen et al., 1998).

*Necator americanus* and *Ancylostoma duodenale*, the 2 major species of human hookworms are sympatric over much of their distribution and people are often simultaneously infected with both species in endemic areas. Despite significant differences in their life histories, the 2 species have traditionally been considered to be identical for treatment and control strategies (Hoagland and Schad, 1978). Failure to consider these differences is probably responsible for reports of failed drug treatments and rapid reinfection rates following anthelmintic treatment. Report of different anthelmintic susceptibilities between the species (Rossignol, 1990)
indicates that administration of only 1 anthelmintic may not be sufficient to kill both species. However, the rational design of hookworm control strategies requires, among other things, knowledge of the species infecting a particular human population in order for treatment to be successful in the long term. Most studies do not attempt to speciate hookworm infections and rely on past epidemiological data, which indicate the predominance of one species over the other (Brooker et al., 1999), because the eggs of the 2 species are similar and not readily distinguishable from one another by classical parasitological methods (Hawdon, 1996). Although, there are established morphological differences between the adult worms (Yoshida et al., 1974a,b; Pawloski et al., 1991), the adult stages are rarely available for routine parasitological examination. Thus, species identification has traditionally been done by using subtle morphological characteristics to differentiate the infective, third-stage filariform (L3) larvae, reared from eggs in coprocultures (WHO, 1981; Pawloski et al., 1991). Although, previous reports from some parts of Nigeria have shown that N. americanus is the ubiquitous and dominant hookworm species (Fisk, 1939; Cowper and Woodward, 1961; Oyerinde, 1978; Adenusi, 1997) that infections with A. duodenale represent only a small proportion of the local hookworm infections, over the years however, the epidemiological situation may not be the same as previously reported. Moreover, the relative distribution of the 2 species may vary from one endemic locality to the other. Thus, similar studies need to be carried out in other parts of the country.

We report on a study to estimate the proportion of hookworm infections represented by N. americanus and A. duodenale, in schoolchildren in Sagamu, an urban community and the headquarters of Sagamu Local Government Area of Ogun State, Nigeria.

METHODS

The study was conducted on 1253 schoolchildren (655 males and 598 females), aged between 5 and 13 years (mean age 8 years), positive for hookworm and who were participants in a large study (to be described in detail elsewhere) on the epidemiology of intestinal helminth infections in Sagamu, Lagos State. Schoolchildren were chosen because they are easily accessible and also constitute the section of the population at greatest risk of parasitic infection.

Each subject was given a clean, plastic container and asked to bring freshly passed stool sample the following day. Instructions on how to avoid contamination were also given to each subject. A brief interview of each subject regarding the time of stool collection was done. Only stool samples collected within 2 hours were recruited in this study. Hookworm eggs in about 4 g freshly passed and unfixed stool samples were cultured to the infective, third stage (L3), filariform larvae at ambient temperature (26 to 28°C), by the Harada-Mori test-tube method (Hsieh, 1961). The cultured larvae were concentrated by centrifugation and stained with Lugol’s iodine. The first 150 larvae (if more than 150) were examined under the microscope and identified according to the criteria of WHO (1981).

RESULTS

Table 1 gives the relative prevalences of the 2 hookworm species, N. americanus and A. duodenale in the study population. Of the 1253 hookworm-positive coprocultures, N. americanus filariform larvae were recovered from a total of 1177, while A. duodenale filariform larvae were recovered from 274. 854 of the 1253 (68.2%) hookworm-positive stool samples had only N. americanus filariform larvae while 76 (6.1%) had only A. duodenale larvae. 323 (25.8%) of the coprocultures had double species infection as evidenced by the recovery of filariform larvae of both species (N. americanus and A. duodenale). However, in all double (mixed) species infections, higher numbers of N. americanus larvae were recovered compared to A. duodenale with the former ranging from 60 to 85% and the latter ranging from 15 to 40% in any mixed infection.

<table>
<thead>
<tr>
<th>Hookworm species</th>
<th>No. of cases observed</th>
<th>Prevalence (% of total hookworm-positive study group (n=1253)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N. americanus</td>
<td>1177</td>
<td>93.9</td>
</tr>
<tr>
<td>A. duodenale</td>
<td>274</td>
<td>21.9</td>
</tr>
</tbody>
</table>

In the present study, filariform larvae of N. americanus varied in length from 490 to 620 µm, with majority measuring between 550 to 580 µm, while A. duodenale larvae varied in length from 670 to 760 µm (majority measured between 670 and 710 µm).

DISCUSSION

This study showed that N. americanus was the dominant hookworm species in the study population, as it solely accounted for 68.2% of all hookworm infections. This result is in agreement with previous ones from different parts of Nigeria (Fisk, 1939; Cowper and Woodward, 1961; Oyerinde, 1978; Adenusi, 1997) that N. americanus is the ubiquitous and dominant hookworm species.

In Lagos, Nigeria, Oyerinde (1978) showed that apparently all infections with A. duodenale occurred always in association with N. americanus, with the latter occurring independent of the former, and concluded that
perhaps, less than 1% of hookworm infections from the Lagos population, were due solely to *A. duodenale*. This report (Oyerinde, 1978) would seem to suggest that *A. duodenale* seldom occurs solely in human hosts, at least in the studied Lagos population. A recent study in Lagos (Adenusi, 1997) however, found *A. duodenale* solely accounting for 4.5% of hookworm infections.

In the present study, although *A. duodenale* was solely responsible for 6.1% of all hookworm infections, it nevertheless occurred concurrently with *N. americanus* (mixed hookworm infection) in 25.8% of the subjects. These were probably more heavily exposed, as to have been infected with *A. duodenale*, whose overall prevalence was about a third that of *N. americanus*, the commoner of the two in this locality.

Inspite of the fact that a female *A. duodenale* lays an average of 30,000 eggs per day compared to about 9000 by an adult female *N. americanus* (Piekarski, 1989), much higher numbers of *N. americanus* infective larvae were recovered in coprocultures, compared to *A. duodenale* in all mixed infections. This would suggest that much higher number of adult female egg-laying *N. americanus* worms were present compared to *A. duodenale* in mixed infections, as all the eggs were subjected to the same culture conditions. Moreover, none of the patients had received any form of anthelmintic therapy in the 6 months preceding the study, which could have eliminated more *A. duodenale* than *N. americanus*. Evans et al. (1991) had reported that in mixed hookworm infections, a much higher percentage cure rate is obtained for *A. duodenale* than *N. americanus* by treatment with anthelmintics.

Epidemiological assessment of the public health significance of hookworm infections should not, as has been the case over the years, be focused only on estimation of the number of hookworm infections, which occur in a given population (prevalence). Rather, it should also include identification of the infecting hookworm species. This is vital to the evaluation of hookworm infection as a public health problem where hookworm species. This is vital to the evaluation of hookworm infections, a much higher percentage cure rate is obtained for *A. duodenale* than *N. americanus* by treatment with anthelmintics.

Further studies are underway to estimate the total number of worms in each subject (including ratio of male to female worms, as well as the ratio of adult worms of the 2 species in mixed infections) following purgation of infected subjects and identification of passed (dislodged) adult hookworms.

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