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Research Report

Cognitive Behavior Change for the Improvement of Health Care, Cognitive Function and School Achievement in *Helminth* Infected Children

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ABSTRACT

Overall helminth infection prevalence in Central Java in 2002 was high (20–100%). Unfortunately, the knowledge, attitude and practice (KAP) of children and their parent's about worm infection were in general very low. Objective of this study was to determine the improvement of parents' health care behavior on helminth infected children by improving their KAP, in order to decrease re-infection rate of helminth infestation and improving school achievement. Design study is quasi experiment with pre and post test control group design on community participation toward school aged children in Sragen sub-district in Central Java. A sample of one hundred and thirty one of children deriving from a systematic random sampling was used in the study and divided into 66 children for intervention population and 65 children for control population. During the study, the children in selected area were given with 400mg chewable albendazole, and after a month, their stools were examined to find out the negatives. Parent's participation was needed in improving the KAP on re-infestation that was performed by an intervention using a module. Data were analysed using chi-square test to determine the relationship between variables among groups. Stools were examined for the presence of geohelminth's egg using Kato-Katz Technique. Three subject matters (Mathematics, Indonesian Language and Natural Science) were obtained by a special tool. Digit Span, Coding and Stroop Test were used to determine the level of cognitive function. Monitoring and the ladder-snake game were use to observe the improvement of the behavior. It revealed that re-infestation of Ascaris lumbricoides, Trichuris trichhiura and Oxyuris vermicularis occurs 2 times greater in control group, even there was no significant different. In both groups, there was no hookworm re-infestation. A good knowledge and attitude can be predicted to be a better practice to prevent the re-infestation. Oxyuris vermicularic re-infection could have adverse effect on study Achievement (Mathematics, Indonesian Language and Natural Science) and The Cognitive Function, such as memory, attention, visual-motoric co-ordination. The moshly affected cognitive function was memory-based and specifically represented the components of the working memory. From the monitoring of health care behavior, this study found that the more convinced the mothers in changing their degree of family's health were, the higher the level of children's health was.

Key words: *Worm re-infestation, school achievement, cognitive function.*

INTRODUCTION

School performance can be affected by family care pattern and health status. In most agricultural areas, where the sanitation program and city planning are not carefully prepared, this situation can increase the prevalence of *helminth* infestation in children, especially in school-age children. Worm infection can bring about the decrease of nutritional status. As a consequence, this makes someone easy to get other infected diseases. Many studies showed that there was a strong relationship between *helminth* infection and malnutrition, health status, absenteeism, sanitation, and school achievement.

In 1996, a biomedical survey on school-age children in 5 countries, including Indonesia, confirmed that 23-96% were infected by parasitic infection (PCD, 1997). The overall *helminth* infection prevalence in Central Java Indonesia in 1996 was 20–100% (Satoto, Hertanto and Hendratno, 1997).

Of all Helminthes, *hookworm* causes the most severe anemia because of the iron deficiency due to chronic blood loss. It is also well known that iron deficiency is the most prevalent nutritional disorder in the world, affecting some 50 million people. Nutritional anemia caused by iron deficiency is common throughout Indonesia, being most prevalent in pregnant women, under five-year-old

children and school-aged children, especially in lower socio-economic groups.

The result of the study in Karanganyar (Central Java), in 1996, as the previous study, showed that *helminth* infection especially *hookworm,* can influence the concentration and motivation, particularly of 11–13 years rather than 8–9 years old children. In further analysis, it was found that there was a strong correlation between long term memory skill and school performance in Mathematics ($p=0.004$) and Indonesian Language ($p<0.0001$). The results suggest that *hookworm* infestation can have a significant adverse effect on children's working memory which may have consequences for a child's reasoning ability and reading comprehension. On the other hand, parents' education and the willingness of parents to closely assist their children while they learn, can influence the school achievement.

Unfortunately, the study about health care education related to reducing re-infection were rarely done. Based on the description above, the prevention for *helminth* infection would yield better results if it is conducted in the early age. The most important one is the parent's participation in medication management, so that the parents will be able to make their own decision and have a sense of belongings and responsibility to do their decision.

Another study done by Andre and Rachel, in 1995 found that the program derived from educational diagnosis requires the participation of representative advisory boards and multiple actors, including parents. School health research, whose work has demonstrated positive outcomes, are unanimous in their conclusion that development of relevant cognitive skills, resistance to peer pressure, and social competence skills, in some combinations, facilitates change or resistance to change. Concerning to this result, the parents at home, who deal with the children every day, are the right persons to maintain health care and act as a model of healthy behavior to minimize the effect of health problem and to improve school achievement.

Rousham (1994) argued that health education is considered to have an important role in the prevention and control of *helminths*, but the dissemination and implementation of health message is rarely evaluated. Without information on these broader aspects of *helminth* treatment and prevention, the design of appropriate *deworming* programs is hindered. So far, the studies about the effect or benefits of parent participation on reducing re-infection rate are rarely done. A study on effectiveness of *albendazole* toward *hookworm* infection showed that it 85.8% affective for the cure rate, but there was 14.2% who got re-infected.

Helminth infection can adversely affect the cognitive function of children, specifically on attention ability and working memory. It can provide a negative affect on intelligence, concentration and learning ability, that in turn it can affect the school achievement (Sakti et al., 1997). The qualitative study in evaluating the knowledge, attitude and practice of school aged-children and their parents about worm infection and related issues appeared very low in general. Parents' knowledge about transmission and prevention of helminth infection much lower than their children, and it is assumed that it can stimulate the re-infection. Even the knowledge attitude and practice about helminth infection among the parents in Karanganyar, Central Java, was very low, but the willingness of the parents to participate in the prevention program was a great.

The module has been arranged with the title: "Modul Pelatihan Peningkatan Perilaku Sehat Anak dan Ibu terhadap Kecacingan (Peningkatan PERISAI Kecacingan)". The module used affective approach containing: (1) Who we are, (2) Children and Us, (3) What Should We Do, (4) Talk about Health and Helminth Infection and (5) Our Responsibility.

Working memory refers to a brain system that provides temporary storage and manipulation of the information necessary for more complex cognitive tasks such as language comprehension, learning and reasoning (Waters, Caplan, 1996). Within the system, there is Attentional Controller / Central Executive which is supplemented by two subsidiary systems called the Phonological Loop and the Visual-Spatial Sketchpad. The Phonological Loop is assumed to be responsible for maintaining speech-based information. The Digit Span test provides a good example of this role and was significantly adversely affected by *hookworm* and *T.trichiuria* infection (Sakti et al., 1997).

Whatever the mechanism, if working memory is affected, it could have broader implication for the educational achievement and development of a child, not least because of the underlying association of working memory with complex real-world tasks such as reasoning ability and reading comprehension (Water, Caplan, 1996).

Cognitive factors also determine whether or not individuals practice health behaviours. Such cognitive factors include the belief that a particular health practice is beneficial, the belief that it can help stave off a particular illness a sense of vulnerability to illness and feeling of self-efficacy (Bandura, 1977).

Participatory research method can be used not only to enable local people to seek their own solutions according to their priorities, but also to secure funding, to co-operate with local people into the agendas of others or to justify short cut research within a top-down process (Rifkin, 1994).

This study revealed that re-infestation of *Ascaris lumbricoides*, *Trichuris trichiura and Oxyuris vermicularis* occurred (two) times greater on control group even there was no significant different. In both groups, there was no hookworm re-infestation. A good knowledge and attitude can predict a better practice to prevent the re-infestation. *Oxyuris vermicularis* re-infection could provide adverse effect on the School Achievement (Mathematics, Indonesian Language and Natural Science) and The Cognitive Functions, such as memory, attention, visual-motoric co-ordination. The cognitive function which was mostly affected were memory-based and specifically represented the components of the working memory. From

the monitoring of health care behaviour, this study found that the more confinced the mothers in changing their degree of family's health were, the higher the level of the children's health.

Materials and Methods

Study Sites-selection of Schools of Children

This study was held in Sragen Regency in Central Java Indonesia, which is an agricultural area with high prevalence on *hookworm* (74%) in 1996 (Mitra, Bulletin, 1996). The Decision to use these areas for intervention and control group had been discussed and consulted with Regional Head Department of Central Java Province in Sragen, in collaboration with Department of Health and Department of Education.

Two areas had been selected in accordance with the similarities in terms of physical and environmental factors related to health. Schools were also selected by soil sample test. The similar geographical condition and the school condition was the pre-requirement for this experimental study. The target population on school-age children in high prevalence of hookworm infection, sitting in grade 3, 4, and 5 in Primary School. They have been tested with School Achievement Test and Cognitive Function Test. They were also suggested to collect their stools. A day after, they were dewormed by giving Albendazole SKB 400mg single dose (chewable). A month later, the stools were collected again to see the negative infection to determine the selected children on each intervention and non intervention group. Intervention to their parent conducted through the health counseling and education course and followed by giving post test of stools on the sixth month.

The selected parents were interviewed to collect the information about their perception on worm infection and the willingness to participate for the prevention and other related things. Question on knowledge, attitude and practice of the parents were administered by FGD and in-depth interview for gathering the data. Participative observation using home visit was performed to observe the environmental condition.

The observation included the portable water resource, the latrine, the place to wash hands, etc. Furthermore, the study also collected social economy status of the family, such as parent's job, parent's final education.

Experimental Design

A Quasi Experiment with Pre Test and Post Test Design. In a quasi-experimental design, a group of intervened parents was compared to those who were not intervened. This two groups were separated by distance.

The inclusion criteria for students were: (a) Students of grades 3, 4, and 5 (age 9–11) in elementary school, (b) Students who suffered from hookworm infestation. The exclusion criteria were: (i) Students who had mental and physical defect (hands and legs), (ii) Students who were colored-blind, and (iii) The ones who had not been trained as the little doctor.

Some characteristic for environments were: (1) Area with high prevalence more than 60% in worm infection, (2) Developing agricultural and industrial area which have plantation and manpower who worked there, (3) The soil around schools had been tested and recommended not to have worm eggs or was minimally the same between the two areas, (4) Criteria determination for the two sub-districts was as follows: (a) Each of the sub-districts had the same distance from the capital of the district, (b) Each of the sub-districts had the same distance from Puskesmas and had the same geographical condition, i.e., near from reservoir, (c) Each of the sub-districts had the same socio-economical condition (non IDT), (d) Each of the sub-districts had the same condition of playing place in school (unpaved yard), (e) Each of the sub-districts had the same school's condition/ status, i.e./ government school and had School Health Unit (*Unit Kesehatan Sekolah*).

Material and Administration Test

Parasite Infection

Pots for faeces were distribute to all subjects one day before examination in selected school. An illustrated direction sheet had been provided to all children on method to collect faeces using the pots correctly. On the following day, the other team collected post filled with fresh faeces and were brought to the Puskesmas' laboratory in Sragen, maximum 24 hours after taking.

Microscopic examination of worm eggs in the faeces was administered using Kato Katz technique (WHO, 1982). The result of the examination included eggs of *Ascaris lumbricoides, Trichuris trichiura, Hookworm and Oxyuris vermicularis* recorded in a form in accordance with the total number of each type.

Knowledge, Attitude and Practice for Parent and Children

The objective of the baseline data collection on knowledge, attitude, and practice of school children and their parent was to assess the health behavior on worm infection, personal hygiene and health care behavior. This test administered in class for the children, and for parents by home visit and environmental condition that had been observed during visit, including potable water resources, the latrine, the place to wash hands, etc.

School Achievement test

This study used a set of school achievement test instrument that was developed by Indonesian Partnership of Child Development, 1997. This test consists of 3 subjects: Mathematics, Indonesian Language and Natural Science for grade 3, 4, and 5, in which each subject consists of 40–50 questions. It was developed for the first quarter. Their test was conducted in natural setting class by teachers and performed as a common test on the 3 subjects.

The inter-ratter reliability test for Mathematics was 1.0 and Indonesian Language was 0.99. The result of inter-ratter split-half for Mathematics was 0.88 and Indonesian Language 0.78. Test tools for Mathematics and Indonesian

language had been developed beforehand. For Natural Science Test used UUB (Quartile Evaluation Test).

Cognitive Function Test

This study used 3 battery tests to measure cognitive function, which were: Stroop Test, Digit Span and Coding. Low cognitive phase was attention, was measured by Stroop Test. Medium phase was memory which were measured by Digit Span Test. Visual motor test were measured by Coding Test. The duration of cognitive test per child was about 30 minutes (WISC-R Manual, 1974).

1. Stroop Test
   Stoop Test had been adapted into Indonesian language and is thus a culture-fair test. The Stroop Test consist of two tasks: The Colour task which consists of a card with the names of four colour (tan, red, blue, and green). The procedure was started by asking children to read the word written and ignoring the colour in which the word was print. The score was the total number of correct answer given in 2 minutes. The correlation of the Stroop test from the first and second administration was 0.90, suggesting a high degree of temporal stability. Validity of the Stroop Test was indicated from discriminate analysis which were performed by using the presence or absence of brain damage as dependent variables and Colour-Word score as the predictor. The correlation was 0.70 (Max R, 1989).
2. Digit Span Test
   Digit Span Test is part of the Weschler Intelligence Scale for Children (WISC-R, 1974) used for measuring the phonological loop which includes memory skill. Increasingly longer string of number were read with the speed of one number per second, and performed soon after each trial. The child was required to recall or repeat the string of numbers either forward or backwards. The score was the total number of correct trials. For Digit Span Forward the reliability test was 0.74 and Backward was 0.72 (Sakti et al., 1997)
3. Coding
   It is also part of WISC test, consisting of 93 blocks with numbers that had to be joined with the symbols. The score was the total number of correct trials in 2 minutes. The reliability was 0.78. The sequence of test device administration was based on the child psychology. It means that the test aimed at being a game so that the child did not feel tense. The tests given were started with the easy questions and going through to the difficult ones. Therefore, the 2 testers had been trained beforehand and received the test-retest reliability 0.88.

School Characteristic

The objective of survey on school characteristic was to find out the condition of soil surrounding school. It was expected to be clean of worm eggs or minimally the same condition between the two schools.

RESULTS

A total of 131 children participated in the course of this study in Sragen, Central Java. The children were geographically divided into two areas: (1) sixty-six children were in the south area intervention group and (2) sixty-five children were in the north area as the control group, who did not receive any intervention for their parents.

RE-INFESTATION ANALYSIS

Table 1. shows that there was a re-infestation on *Trichuris trichiura* (3%) and *Oxyuris vermicularis* (1.5%) on intervention group, even it was not statistically significant. Re-infestation mostly occurred on control goup (10.6%) rather than intervention group (4.5%).

Three types of worm that re-infested positively in control group were *Ascaris lumbricoides, Trichuris trichiura* and *Oxyuris vermicularis.* The greater re-infestation worm was on *Oxyuris vermicularis* (6.1%) rather than *Trichuris trichiura* (3%) and *Ascaris lumbricoides* (1.5%).

Only two types of worm that was re-infesting the intervention group, they were *Trichuris trichiura* (3%) and *Oxyuris vermicularis* (1.5%). Both on intervention and control group, there was no positive re-infestation of hookworm.

There was no hookworm re-infestation, both in intervention and control group. The intervention group was only re-infested, whereas in control group which were no intervention, there was re-infestation on *Ascaris lumbricoides, Trichuris trichiura* and *Oxyuris vermicularis.*

Re-infestation of *Oxyuris vermicularis* can induce adverse effect to Indonesian language and Natural Science. There was a strong correlation between the re-infestation on *Oxyuris vermicularis* toward the decreasing grade of Indonesian Language ($p<0.001$) and Natural Science ($p<0.001$).

In control group, the re-infestation of *Ascaris lumbricoides* had strong correlation with the decreasing grade on Mathematics ($p<0.001$). It means that the re-infestation of *Ascaris lumbricoides* could provide adverse effect for the school achievement especially on Mathematics.

This study also found that re-infestation of *Oxyuris vermicularis* statistically correlated with Mathematics in control group ($p=0.037$). The re-infestation of *Oxyuris vermicularis* could provide adverse effect on the decreasing grade of mathematics. Another result conducted by Sadjimin and Rini (2000) found that infestation of worms could decrease children's verbal ability, comprehension, reasoning, and cognitive ability.

Table 1. Prevalence of re-infestation

Type	Parent Participation		Non Parent Participation		*p*
	Reinfest.(-) n (%)	Reinfest.(+) n (%)	Reinfest.(-) n (%)	Reinfest.(+) n (%)	
Ascaris	66 (100%)	-	65(98.5%)	1 (1.5%)	1
Trychuris	66 (100%)	2 (3%)	64 (97%)	2 (3%)	0.496
Hookworm	66 (100%)	-	66 (100%)	-	-
Oxyuris	65 (98.5%)	1 (1.5%)	62 (93.4%)	4 (6.1%)	0.365
	Total	4.5%		(10.6%)	

Table 2. Correlation between Δ egg worm and Δ subject matters for intervention and control group

Group	Subject matters	Δ egg worm (reinfestation)			
		Ascaris	Trichuris	Hookworm	Oxyuris
Intervention	Δ Mathematics	-	-	-	0.452
	Δ Ind. Language	-	-	-	<0.001
	Δ Natural Science	-	-	-	<0.001
Control	Δ Mathematics	<0.001	0.841	-	0.037
	Δ Ind. Language	-	-	-	0.992
	Δ Natural Science	-	-	-	0.980

Table 3. Correlation between Δ Cognitive Function, Δ Re-investation and Δ School Achievement

Δ Cognitive Function Test	Δ Subject Matters of school Achievement											
	Δ Mathematics				Δ Ind. Language				Δ Natural Science			
	As	Tr	Hk	Ox	As	Tr	Hk	Ox	As	Tr	Hk	Ox
Digit Span Fw	-	-	-	0.050	-	-	-	0.014	-	-	-	-
Digit Span Bw	-	-	-	-	-	-	-	-	-	-	-	-
Coding	-	-	-	0.051	0.046	-	-	0.031	-	-	-	-
Stroop C	-	-	-	0.023	-	-	-	-	-	-	-	-
Stroop CW	**-**	**-**	**-**	**-**	**0.046**	**-**	**-**	**0.014**	**-**	**-**	**-**	**0.046**

COGNITIVE FUNCTION ANALYSIS

The cognitive function test used in this study were: Coding Test, Digit Span Test and Stoop Test. The functions which were most affected were memory-based and specifically represented the components of Working Memory Model (Baddeley, 1992).

Those three tests measured the concentration and short term memory. Low cognitive phase was attention, which in this study was measured by Stroop Test. Medium phase was memory which was measured by Digit Span Test. Visual motor test was measured by Coding Test. This result found that there was no significant difference in both pre test and post test.

Re-infestation of *Ascaris lumbricoides* can influence the school achievement on Indonesian Language and also the cognitive function on visual motor and attention. This study shows that the re-infestation of *Oxyuris vermicularis* can effect Mathematics, Indonesian Language and Natural Science and it was shown in the correlation with the cognitive function tests.

The cognitive functions which were most affected were memory-based and specifically represented the components of the Working Memory Model (Baddeley, 1992). This drove an emerging hypothesis that helminth infection adversely affects working memory (Nokes & Bundy., 1994) and especiallythe result of Digit-Span Forwards test (Boivin et al., 1993).

Working memory refers to a brain system that provides temporary storage and manipulation of the information necessary for more complicated cognitive tasks such as language comprehension, learning, and reasoning (Waters & Caplan, 1996). Within memory system, there is an Attentional Controller Central Executive which is supplemented by two subsidiary systems called the Phonological Loop and the Visual-Spatial Sketchpad. The Phonological Loop is presumed to be responsible for maintaining speech-based information. The Stroop Test provides a good example of this role and was significantly adversely affected by hookworm.

The Central Executive in the cerebral function was considered to be a type of attentional controller (Baddeley, 1996). The 4 tasks, which could be considered measures of the Central Executive and Neuropsychologycal factor, were adversely affected by all types of worm infestation after controlling the confounding variables.

The reason for why working memory, as oppose to other cognitive domains, could be affected by *helminth*s

infection was still unclear. Central Executive tasks in particular involve the frontal lobe, a part of the brain which seems to continue developing through to adolescence and is thus still developing during the period when children are most likely to he infected with *helminths*. Whatever the mechanism, if working memory is affected, it could have broader implications for the educational achievement and development of a child, not least because of the underlying association of working memory with complex real-world tasks such as reasoning ability and reading comprehension (Waters, Caplan, 1996).

HEALTH BEHAVIOR ANALYSIS

The previous result conducted by Sakti and Nokes (1997) demonstrated that hookworm infestation could deteriorate children's memory and had an effect on reasoning ability and reading comprehension. A further result also suggested that infestation of hookworms was primarily found in older children (age between 11 and 12 years old) rather than younger children (age between 8 and 9 years old). Based on those results, a conclusion could drawn was that the longer the infestation of hookworms occurred, the worse the anemie condition appeared. This condition give an effect in children's cognitive ability.

An interesting result which had been found at the beginning of information-providing was that all mothers considered that wormness was not a dangerous disease if compared to diarrhea, blood fever, tuberculosis and malaria. After monitoring for four times, it was found that mothers, belief on the increase in children's health had an extremely significant correlation with mothers' perception on the level of children's health.

The different amount of wormeggs between pre-test and post test had a strong correlation between level of mother's feeling was accompanied with the increase in children's level of health (p=0.12). The same results was also shown in the significant correlation between level of children's health and level of mother's belief to their degree of family health (p=0.003).

From the result of monitoring health behavior both in children and in parents, it was well-demonstrated that there had been an improvement in the practice of self-cleanliness, healthy behavior, environmental cleanliness, mother's attention, and children's perception on their mother's attention.

This result represents an indication that the more frequent the behavior appeared, the more possible a significant behavior modification occurred. It was also found that monitoring result, mothers attention on their children's health did not correlate significantly with modification in children's health behavior, but mother's belief in modifying children's health degree was more influential on children's behavior. The assumption which could be put forward was that level of mother's belief of family's health was accompanied with the changes in children's health. In other words, the more convinced mothers in changing their degree of family's health were, the higher level of children's health was. This also meant that mothers or parents could become an effective medium for the modification of children's health behavior, especially when coping with the danger of wormness.

In respondent's evaluation about the ever-received information-providing before this research and the present information-providing, it was found that there was a significant change, especially in the change of environmental health (p=0.047). This was shown by the change in environmental cleanliness which could be regarded as a manifestation of an attention to family's health and mother's self-convince to improve their family's degree of health This result was in line with the result shown by Sadjimin (2000).

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