PARASITOLOGICAL AND NUTRITIONAL SITUATION OF SCHOOL CHILDREN IN THE SUKARAJA DISTRICT, WEST JAVA, INDONESIA

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Abstract. A parasitological survey of children aged 8 to 10 years from ten schools located in the rural district Sukaraja, West Java, Indonesia was conducted in December 1995. A total of 348 fecal samples were examined by using modified Kato-Katz thick smear techniques, 365 blood samples for the measurement of hemoglobin concentration, and anthropometric data were obtained from 404 participants. Four nematode (hookworm taken as one species), two cestode and nine protozoan species were detected, but no trematode infection was observed. Among helminths, soil-transmitted nematode infections were predominant, *Trichuris trichiura* with a prevalence of 76% being the most common infection, followed by *Ascaris lumbricoides* (44%). Hookworm and *Enterobius vermicularis* were found in 9% and 3% of the children examined, respectively. Among protozoa, *Blastocystis hominis* was by far the most common species, detected in 60% of volunteers cases. For the helminths *A. lumbricoides, T. trichiura* and hookworm, school to school differences in parasite prevalence and infection intensity were observed; these were probably due to different socioeconomic and sanitary-environmental conditions. Intensity of *Ascaris* and hookworm infection tended to be highly over-dispersed; 85% of the worms identified were harbored by 15% and 7% of the children, respectively. Nutritional status was characterized by an average anemia rate of 13% and a prevalence of 51% stunting. All nutritional indicators differed significantly from school to school. Intensity of geohelminths infection could not be associated to the observed nutritional indicators. Thus, there must be additional factors contributing to the studied nutritional indicators of the school children which overlay a possible influence of moderate to heavy worm burden.

INTRODUCTION

Infestation of intestinal parasites still remains a formidable public health problem in many rural areas of Indonesia. Prevalence of helmithiasis is highest in children aged 5 to 10 years (Bundy *et al*, 1988;1992; Chan *et al*, 1992; Hall, 1993), probably due to age-related exposure to infection (*eg* promiscuous defecation on children's playgrounds). With increasing age worm burden decreases, probably due to changes of exposure or susceptibility or a combination of both (Anderson and May, 1985).

Parasitological studies conducted in Indonesia during the last two decades have found prevalence rates of *A. lumbricoides* ranging between 14-90%, of *T. trichiura* between 1-91% and of hookworm between 21-89%; these differed markedly due to geographical and social-environmental conditions as well as the age of the populations (Cross *et al*, 1970; Clarke *et al*, 1973; Kurniawan *et al*, 1976; Higgins *et al*, 1984; Bundy and Cooper, 1988; Hasegawa *et al*, 1992; Bakta *et al*, 1993; Mangali *et al*, 1993, 1994). The Indonesian province of West Java has been the site of many surveys of human intestinal parasitic infections: Clarke *et al* (1973) made investigations in Kresek near Jakarta; Higgins and colleagues (1984) studied two rubber plantations in the Sukamaju District near Sukabumi. In both surveys, high prevalence rates of soil-transmitted parasite infections were indentified. In Kresek, *T. trichiura* was the most prevalent intestinal helminth with a prevalence of 91%, followed by *Ascaris* and hookworm infection present in 90%

and 67% of the study population, respectively. In Sukamaju, hookworm was the most common geohelminth species with a prevalence rate of 73%, whereas *Ascaris* and *Trichuris* were almost equally prevalent at 57% and 60%, respectively. In both regions, marked differences in geohelminth prevalence were found even between adjacent areas. To get a more complete picture of the parasitological situation in West Java, more parasitological surveys will have to be conducted. Moreover, at least ten years have passed since the aforementioned surveys were completed; presumably, the program for parasite control in Indonesia, which started around 1970, should have already led to some changes in the parasitological situation in West Java. The present study was conducted to obtain information about the present situation concerning the magnitude and severity of geohelminths infections, and to determine the relationship to nutritional status in elementary school children 8 to 10 years old in the Sukaraja District of West Java, Indonesia.

MATERIALS AND METHODS

Description of area

The Sukaraja District is the most easterly administrative district of Sukabumi Regency in the West Java Province, consisting of 20 villages and 79 hamlets with a total population of 110,713 people (55,804 males and 54,908 females), living in 27,669 households (Census 1990). On average, approximately four persons live in each household (Sukabumi Department of Statistics, 1993). Ten elementary schools, located in six neighboring villages (Sukamaju, Sukalarang, Cimangkok, Titisan, Prianganjaya and Semplak), were chosen for survey by the District Health Office Sukabumi and the local Office of Education in Sukalarang. The villages were located in a rural area between kilometers 10 and 15 of the Sukabumi-Cianjur road, the most northern parts of their area directly at the foot of Mt Pangrango. The altitude of the study area was about 900-1,000 m above sea-level. Due to the altitude, daily temperatures were only between 15 to 25°C during the rainy season (October to May). During the study period (December 1995) rainfall was lower than usual. Annual precipitation was 980 mm and 1,875 mm in 1993 and 1994, respectively. Due to the vicinity to the volcano Mt Pangrango, the soil consisted of volcanic remains which tended to be heavy and lumpy during the wet season.

Subjects

Forty to forty-seven children of the desired age class of 8 to 10 years, were selected randomly from student lists at each school. For statistical analysis, subdivision of the study population into ten groups by the grouping factor 'school visited' best reflected the place of living. However, not all children attending a school in a village also lived in that village, but they did live relatively near by the school and most of them close to each other. In total, 408 children (210 boys and 198 girls) with a mean age of 8.9±0.8 years, ranging from 8-10 years, participated in the survey.

Study design

The study was a cross-sectional, baseline survey to obtain point-prevalence and intensity information about the parasitological and nutritional situation of the study area. Between the 12th to 29th of December, 1995, containers for fecal specimen were delivered to each of the schools on the day before the visit of the survey group. Fecal samples were collected the following morning. Besides the fecal sample collection, a survey on living conditions and sanitary practices was conducted, and anthropometric data were obtained. Furthermore, 200 µl finger prick blood per person were collected. Later, appropriate anthelminthic was given to the children who proved to be infected with helminthic parasites.

Parasite analysis in stool

Fecal samples from 348 participants (85.3% of the study population) were examined. The specimens were preserved with 10% formalin in a volume ratio of one-to-one on the day of collection and stored at room temperature until examined. One to four weeks later at the Department of Parasitology of the University of Indonesia, Jakarta (DP-UI), for *A. lumbricoides* and *T. trichiura* eggs, and at the Department of Parasitology of the US Naval Medical Research Unit No. 2, Jakarta (DP-NAMRU-2), for all kinds of intestinal worm eggs and protozoal infections. Both laboratories used modifications of the Kato-Katz thick smear technique. DP-UI followed the modified Kato-Katz thick smear technique of Martin and Beaver (1968), but used 10 mg of specimen only. DP-NAMRU-2 also used 10 mg of specimen, but just covered this amount with a cover glass and examined it immediately with a microscope. The latter method has the advantage that hookworm eggs will not be destroyed by glycerine. This may happen 20 minutes after covering the specimen with cellophane soaked in malachite green solution, with the previously described modification of Kato-Katz thick smear technique is used. Results were expressed as eggs per gram formed feces (epg). The prevalence of *Ascaris* and *Trichuris* was computed using the results of both laboratories, since both laboratories, and also both methods, proved to obtain similar results with regard to these helminths. The prevalence rates of all other worm and protozoa species were computed from the results of DP-NAMRU-2.

Blood chemistry

Blood samples were obtained from 365 children (89.5% of study population). Two hundred micro liter finger prick blood samples were collected from each participant and placed on 2×4 cm filter paper. The filter papers were examined five weeks after collection in the laboratory of SEAMEO-TROPMED, University of Indonesia, Jakarta, using a modification of the cyanomethemoglobin method of Drabkin and Austin (Cook *et al*, 1985). The filter papers were soaked in Drabkin-solution (Merckotest Hemoglobin, no. 1.03317.0001 and Hemoglobin Cyanide Standard Solutions, no. 1.03298.0001, Germany) for at least 48 hours, and then measured photometrically following the instructions of manufacture.

Anthropometric measurements

Anthropometric indicators were computed of 404-406 participants (99.3%). Subjects were weighed without shoes by using an electronic, platform-model weighing scale (SECA 770 alpha; SECA, Hamburg, Germany). The weight was recorded to the nearest 0.1 kg. Height was measured to the nearest 0.1 cm by using a microtoise (CMS Weighing Equipment, Ltd. London, Great Britain). Anthropometric indicators of malnutrition were obtained by computing weight-for-height (W/H), height-for-age (H/A) and weight-for-age (W/A). Z-scores of the indicators W/H, H/A and W/A were calculated by using the National Center for Health Statistics (NCHS, 1977) reference data to correct for effects of sex and age on growth. Minus two Z-scores of the NCHS reference population's distribution was considered the cut-off point for malnutrition, as recommended by the WHO Working Group (1986). For iron deficiency anemia, the cut-off point and was 110 g/l (Cook *et al*, 1985)

Statistical analysis

For statistical analysis SPSS for Windows 6.0.1 (SPSS Inc, Chicago, USA) was used. Prevalence data were compared by the chi-square test for independence. Probability less than 5% for null hypothesis was considered significant. Since egg count distribution was markedly skewed, only non-parametric tests were taken for statistical analysis: for comparison of two independent groups the Mann-Whithey U test; and for *k* independent groups the Kruskal-Wallis H test. For correlation, Spearman's rank correlation coefficient was utilized. When data were following a normal distribution (hemo-globin results and Z-scores of the anthropometric indicators), student's *t*-test for two independent groups and one-way ANOVA for *k* independent groups were applied. Following ANOVA, multiple comparison test of Duncan was performed, considering probability less than 5% for null hypothesis significant. Based on the fecal egg counts, groups for intensity of infection were formed as follows:

Grade of infection	*A. lumbricoides* (epg)	*T.trichiura* (epg)	hookworm (epg)
No or light	0 - 4,999	0 - 999	0 - 499
Moderately light	5,000 - 27,499	1,000 - 5,499	500 - 1,999
Moderately heavy	27,500 - 50,000	5,500 - 10,000	2,000 - 5,000
Heavy	>50,000	>10,000	>5,000

Ethical considerations

The international ethical guidelines for epidemiological studies were considered in this study (CIOMS, 1991). Study design and protocol were approved by the Committee for the Protection of Human Subjects, NAMRU-2, Jakarta, the Ethical Committee of LITBANGKES, Jakarta, Indonesia and the SEAMEO-TROPMED Regional Center for Community Nutrition. Consent was obtained from a total of 413 participants and their guardians.

RESULTS

Social and environmental conditions

The social and environmental health conditions of the surveyed area, derived by questionnaire, are summarized in Table 1. Most of the children's fathers were farmers; followed by day laborers then merchants. More than half of the houses' floors were made of cement, and the remainder were made of bamboo. Existence of a latrine in the houses of the children's families differed markedly among the schools visited, Gedurhayut students having the lowest rate of latrines at home, and Sukalarang II the highest rate. While most children's households in the villages had electricity, only 4% of the houses of Gedurhayu pupils were supplied with electricity. Also, possession of wealthy goods was lowest in Gedurhayu pupils' households, reflecting a markedly lower socioeconomic status of these children in comparison to all other schools studied.

The most often used site for defecation was the latrine at school (49%); this was used mostly by children without a latrine at home. but also by a few children who had such a facility. Thirty-three percent of all children used their latrines at home. In Cipriangan and Sukalarang I about one-fifth of the children defecated in a lake or pond. Another fifth of the children of Cipriangan used an earthen hole around their house for defecation. In the Sukaraja District, there was no tradition of using human excreta as fertilizer. Most families used their own bathroom for taking a bath (Sukalarang I, Sukalarang II, Cimangkok), a lake or pond (Cipriangan, Semplak, Kabandungan) or, alternatively, a well or spring (Manglid, Pangestu, Gedurhayu). Thirty-four percent of all children's houses had a latrine. Nearly all of these households also had a bathroom, and children living in these houses used their latrines and bathrooms.

Usual footwear were simple sandals, or sometimes shoes. Most of the children wore shoes or sandals outside the house. However, 20 to 40% of the children in Manglid, Gedurhayu, Cimangkok and Sukalarang I stated they wore footwear rarely. The highest frequencies of wearing footwear were favored in Sukalarang II, Kabandungan and Margawangi.

South to the Sukabumi-Cianjur road mostly wet land paddy fields were cultivated with traditional irrigation methods. North of the road, mostly corn, cucumber and banana were cultivated, due to the higher altitude. Furthermore, cabbage, coffee and other crops were produced. As in the whole Sukabumi Regency, inland fishery, particularly gold fish breeding, was an important branch of animal food production in the study area. Staple foods were rice, sweet potato and cassava. Chicken, freshwater fish and sometimes beef were consumed frequently, all after being well cooked. Most commonly eaten vegetables were cucumber, carrots, corn, and leaves of the eucalyptus tree. Water was usually boiled before drinking or a specific drinking water supply system was used ('aqua'-cans), as in many parts of West Java.

Prevalence of intestinal parasites

The prevalence of intestinal parasite infections by locality, sex and age is shown in Table 2. The observed helminth species were mostly nematodes and in some cases cestodes, but no trematode infection was detected. The total prevalence of helminth infestations was 84%, ranging from 53% to 100% among the schools. The protozoa detected were mostly amebae, flagellates and coccidia showing a total prevalence of 77%. Prevalence of intestinal helminth infections was higher in males than in females, and higher in the age group of 9 than in the other two age groups (8-10), but differences were not significant. In detail, *T. trichiura* infection was most common (76%), followed by *A. lumbricoides* infection (44%). Hookworm infection was far less common (9%), and totally absent in the schools Sukalarang I and Cimangkok. *E. vermicularis* showed a total prevalence of 3%, occurring in only 6 the 10 schools. The cestodes *Hymenolepis nana* and *H. diminuta* were seldom observed. Among the protozoa, *Blastocystis hominis* (60%) was the most

Table 1

Social and hygienic characteristics of the surveyed area in Sukaraja District, West Java, according to questioning of the children, by locality.

Elementary school	Marga-wangi	Sukala-rang I	Sukala-rangII	Cimang-kok	Pangestu	Gedur-hayu	Cipriang-an	Semplak	Kaban-dungan	Manglid	Total
No. persons questioned	40	38	40	39	41	47	41	41	41	39	407
Occupation of wage-earner	(38)[a]	(33)	(37)	(37)	(38)	(43)	(40)	(39)	(41)	(37)	(383)
Farmer	23.7	24.2	35.1	16.2	42.1	65.1	42.5	30.8	53.7	18.9	36.0
Casual laborer	47.4	30.3	27.0	32.4	21.1	14.0	40.0	28.2	12.2	51.4	30.0
Craftsman				2.7				5.1			0.8
Official worker	10.5	6.1	13.5	8.1	7.9	2.3		10.3	9.8	5.4	7.3
Merchant	15.8	24.2	18.9	27.0	23.7	14.0	15.0	25.6	22.0	16.2	20.1
Others	2.6	15.2		13.5	5.3	2.3			2.4	2.7	4.2
No job			5.4			2.3	2.5			5.4	1.6
Household, basic data	(40/39)	(38/35)	(40/35)	(39/36)	(41/39)	(47/44)	(41/39)	(41/38)	(41/39)	(39/36)	(407/380)
Material of floor											
Cement	52.5	47.4	77.5	66.7	53.7	17.4	53.7	63.4	53.8	38.9	52.1
Stone	2.5					13.0					1.7
Wood/timber		2.6	2.5		12.2	34.8	2.4	2.4	10.3	13.9	8.5
Bamboo	45.0	50.0	20.0	33.3	34.1	34.8	43.9	34.1	35.9	47.2	37.7
Latrine existing	27.5	42.1	67.5	57.9	46.3	4.3	17.1	31.7	26.8	28.2	34.3
Electricity	92.5	89.5	95.0	89.7	97.6	4.3	95.1	97.6	85.4	87.2	82.1
No. bedrooms (mean)	2.6	2.6	2.7	2.7	2.8	2.5	2.5	2.6	2.6	2.4	2.6
No. siblings (mean)	3.3	2.8	2.5	3.2	3.3	3.5	2.6	2.2	2.5	2.8	2.9
Household,	(40)	(38)	(40)	(39)	(41)	(47)	(41)	(41)	(41)	(39)	(407)
Possession of[b]											
Radio	47.5	60.5	42.5	61.5	31.7	36.2	43.9	65.9	46.3	51.3	48.4
Television	37.5	55.3	55.0	43.6	56.1	29.8	26.8	75.6	41.5	43.6	46.2

(Continue)											
Bicycle	32.5	21.1	17.5	20.5	22.0	17.0	24.4	24.4	22.0	17.9	21.9
Motorcycle	10.0	7.9	10.0	5.1	7.3	2.1	12.2	7.3	4.9	5.1	7.1
Car	5.0	5.3	7.5	5.1	7.3		4.9	7.3	4.9	5.1	5.2
Frequency of shoe/slippers wear outside after school	(39)	(38)	(40)	(39)	(41)	(47)	(41)	(41)	(41)	(39)	(406)
Always	25.6	31.6	62.5	23.1	17.1	10.6	4.9	19.5	12.2	15.4	21.9
Most times	66.7	47.4	30.0	53.8	63.4	66.0	80.5	70.7	82.9	43.6	60.8
Rarely	7.7	21.1	5.0	23.1	19.5	23.4	12.2	9.8	4.9	38.5	16.5
Never			2.5				2.4			2.6	0.7
Place of bathing	(40)	(37)	(39)	(38)	(41)	(47)	(40)	(40)	(41)	(39)	(402)
Bathroom at home	30.0	43.2	71.8	50.0	43.9	6.4	20.0	37.5	29.3	38.5	36.3
Pump outside home	20.0	10.8	2.6	15.8			5.0	5.0	7.3	7.7	7.2
Well/spring	17.5	10.8	10.3	13.2	56.1	53.2	5.0		2.4	51.3	22.6
Lake/pond	32.5	35.1	12.8	21.1		40.4	70.0	57.5	61.0		33.3
River			2.6							2.6	0.5
Defecation site	(40)	(36)	(40)	(39)	(41)	(47)	(41)	(40)	(41)	(39)	(404)
Latrine at home	27.5	38.9	65.0	51.3	46.3	4.3	14.6	32.5	26.8	28.2	32.9
Latrine at school	57.5	30.6	22.5	28.2	48.8	80.9	36.6	52.5	53.7	71.8	49.0
Earth hole	12.5	2.8	2.5	10.3	4.9	14.9	17.1	7.5	7.3		8.2
Lake/pond	2.5	19.4	10.0	10.3			24.4	5.0			6.9
River		8.3					7.3	2.5	12.2		3.0

[a]No. children answered
[b]With multiple response

Table 2

Prevalence of intestinal parasite infections in ten schools of Sukaraja District by locality, sex and age

	School[a]										Sex		Age (Years)			
Parasite	1	2	3	4	5	6	7	8	9	10	Male	Female	8	9	10	Total
Worms																
Ascaris lumbricoide[b]	50	27	41	28	50	91	38	39	29	31	46	41	43	46	41	44
Trichuris trichiura[b]	79	87	62	53	58	86	91	78	87	78	80	72	72	81	72	76
Hookworm	18		9		3	16	3	6	13	16	9	8	8	7	11	9
Enterobius vermicularis		7	3			5	6	8		3	3	4	3	2	6	3
Hymenolepis nana	3	3			3			3			1	2	1	2		1
Hymenolepis diminuta					3							1		1		
Total prevalence[b]	91	90	69	53	72	100	97	83	92	91	88	80	82	87	83	84
Protozoa																
Blastocystis hominis	76	53	67	50	46	59	66	56	76	47	59	61	57	61	61	60
Entamoeba histolytica	29	43	21	34	32	11	34	28	24	28	26	29	25	30	27	28
Entamoeba hartmanni	18	10	18	19	8	9	16	11	13	25	13	16	15	15	12	14
Entamoeba coli	15	17	12	6	22	14	6	6	18	12	13	12	13	12	15	13
Endolimax nana	9	20	39	28	43	18	12	6	8	25	23	18	27	16	22	21
Giardia lamblia	18	27	24	19	13	11	25	19	10	16	20	15	17	17	20	18
Iodamoeba bütschlii	12	7	24	9	22	7	16	8	21	9	16	11	12	17	10	14
Chilomastix mesnili		7									1	1	1	1		1
Cyclospora spp			6								1	1	1	1		1
Total prevalence	82	83	91	75	76	71	75	64	84	69	77	77	76	76	78	77
Total no. examined	34	30	33	32	36	44	33	36	38	32	185	163	109	151	88	348

[a]Code for schools:: 1=Margawangi, 2=Sukalarang I, 3=Sukalarang II, 4=Cimangkok, 5=Pangestu, 6=Gedurhayu, 7=Cipriangan, 8= Semplak,9=Kabandungan, 10= Manglid

[b]Total no. examined: 346 (with exception of school 2 and 7 the samples were examined 2 times)

common parasite. Prevalence of amebae ranged from 14-28%, *Entamoeba histolytica* being the most common among them. *Chilomastix mesnili* and *Cyclospora* spp were found in two cases each.

Significant differences ($p<0.001$) were found in the prevalence of *A. lumbricoides* and *T. trichiura* among localities. Prevalence rates of *A. lumbricoides* (91%), *T. trichiura* (86%) and hookworms (16%) were all high in Gedurhayu, prevalence of infection with *A. lumbricoides* being markedly higher than in all other schools (27% to 50%). The school children in Margawangi showed the highest prevalence of hookworm infection (18%), and additionally a relatively high prevalence of *Ascaris* infection (50%). Relatively high rate of *Ascaris* infection (50%) was found in Pangestu, accompanied by a relatively lower prevalence of *Trichuris* (55%). In Manglid, a relatively high prevalence of hookworm infection (16%) together with a high rate of *Trichuris* (78%) was present. *Trichuris* infection was most prevalent in Cipriangan (91%), followed by Kabandungan (87%), Sukalarang I (87%) and Gedurhayu, prevalence rates being clearly higher than those of Cimangkok (53%), Pangestu (58%) and Sukalarang II (62%). The prevalence of *Trichuris* infection in Sukalarang I was accompanied by a very low prevalence of *Ascaris* (27%) and there were no hookworm infections. Sukalarang II showed, in contrast to Sukalarang I, a relatively low infection rate of *Trichuris*, but a higher prevalence of *Ascaris* infection (41%), although both schools were located in the same place. A similar phenomenon in two neighboring schools was observed in Semplak and Kabandungan. The lowest infection rates for all four geohelminths species were found in Cimangkok. All in all, prevalence of *Trichuris* infection showed an altogether lower range among the localities investigated than did of *Ascaris* infection. The ratio of *Trichuris/Ascaris* infection rates was lower north to the Sukabumi-Cianjur road (0.95-1.89) except Sukalarang I (3.22) than south to the road (2-3), *ie* the share of *A. lumbricoides* in the total prevalence was higher north to the road than south to it and vice versa for *T. trichiura* infection (Fig 1).

Prevalence of the geohelminths as single and mixed infections according to locality, sex and age group is presented in Table 3. Most infections were single infections (45%), double infections, and triple infections were observed in 34 and 6% of the study population, respectively. In addition, *Trichuris* infection appeared similarly frequent as a single infection (37%) and, together with *Ascaris*, as a double infection (31%). Thus, prevalence of *Ascaris* and *Trichuris* infection were significantly related ($p<0.01$). Single infection with *Ascaris* was rare (7%); the highest rates occurred in Gedurhayu and Pangestu, the schools with the highest *Ascaris* prevalence. Most hookworm infections occurred in individuals with triple infections, especially in Gedurhayu and Manglid, while a single infection of hookworm was only found in three schools (Margawangi, Manglid and Kabandungan) and double infections which seldom occurred in five of the ten schools together with *Trichuris*, but never with *Ascaris*. Nevertheless, *Ascaris* and hookworm infection were significantly related ($p<0.05$).

Significant differences of protozoal prevalence rates among localities were found only for *E. nana*, being more prevalent in Pangestu (43%), Sukalarang II (39%), Cimangkok (28%) and Manglid (25%) and least prevalent in Semplak (6%) and Kabandungan (8%). *B. hominis* was, in contrast to *Endolimax nana*, most prevalent at 76% in Kabandungan and Margawangi, and less prevalent in Pangestu (46%), Manglid (47%) and Cimangkok (50%), but the differences were not significant.

Prevalence rates of helminths and protozoa infections were not related, except *B. hominis* and *I. bütschlii* infection appearing significantly more often in *Trichuris* infected children than in non-infected school children ($p<0.01$) and *Entamoeba hart manni* being significantly more often found in hookworm infected than in non-infected children ($p<0.05$). *E. coli* and *E. histolytica* occurred non-significantly more often in *T. trichiura* infected than in non-infected school children.

The comparison of prevalence data with factors of social conditions and hygienic behavior showed some significant connections. In general, lower infection rates were found in children with a latrine at home, better socioeconomic conditions (*ie* electricity at home, possession of wealthy goods, cement floor), and who took their bath at home, defecated at home and always wore slippers (Table 1). Prevalence was highest for all four geohelminths, when the children washed themselves at a well or spring and defecated in an earth hole around their house ($p<0.05$ for *Ascaris* and *Trichuris* prevalence rates). Existence of a latrine at home had no direct influence on the prevalence of hookworm infection, but it did for *Ascaris*-($p<0.05$) and *Trichuris* ($p<0.01$) infections, being in both cases higher in

Table 3

Occurrence of *Ascaris, Trichuris* and hookworm as single and mixed infections among school children of ten schools in Sukaraja district.

			Percentage of population					
			Single infection			Double infection		Triple infection
Group	Count	Uninfected	*Ascaris*	*Trichuris*	Hookw	*Ascaris/ Trichuris*	*Trichuris/* Hookw	*Ascaris/ Trichuris/* Hookw
School								
Margawangi	34	8.8	8.8	35.3	2.9	29.4	2.9	11.8
Sukalarang I	30	10.0	3.3	63.3		23.3		
Sukalarang II	32	31.3	6.3	25.0		28.1	3.1	6.3
Cimangkok	32	46.9		25.0		28.1		
Pangestu	36	27.8	13.9	22.2		33.3		2.8
Gedurhayu	44		13.6	9.1		61.4		15.9
Cipriangan	32	3.1	6.3	56.3		31.3	3.1	
Semplak	36	16.7	5.6	44.4		27.8		5.6
Kabandungan	38	7.9	2.6	55.3	2.6	21.1	5.3	5.3
Manglid	32	9.4	6.3	46.9	6.3	21.9	6.3	3.1
Sex								
Male	184	12.0	6.5	38.6	1.6	33.7	1.6	6.0
Female	162	19.8	7.4	35.8	0.6	29.0	2.5	4.9
Age								
8 years	109	18.3	8.3	33.9	0.9	31.2	3.7	3.7
9 years	150	12.7	4.7	39.3	1.3	36.0	0.7	5.3
10 years	87	17.2	9.2	37.9	1.1	24.1	2.3	8.0
Total	346	15.6	6.9	37.3	1.2	31.5	2.0	5.5

children without latrines at home. Frequent use of footwear resulted in different prevalence rates of hookworm infection, being significantly higher ($p<0.01$) in children wearing slippers rarely or never than in children always wearing slippers. *Trichuris* infections were significantly higher in children taking their bath in a pond or at a well ($p<0.05$), and washing themselves at a well or in a river led to significantly higher ($p<0.001$) prevalence rates of *Ascaris* infection. The group of children living in houses with a cement floor showed a significantly lower *A. lumbricoides* and hookworm infection rate, while prevalence was highest in the group of children living in houses with a bamboo floor ($p<0.01$). Children of day laborers and farmers were found to have higher prevalence rates of *T. trichiura* infection than children of civil servants, but differences were not significant. Generally, correlations were most pronounced in *Ascaris* infection.

Among the protozoal infections, prevalence was significantly different ($p<0.01$) for *E. nana*, being higher in children who take their bath in a river, at a pump or at a well, and lowest when washing themselves at home or in a pond. Infections with *E. coli* and *B. hominis* were more prevalent in children defecating in an earth hole around their house, at school or in a river than in children defecating at home or in a pond, but differences were significant only for *B. hominis* ($p<0.05$). *G. lamblia* infection more often occurred in better socioeconomic conditions, but differences were not significant.

Intensity of geohelminths infections

Results of the egg count for *A. lumbricoides*, *T. trichiura* and hookworm are shown in Table 4, differentiated for locality, sex and age group. Mean intensities of infection were strongly correlated with prevalence rates of infection at school level for

A. lumbricoides, *T. trichiura* and hookworm with r=0.81, r=0.88 and r=0.93, respectively ($p<0.01$). Intensity of *Ascaris* and *Trichuris* as well as *Ascaris* and hookworm infection showed weak correlation with r=0.11 and r=0.13, respectively ($p<0.05$).

Intensity of *Ascaris* infection was highest in Gedurhayu, being significantly different from all other schools' results ($p<0.001$), while Pangestu showed the second highest intensity, significantly different from Cimangkok, Manglid, Semplak and Kabandungan ($p<0.05$). In Margawangi, intensity of *Ascaris* infection was found to be significantly higher than that of Cimangkok and Kabandungan ($p<0.05$). Cimangkok had the lowest intensity of *Ascaris* infection. Intensity of *Trichuris* infection was highest in Cipriangan and lowest in Pangestu, but none of the differences between schools were significant. Intensity of hookworm infection showed only slight differences. Differences between gender were not significant, although intensity of *A. lumbricoides* infection was slighty higher in females, and *Trichuris* and hookworm infection intensities were slightly higher in males. A decrease of *Ascaris* infection intensity with age, and highest intensities of *Trichuris* and hookworm infections in the group of 9-years-old were also not statistically significant. Generally, the highest intensity was found in *Ascaris* infection while hookworm infection showed only a very low intensity.

Influences of environmental conditions on the intensity of infections were mostly the same as those described for the prevalence of the respective worm species. Besides these, the intensity of infection of both, *A. lumbricoides* and hookworm, was lower when the defecation site was a pond or river. *Trichuris* infection intensity was lower when the latrine at home was used.

Distribution of geohelminths eggs showed a marked aggregation in *Ascaris* and hookworm infection, 85% of the worm eggs were detected in the stools of 15% and 7% of the children, respectively. Intensity of *Trichuris* infection was less aggregated, 57% of worm eggs being detected in stools of 20% of the children (Table 4).

Nutritional status

Prevalence rates of wasting, stunting, underweight and iron deficiency anemia by locality, sex and age are shown in Table 5, and distribution parameters are summarized in Table 6. The most marked feature of the nutritional situation in the study population was stunting, occurring in over 50% of the children. Significant (<-2 Z-scores) under-weight was found in 28% of children, while the prevalence wasting (1%) gave no indication of undernutrition. Anemia was present in 13% of the school children. There were no significant differences within age groups, although all three anthropometric malnutrition indicators showed increasing prevalence with age. Between sexes, significant differences existed for W/H, but there was no significant difference for W/A and H/A. W/A and H/A were strongly positive correlated with r=0.73 (controlled for gender and age), as were W/H and W/A with r=0.62 (controlled for gender and age). A weak positive correlation existed between hemoglobin level and W/A (r=0.12), but significance disappeared when the partial correlation coefficient controlled for gender and age was calculated. No significant correlation was found between H/A and W/H.

Among localities, the lowest stunting rate was found in Gedurhayu (36%), followed by Margawangi (43%), and the highest stunting rate was 63% in Sukalarang I and Cipriangan. Marked differences were also found among localities for W/A and hemoglobin levels. Average W/A in Gedurhayu (-1.36) was significantly higher ($p<0.05$) than in Cimangkok (1.74) and Semplak (-1.74). The average hemoglobin level of Gedurhayu (129 *g*/l) was found to be significantly higher than that of Semplak (114 *g*/l), Cimangkok (120 *g*/l), Manglid (120 *g*/l), Pangestu (121 *g*/l) and Cipriangan (123 *g*/l), while in Margawangi (128 *g*/l) the average hemoglobin level was proven to be significantly higher than that of Semplak, Cimangkok, Manglid and Pangestu. The lowest mean hemoglobin level was found in Cimangkok, being significantly lower than that of all other schools.

Indicators for malnutrition compared withprevalence and intensity of intestinal geohelminths gave the following picture: iron deficiency occurred non-significantly more often in children with helminth infestation, and was non-significantly positive correlated to the intensity of a *Trichuris* and hookworm infection, but vice versa in a *Ascaris* infection. Stunting occurred significantly ($p<0.05$) less often in hookworm infected children, independent of intensity of infection. W/A was in individuals infected with one or more of the three worm species (hookworm taken as one worm species) nearer to the reference population's values in the more severely infected groups of

Table 4

Intensity of intestinal helminth infestations in children of ten schools located in Sukaraja district by locality, sex and age.

Parasite	School[b]										Sex		Age (Years)			Total
	1	2	3	4	5	6	7	8	9	10	Male	Female	8	9	10	
Ascaris lumbricoides																
Intensity groups:																
No/light infestation (%)[a]	79	93	90	100	76	23	91	94	95	94	80	83	78	82	86	82
Moderately light inf (%)[a]	18	3	6		22	52	3	6	5	6	15	12	16	13	10	13
Moderately heavy inf (%)[a]	3	3	3		3	16	3				4	2	4	3	3	3
Heavy infestation (%)[a]						9	3				1	2	2	2	0	1
Mean egg count (epg)	2,929	1,697	3,575	600	3,750	20,568	3,903	789	647	1,637	4,370	4,565	5,335	4,730	3,125	4,461
Std dev	6,137	5,602	9,909	1,142	6,789	23,709	11,576	1,807	1,591	4,260	10,442	13,470	15,070	11,532	7,834	11,944
Trichuris trichiura																
Intensity groups:																
No/light infestation (%)[a]	85	83	91	84	95	82	79	81	79	87	83	87	90	81	84	84
Moderately light inf (%)[a]	15	17	9	16	5	18	18	19	21	13	17	13	10	18	16	15
Moderately heavy inf (%)[a]							3				1			1		1
Mean egg count (epg)	476	573	364	396	227	459	721	622	537	406	522	422	370	576	432	474
Std dev	542	658	617	699	331	430	1,045	706	573	615	699	581	481	770	571	644
Hookworm																
Intensity groups:																
No/light infestation (%)[a]	91	100	97	100	97	100	97	100	92	94	98	96	97	97	96	97
Moderately light inf (%)[a]	9		3		3		3		8	6	2	4	3	3	4	3
Mean egg count (epg)	94		48		16	59	55	22	79	87	49	45	41	47	57	47
Std dev	232		187		99	140	313	93	221	227	189	173	149	206	174	180
Total number	34	30	33	32	37	44	33	36	38	32	185	164	109	152	88	349

[a] % of cases examined

[b] Code for schools: 1=Margawangi, 2=Sukalarang 1, 3=Sukalarang 11, 4=Cimangkok, 5=Pangestu, 6=Gedurhayu, 7=Cipriangan, 8=Semplak, 9 = Kabandungan, 10=Manglid

Table 5

Prevalence of wasting, stunting, underweight and iron deficiency in ten schools of Sukaraja district by locality, sex and age.

Malnutritino Indicator	School[a]										Sex		Age (Years)			
	1	2	3	4	5	6	7	8	9	10	Male	Female	8	9	10	Total
Anthropometry																
(Z-scores)																
Weight/Height	(40)	(38)	(40)	(40)	(40)	(47)	(41)	(40)	(40)	(38)	(208)	(196)	(129)	(176)	(99)	(404)
adequate (≥-2)	100	97	97	97	100	100	98	100	100	100	99	98	98	100	98	99
wasted (<-2)		3	3	3			2				1	2	2		2	1
Height/Age	(40)	(38)	(40)	(40)	(41)	(47)	(41)	(39)	(40)	(38)	(210)	(194)	(130)	(177)	(97)	(404)
adequate (≥-2)	57	37	47	47	49	63	37	48	45	53	43	54	52	48	46	49
stunted (<-2)	43	63	53	53	51	37	63	52	55	47	56	46	48	53	54	51
Weight/Age	(40)	(38)	(40)	(40)	(41)	(47)	(41)	(40)	(40)	(39)	(208)	(198)	(130)	(176)	(100)	(406)
adequate (≥-2)	82	68	67	67	73	79	83	67	62	72	73	72	75	74	67	72
underwt, (<-2)	18	32	33	33	27	21	17	33	38	28	27	28	25	26	33	28
Hemoglobin (g/l)	(40)	-	(38)	(40)	(41)	(47)	(41)	(39)	(41)	(39)	(191)	(174)	(118)	(159)	(88)	(365)
normal (≥110)	95	-	90	85	83	96	88	69	93	82	86	87	87	86	87	87
deficient (<110)	5	-	10	15	17	4	12	31	7	18	14	13	13	14	13	13

[a] Code for schools: 1=Margawangi, 2=Sukalarang I, 3=Sukalarang II, 4=Cimangkok, 5=Pangestu, 6=Gedurhayu, 7=Cipriangan, 8=Semplak, 9 = Kabandungan, 10=Manglid

Table 6

Distribution parameters of weight-for-height, height-for-age,weight-for-age and hemoglobin levels from the children of ten schools of Sukaraja district by locality, sex and age.

Indicator	School[a]										Sex		Age (Years)			Total
	1	2	3	4	5	6	7	8	9	10	Male	Female	8	9	10	
Anthropometry																
(Z-scores)																
Weight/Height	(40)	(38)	(40)	(40)	(40)	(47)	(41)	(40)	(40)	(38)	(208)	(196)	(129)	(176)	(99)	(404)
Mean	-0.37	-0.10	-0.30	-0.46	-0.30	-0.23	-0.19	-0.50	-0.31	-0.17	-0.42	-0.16	-0.33	-0.28	-0.27	-0.29
Std dev	0.70	0.90	1.00	0.87	0.74	0.75	0.83	0.60	0.98	0.70	0.73	0.88	0.71	0.85	0.87	0.81
Height/Age	(40)	(38)	(40)	(40)	(41)	(47)	(41)	(39)	(40)	(38)	(210)	(194)	(130)	(177)	(97)	(404)
Mean	-1.88	-2.06	-2.08	-2.11	-2.03	-1.72	-2.08	-1.92	-2.02	-1.96	-2.04	-1.92	-1.93	-2.02	1.98	-1.98
Std dev	0.67	0.84	0.79	0.79	0.92	0.85	0.68	0.73	0.62	0.71	0.76	0.77	0.77	0.77	0.76	0.77
Weight/Age	(40)	(38)	(40)	(40)	(41)	(47)	(41)	(40)	(40)	(39)	(208)	(198)	(130)	(176)	(100)	(406)
Mean	-1.60	-1.52	-01.66	-1.74	-1.62	-1.36	-1.63	-1.73	-1.65	-1.58	-1.67	-1.54	-1.59	-1.62	-1.61	-1.61
Std dev	0.42	0.85	0.60	0.64	0.72	0.76	0.48	0.54	0.64	0.58	0.56	0.71	0.63	0.64	0.66	0.64
Hemoglobin (g/l)	(40)	-	(38)	(39)	(41)	(47)	(41)	(39)	(41)	(39)	(191)	(174)	(118)	(159)	(88)	(365)
Mean	127	-	125	120	121	129	123	114	125	120	123	122	122	122	125	123
Std dev	10	-	10	10	13	11	10	9	11	11	12	11	10	12	12	11

[a]Code for schools: 1=Margawangi, 2=Sukalarang I, 3=Sukalarang II, 4=Cimangkok, 5=Pangestu, 6=Gedurhayu, 7=Cipriangan, 8=Semplak, 9 = Kabandungan, 10=Manglid

children, but a significant weakly positive correlation was only found between hookworm infection intensity and W/A with r=0.14. Lower W/H values were found in moderately heavy to heavy. *Ascaris* and moderate *Trichuris* infection, but differences were not significant. There were no significant differences between protozoa infected and non-infected children, although mostly the nutritional situation was slightly better in protozoa infected than in non-infected children.

Differences in socioeconomic aspects were as follows: In farmers' families, stunded children were often found (46%), but as to W/A, W/H and hemoglobin levels, these were the best of all the children surveyed. Most cases of stunting (56%) and a relatively high rate of underweight (29%) as well as 17% of iron deficiency occurred in children of day laborers' families, differences being significant for stunting and underweight ($p<0.05$). Traders' children were on average less often stunted (7%), but most often underweight (34%). The least rates of anthropometric indicators below the cut-off point were found in civil servants' children, who showed 7% stunting and 25% underweight. However, 16% of these children were anemic.

In general, the nutritional status was better in children from households in lowere socioeconomic conditions (*ie* floor made of stone, wood or bamboo, and without latrine, electricity, bathroom, radio, television and other wealthy goods). A significant difference was found for iron deficiency which occurred less often in children from households without electricity ($p<0.05$). Stunting occurred significantly more often in children having their bath at home or in a pond ($p<0.05$), while underweight was significantly more prevalent in children defecating at home than in those using the latrine at school ($p<0.05$). All four indicators of malnutrition observed in this study were significantly lower in children living in households with non-cement floor.

DISCUSSION

Intestinal parasitic infections in school children of the study area round Sukalarang are characterized by a high prevalence of soil-transmitted nematode infections, and of *B. hominis* and ameba infections. The high prevalence of geohelminth infections is common in many areas of Indonesia, as reports during the last 25 years have described (Clarke *et al*, 1973; Kurniawan *et al*, 1976; Higgins *et al*, 1984; Bundy and Cooper, 1989; Mangali *et al*, 1993; Bakta *et al*, 1993). In Java, the prevalence of parasite species in children differed from province to province. Cross *et al* (1970) reported that in Central Java, A. *lumbricoides* was the most common nematode (73%), followed by *T. trichiura* (45%) and hookworm (23%). In West Java, almost similar prevalence of *A. lumbricoides* and *T. trichiura* (over 90% both) was found in Kresek near Jakarta, while hookworm was less common with its prevalence of approximately 50% (Clarke *et al*, 1973). Higgins *et al* (1984) observed infection rates of 60% for *Ascaris*, 65% for *Trichuris* and 80% for hookworms in Sukamaju near Sukabumi. The results of the present study confirm the findings of the other authors, namely that the most common helminth in West Java is *T. trichiura* (76%). This survey, however, determines a lower rate of *A. lumbricoides* (44%). The most remarkable result is the very low prevalence of hookworm infections (9%), which according to other studies in Indonesia was seldom below 20% (Cross *et al*, 1970; Clarke *et al*, 1973; Higgins *et al*, 1984; Mangali *et al*, 1993; Bakta *et al*, 1993). This is even more surprising, as the survey was conducted at the beginning of the wet season, when prevalence rates usually increase (Higgins *et al*, 1984). The low hookworm infec-tion rate must be explained by changing practices and behaviors. For example it was reported and observed that most of the school children were wearing slippers or shoes outside. Since *Necator americanus*, the skin penetrator, was found to be the predominant hookworm species in Indonesia (Higgins *et al*, 1984; Mangali *et al*, 1993), the fre-quent use of footwear is likely to reduce prevalence rates as well as the intensity of hookworm infections. This is in accord with the observation that hookworm prevalence is higher in groups of individuals rarely or never wearing footwear outdoors than in individuals usually or always wearing foot-wear. Another possible explanation may be that the most frequently used defecation sites were private or public latrines, or lakes, rivers and canals, while defecation in gardens, fields or in the forest was never mentioned by the children. The low prevalence of *E. vermicularis* may depend on the examination method, because fecal examination is known to be positive for only 5% of infections (Zink, 1990).

Prevalence and intensity in all four geohelminths species were closely related and dependent on socioeconomic and hygienic conditions. Similar results were obtained in other surveys (Kurniawan *et al*, 1976; Hasegawa *et al*, 1992; Abidin *et al*, 1992). Nevertheless, these conditions alone cannot explain the differences observed between localities. For instance, school children in Cimangkok showed the lowest prevalence and intensity rates in all nematode species, but environmental conditions for that school's students were not the best within the study population. Other reasons remain unclear; soil conditions, population density or factors like parents' level of education may play a role.

The egg counts revealed an aggregated distribution of all geohelminths. such pattern is known to be quite common in the soil-transmitted helminthiases (Anderson, 1985). The majority of infected children developed only light infections, and just a few cases of severe *Ascaris* infection appeared, while *Trichuris* infection were never higher than moderately intense, and there were only light hookworm infestations. It has been observed that heavily infected individuals have a tendency to acquire heavy reinfection, and vice versa for lightly infected persons, probably due to some genetical predisposition of the immune system (Bundy *et al*, 1988; Hall *et al*, 1992). Opinions about the importance of this phenomenon for parasite control measures vary; since only heavy infections lead to overt disease symptoms, it would be more cost-effective to treat only those heavily infeted rather than all the inhabitants of an area at risk (Anderson and Medley, 1985). This seems to be not only advisable for reasons of efficiency, but also because it would reduce the risk that treatment might be counterproductive in individuals with light infections, who may have acquired a natural immunity. For example, Hall *et al* (1992) carried out a longitudinal intervention trial involving three types of anthelminthic treatment at 6-months intervals. Stool samples were collected following each treatment to count the number of expelled worms. Hall and colleagues (1992) reported that in at least one of the stool samples from two third of the study population heavy worm burden was detected, irrespective of the chosen cut-off point (expressed in number of worms) for heavy infection. This means that not only before treatment heavily infected individuals but also lightly infected may acquire heavy infections following treatment. Further investigation is needed to settle the question whether genetic predisposition or behavioral differences or a combination of both account for the number of worms in an infection or a reinfection after treatment. Another point in favor of selective treatment is the suggestion that a low worm burden may be protective against subsquent infections of the same species, the so called 'concomitant immunity' (Mitchell, 1991); thus, the acquired immunity can be maintained, and a targeted treatment may minimize the selection pressure on the development of resistance by the parasite (Keymer and Pagel, 1990). On the other hand, even a moderate intensity of the worm burden may cause certain forms of malnutrition, *eg* stunting and impaired cognitive function, due to increased fecal nitrogen and fecal fat, as well as inadequate carbohydrate absorption (Garcia and Bruckner, 1993). Therefore, the eradication of the parasites in heavily infected individuals alone would not solve these problems. Furthermore, approaches requiring diagnostic screening were found to be 2-6 times more expensive than mass treatment; considering the limited health budget of developing countries, this may determine the economic feasibility of a parasite control program. In addition to that, diagnostic screening for selective treatment would imply many more technical skills and manpower than mass treatment, so it might be impossible to implement such a program due to the scarce resources available (Bundy, 1990). Since broad-spectrum anthelminthic drugs of proven safety and efficacy are nowadays available, the risk of morbidity due to infection exceeds the risk of side effects due to treatment except in women of reproductive age, because albendazole, like some of the other benzimidazoles, is known to contain the possible risk of teratogenic effects (Bogan and Marriner, 1984). Thus, nowadays mass treatment especially of school age children, the group at highest risk of infection and morbidity, is recommended by the WHO (WHO, 1987). Further investigations have to be conducted on the most effective treatment schedule, for example whether to administer one single dose or six smaller doses over a period of three days (WHO, 1987) or according to any other schedule, and on the frequency of a treatment in order to diminish the reinfection rate on the one hand and the risk of the parasite developing resistance on the other hand. At present, treatment is thought to aim to reduce levels of infection below those associated with morbidity rather than to eradicate or prevent infection (Savioli *et al*, 1992; Hall *et al*, 1992). The latter has to be a long-term goal, to be reached by sanitation and health education programs.

Mean intensity of worm burden and prevalence of infection were found to be closely linear correlated in the present study. Other studies found a non-linear relationship between intensity and prevalence of worm burden in such a way that in prevalence rates up to 60% a linear relationship existed, but in higher prevalence increasing ranges of worm burden were found(Guyatt *et al*, 1990). In cases of high mean intensities detected in areas with high prevalence rates, such findings may portend an overall linear relationship between the two variables. Therefore, our findings are in accord with the results of Guyatt et al (1990).

For A. lumbricoides, a markedly broader range of prevalence rates (27-91%) was found in the present survey compared to *T. trichiura* (53-91%) and hookworm (3-18%). This pattern of a patchy prevalence even within communities is well known to be a feature of *Ascaris* distribution (Pawlowski, 1986).

The nutritional situation in the study area was characterized by the high prevalence of stunted (51%) and underweight (28%) children, whereas the group of elementary school children of the study area were not wasted. These results match the prevalence rates of undernutrition given in a report of the Government of Indonesia and UNICEF (Government of Indonesia-UNICEF, 1989). In contrast to the results of that report, in the present study males were found to be more often stunted and underweight than females. Surprisingly, differences among localities gave the following picture: in Gedurhayu with pupils living under the lowest socioeconomic and sanitary conditions within the study population and showing the highest prevalence and intensity in all geohelminths species, the best nutritional situation was observed, while in Cimangkok, with the lowest prevalence and intensity of geohelminths, malnutrition often occurred compared to the other localities of the study area. However, the results of the present study are point prevalence rates and point intensities, but apparently negative relations between intestinal helminth infestations and nutritional status are of complex nature, and many factors, those, too, that played a role in the early stages of the child's development, may interfere (for example, duration of breast feeding, weaning practices, frequency of infectious diseases), and it is impossible to determine all these possible factors. Therefore, the influence of geohelminths on nutritional status can best be identified in anthelminthic treatment trials in which all other conditions remain constant and in which growth gain is measured after treatment (Hall, 1993). Since many previous surveys showed a markedly positive effect of anthelminthic treatment on growth velocity, cognitive function and physical activity, negative effects of geohelminths on the nutritional status of the present study's population are likely to occur (Gupta et al, 1977, 1982; Stephenson *et al*, 1989; Cooper *et al*, 1990; Adams *et al*, 1994). However, this influence could not be detected by the analysis of the present data, which suggests that other factors, which affect the nutritional status, are predominant. Therefore, further investigation is needed to settle this problem.

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