# PREVALENCE OF INTESTINAL HELMINTHIC INFECTIONS IN KAO DISTRICT, NORTH HALMAHERA, INDONESIA

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**Abstract.** A parasitological survey was conducted on the inhabitants of six villages of Kao District, Halmahera Island, North Maluku, Indonesia, in July 1993. A total of 422 fecal samples were examined by using Kato-Katz thick smear, modified Harada-Mori culture and formalin ether concentration techniques. Seven nematode species, ie *Ascaris lumbricoides, Trichuris trichiura, Necator americanus, Ancylostoma duodenale, Strongyloides stercoralis, Enterobius vermicularis* and unidentified rhabditoids of free-living nature, were detected. Trematode and cestode infection was not proven. *Necator americanus* was the predominant species of hookworm. Soil-transmitted nematode infections were highly prevalent. Among the young inhabitants aged less than 15, positive rates of *Ascaris, Trichuris* and hookworm infections were 32.7, 52.7 and 68.6%, respectively. Among the people aged 15 or more, the positive rate for hookworm (85.9%) was much higher than that for *Ascaris* and *Trichuris* (13.5 and 40.5%, respectively). Egg count revealed that more than 90% of inhabitants with *Trichuris* or hookworm had light infections. The latrines in the surveyed area seemed to have only limited effects on the improvement of the parasitological status because the prevalence of *Trichuris* infections was much higher in a village where most houses were provided with latrines. These conflicting conditions were considered to have been caused by many factors including the inadequate structure of the latrines.

## INTRODUCTION

Halmahera Island, Indonesia, is located between North Sulawesi and Irian Jaya (West New Guinea). There has been no report available on the prevalence of parasitic infections among humans on this island. For the health administration, basic data on the parasite prevalence is quite necessary. During the medico-zoological survey in North Halmahera, 1993, we had an opportunity to make parasitological examinations of the inhabitants in six villages in Kao District. This paper deals with the prevalence of intestinal helminthic infections in this area with special reference to the factors affecting the transmission of parasites. Intestinal and blood protozoan infections will be reported elsewhere.

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## DESCRIPTION OF AREA

Kao District is located in the east side of basal part of North Peninsula of Halmahera Island, Indonesia, and belongs to the North Maluku Prefecture of the Maluku Province in the administrative system (Fig 1). The climate is of tropical rain-forest type, the temperature ranges from 20 to 34°C throughout the year, the annual precipitation is about 1,500 mm, and has a short dry season from July to September. Kao District has 20,357 (10,601 male and 9,756 female) inhabitants in 4,044 families in 39 villages (census in 1992). Six villages, namely Popon, Sasur, Jati, Kukumutuk, Patang and Biang, to which land access was relatively easy, were chosen for survey. Popon and Sasur are located inland, while the other four are coastal villages (Fig 1). Jati is located near Kao, the central town of the district.

Some demographic and health environmental conditions of the surveyed villages are summarized in

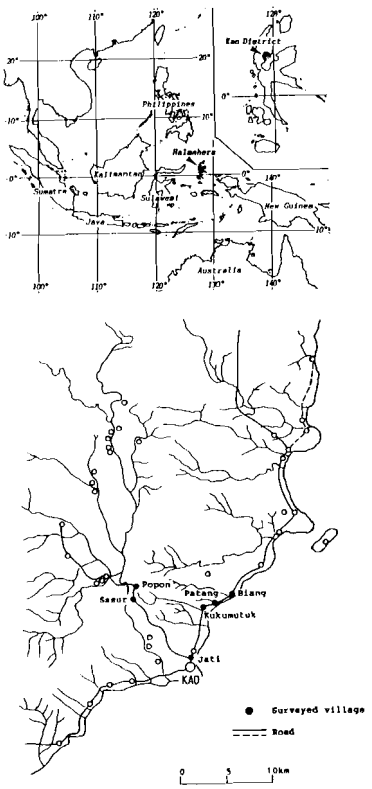


Fig 1–Map of the survey area. Geographical location of Halmahera Island (upper), Kao District (inset), and surveyed villages.

Table 1 based on the statistics by the Kao Health Office and questionnaires filled by the examined inhabitants.

Most of the adult inhabitants were farmers except in Jati, where many official workers resided. The native inhabitants were Protestant, but some inhabitants in Jati were Islamic or Catholic. More than a half of the houses in Jati were made of concrete, but most houses in other villages were wooden and of simple structure. In Sasur, Jati, Patang and Biang, most of the houses had own bathrooms, often of quite simple style, while in Popon and Kukumutuk people bathed in rivers. The frequency of bathing was once a day for most people residing in the houses with bathroom, but twice a day for inhabitants who bathed in the rivers.

Nearly 90% of the houses in Jati and Biang had own latrines, whereas more than 95% of the houses in other villages lacked latrine. In Jati, both water-closet and pit latrine were used, but in Biang, all latrines were pit-type. The inhabitants whose houses lacked latrines defecated around their houses (especially in Popon and Kukumutuk), in surrounding bushes (in Sasur) or at the seaside (in Patang). In Kao District, as in most other parts of Indonesia, there was no tradition of using human excreta as fertilizer.

Staple foods were sago, sweet potato, cassava and rice. Rice was seldom consumed in the inland villages. Chicken, pork and marine fishes were commonly taken in the inland and coastal villages. Freshwater fish were consumed frequently in the inland villages. Squids were eaten only by the inhabitants along the coast. All of these animals were eaten after being well cooked. Vegetables consumed usually were cucumbers, tomatos, onions, and carrots. Tap water supply was absent in the most villages of Kao District. People utilized well or river water. In Sasur, most houses stored rain water for drinking use. In most cases, the drinking water was well boiled before use.

Footwear was usually simple. Most farmers and children wore sandals outside, although some inhabitants in Jati and Biang wore shoes. However, they were often barefooted in and around their houses. More than a half of the Popon inhabitants were barefooted usually.

## MATERIALS AND METHODS

One hundred fecal containers were delivered in each of the villages, and fecal samples were collected from the inhabitants during 1 to 6 July 1993. Besides the fecal sample collection, a questionnaire on life style and sanitary conditions was made. Appropriate anthelmintics were given for the inhabitants who were proved to be infected with parasites.

Fecal samples were examined on the day of collection by Kato-Katz thick smear technique. Egg count was made on whole field of Kato-Katz thick smear with 30 mg feces. Harada-Mori culture was also started on the same day. The remaining feces were fixed with 10% formalin and transported to the Department of Parasitology, University of Hasanuddin, and examined with formalin-ether concentration techniques. Procedures of these techniques were as referred in the previous report (Mangali *et al*, 1993).

Statistical analyses for the difference between percentages were made by chi-square test or, when the sample size was less than 20, by Fischer's exact

Table 1

Some demographic and hygienic information by questionnaire of six villages in Kao District, Halmahera, North Maluku Regency, Indonesia.

| Village | Popon | Sasur | Jati | Kukumutuk | Patang | Biang |
|---|---|---|---|---|---|---|
| Total population* | 279 | 240 | 544 | 222 | 253 | 520 |
| Aged 1-14 | 128 | 110 | 253 | 103 | 103 | 241 |
| Aged 15 or more | 151 | 130 | 291 | 119 | 150 | 279 |
| No. questioned | 95 | 75 | 84 | 27 | 71 | 69 |
| (Male/Female) | 53/42 | 36/39 | 38/46 | 17/10 | 41/30 | 41/28 |
| Occupation | (7)** | (24) | (17) | (24) | (12) | (34) |
| Farmer | 86% | 96 | 35 | 100 | 100 | 100 |
| Official worker | 14 | 4 | 65 | | | |
| Religion | (89) | (74) | (65) | (25) | (66) | (57) |
| Islam | | | 9 | | | |
| Protestant | 100 | 100 | 89 | 100 | 100 | 100 |
| Catholic | | | 2 | | | |
| Housing | (91) | (70) | (76) | (25) | (68) | (68) |
| Concrete-made permanent | | | 54 | | | 10 |
| Wood-made temporary | 100 | 100 | 46 | 100 | 100 | 90 |
| Staple food*** | (85) | (66) | (72) | (27) | (69) | (67) |
| Rice | | 8 | 86 | 100 | 54 | 82 |
| Corn | 1 | | 1 | | | 1 |
| Sago | 100 | 2 | 99 | 96 | 94 | 99 |
| Sweet potato | 92 | 97 | 93 | 85 | 96 | 99 |
| Cassava | 92 | 95 | 90 | 100 | 100 | 100 |
| Drinking water | (94) | (72) | (84) | (27) | (70) | (67) |
| Tap water | | | 2 | | 1 | |
| Well water | 5 | | 93 | 100 | 97 | 97 |
| River water | 94 | 1 | 5 | 4 | 1 | 1 |
| Rain water | 1 | 99 | | | | 1 |
| Bathing | (88) | (70) | (80) | (27) | (69) | (69) |
| With own bathroom | 1 | 99 | 100 | | 97 | 94 |
| Public bathroom | | | | | | 6 |
| River | 99 | 1 | | 100 | 3 | |
| Frequency of bathing | (95) | (74) | (82) | (27) | (69) | (69) |
| 1/day | 16 | 99 | 98 | | 83 | 97 |
| 2/day | 84 | 1 | 2 | 100 | 17 | 3 |
| Latrine | (89) | (73) | (92) | (25) | (73) | (69) |
| With latrine | | 5 | 87 | 4 | 3 | 88 |
| Water closet | | 5 | 34 | | | |
| Pit latrine | | | 52 | 4 | 3 | 88 |
| Other style | | | 1 | | | |
| Without latrine | 100 | 95 | 13 | 96 | 97 | 12 |
| Defecation site: | | | | | | |
| Public lavatory | | 10 | 13 | | | 7 |
| Around house | 97 | 12 | | 96 | 22 | |
| Surrounding bush | 3 | 71 | | | | 1 |
| Riverside | | 1 | | | | |
| Seaside | | | | | 75 | 3 |

* Census in 1992; ** No. inhabitants answered; *** With multiple answers.

probability test. The probability less than 5% for null hypothesis was considered significant. The aggregation of distribution of the egg count values was judged by ID index of Southwood (1978). Fitting of egg count values to the negative binominal distribution was tested by the methods of Anscombe (1950) and Bliss and Fisher (1953).

## RESULTS

Fecal samples from a total of 422 inhabitants were examined. The observed helminths were all nematodes and no cestode or trematode infection was proven. The prevalence of the soil-transmitted nematode infections by locality, sex and age group is shown in Table 2. The prevalence of *Trichuris trichiura* and hookworm infections by age class and sex is shown in Figs 2 and 3. In total, hookworm infection was most common, being followed by *Trichuris* and *Ascaris lumbricoides* infections, both in young (aged 2-14) and elder (aged over 15) groups. *Strongyloides stercoralis* infection was less common, and not observed in Jati. *Necator americanus* was the predominant hookworm species, being found in 195 out of 199 samples (98.0%) cultured with Harada-Mori method. *Ancylostoma duodenale* was observed only in 16 cases (8.0%) with 12 (6.0%) concurrent infection with both species. *Enterobius vermicularis* eggs were also observed in 5 (1.2%) samples, and an unidentified rhabditoid species of free-living nature was observed in one case by Harada-Mori culture. Among 33 infants aged less than 2 years, 2 (14 and 18 month-old females) had *Ascaris* infection and 1 (7 month-old female) with *N. americanus* infection.

No significant difference was observed in the prevalence of *Ascaris* infection between the sexes both in young and older age groups. The prevalence of *Trichuris* infection was significantly higher in females than in males of older age, although the difference by sex in the young age group was not significant (Table 2, Fig 2). The prevalence of hookworm infection was significantly higher in males than in females in both age groups (Table 2, Fig 3). *Ascaris* infection was significantly higher in the young age group in both sexes, and *Trichuris* infection was also significantly higher in older males than in young males in total. No significant difference was proved in *Trichuris* prevalence between the two age groups of females. Hookworm infection was much higher in the older age group in both sexes in total (Table 2). In *Trichuris* infection, the prevalence decreased gradually with age in the groups older than 15 years (Fig 2). However, the hookworm prevalence showed a slight decrease only in the age group over 50 years (Fig 3).

Among the young inhabitants, the prevalence of *Ascaris* infection was significantly higher in Patang where more than a half of them harbored this parasite,

Table 2

Prevalence of intestinal helminthic infections among inhabitants by age groups in six villages of Kao District, Halmahera, North Maluku Regency, Indonesia.

| Village | Popon | Sasur | Jati | Kukumutuk | Patang | Biang | Male | Female | Total |
|---|---|---|---|---|---|---|---|---|---|
| Aged 2 to 14 years | | | | | | | | | |
| No. examined | 44 | 33 | 48 | 15 | 48 | 38 | 128 | 98 | 226 |
| *Ascaris* | 15.9% | 30.3 | 29.2 | 26.7 | 56.3 | 31.6 | 32.8 | 32.7 | 32.7 |
| *Trichuris* | 29.5 | 27.3 | 75.0 | 20.0 | 70.8 | 63.2 | 52.3 | 53.1 | 52.7 |
| Hookworm | 90.0 | 66.7 | 31.3 | 66.7 | 89.6 | 65.8 | 76.6 | 58.2 | 68.6 |
| *Strongyloides* | 9.1 | | | 6.7 | 4.2 | 7.9 | 2.3 | 7.1 | 4.4 |
| Aged 15 years or more | | | | | | | | | |
| No. examined | 39 | 36 | 32 | 11 | 21 | 24 | 81 | 82 | 163 |
| *Ascaris* | 7.7 | 8.3 | 15.6 | | 28.6 | 20.8 | 9.9 | 17.1 | 13.5 |
| *Trichuris* | 25.6 | 30.5 | 68.8 | 9.1 | 42.9 | 54.2 | 32.1 | 48.8 | 40.5 |
| Hookworm | 89.7 | 97.2 | 56.3 | 90.9 | 90.5 | 95.8 | 91.4 | 80.5 | 85.9 |
| *Strongyloides* | 10.3 | 2.8 | | 9.1 | 19.0 | 4.2 | 9.9 | 3.7 | 6.7 |

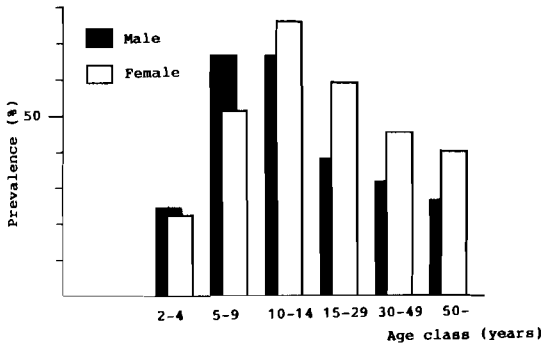


Fig 2–Age-prevalence profiles of *Trichuris* infection by sex in Kao District, Halmahera, North Maluku, Indonesia, 1993.

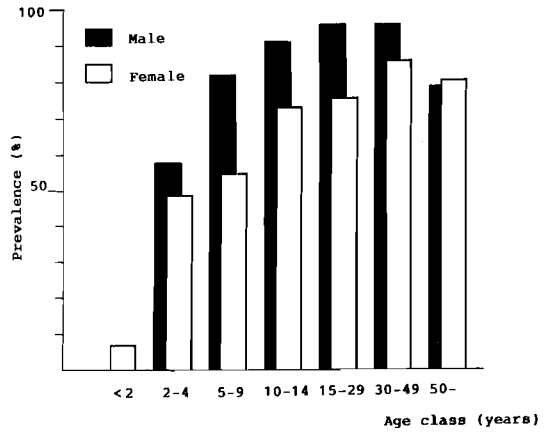


Fig 3–Age-prevalence profiles of hookworm infection by sex in Kao District, Halmahera, North Maluku, Indonesia, 1993.

and the prevalence in the other 5 villages was statistically similar each other. However, such difference by villages was not proven in older inhabitants. The prevalence of *Trichuris* infection among the young age inhabitants was significantly lower in Popon, Sasur and Kukumutuk than in the other 3 villages. In the older group, the prevalence of *Trichuris* infection in Jati was significantly higher than that in other villages except Biang. It was statistically similar among the older age groups of Popon, Sasur and Kukumutuk. The prevalence of *Trichuris* infection in the older age group of Biang was significantly higher than that of Popon and Kukumutuk, but was not statistically different from that of Sasur and Patang. The prevalence of hookworm infection was markedly lower in Jati than in other villages. The hookworm prevalence was significantly higher in Popon than in Sasur and Biang in the young age group.

Egg count by Kato-Katz thick smear was carried out for 182 and 251 inhabitants infected with *Trichuris* and hookworm, respectively. It was revealed that 76.9% and 52.2% of the *Trichuris*- and hookworm-infected inhabitants, respectively, had less than 20 eggs in their 30 mg feces (= ca 670 EPG), and 93.5% and 76.9%, respectively, of them had less than 60 eggs (= ca 2,000 EPG). Only 1.5% and 6.6% of the inhabitants infected with *Trichuris* and hookworm, respectively, were proved to have more than 150 eggs (= ca 5,000 EPG). In every village, the egg count values were proved to be highly aggregated and fitted with the negative binominal distribution ($p < 0.005$).

Latrine type and helminth prevalence were compared in Jati (Table 3). In total, *Ascaris* and *Trichuris* prevalence was almost equal between the water-closet users and pit latrine users. The hookworm infection was less prevalent in water-closet users (Table 1). However, statistical analysis revealed that there was no significant difference between the users of the different types of latrines. The prevalence of *Trichuris* and hookworm infections by occupation was calculated in Jati. Among 5 male farmers, all had hookworm infection and 3 with *Trichuris* infection. Meanwhile among 9 official workers (5 males and 4 females), hookworm infection was proved in 4 (3 males and 1 female), and *Trichuris* infection was found in 6 (4 males and 2 females).

Table 3

Prevalence of helminthic infections in Jati by type of latrines.

| Latrine type | Water closet | Pit |
|---|---|---|
| Aged 2 to 14 years | | |
| (No. examined) | 15 | 27 |
| *Ascaris* | 6 (40.0) | 8 (29.6) |
| *Trichuris* | 11 (73.3) | 20 (74.1) |
| Hookworm | 2 (13.3) | 8 (29.6) |
| Aged 15 years or more | | |
| (No. examined) | 13 | 18 |
| *Ascaris* | 1 (7.7) | 4 (22.2) |
| *Trichuris* | 9 (69.2) | 12 (66.7) |
| Hookworm | 6 (46.1) | 12 (66.7) |

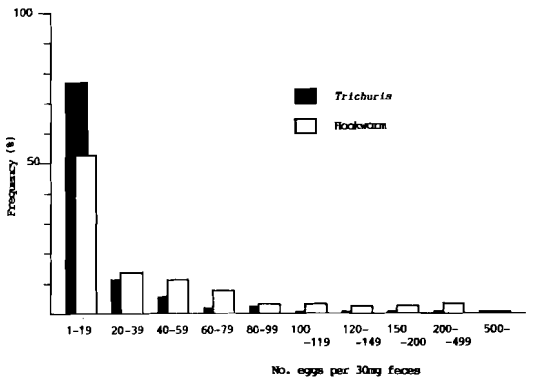


Fig 4–Intensity distribution of *Trichuris* and hookworm infections in Kao District, Halmahera, North Maluku, Indonesia, 1993.

## DISCUSSION

Intestinal helminthic infections in Kao District are characterized by the high prevalence of soil-transmitted nematode infections. Such condition is common in most areas of Indonesia as seen in the reports in recent 15 years (*cf* Stafford *et al*, 1980 a, b; Purnomo *et al*, 1980; Joesoef and Dennis, 1980; Cross and Basaca-Sevilla, 1981; Higgins *et al*, 1984; Abadi, 1985; Imai *et al*, 1985; Soeripto, 1991; Hasegawa *et al*, 1992; Mangali *et al*, 1993). The predominant hookworm was *N. americanus*, the skin penetrator, and most inhabitants had only poor footware or were actually bare footed. The Kao inhabitants thus are constantly exposed to cutaneous infections with hookworm infective larvae besides oral infection with *Ascaris* and *Trichuris* eggs. On the other hand, trematode and cestode infection was not proved in Kao District. This may be explained by the fact that the people do not take raw meat nor raw fish.

The egg count revealed an aggregated distribution of *Trichuris* and hookworms. Such pattern has been known to be quite common in the soil-transmitted helminthiases (*cf* Bundy, 1990). The majority of the inhabitants with *Trichuris* and hookworm were lightly infected because an infection with EPG less than 5,000 usually does not accompany clinical manisfestation (Beaver *et al*, 1984). However, about 5% of the infected inhabitants might have some clinical symptom due to these nematodes, passing so many eggs in their feces. It has been observed that such heavily infected individuals have a tendency to acquire heavy reinfection probably due to some predisposition with immunogenetical background (Schad and Anderson, 1985). Thus, for a control measure, treatment should be given for the inhabitants with high egg count value. Such targeted treatment has been considered to be more cost-effective in control of soil-transmitted helminthiases, in minimizing the selection pressure on the development of resistance by the parasite, and in maintaining the acquired immunity condition (*cf* Keymer and Pagel, 1990).

It is apparent that latrines and their structure are important factors influencing the soil-transmitted helminthic infections (*cf* Kilama, 1989; Cairncross, 1990). In general, construction and improvement of latrines are believed to diminish the parasite prevalence. In Kao District, the hookworm infection was significantly lower in Jati, where nearly 90% of the houses provided with latrines, than in other villages. However, this difference seemed to be attributed not only to the latrine prevalence but also to the occupational difference among the localities. All of the 5 farmers examined in Jati harbored hookworms, while only 4 out of 9 official workers were parasitized with this nematode. In Biang, where nearly 90% of the houses had latrines as in Jati but all adults were farmers, the hookworm prevalence among adults was similar with those in the villages with low latrine-possessing rate (Table 2). These phenomena suggest that the latrines had only a limited influence on the hookworm prevalence in the Kao area.

Surprisingly, the prevalence of *Trichuris* infection in Jati was significantly higher than that in Popon, Sasur and Kukumutuk, where more than 95% of the houses lacked latrines. The prevalence of *Trichuris* infection in Biang was statistically similar with that in Sasur, but significantly higher than that in Popon and Kukumutuk (Table 2). Moreover, the *Ascaris* prevalence of Jati was statistically similar with that of other villages (except that among the young age group of Patang). These findings may indicate that the latrines in Jati and Biang did not result in any improvement in these orally-transmitted helminthiases or even brought about an adverse effect. A similar phenomenon has been recorded in Campalagian District of South Sulawesi. In the Campalagian coastal villages where more than 75% of the houses provided with latrines, the prevalence of *Ascaris* and *Trichuris* infections was much higher than the inland village where only 4% of the houses had latrines, although the hookworm infection was less prevalent in the former villages (Mangali *et al*, 1993).

The cause of these curious phenomena has not been elucidated completely. One factor may be the structure of the latrines as suggested in a previous study (Mangali *et al*, 1993). In Jati and Biang, more than a half of the water-closets were septic tank type. The septic tanks do not dispose of wastes but only accelerate the sedimentation of solid matter to the bottom (*cf* Cairncross, 1990). The liquid effluent, still containing viable eggs, flows out of the tank. However, there is no complete sewerage system in the Kao area, and the effluent flows in open ditches. Thus this type of latrine may produce little improvement in parasitological status at least with regards to *Ascaris* and *Trichuris* infections.

Another type of the water-closets is a pour-flush latrine that is called "goose neck" in Indonesia. In this type latrine, flushed excreta are stored in an underground pit. There is no outlet in the tank, and the flushed excreta stored in the tank gradually penetrate into the bottom soil. This structure may be better than the septic tank latrine from the parasitological viewpoint because parasite eggs and protozoan cysts may not be appeared in the outer environment unless the pit overflows. Therefore, assessment of the parasite egg elimination efficacy of these latrines types may be necessary in order to establish a control strategy for the soil-transmitted helminthiases in Kao and probably also in the most other parts of Indonesia.

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