

# QUESTIONNAIRE SURVEY AND PREVALENCE OF INTESTINAL HELMINTHIC INFECTIONS IN BARRU, SULAWESI, INDONESIA

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**Abstract.** A questionnaire survey with parasitological study was carried out on the inhabitants of 4 villages in Barru district, Sulawesi, Indonesia from 1994 to 1995. The questionnaire dealt with life style and sanitary conditions. In 482 houses in the 4 villages, interviews for the items of the questionnaire were conducted with the owner, housekeeper and children of the same family. In Pancana and Lalolang, 37.7% and 50% respectively of man inhabitants surveyed were fishermen, while in Lompo Riaja and Pattappa, 38.6% and 65.5% respectively were farmers. The highest proportion of official workers was 33.7% in Lompo Riaja. Educational level was low; 88.4% in Pancana, 90.4% in Lalolang, 62.1% in Lompo Riaja and 91.2% in Pattappa had elementary or below elementary school education. In Lompo Riaja, 30.8% of the inhabitants graduated from senior high school or university. The percentage of families having their own latrine was 30.3% in Pancana, 13.2% in Lalolang, 31.9% in Pattappa and 60% in Lompo Riaja. The people without latrines usually defecated in rice fields, seaside or riverside.

A total of 654 fecal samples was examined by the modified Kato-Katz thick smear method. Five nematode species, *Ascaris lumbricoides*, *Trichuris trichiura*, *Necator americanus*, *Strongyloides stercoralis* and unidentified Rhabditoids of free-living nature were detected. Cestode, *Hymenolepis nana* infection was confirmed. All the hookworms examined by the modified Harada-Mori culture technic were *Necator americanus*.

*Trichuris* infection was most common, followed by hookworm and *Ascaris* infections, both in young (aged 4-14) and older (aged over 15) age groups. The prevalence of hookworm infection was significantly higher in males than in females of older age. Among the older age group, the prevalence of *Trichuris* infection was significantly lower in Lompo Riaja, while hookworm infection was the highest in Pattappa. Among all the inhabitants examined for parasite infection, 17.4% had 3 kinds of nematode, *Ascaris*, *Trichuris* and hookworm. However, egg counts revealed that most of the inhabitants with *Trichuris* or hookworm had light infections.

The inhabitants with higher education background had significantly lower infection rates of *Ascaris* and *Trichuris*. The prevalence of hookworm infection was not significantly different between the inhabitants owning latrine and without it, but the prevalence of *Ascaris* and *Trichuris*, differed significantly.

## INTRODUCTION

Recently, the prevalence of intestinal parasitic infections of humans in Sulawesi has been documented (Abadi, 1985; Hasegawa *et al*, 1992; Mangali *et al*, 1993, 1994). Hasegawa *et al* (1992) studied in Likupang, North Sulawesi, while Mangali *et al* (1993) carried out the survey in Campalagian, South Sulawesi. These surveys found a high prevalence of

soil-transmitted parasite infections and differences of parasite infections between coastal and inland areas.

During a medico-zoological survey in South Sulawesi, 1994-1995, we had an opportunity to carry out a questionnaire survey from July to August, 1994 and parasitological examinations of the inhabitants in 4 villages, Barru district in March, 1995.

This paper deals with the results of the questionnaire regarding factors in the transmission of parasites, the prevalence of intestinal helminth infections, and the relationship of the findings of the questionnaire and parasite infection. It also examined the efficacy of the Kato-Katz thick-smear method

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modified for long-term preservation of fecal samples in small containers.

**Study area**

Barru district is located about 100 km north of Ujungpandang, the capital of South Sulawesi, and consists of 52 villages with a total population of about 150,000 (Fig 1). The populations of Pancana, Lalolang, Lompo Riaja and Pattappa were 2,869, 3,596, 3,389 and 3,874, respectively in the census of 1993. The temperature ranges from 22 to 33°C throughout the year, and the annual rainfall is about 3,800 mm. Meteorologically, this area belongs to the tropical monsoon region with rainy season usually from October to March and dry season from April to September.

Two coastal villages, Pancana and Lalolang, and 2 inland villages, Lompo Riaja in flatlands and Pattappa in foot of mountain were chosen for parasitological study. Lompo Riaja and Pattappa are 20km and 25km away from the west coast of Barru district, respectively. Domestic water sources in coastal areas relied primarily on wells, while in the inland villages, water was supplied as piped water from simple reservoirs. Inhabitants of Pattappa were supplied with water from a mountain stream. Among the 4 villages, the inhabitants in Lalolang and Lompo Riaja were relatively rich.

**MATERIALS AND METHODS**

**Questionnaire survey**

A questionnaire survey on life style and sanitary conditions was made in the 4 villages during 28 July to August 4, 1994. For the survey 119 to 121 houses per village were selected randomly, totalling 482 houses in the 4 villages. Interviews for items on the questionnaire were conducted with the owner, housekeeper and children of the same family by us with staff of the Barru Health Center.

**Fecal examination**

Fecal examination was carried out from March 27 to April 6, 1995. Approximately 1,400 fecal containers were delivered to the inhabitants who answered the questionnaire from July to August, 1994, and 654 fecal samples were collected for 3 days after delivery of the containers.

Fecal samples collected from the inhabitants were filtered by fine stainless mesh. The 60 mg feces obtained by a polyvinyl template (thickness 2 mm with 6 mm diameter punch hole) were fixed with 10% formalin in new containers. The remaining feces were used for species identification of hookworm, carried out in Barru by the modified Harada-Mori culture method (Mangali *et al*, 1993) within 1 to 2 days after fecal collections. The parasite eggs

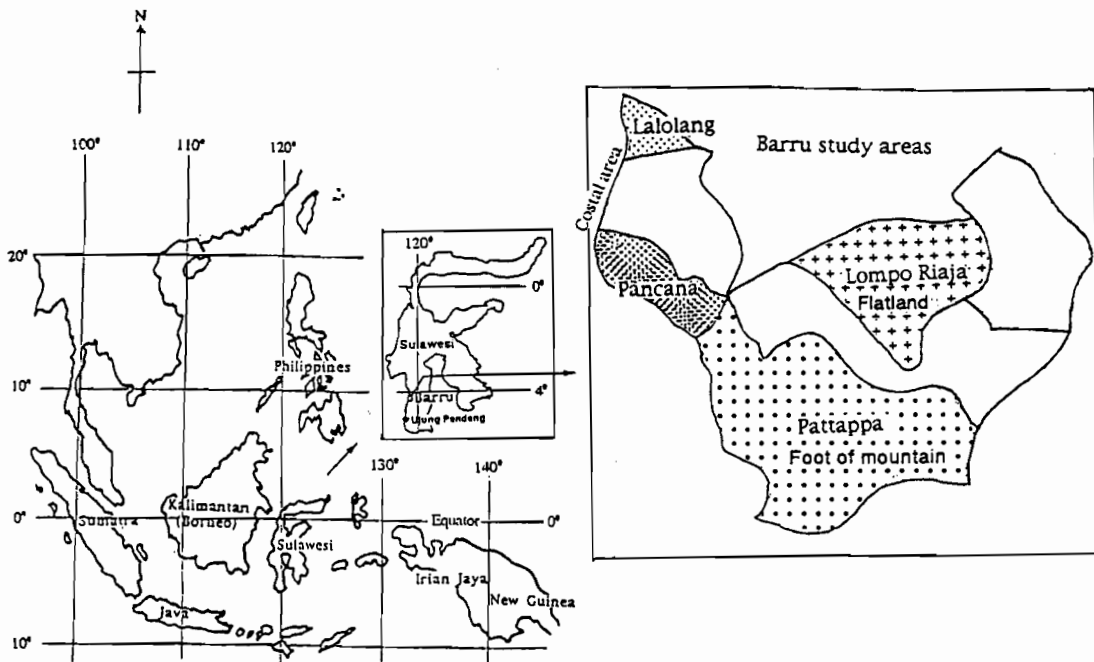


Fig 1-Map of larval study areas in Barru, South Sulawesi, Indonesia.

in the feces preserved with formalin were counted back in Japan by the modified Kato-Katz thick smear method.

The eggs in the feces preserved in 10% formalin were examined as follows: the 60 mg feces in each small container were transferred to a glass spitz tube (15 ml) with 5-8 ml of 10% formalin. The feces solution was centrifuged at 3,000 rpm for 5 minutes. The supernatant (No.1) was removed, and 0.5-1.0 ml of 50% glycerine was added to the precipitates, which were kept over night at room temperature. The feces solution with 50 % glycerine was centrifuged at 3,000 rpm for 5 minutes, and the supernatant (No.2) removed. The precipitates were transferred on to 1 or 2 glass slides (52 x 76 mm) using a tapering pipette. When some precipitates on the bottom and/or wall of the spitz test tube were visible to the naked eye, a small amount of 50% glycerine was added, and the solution including the precipitates was sucked up completely (No. 3). The precipitates on the glass slides were covered with cellophane paper (measuring 45 x 60 mm) that had been soaked in distilled water; the number of parasite eggs was counted and the species identified under a microscope.

In order to know the recovery rate of parasite eggs by using the modified Kato-Katz thick smear method, the supernatants, No.1 and No.2, and the precipitate in a small amount of solution, No.3, were each filtered with filter paper of 1.0  $\mu$ m pore size. The eggs on the filter paper were counted, the species identified, and the recovery rate of each species was calculated.

Statistical analysis for the differences between percentage in some groups was made by chi-square test.

## RESULTS

### Questionnaire survey

The results of the questionnaire survey are shown in Table 1. In Pancana and Lalolang, 37.7% and 50% respectively of the male inhabitants surveyed were fishermen, while in Lompo Riaja and Pattappa, 38.6% and 65.5% respectively were farmers. The highest proportion of official workers was 33.7% in Lompo Riaja. Most of the women (83.5-95.2%) had no occupation.

In the 4 villages, all the inhabitants surveyed were Islamic. The educational level was low, 88.4% in Pancana, 90.4% in Lalolang, 62.1% in Lompo Riaja and 91.2% in Pattappa had elementary or below elementary school education. In Lompo Riaja, 30.8%

of the inhabitants had graduated from senior high school or university.

About 90% of the inhabitants in the 4 villages lived in wooden houses. More than 70% of the inhabitants had been living for more than 6 years in the same village. In Pancana, Lalolang and Lompo Riaja, more than 74% of the houses had electricity, while in Pattappa, only 1.7% had it; the rate was significantly higher in Lompo Riaja and lower in Pattappa.

The percentage of having one's own latrine was 30.3% in Pancana, 13.2% in Lalolang, 31.9% in Pattappa and 60% in Lompo Riaja (with significantly highest rate). The proportion of pit latrine was 15.3% to 37.8%, and was not significantly different in the 4 villages. 76.4% to 100% of the latrines had a tanks under the ground. The depth of most of the tanks was more than 2 m and most of the tank wall and bottom were made of concrete and/or mud. 5.4% to 11.4% of the latrines overflowed in rainy season, with 0% in Lalolang and 11.4% in Pattappa. The people without latrine usually defecated in rice fields (or farm), seaside or riverside.

The staple food of the inhabitants was rice. Vegetables such as "*kangkung*" (*Ipomoea aquatica*) (93.3-98.3%), spinach (83.3-98.3%) and bean (84-95.8%) were eaten; they were washed with well water in Pancana and Lalolang, and with pipe water in Lompo Riaja and Pattappa, and were eaten well-cooked by boiling, frying, baking or steaming, but were sometimes taken raw. Boiled drinking water were used by 90% (in Pattappa) to 100% (in Pancana, Lalolang and Lompo Riaja) of the inhabitants.

The rate of hand washing after using latrine was significantly higher in Lalolang and lower in Pancana. Most of the inhabitants in the 4 villages wore simple footwear such as sandals.

The proportion of those having taken antihelmintic was significantly higher in Pancana and Lalolang.

### Fecal examination

Fecal samples from 654 inhabitants were examined. Most of the helminths detected were nematodes. The prevalence of the soil-transmitted nematode and cestode infections in each locality, sex and age groups are shown in Table 2. The prevalence of *Ascaris lumbricoides*, *Trichuris trichiura* and hookworm infections in different age groups are shown in Fig. 2. In total, *Trichuris* infection was the most common, followed by hookworm and *Ascaris* infections, both in young (aged 4-14) and older (aged over 15) groups. *Strongyloides stercoralis*,

Table 1a  
Some demographic and hygienic information obtained by questionnaire for 4 villages  
in Barru district, South Sulawesi, Indonesia.

Village	Pancana	Lalolang	Lompo Riaj	Pattappa
No. of persons interviewed (A)	[350]	[351]	[344]	[346]
Male/Female	44.0/56.0%	44.4/55.6	44.8/55.2	47.4/52.6
Age proportion	[350]	[351]	[344]	[346]
0 to 14 years old	11.1	10.0	7.0	12.1
15 years and above	88.9	90.0	93.0	87.9
Occupation (O, H)				
Male/Female	[106]/[136]	[100]/[140]	[101]/[139]	[113]/[125]
Fisherman	37.7/2.2	50.0/5.0	4.0/2.2	1.8/0.0
Farmer	20.8/0.0	17.0/0.0	38.6/0.7	65.5/0.8
Merchant	19.8/0.7	16.0/0.0	11.9/2.2	11.5/2.4
Official worker	12.3/6.6	5.0/2.1	33.7/11.5	8.8/1.6
Without occupation	9.4/90.4	12.0/92.9	11.9/83.5	12.4/95.2
Education (O, H)	[242]	[240]	[240]	[237]
None	6.6	15.4	12.5	24.5
Interrupted elementary school	37.2	37.5	27.5	43.5
Elementary school	44.6	37.5	22.1	23.2
Junior high school	5.4	5.0	7.1	0.8
Senior high school	5.4	3.8	30.0	7.6
University	0.8	0.8	0.8	0.4

[ ] : No. of persons responded to the questionnaire.

(O), (H) and (A) mean that questionnaire was administered to owners, housekeepers and all members including children, respectively.

unidentified *Rhabditis* sp and *Hymenolepis nana* infections were not common. All the hookworms examined in the 60 samples were identified as *Necator americanus* from larvae cultured by the Harada-Mori method. Significant difference was observed in the prevalence of *Ascaris* infection between males in young (4-14) and older age (over 15) groups (Table 2). No significant difference was observed in *Trichuris* prevalence between the sexes both in young and older age groups. The prevalence of hookworm infection was significantly higher in males than in females of older age, although the difference by sex in the young age group was not significant. The prevalence of *Ascaris* infection was significantly higher in the 4-9 years group (Fig 2). In *Trichuris* infection, the prevalence decreased gradually in the older age (over 30), and the hookworm prevalence showed a slight increase in the age group of over 50 years (Fig 2). However, no statistically significant differences in ages were observed.

The prevalence of *Ascaris* infection was significantly lower in Lompo Riaja in both age groups. Among the older age group, the prevalence of *Tri-*

*churis* infection was significantly lower in Lompo Riaja, while hookworm infection was highest in Pattappa.

Among the 654 inhabitants examined for parasite infection, 9.2% had no parasite, and 17.4% had three kinds of nematodes, *Ascaris*, *Trichuris* and hookworm (Fig 3).

Egg count by the modified Kato-Katz smear method was carried out for 489 and 374 inhabitants infected with *Trichuris* and hookworm, respectively. 58.9% of the *Trichuris*- and 84.1% of the hookworm-infected inhabitants had less than 40 eggs in their 60 mg feces (=ca 670 EPG), and 86.3% and 99.2% respectively had less than 300 eggs (=ca 5,000 EPG). The number of inhabitants who had less than 40 eggs in the 60 mg feces was significantly higher than those who had more than 40 eggs (Fig 4).

#### Relationship between the results of questionnaire survey and parasite infection

The relationship between the results of questionnaire survey and parasite infections is shown in

Table 1b  
Some demographic and hygienic information obtained by questionnaire for 4 villages in Barru district,  
South Sulawesi, Indonesia.

Village	Pancana	Lalolang	Lompo Riaja	Pattappa
Latrine (O)	[122]	[121]	[120]	[119]
With <sup>a, d, e, f</sup>	30.3	13.2	60.0	31.9
Latrine (O)	[37]	[16]	[72]	[34]
With tank <sup>b, f</sup>	100.0	93.7	76.4	97.1
Quality of tank wall and bottom (O) <sup>c</sup>	[37]	[15]	[55]	[35]
Mud	8.1	6.7	7.3	5.7
Concrete wall, mud bottom	70.3	46.7	36.4	28.6
Concrete	21.6	46.7	56.4	65.7
Overflow from tank in rainy season (O)	[37]	[16]	[70]	[35]
Yes	5.4	0.0	8.6	11.4
Type of latrine (O)	[36]	[16]	[72]	[37]
Pit latrine	25.0	25.0	15.3	37.8
Water closet	75.0	75.0	84.7	62.2
Utility of space from house to latrine (O)	[37]	[16]	[72]	[38]
Washing plates	0.0	0.0	1.3	0.0
Drying plates	0.0	6.3	1.3	2.6
Animal take caring	10.8	31.3	27.8	34.2
Playing place	18.1	87.5	62.5	71.1
Defecation site of persons without latrine (A) <sup>e, f</sup>	[247]	[301]	[130]	[232]
Public lavatory	3.2	0.0	1.5	0.0
Neighbor's lavatory	7.7	3.3	10.8	1.3
Garden near house	2.2	1.3	2.3	23.7
Ricefield or farm	21.9	25.6	42.3	33.6
Seaside 47.8	69.8	2.3	0.4	
Riverside	17.4	0.0	40.8	40.9
Type of cooking (H) <sup>†</sup>	[119]	[120]	[118]	[120]
Boiling	99.2	98.3	100.0	100.0
Fry	75.6	72.5	72.9	64.2
Baking <sup>b, d, e, f</sup>	100.0	100.0	95.8	100.0
steam <sup>a, b, e, f</sup>	95.8	88.3	89.0	98.3
Raw <sup>a, c</sup>	0.0	13.3	16.1	15.0
Hand washing before cooking (H)	[119]	[120]	[118]	[120]
Yes <sup>a, d, e</sup>	65.5	95.8	74.6	72.5
Boiling of drinking water (H)	[118]	[120]	[118]	[120]
Yes <sup>c, e, f</sup>	100.0	100.0	100.0	90.0
Footwear (A)	[352]	[351]	[346]	[349]
Sandals	96.9	98.9	98.3	95.7
Shoes	0.6	0.0	0.6	0.0
Bare foot	2.6	0.9	1.2	4.3
Others	0.0	0.3	0.0	0.0
Handwashing after using laterine (A)	[349]	[345]	[340]	[348]
Yes <sup>a, e</sup>	63.9	89.6	80.9	75.0
Anthelmintic (A)				
Experience of taking	[348]	[351]	[346]	[349]
Yes <sup>b, f</sup>	33.0	33.0	18.2	9.2
When <sup>c, e, f</sup>	[101]	[115]	[59]	[30]
within 3 months	33.7	29.6	25.4	3.3
4-6 months before	16.8	16.5	10.2	16.7
7-12 months before	3.0	0.9	5.1	0.0
More than 1 year before	46.5	53.0	59.3	80.0

† with multiple answers.

[ ] : No. of persons responded to the questionnaire.

(O), (H) and (A) mean that questionnaire was administered to owners, housekeepers and all members including children, respectively.

<sup>a, b, c, d, e, f</sup> mean significantly different ( $p < 0.01$ ) between Pancana and Lalolang, Pancana and Lompo Riaja, Pancana and Pattappa, Lalolang and Lompo Riaja, Lalolang and Pattappa, and Lompo Riaja and Pattappa, respectively.

<sup>a, b, c, d, e, f</sup> mean significantly different ( $p < 0.05$ ) between Pancana and Lalolang, Pancana and Lompo Raija, Lalolang and Lompo Raija Lalolang and Pattappa, and Lompo Riaja and Pattappa, respectively.

Table 3. Significant differences in the prevalence of *Ascaris* and *Trichuris* infections were observed between the occupation of fisherman and the other occupations. The prevalence of *Ascaris* and *Trichuris* infections were significantly lower in those who graduated from senior high school or university. The prevalence of hookworm infection was not significantly different between the people with latrine and without it, while the prevalence of *Ascaris* and *Trichuris* infections showed significant difference. For the people with latrine, the types of toilet showed no relationship with the infection rates of *Ascaris*, *Trichuris* and hookworm. For the people without their own latrine, 62.1% of them with *Ascaris* and 44.9% with *Trichuris* is defecated in the sea. The infection rates of *Ascaris*, *Trichuris* and hookworm were not different in both groups, washing and without washing hands after defecation. No significant difference in *Ascaris* and *Trichuris* infections was observed between those having taken helminthic medicines and those without.

#### Recovery rate of parasite eggs by the modified Kato-Katz smear method

The number of eggs lost was small in the three steps of the modified Kato-Katz thick smear method. The recovery rates of parasite eggs in 45 samples were very high, being 99.7% for *Ascaris*, 99.5% for *Trichuris* and 99.3% for hookworm (Table 4).

## DISCUSSION

Intestinal helminth infections in Barru district, South Sulawesi, Indonesia are characterized by the high prevalence of soil-transmitted nematode infections. The prevalence of *Trichuris* infection was highest, followed by hookworm and *Ascaris* infections. The cestode infection was very low, and no trematode infection was observed. This phenomenon was also found in most areas of Indonesia (Joesoef *et al*, 1980; Purnomo *et al*, 1980; Stafford *et al*, 1980a, b; Higgins *et al*, 1984; Abadi, 1985; Imai *et al*, 1985; Soeripto, 1991; Hasegawa *et al*, 1992; Mangali *et al*, 1993, 1994; Pegelow *et al*, 1997). The infection rates of *Trichuris* and *Ascaris* were relatively low in inland Lompo Riaja and Pattappa.

It is apparent that having latrines and their structure are important factor influencing the soil-transmitted helminth infections (Cairncross, 1987; Mangali *et al*, 1994). The proportion of houses with latrine was about 30% in Pancana, 13% in Lalolang, 60% in Lompo Riaja, and 32% in Pattappa. Most latrines were placed within 1-2 m from the houses. The people of houses without latrine used seashores, rivers, fields, gardens etc as defecation sites. In Barru district, the area around the houses with or without latrine served multiple functions as washing place for clothes, dishes and personal hygiene, children's

Table 2  
Prevalence of intestinal helminth infections among the inhabitants by age groups in 4 villages of Barru, South Sulawesi, Indonesia in 1995.

	Village	Riaja				Male	Female	Total
		Pancana	Lalolang	Lompo	Pattappa			
Aged 4 to 14 years	No. examined	17	11	15	22	27	38	65
	<i>Ascaris</i>	64.7%	72.7	13.3**	18.2	51.9*	28.9	38.5
	<i>Trichuris</i>	100.0	100.0	80.0	68.2	81.5	86.8	84.6
	Hookworm	64.7	54.5	26.7	72.7	55.6	57.9	56.9
	<i>Hymenolepis</i>	5.9	0.0	0.0	0.0	0.0	2.6	1.5
Aged 15 years or above	No. examined	133	132	187	137	259	330	589
	<i>Ascaris</i>	54.9%	53.0	8.6**	9.5	29.0	29.4	29.2
	<i>Trichuris</i>	97.0	97.7	55.1**	53.3	73.0	74.2	73.7
	Hookworm	48.9	45.5	54.5	80.3**	68.7**	48.2	57.2
	<i>Strongyloides</i>	1.5	0.0	0.5	2.9	1.5	0.9	1.2
	<i>Rhabditis</i>	0.0	0.8	4.3	3.6	1.5	3.0	2.4
<i>Hymenolepis</i>	0.8	0.0	0.0	0.0	0.0	0.3	0.2	

\*\*  $p < 0.01$ , \*  $p < 0.05$

Table 3  
Relationship between the results of questionnaire survey and parasite infections.

	Infection rate		
	<i>Ascaris</i>	<i>Trichuris</i>	Hookworm
Occupation (n = 479)			
Fisherman (54)	68.5**	100**	75.9
Farmer (82)	11.0	57.3	85.4
Merchant (34)	14.7	67.6	44.1
Official worker (51)	15.7	49.0	47.1
Without occupation (258)	29.8	72.1	50.0
Education (n = 649)			
Did not go to school (292)	35.3	76.0	64.0**
Graduated			
Elementary and Junior (251)	31.9	77.3	53.0
Senior high and University (106)	12.3**	65.1*	47.2
Latrine (n = 652)			
With (245)	14.3**	66.1**	52.7
Without (407)	39.8	80.1	60.0
Type of latrine (n = 240)			
Pit latrine (49)	10.2	63.3	63.3
Water closet (191)	14.7	66.0	50.3
Defecation site (n = 399)			
Public lavatory (4)	1.2	1.2	0.4
Neighbor's lavatory (16)	1.2	3.7	3.7
Garden near house (39)	3.1	7.5	13.3
Ricefield or farm (130)	23.6	30.2	33.2
Seaside (146)	62.1*	44.9**	32.8
Riverside (64)	8.7	12.5	16.6
Handwashing after using latrine (n=644)			
Yes (503)	31.8	77.9	58.4
No (141)	23.4	64.0	53.2
Footwear (n=588)			
Sandals (474)	32.5	77.2	57.4
Bare foot (114)	26.3	65.8	64.9
Anthelmintic			
Experience of taking (n=652)			
Yes (165)	48.5	90.3	49.7*
No (487)	23.8	69.5	60.0

\*\* p < 0.01, \* p < 0.05

Table 4  
Recovery rate of parasite eggs by the modified Kato-Katz thick smear method.

Step	<i>Ascaris</i>	<i>Trichuris</i>	Hookworm
No. of eggs lost			
No. 1 (Supernatant)	3	4	0
No. 2 (Supernatant)	5	14	6
No. 3 (Inside spitz test tube)	96	72	21
Total no. (A)	104	90	27
No. of eggs recovered and counted (B)	30,928	18,132	3,807
Total no. of eggs included in samples (A+B)	31,032	18,222	3,834
Recovery rate [(B/A+B)x100]	99.7	99.5	99.3

45 samples were examined.

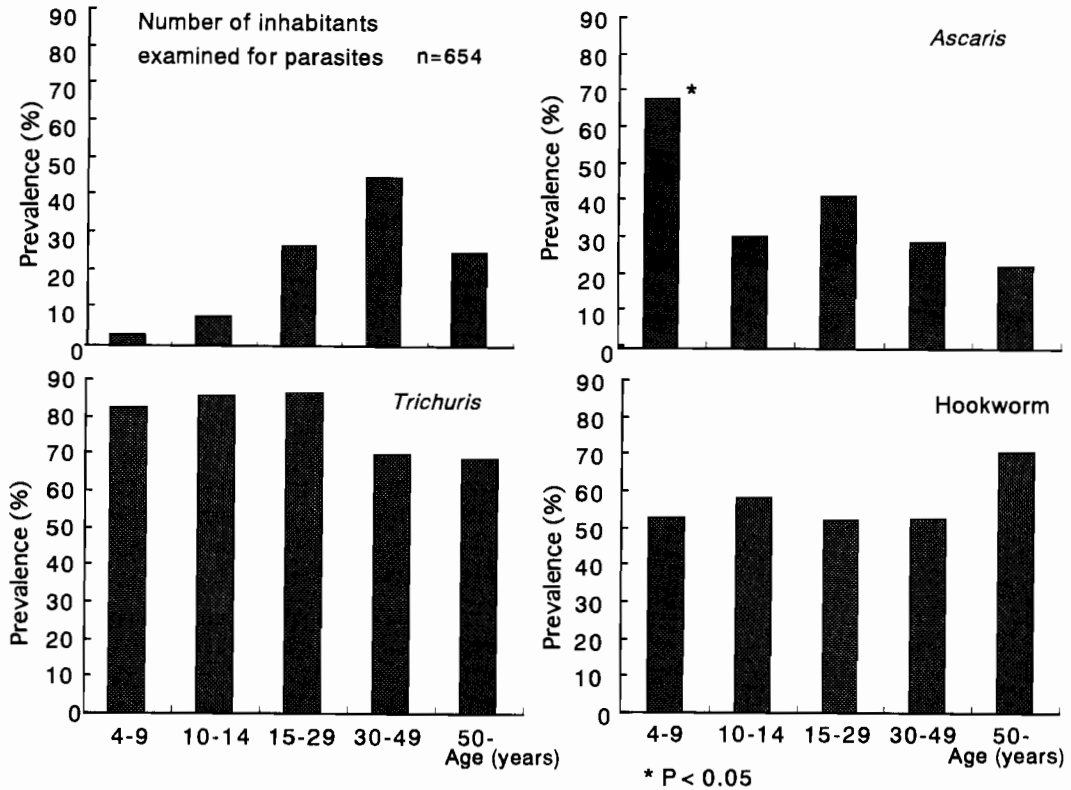


Fig 2—Age-prevalence profiles of *Ascaris*, *Trichuris* and hookworm infections in Barru, South Sulawesi, Indonesia (1995).

playground, and keeping domestic animals. Kroeger *et al* (1992) reported the presence of *Ascaris* and *Trichuris* eggs in soil, house dust and in the air in Peruvian rainforest. They suggested that the contaminated dust was dispersed from defecation sites to the whole community by human feet, animals and wind. In the survey of Brazilian cities by Schulz and Kroeger (1992), *Ascaris* eggs were found in the soil from indoor, backyard and defecation site; they also reported that keeping of pigs was correlated with increased yard contamination. In Barru, where people are Islamic, no pig was found around the houses; however, other animals such as chickens and dogs were reared near houses and defecation sites. Ingestion of *Ascaris lumbricoides* and *Trichuris trichiura* eggs in the soil by children was reported in Jamaica (Wong *et al*, 1991).

It is thought that the soil and sand in the seaside used as defecation site are kept in dry condition compared to those of mountainous area, and *Ascaris* and *Trichuris* eggs with soil and sand are easily dispersed to the community by wind etc and/or ingested. The high infection rate of *Ascaris* and *Tri-*

*churis* in the coastal area of Barru district is thought to be due to the reasons stated above. The prevalence of hookworm infection was highest in Pattappa in the mountainous area, where water from the mountain was supplied in enough volume by simple water supply system. The pathway consisted of mud and stones between the houses, and some areas around the houses were always wet. This environmental condition is thought to be suitable for hatching hookworm eggs and the infection. The low proportion of houses with latrine and the wet conditions might correlate with the high hookworm infection. It is thought that hookworm infection in general becomes higher in inland villages with relatively higher humidity, but the hookworm prevalence in the inland villages Lompo Riaja was low, almost the same as the 2 villages in the coastal area. The reason is that about 60% of the inhabitants had latrines and most inhabitants had a high educational background.

The infection rate of the people with 3 kinds of parasite, *Ascaris*, *Trichuris* and hookworm was 17.4%, and the rate of those with 2 of the 3 parasites was 36.9% in Barru district. The classification of the



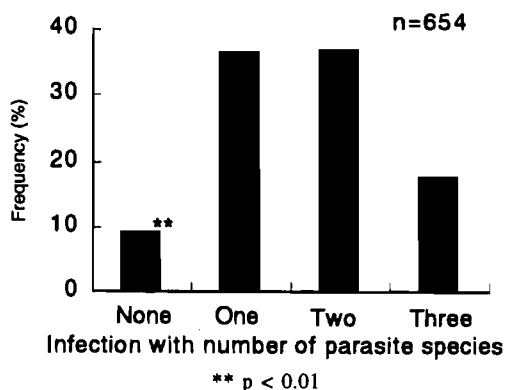


Fig 3—State of multi-infection of parasites (*Ascaris*, *Trichuris* and hookworm) in the inhabitants of Barru, South Sulawesi, Indonesia (1995).

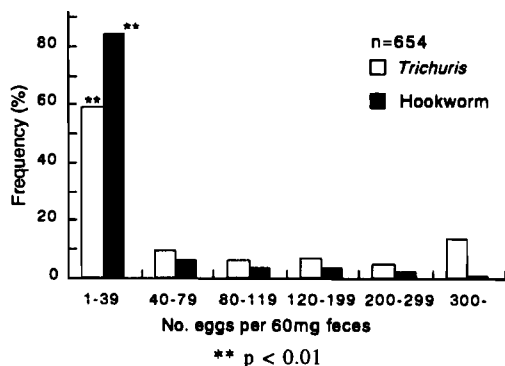


Fig 4—Intensity of *Trichuris* and hookworm infections in the inhabitants of Barru district, South Sulawesi, Indonesia, 1995.

degree of parasite infection differs by researchers (Beaver *et al*, 1984; Bakta *et al*, 1993). Among the inhabitants infected with *Trichuris* and hookworm, 86.3% and 99.2% respectively showed light infection under 300 eggs in 60 mg of feces, which is equivalent to 5,000 eggs per gram (EPG) and usually does not show clinical manifestation (Beaver *et al*, 1984; Mangali *et al*, 1994; Pegelow *et al*, 1997).

Footwear of the people were usually simple; most people wore sandals outside houses. Vegetables were eaten raw and drinking water was not boiled in some cases. Hand washing after defecation, footwear, heat treatment of food and water are important for the control or prevention of infection with soil-transmitted helminths. However, these habits did not always contribute to decrease in *Ascaris*, *Trichuris* and hookworm infections in Barru district. The reasons are thought to be related to their life style without latrines in most houses. The prevalence of *Ascaris*, *Trichuris* and hookworm infections

was also not always lower in people who took antihelmintics. It is thought that prevalence differs by the interval in taking medicine and the degree of contamination in their communities.

Significantly lower infection rate in *Ascaris*, *Trichuris* and hookworm was observed in inhabitants who graduated from junior high school or university. In the people with latrine, the prevalence of *Ascaris* and *Trichuris* infections was significantly lower. It was thought that latrine played a role to interrupt a part of the infection pathway of oral-transmitted parasites. In Barru district, there were 2 types of latrine, pit and water closet (Cairncross, 1987). No significant difference was observed in the prevalence of *Ascaris* and *Trichuris* due to the types of latrine. Also, no significant difference in the prevalence of hookworm infection was observed in inhabitants with latrine and without it. This result is similar to that in Kao area of Halmahera Island (Mangali *et al*, 1994).

In Sulawesi, the predominant hookworm species is *Necator americanus* (Hasegawa *et al*, 1992; Mangali *et al*, 1993, 1994). In this survey, all the larvae cultured by the Harada-Mori method were identified as *Necator americanus*. No significant difference in hookworm infection rates between inhabitants with and without latrine was observed in this survey. The factors influencing soil-transmitted helminth infections include natural factors such as temperature and humidity, and socioecological factors, structure of dwelling, life style, custom of food consumption, etc. It is difficult to pinpoint any one factor for the prevalence of parasite (*Ascaris*, *Trichuris* and hookworm) infections. However, as mentioned by Mangali *et al* (1994) and Hasegawa and Miyagi (1995), the construction of latrines and improvement of education might contribute to decrease the infection rate of soil-transmitted helminths in Indonesia.

The effectiveness of the Kato-Katz thick smear method modified for preserving feces was proven by the high recovery rates of *Ascaris*, *Trichuris* and hookworm eggs. After feces collection, if there is not enough time to examine parasite eggs, this method is recommended.

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