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THE EFFECT OF INTERVENTION METHODS ON NUTRITIONAL STATUS AND COGNITIVE FUNCTION OF PRIMARY SCHOOL CHILDREN INFECTED WITH *ASCARIS LUMBRICOIDES*

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Abstract. The prevalence rate of ascariasis in primary school children in northern Jakarta, Indonesia varies from 60% to 90%. An association between helminthic infection and educational achievement has long been recognized. This study was carried out in the northern part of Jakarta among primary school children 6–8 years of age. Treatment of ascariasis and health education were used as the interventions. Before the interventions, basic data on socioeconomic status, epidemiology, infection with *Ascaris lumbricoides,* nutritional status, and cognitive function were collected. After the interventions, only data on infection with *A. lumbricoides,* nutritional status, and cognitive function were collected. The children were divided into five groups. Group I was given an anthelminthic (mebendazole), group II was provided with health education, group III was given an antihelminthic and provided with health education, group IV was given a placebo (controls), and group V consisted of egg-negative children, who also served as controls. Data from 336 students were analyzed by analysis of covariance. Parasitologic examinations showed a mean prevalence rate of 58.4% for *A. lumbricoides* infection in the pre-intervention children and a mean prevalence rate of 40.6% in the post-intervention children. Concerning nutritional status, approximately 80% of the children showed good scores in the pre- and post-treatment data, and only a small percentage (0.9–16.2%) showed mild or moderate malnutrition. No significant difference was found between the pre- and post-treatment nutritional status. The results of the cognitive test showed that the group treated with mebendazole showed significant improvement in the Colored Progressive Matrices and Coding test. Children also showed an improvement in their learning ability, concentration, and eye-hand coordination after five months of receiving this intervention.

The prevalence of *Ascaris lumbricoides* infection in urban slum areas of Jakarta, Indonesia is high, especially in primary school children, in whom it ranges from 60% to 90% (Ismid IS and others, unpublished data). School children were reported to have the highest prevalences and intensities of these geohelminth infections,[1] which result in morbidity, malnutrition, and iron deficiency anemia.[2] An association between iron deficiency anemia and malnutrition in Indonesia has demonstrated their possible contribution to impaired cognitive function and educational achievement.[4] A correlation between helminthic infection and educational achievement has long been recognized.[5,6] However, it is unclear whether these relationships are causal or result from differences in socioeconomic status.[7] This paper reports the results of a study using an experimental design with two types of interventions, namely, the administration of an anthelmintic and health education. The objective of this study was to examine whether infection with *A. lumbricoides* in school children correlates with nutritional status and cognitive function.

MATERIALS AND METHODS

Study area. The study area was located in northern Jakarta, in the subdistricts of Koja and Pademangan. These are slum areas in which environmental sanitation, as well as personal hygiene, was poor.

Selection of samples. The study was reviewed and approved by the Ethical Clearance Committee of the Faculty of Medicine of the University of Indonesia. Informed consent for participation in the study was obtained from the parents of the children. Children unwilling to participate were excluded from the study. Five schools were selected for this study. These schools were randomly assigned to receive either treatment with an antihelmintic (mebendazole), health education, mebendazole plus health education, or a placebo (a similar-looking tablet containing cassava flour mixed with sugar, but without mebendazole). A group of egg-negative children was used as a control group, in addition to the placebo group. Stool samples from this group were negative for *A. lumbricoides* before and after the interventions. These children were from the same schools as the infected children who received the treatments.

Approximately 1,000 children were targeted for parasitologic, nutritional, and psychological examinations before and after an intervention. The interval between these two examinations was five months. The objective of this research was to study the effect of *A. lumbricoides* infection on nutritional status and cognitive functions. Since monoinfection with *A. lumbricoides* is rare in Indonesia, mixed infections with *A. lumbricoides* and *Trichuris trichiura* could not be avoided. To eliminate the influence of *T. trichiura* infection on cognitive function, children with high egg counts of *T. trichiura* ($>$ 500 eggs per gram of feces [epg]) were excluded from the study because infection with this parasite can cause a decrease in cognitive function.[10] Data collected before the intervention were used as baseline, and data collected after the intervention were used as the postintervention data.

Collection of socioeconomic and epidemiologic data. Socioeconomic and epidemiologic data were collected from the mothers or fathers of the children by means of a questionnaire. The questions were targeted to educational and employment status. Epidemiologic data on the prevalence of A. lumbricoides infection was collected. A description of the environment, the existence of latrines, and water sources was recorded.

Parasitologic study. School children 6–8 years of age were chosen for the study; stool samples were requested from these children. Stool examinations were carried out in the Department of Parasitology of the University of Indonesia using the Kato-Katz technique before and after five months of an intervention. Children with *A. lumbricoides* infections with or without *T. trichiura* infections that were less than 500 epg, and whom had normal IQs and no severe malnutrition were studied. The intervention was provided immediately after the collection of baseline data.

The children were divided into five groups: four groups of *A. lumbricoides*-positive children and one group of *A. lumbricoides*-negative (egg-negative) children. The first group was treated with mebendazole (a single dose of 500 mg); drug administration was witnessed by one of the researchers. The second group was given health education on ascariasis and nutrition. Trained teachers provided health education to this group every week for five months, and the research team monitored the health education. The topics covered were on the prevention of *A. lumbricoides* infection, as well as nutrition. The emphasis on nutrition was how to choose the right food from the available local food resources that the community could afford. The third group was given a single dose of 500 mg mebendazole and health education. The fourth group was treated with placebo. The fifth group was egg-negative children. The latter two groups served as controls.

In this study, each school received one kind of treatment. Although the schools were selected at random and the treatments were assigned randomly to the school, it turned out that the environmental sanitary condition of the children in the group given a combination of health education and mebendazole treatment was the worst in comparison with the other three groups.

Anthropometric assessment. To classify the nutritional status of school children, the weight-for-height index was used. This was used because this index is a simple screening method for the detection of malnutrition in a field study and had been recommended by the Health Department of the Republic of Indonesia. Nutritional status was divided into six categories: obese, > 120% (the percent values indicate the weight-for-height index); overweight, 110–120%; normal–good nutrition, 90–109%; mild malnutrition, 80–89%; moderate malnutrition, 70–79%; and severe malnutrition, < 70%. We did not use skinfold measurement since this measurement indicates only body composition, i.e., fat, and it did not provide any conclusion in terms of growth.

Psychological examination. It is known that geohelminth infections are associated with iron deficiency anemia[2] and that iron deficiency anemia influences attention, memory, and learning processes.[3] The tests chosen measured attention, short-term and long-term memory, and learning processes. A test for assessing the intelligence of the children was also used. The tests used to measure attention were the same as those used by Nokes and others.[5] The tests were administered individually to the children by senior students of the Faculty of Psychology of the University of Indonesia. These students did not have any knowledge about the different treatments given to the children. The tests given were Arithmetic (measures mathematical knowledge, mental computations, and concentration), Digit Span Forward and Backward (measures attention span and short-term memory) and Coding (measures motor coordination, speed of mental operation, and short-term memory). These three tests were taken from the Wechsler Intelligence Scale for Children.[8] They measure a factor called freedom from distractability,[9] which is the ability to pay attention and to concentrate. The other test given was the Raven's Colored Progressive Matrices, which measures reasoning ability based on figure materials and is assumed to give an estimate of general intelligence[9] and oddity learning. This test measures the ability to learn a concept, i.e., the concept odd by discrimination. It also measures attention and memory. This test has been used previously (Pollitt E and others and Soewondo S, unpublished data).

Statistical analysis. The statistical procedures used were analysis of variance (ANOVA) and analysis of covariance, in which the covariates were entered first (experimental method). All analyses were done using the SPSS (SPSS, Inc., Chicago, IL) Statistical Program for Social Sciences. In addition, Kolmogorov-Smirov and chi-square tests were used to analyze the nutritional and parasitologic status. Statistical significance was assumed at a P value < 0.05.

The variables used in this study were the education of the mother (0 = primary school not finished; 1 = finished primary school; 2 = finished junior high school; 3 = finished high school; 4 = tertiary education), nutritional status of the children (1 = moderate malnutrition; 2 = mild malnutrition; 3 = good/normal nutrition), intensity of infection with *A. lumbricoides* and *T. trichiura* (epg), intelligence (score on the Raven's Colored Progressive Matrices), and the cognitive functions (scores on the other psychological tests).

To examine the effect of the different treatments, gain scores were computed by subtracting each child's pretreatment score from his or her post-treatment score.

RESULTS

Stool samples from 1,000 children between six and eight years of age from five schools were examined. Of this group, 972 children had complete records of the pretreatment psychological tests. After excluding children with high intensity of *T. trichiura* infection (> 500 epg), the number of these children decreased to 696. From this group, only 483 children participated in the postintervention examinations. The number of children remaining who had complete records of the pre- and post-treatment examination and background variables was 336. Part of this decrease was also due to the exclusion of children in the egg-negative group whose condition changed from not being infected by *A. lumbricoides* in the pretreatment examination and to being infected in the post-treatment examination (Figure 1).

The result of an environmental survey showed that the study area was a slum area with very poor sanitary conditions. Most of the irrigation ditches seemed to be the main places for defecation. The ditches were full of garbage and human feces polluted the river water. Of the latrines in the area, 27.4% were community latrines and 71.9% were household latrines; 0.7% of the population defecated in the river. When the sources of clean water were investigated, 24.2% of the people bought their drinking water, 74.0% got their water from taps, 1.4% from open wells, and 0.4% from

Children recruited from five schools for

examination of infection

One month Status (n = 1,000)

Psychologic tests (n =972)

Excluded: cases with *Trichuris trichiura* infection (>500 epg) and cases with missing data

Mebendazole	Health education	Mebendazole plus health education	Placebo	Egg negative
(School 3)	(School 2)	(School 4)	(schools 1 and 5)	(schools 1 to 5)
(n = 191)	(n = 104)	(n = 110)	(n = 119)	(n = 172)

Total (n = 696)
Treatment or placebo given

Post-treatment examination (examination of infection status and psychologic tests)

Five months Excluded: cases from the egg-negative group who changed to an egg-positive status, cases with missing data, and cases with *T. trichiura* infection (> 500 epg)

Mebendazole	Health education	Mebendazole plus health education	Placebo	Egg negative
(n = 54)	(n = 49)	(n = 48)	(n = 99)	(n =86)

Total (n = 36)

water pumps. With regard to the education of the mother, 60.0% belonged to the lowest level (primary school graduate or lower), 37.4% belonged to the middle class (secondary school), and only 1.7% had attained the highest level (university education).

The results of parasitologic examinations are shown in Table 1. These include the overall prevalence rates of *A. lumbricoides* infection in all school children who underwent stool examinations. The overall mean prevalence rate of *A. lumbricoides* infection in school children in the post-treatment group was much lower in comparison with the pretreatment group, but the difference was not significant ($P > 0.05$). The group treated with mebendazole showed a post-treatment prevalence rate that was approximately half that of the pretreatment rate. The same result was seen in the group receiving health education and mebendazole. Although reinfection and new infections after the interventions could occur, post-treatment rates were always less than pretreatment rates.

TABLE 1

Prevalence of *Ascaris lumbricoides* infection before and after treatment

Group	Number examined		Prevalence	
	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment
Mebendazole	222	154	138 (62.6%)	50 (32.4%)
Health education	230	213	113 (49.1%)	77 (36.1%)
Mebendazole plus health education	175	160	125 (71.4%)	67 (41.8%)
Placebo	400	322	224 (56.1%)	151 (47.0%)
Total	1,027	849	600 (58.4%)	345 (40.6%)

Nutritional status data before and after (values in parentheses) the interventions are shown in Table 2. In group I, 84.7% (82.0%) of the children had good nutritional status, 4.5% (7.2%) had mild malnutrition, and 10.8% (10.8%) had moderate malnutrition. In group II, 13.3% (12.4%) had moderate malnutrition. In group III, 86.5% (83.8%) of the children had a good nutritional status. In group IV (the placebo group), 83.8% (82.1%) had good nutrition, 4.3% (1.6%) had mild malnutrition, and 11.9% (16.2%) had moderate malnutrition. Evaluation of results after the interventions showed no significant difference with pre-intervention nutritional status ($P > 0.05$).

To assess the effect of different treatments, one-way ANOVA was carried out to reveal the uniformity of the existing variables. It was evident that the baseline of the groups were not equal for all variables, e.g., mother's education, degree of infection with both parasites, and scores on the psychological tests (Table 3).

The mebendazole-treated, placebo, and the egg-negative groups had better educated mothers, with a greater percentage having completed their secondary education. Some of these mothers had also completed their tertiary education.

TABLE 2

Results of nutritional status examination of primary school children before and after interventions*

Nutritional status	Group I Mebendazole		Group II Health education		Group III Mebendazole plus health education		Group IV Placebo	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Good	94 (84.7)	91 (82.0)	97 (85.9)	98 (86.7)	64 (86.5)	62 (83.8)	155 (83.8)	152 (82.1)
Mild malnutrition	5 (4.5)	8 (7.2)	1 (0.9)	1 (0.9)	3 (4.0)	5 (6.7)	8 (4.3)	3 (1.6)
Moderate malnutrition	12 (10.8)	12 (10.8)	15 (13.3)	14 (12.4)	7 (9.4)	7 (9.4)	22 (11.9)	30 (16.2)
Total	111		113		74		185	

* Evaluation of results after the interventions showed no significant difference with prenutritional status ($P > 0.05$).

The results in Table 3 show that the mebendazole-treated group had the highest mean number of *A. lumbricoides* epg. Although infection with *T. trichiura* was low in the infected groups (< 500 epg), the mebendazole-treated group had the highest mean number of *T. trichiura* epg. Conversely, this group had the lowest mean scores for the Colored Progressive Matrices, coding, and oddity learning, although this difference, when analyzed by one-way ANOVA, was not significant.

Since the inequality of the groups could influence the gain scores of the variables, analysis of covariance was used to assess the effects of the various treatments. The education status of the mothers, the Colored Progressive Matrices scores, and the status of infection with both worms (epg) before treatment were used as covariates. The results of the analysis of covariance in terms of the significance of the F tests are shown in Table 4, together with the mean gain scores of the variables. The results of the F tests were significant for the Colored Progressive Matrices, Coding, and the number of eggs of both worms. This indicates that a significant effect of the different treatments was found only for these variables. In the Colored Progressive Matrices, the greatest mean score was observed in the mebendazole-treated group; the mean was greater than those of the egg-negative and placebo groups. When one considers that this group had the lowest baseline level (Table 3) in this test, this indicates that the treatment was able to improve the test performance of this group. This was also true for Coding.

DISCUSSION

We expected that the test performance of the group treated with mebendazole and health education (group III) would be better than that of the group treated with mebendazole (group I). However, this was not the case. Group I did not show better results than the placebo group, although there was a reduction in epg in the group treated with mebendazole and health education, which did not occur in the placebo group.

The greatest decrease in the number of parasite eggs occurred in the mebendazole group; before treatment, this group had the greatest mean epg of *A. lumbricoides.* A decrease in infection also occurred in the other treatment groups. but to a lesser extent. Conversely, an increase in infection occurred in the placebo group. When the mean gain scores of the other treatment groups were compared with those of the placebo group, differences could be found in the results of the cognitive tests, except that in the group that received health education, no gain was found in the Colored Progressive Matrices, which is contrary to the expectation that test performance in general of the placebo group was not lower than that of the egg-negative group. This could be explained by the fact that all treatment groups had only light *A. lumbricoides* infections and their nutritional status were mostly good–normal; this condition might have caused the increase in the test results in the placebo group. The additional increase in test scores in the placebo group

TABLE 3

Means of the five groups for all variables in the study in pre- and post-treatment examinations*

Variables	Group I Mebendazole (n = 62)		Group II Health education (n = 72)		Group III Mebendazole plus health education (n = 88)		Group IV Placebo (n = 125)		Group V Egg-negative (n = 136)	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Education of mother†	2	(n = 54)	1	(n = 49)	1	(n = 48)	2	(n = 99)	2	(n = 86)
Nutritional status	3	3	3	3	3	3	3	3	3	
Ascaris lumbricoides‡ (epg)†	2,435	657	1,264	812	1,679	819	1,898	1,919	0	0
Trichuris trichiura (epg)†	143	58	88	82	104	37	113	160	56	47
Raven's colored progressive matrices†	14	17	18	18	17	19	16	18	16	18
Arithmetic	5	6	6	6	6	6	5	6	5	6
Coding†	31	44	37	45	39	44	37	43	38	44
Digit span forward	4	5	5	5	5	5	4	5	5	5
Digit span backward†	2	3	2	3	2	3	2	3	3	3
Oddity learning	49	55	53	54	52	54	51	54	52	54

* epg = eggs per gram of feces.
† Variables that show significant differences between the groups on the pretest (baseline study) based on the one-way analysis of variance.
‡ The negative group was excluded from the analysis.

TABLE 4

Mean gain scores in the five groups and the significance of F due to treatment effects (analysis of covariance on gain scores)

Variable	Group I Mebendazole (n = 54)	Group II Health education (n = 49)	Group III Mebendazole plus health education (n = 48)	Group IV Placebo (n = 99)	Group V Egg-negative (n = 86)	Significance of F (n = 336)
Colored progressive matrices	3.63	−0.61	1.40	1.73	2.70	0.000*
Arithmetic	0.78	0.37	0.38	0.74	0.97	0.763
Coding	12.61	6.12	4.69	6.60	5.91	0.031†
Digit span forward	0.43	0.49	0.23	0.54	0.34	0.573
Digit span backward	0.65	0.41	0.48	0.64	0.51	0.706
Oddity	5.41	0.41	1.83	3.16	2.30	0.080
Ascaris lumbricoides	−1,682.37	−664.67	−870.65	246.78	0.00	0.000*
Trichuris trichiura	−76.44	8.08	−73.13	21.13	−3.20	0.001*

* $P < 0.01$.
† $P < 0.05$.

may have been caused by anxiety experienced by the children during the initial testing. For most of these children, the individually administered tests were something strange; therefore, anxiety had a deleterious effect on test performance.[10] However, when tested the second time, their anxiety would be greatly reduced due to familiarity with the testing situation, and this would improve their test scores. Another possible explanation for the improvement in test scores could be that the children were additionally motivated to do their best because of the interest shown by the examiners in their performance. This is known as the Hawthorne effect.[11] Thus, the increase of post-treatment test scores in the egg-negative and placebo groups could be explained by a reduction in anxiety and the Hawthorne effect. In the other groups, the increases in post-treatment test scores could be due to these two effects plus the treatment effects.

Three conclusions can be drawn from the data in Table 4. 1) Treatment with mebendazole caused the greatest gain scores in the Colored Progressive Matrices and coding, and also the greatest decrease in the amount of parasite eggs. 2) Compared with the mebendazole intervention, the mebendazole and health education intervention was not more effective. 3) Health education is the least effective over a short time period.

It can be concluded from this study that the intervention methods carried out on school children did not show any effect on nutritional status. The mebendazole-treated group showed an improvement in cognitive function five months after treatment, but this was not observed in the group that received the mebendazole plus health education intervention. The unexplained results concerning the mebendazole/health education combination treatment group indicate the complexity of the subjects that were studied. Additional investigations with better controls and equivalent groups (groups with comparable baseline data) are suggested.

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