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Soil-Transmitted Helminth Infection: The Severity of Anaemia and Learning Concentration Levels

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Abstract

Soil-Transmitted Helminth (STH) is a worm infection with a prevalence of 1.5 billion people worldwide and is mostly found in preschool and school children. Worm infection can affect the level of concentration and the quality of learning in less optimal achievement within their potential. The purpose of the research was to determine the correlation between STH infection with the occurrences of anaemia and the level of learning concentration in children in grades II-VI of the elementary school in Kampung Melayu Sub-district, Bengkulu City. The research was conducted using an analytic observational with a cross-sectional design. The research took 215 students as samples with a stratified random sampling method. Faces specimens were examined by using the Kato-Katz technique. Haemoglobin levels were measured by using the POCT method and students' learning concentration levels were measured by using the Bourdon Vos Test. The results showed a significant relationship between STH infection with the occurrences of anemia ($p = 0.001$; $r = 0.225$) and the learning concentration level ($p = 0.014$; $r = -0.167$). Continuous education and coordination with related institutions are necessary to carry out strategies for preventing and treating worms thoroughly.

INTRODUCTION

Soil-Transmitted Helminth (STH) infection is the most common infection spreading worldwide, especially in tropical and subtropical areas with low sanitation (CDC, 2018). More than 1.5 billion or 24% of the world's population have worm infections (WHO, 2019). The highest number incidence of worm infection occurs in areas with tropical and subtropical climates (Blum & Hotez, 2018). In Indonesia, worm infection is still a significant health problem, because the country's geographic location is suitable for the worms' life cycle (WHO, 2019).

Worms can infect humans of all ages, epidemiological studies state that children in elementary school are the population most susceptible to worm infection. The level of worm infection that occurs in children throughout Indonesia within the age range of 1-6 and 7-12 are reaching 30% to 90% (Ministry of Health, 2015).

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In 2000, the percentage of worm species infecting elementary school children in the transmigration area of Bengkulu Province was *Ascaris lumbricoides (A. lumbricoides)* as much as 65%, *Tricuris trichiura (T. trichiura)* with 55% and hookworms 22% (Marlina & Junus, 2012). Intestinal worm infection is still a common health problem that is found both in cities and villages which can lead to anaemia, nutrition deficiency, growth problems, and intellectual interferences (Arcanjo et al., 2016).

Worm infections that are mild and do not cause significant symptoms are often neglected without any treatment carried out and later become chronic infections that lead to a wider range of health problems (Wibisono et al., 2014). Chronic infection in children can cause growth disruption due to decreased appetite, interference in the digestive process and absorption failure. In *T. trichiura* infection, the anterior part of the worms that enter the intestinal mucosa causes trauma which causes inflammation and bleeding resulting in anaemia The worms *Necator americanus (N. americanus)* and *Ancylostoma duodenale (A. duodenale)* also cause blood loss due to parasite invasion of the mucosa and submucosa at the small intestine (Ministry of Health, 2015).

The impacts of anaemia on elementary school students are disruption of physical growth and development, low disease resistance, and affects the level of learning concentration which can lead to low learning achievement (Putri et al., 2021). Low haemoglobin (Hb) levels can affect learning concentration and decrease work productivity and children's learning achievement. Low level of haemoglobin associated a lower probability of attending school (Mosino, 2020; Mantey et al., 2021).

Dense and slum environments are a factor that influences the development of worm infections. The increasing population and high flow of urbanization have caused highly populated areas to lean towards slum areas that are at risk of increasing worm infection (Rosyidah & Prasetyo, 2018). One study explained that children living in slum areas have a higher risk of STH infection than children living in cities (Kattula et al., 2014). The purpose of this study was to determine the relationship between STH infection with the occurrences of anaemia and the level of learning concentration of elementary students in grade II-VI in kampung Melayu subdistrict, Bengkulu City, which is a coastal area.

METHOD

The study was conducted in January-March 2020 and has been approved by the Health Research Ethics Committee of the Faculty of Medicine and Health Sciences, Universitas Bengkulu, with numbers 69/UN30.14.9/2020. The design of this study was an analytic observational study with a cross-sectional study design. The target population of the study was elementary school students in Kampung Melayu District, Bengkulu City (10 schools). The sample of this study were elementary school students from grade II to grade VI (aged 8-12 years) in Kampung Melayu Bengkulu Sub-district who received approval from their parents to become the research sample by filling out and signing informed consent. The sampling technique used was probability sampling with the stratified random sampling method (Dahlan, 2016). The respondents were 215 students who met the research inclusion criteria (students from grade II to grade VI, received approval from their parents, and had no deworming in the last 6 months). The technique used to examine Faeces was the Kato-Katz method (Ministry of Health, 2017), haemoglobin levels were checked by using a digital Hb meter with the POCT (Point Of Care Testing) method (Bioptik Technology, 2016) and learning concentration levels were checked by using the Bourdon Vos test (Blotenberg & Schmidt-Atzert, 2019).

Collecting Specimens

The specimen collection phase begins with the provision of a container to accommodate the faeces specimens, which is done in the morning and not to be contaminated with any substance on the floor or mixed with urine by providing prior counselling to parents. Faeces samples collected were added with 10% formaldehyde preservative in a ratio of 1: 3. Faeces that have been submitted and preserved from respondents will be sent to the Laboratory of Parasitology, Faculty of Medicine and Health Sciences, Universitas Bengkulu.

Worm's Egg Identification

The identification of worm eggs was carried out by using the Kato-Katz method. The first step was to soak the cellophane tape in the malachite-green liquid and leave it for 24 hours. After 24 hours, the faeces are placed on wax paper and then pressed with gauze so that the faeces were filtered through the wax paper. The filtered faeces were then printed. The printed faeces were covered with cellophane tape which has been soaked for 24 hours. After all, steps were taken, the faeces specimen was examined under a microscope with magnifications of 10x10 and 40x10. The

number of Soil-Transmitted Helminth eggs was counted by the number of eggs found per gram of faeces. The calculation can be done with the following formula (Ministry of Health, 2017):

$$Amount\ of\ eggs\ per\ gram = \frac{1000}{Feces\ weight(mg)}\ x\ Amount\ of\ eggs$$

The classification of the severity of infection based on WHO 2019 is as follows:

***Ascaris lumbricoides* infection**

Mild infections: 1-4,999; Moderate infections: 5,000-49,999; Severe infections: ≥ 50,000

***Tricuris trichiura* infection**

Mild infections: 1-199; Moderate infections: 1,000-9,999 Severe infections: ≥ 10,000

***Hookworm* infection**

Mild infections: 1-1999; Moderate infections: 2,000-3,999 Severe infections: ≥ 4,000

The Measurement of Haemoglobin Levels. Hb levels measurement in research subjects was carried out by using a digital Hb measuring POCT tool. Measurements are made by preparing the tools and calibrating the tools with the automatic calibrator provided in the form of chip code. The respondent's capillary blood was drawn at the fingertips after disinfection. The blood that comes out was put on the test strip and the blood would automatically seep into the test strip until it beeps. After a few seconds, the results would appear on the screen (Bioptik Technology, 2016). The classification of anaemia degrees based on WHO in 2011 is mild anaemia (11-11.4 g / dL), moderate anaemia (8-10.9 g / dL) and severe anaemia (<8 g / dL) (Garcia-Casal et al., 2019).

Bourdon Vos Test

The process of filling out the Bourdon Vos test began with informed consent. Then, continued with filling out the Bourdon Vos test which was supervised by an examiner who aimed to calculate the completion time of the test per basis to identify allergies in children. This test consists of 3, 4, and 5 points. Instructions used in delivering this test were crossing out pictures with 4 dots on each line. The duration of this test on average was carried out for 10 minutes. The results of the data obtained were converted into Microsoft Excel from Visio Media with the learning concentration level classification (low, average, and high). This study aimed to measure the level of concentration in three aspects, namely speed, accuracy, and a child's constancy (Blotenberg & Schmidt-Atzert, 2019).

RESULTS AND DISCUSSION

Characteristics of the subject

Results showed that 28.8% of children in the age range of 8-10 years old had worm infection with a mild degree (Figure 1). Epidemiologically, the range age of children who experiences worm infection is 6-10 years old with the highest prevalence occurring in the 8-10 year age range (Sofiana & Kelen, 2018; Chu et al., 2014; Molla & Mamo, 2018). A similar study was conducted by Ojja in 2018 in Western Uganda. It is explained that age had a significant relationship with STH infection, namely p = 0.036. The age factor of the children has a relationship with the condition of environmental sanitation, playing pat-

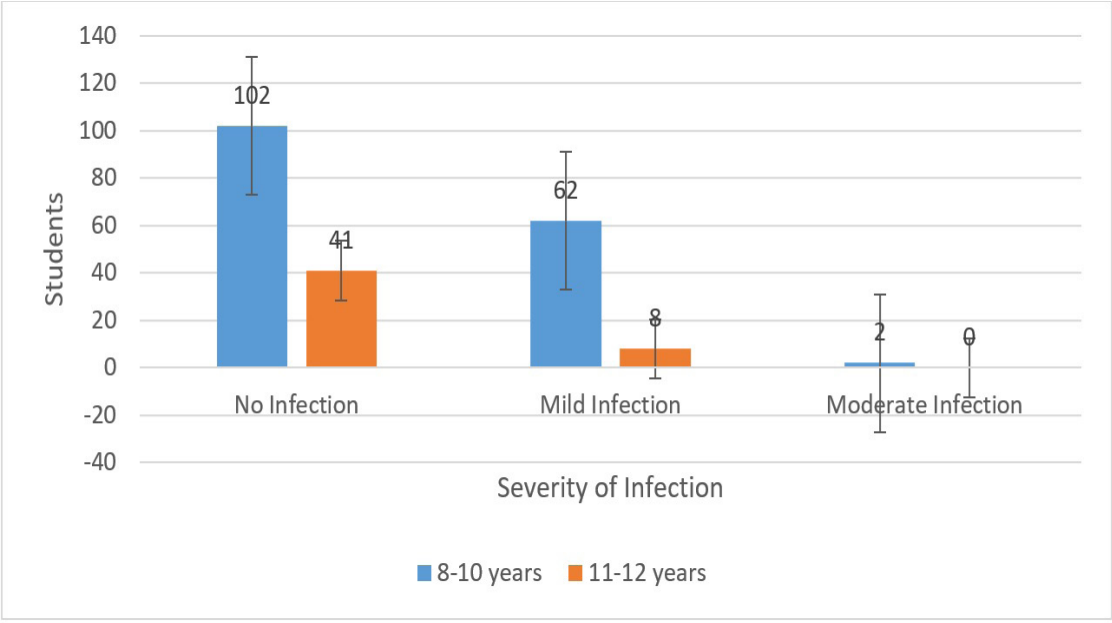

Figure 1. Distribution of STH Infection by Age

Table 1. Severity levels of STH infection among elementary school students in Kampung Melayu District, Bengkulu City

Soil-Transmitted Helmint	Severity Levels of Infection			Total	Sig. value
	No Infection	Mild Infection	Moderate Infection		
A.lumbricoides	-	37 (17,2%)	0 (0%)	37 (17,2%)	Single Infection
T.trichiura	-	25 (11,6%)	2 (1%)	27 (11,6%)	(p= 0,046; r=-0,136)
Hookworms	-	1 (0,5%)	0 (0%)	1 (0,5%)	
Total (Single Infection)	0 (0%)	63 (29,3%)	2 (0,9%)	65 (30,2%)	
A.lumbricoides - T.trichiura	-	6 (2,7%)	0 (0%)	6 (2,7%)	Multiple Infection
A.lumbricoides - Hookworms	-	1 (0,5%)	0 (0%)	1 (0,5%)	(p= 0,763; r=-0,098)
Total (Multiple Infection)	0 (0%)	7 (3,2%)	0 (0%)	7 (3,2%)	
Total	143 (66,5%)	70 (32,5%)	2 (1%)	215 (100%)	

terns, hand washing habits, hygiene, and immunity. The children have low awareness of hygiene potentially infected with STH (Ojja et al., 2018; Sofiana & Kelen, 2018).

Soil-Transmitted Helminth Infection

The research findings showed that STH infection occurred in 72 students (33.5%) with 32.5% degree of mild infection and 1% moderate infection. The distribution of single infection in this study was dominated by *A. lumbricoides* worm infection in 37 students (17.2%) (Table 1). This finding is in line with a study in Cross-Cutucú Equador which stated that the adolescent with a single infection with A. *lumbricoides* (in male 20 person and in female person) more than those with a single infection with T.*trichiura* (in male 15 person and in female 13 person) (Gildner et al., 2016). In 2019, Suryantari held her study in Bali and the findings revealed that *T.trichiura infection* (78.6%) was higher than *A.lumbricoides* infection (21.4%) (Suryantari et al., 2019). De Gier's study in Vietnam (2016) shows the obtained data respectively on *A. lumbricoides* infection (64.1%) *and T. trichiura* (53.7%) and *Hookworm* (5.3%) infections (De Gier et al., 2016).

The difference in worm infection rates in each region can be caused by various factors,

Table 2. Percentage of severity levels of anaemia and types of STH infection (single/multiple) among elementary school students in Kampung Melayu District, Bengkulu City

Soil-Transmitted Helminth Infection	Severity Levels of Anaemia			Total
	Mild Aneamia	Moderate Aneamia	Savere Aneamia	
A.lumbricoides	8 (42.1%)	1 (5.3%)	0 (0%)	9 (47.3%)
T.trichiura	5 (26.3%)	2 (10.5%)	0 (0%)	7 (36.8%)
Hookworms	1 (5.3%)	0 (0%)	0 (0%)	1 (5.3%)
A.lumbricoides - T.trichiura	1 (5.3%)	0 (0%)	0 (0%)	1 (5.3%)
A.lumbricoides - Hookworms	1 (5.3%)	0 (0%)	0 (0%)	1 (5.3%)
Total	16 (84.3%)	3 (15.7%)	0 (0%)	19 (100%)

*Spearman Rank Test with Significance Value (p=0,001; r=0,225)

one of which is the internal factor in the form of a more complex morphological structure of *A.lumbricoides* eggs. *Ascaris lumbricoides* egg's layers have a ridged and grooved outer shape which facilitates their adaptation when they are in a harsh environment and the egg's vitelline layers are strong and can protect eggs while they are laid in the soil (Marques et al., 2020). *Ascaris lumbricoides* and *T. trichiura* infections can be found simultaneously because the epidemiology of the two types of worms is the same; they both inhabit similar soil types and climates, namely tropical and sub-tropical. Simarmata (2015) held research in North Sumatra and stated that variations in STH infections can be influenced by geographic areas, environmental conditions, and individual hygiene (Simarmata et al., 2015). Another study conducted by Sumampouw in Manado City states that coastal areas having a low level of community-based total sanitation and low hygiene behaviour, including nail cutting and hand washing, are the main risk factors for STH infection in preschool and school children. The coastal environment is related to a slum environment and a dense population which causes the transmission of environmental diseases to be faster and more widespread and healthy behaviour is stilly-based lacking. (Sumampouw et al., 2015).

Correlation Between STH Infection and The Occurrence of Anaemia

This study showed a significant correlation between STH infection and the occurrence of anaemia in grade 2-6 elementary school students in Kampung Melayu Sub-district, Bengkulu City with p = 0.001 (p = <0.05). This study is in line with the findings of Molla and Mamo (2018) in Southern Ethiopia which stated that there were significant results on the relationship of STH infection with anaemia (p = 0.006) and OR: 3.72, which means that children with STH infection are 3.72 times more likely to develop anaemia compared to children without STH infection (Molla & Mamo, 2018) anemia and malnutrition that are largely neglected is vital to the control and management of them in a specific setting. This study was, therefore, aimed at determining the status of the three health concerns in one of the high-risk groups, schoolchildren, in South Ethiopia. Results: Among the 443 sampled schoolchildren, 54% were infected with soil-transmitted helminths (STHs. Basalamah (2014) and Oktaviana (2013) held a similar study in Manado and Temanggung, respectively, and it was stated that children with worm infections tended to have abnormal Haemoglobin levels. The mechanism of anaemia is caused by lacerations in the capillary of the intestinal villi and can cause local bleeding in the intestine by *hookworms*, whereas *Ascaris lumbricoides* can interfere with the absorption of dietary nutrients including iron (Oktaviana, 2013; Basalamah et al., 2014). This may occur due to the discharge of blood on the penetration of the anterior part of the *T.trichiura* worm as much as 0.005 ml per worm in one day (Else et al., 2022)

According to the research, it was found that 6 students (2.7%) had a mild degree of multiple *A.lumbricoides* - *T.trichiura* infection and 1 student (0.5%) had multiple *A.lumbricoides* - hookworm with a mild degree of infection associated with the incidence of anaemia and the value of p = 0.019 (P <0.05) was obtained. A similar study in India in 2015 stated that children with multiple STH worm infections tended to experience lower levels of Haemoglobin compared to single infections. Children with multiple infections had a 1.54 times risk of developing anaemia compared with single infections (p = 0.019) (Molla & Mamo, 2018).

The incidence of anaemia is not only influenced by worm infection but can be influenced by factors of food intake, level of parental knowledge and personal hygiene so that the incidence of anaemia is not only assessed by STH infection status (Sandy et al., 2015). Each child has a different food intake, Sirajuddin and Masni's 2015 study in Makassar stated that breakfast habits and consumption patterns of heme sources had a significant relationship with the incidence of anaemia (p = 0.016) (Sirajuddin & Masni, 2015). This is also related to the pattern of consumption from sources of food that can inhibit or accelerate the absorption of iron so that it influences the incidence of anaemia. From the research results, as many as 85% of children have iron deficiency, and the intake of macro and micronutrients is still low compared to the standard nutritional adequacy rate (Briawan et al., 2012).

Learning Concentration Level Against STH Infection

From the statistical results using the Spearman test, it was obtained a p-value of 0.014 ($p \leq 0.05$), which means that there is a relationship between STH infection and learning concentration levels in elementary school children in Kampung Melayu District, Bengkulu City. The Correlation Coefficient (r) value was obtained from the correlation of STH infection with a learning concentration level of -0.167, where the variable correlation is very weak and has a negative cor-

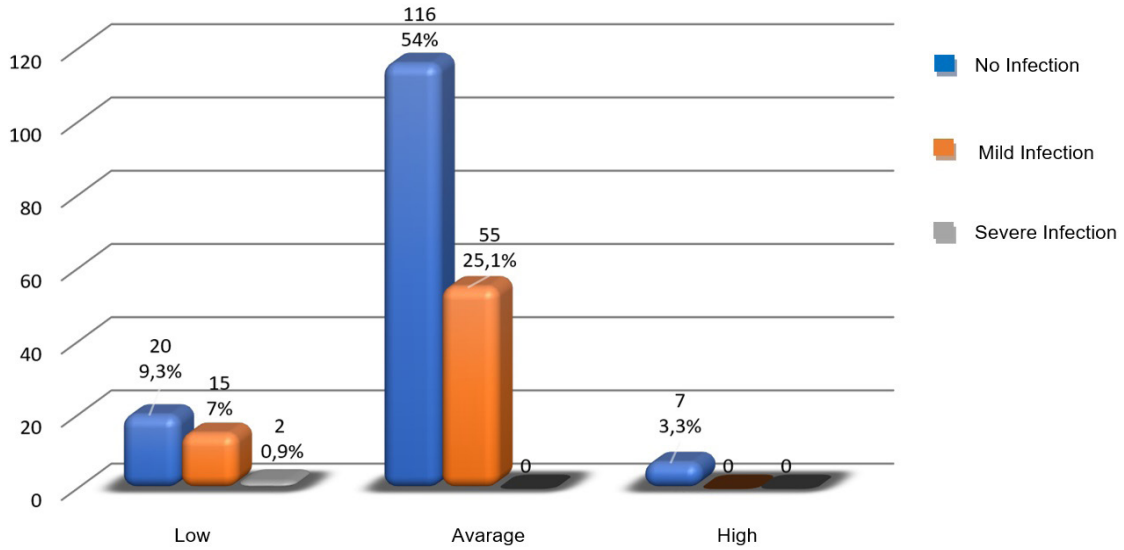

Figure 2. Learning Concentration Level of Elementary School Students in Kampung Melayu District, Bengkulu City

relation direction, meaning that the heavier the STH infection, the lower the learning concentration level. This happens because the intensity of worms infecting students is still classified as mild to moderate and has not yet affected individuals to become malnourished or severely anaemic. The more severe one's malnutrition and anaemia experienced, the worse the cognitive function and ability (Simarmata et al., 2015b; Qin et al., 2019). The number of worms infected will affect the learning concentration level. Children with polyparasitic infections tend to have low levels of nutrients and iron in the body that are depleted more quickly (Guan & Han, 2019). In a study conducted at the State Elementary School of Kampung Melayu District, the intensity of polyparasitic worm infection was still mild so that it could not affect the learning concentration level (Figure 3).

Several studies stated that children who suffer from anaemia due to worms have a more significant effect on decreasing cognitive function, learning concentration levels and achievement (Mosiño et al., 2020). The decrease in concentration levels due to aneamia can be caused by two factors (haemoglobin and Fe). Low levels of Hb can affect concentration and decrease work productivity. Children with low levels of iron or Fe can affect brain energy metabolism and neurotransmitter function in learning achievement (Mosiño et al., 2020; Greig et al., 2013). Anaemia can cause a decrease in concentration levels because iron plays a role in the formation of haemoglobin in the blood which is useful as an oxygen-carrying pigment, while oxygen itself is needed by the body for the combustion process that produces energy and if an individual is anaemic, a decrease in oxygen levels will occur in the blood, disrupting cell functions throughout the body including the brain. This may lead to decreased ability and concentration as well as enthusiasm to do an activity (Abbaspour et al., 2014).

The concentration level is also influenced by the nutritional adequacy of glucose. If inadequate intake in the short term has an impact on individual behavior, such as becoming tired easily and can interfere with concentration, this condition is related to the use of glucose as a source of brain energy. Concentration is influenced by energy intake from breakfast. This condition is related to the use of glucose as an energy source. The central nervous system can only use glucose as an energy source. In the absorption process, glucose is actively absorbed using protein and energy transport vehicles so that if protein adequacy is lacking, the process of transporting glucose as brain nutrition will be disrupted which causes the brain to experience a lack of glucose which will affect its concentration power. The habit of having breakfast before doing activities has a relationship with the level of concentration (Wardoyo & Mahmudiono, 2013; Krisnana et al., 2021). In Table 3, it can be seen that the child with a concentration level low is a child with a single infection of A. lumbricoides and T. trichiurid with 9.7% each.

CONCLUSION

There is a significant relationship between STH infection with the occurrences of anaemia ($p = 0.001$; $r = 0.225$) and the level of learning concentration in children ($p = 0.014$; $r = -0.167$).

Continuous education and coordination with related institutions are necessary to carry out strategies for preventing worms, treating worms thoroughly and re-promoting the deworming program for children.

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