



JNK

JURNAL NERS DAN KEBIDANAN
(JOURNAL OF NERS AND MIDWIFERY)

<http://jnk.phb.ac.id/index.php/jnk>



The Association between Environmental Sanitation and Soil Transmitted Helminths (STH) Coinfection of Tuberculosis Patients in Panti District, Jember Regency



Nita Alfianti¹, Yunita Armiyanti², Bagus Hermansyah³, Enny Suswati⁴, Dini Agustina⁵,
Diana Chusna Mufida⁶

¹Program Studi Pendidikan Dokter, Fakultas Kedokteran, Universitas Jember, Indonesia

^{2,3}Laboratorium Parasitologi, Fakultas Kedokteran, Universitas Jember, Indonesia

^{4,5,6}Laboratorium Mikrobiologi, Fakultas Kedokteran, Universitas Jember, Indonesia

Article Information

Abstract

History Article:

Received, 28/01/2020

Accepted, 11/11/2020

Published, 05/12/2020

Keywords:

Tuberculosis, Environmental Sanitation, STH

Tuberculosis (TB) is a contagious infectious disease caused by the bacteria *Mycobacterium tuberculosis*. More than 80% of TB cases attack the pulmonary organs and the rest are extra-pulmonary TB. Indonesia is one of the countries with the high number of tuberculosis cases besides India, China, the Philippines, and Pakistan. Aside from being a country with a high TB incidence, Indonesia is also an endemic country for helminth infections, especially Soil-Transmitted Helminths (STH). The high prevalence of STH infections in Indonesia allows STH coinfection in TB patients to cause decreasing immunity, thus affecting the outcome of TB infection. STH infection is very closely related to environmental sanitation. The purpose of this study was to identify and determine the association of environmental sanitation risk factors to the coinfection of Soil-Transmitted Helminths (STH) in tuberculosis patients in Panti District, Jember Regency. This type of research was observational research with cross-sectional analytic design. Of the 49 TB patients who were undergoing treatment at the Panti Health Center, 32 people were willing to be respondents, but only 25 people collected stool samples. Fisher's test results showed that the incidence of intestinal co-infection in TB patients in Panti District, Jember Regency was 12% and was caused by two STH species, namely *A. lumbricoides* and Hookworm. Environmental sanitation in TB patients was mostly good, e.g 54.5% of respondents had good environmental sanitation, but there was no significant association between environmental sanitation and the incidence of intestinal co-infection in TB patients in Panti District, Jember Regency ($p > 0.05$).

© 2020 Journal of Ners and Midwifery

✉ Correspondence Address:

Universitas Jember – East Java, Indonesia

Email: yunita.fk@unej.ac.id

DOI: 10.26699/jnk.v7i3.ART.p354-361

This is an Open Access article under the CC BY-SA license (<http://creativecommons.org/licenses/by-sa/4.0/>)

P-ISSN : 2355-052X

E-ISSN : 2548-3811

INTRODUCTION

Tuberculosis (TB) is an infectious disease caused by *Mycobacterium tuberculosis*. More than 80% of TB cases are pulmonary TB, and the rest are extrapulmonary TB (Shahverdi and Khani, 2017). Based on the WHO's Global Tuberculosis Report (2014), pulmonary TB is a significant health problem because it has a high mortality rate in the world (Ali et al., 2017). In 2015, there were 10.4 million new TB cases worldwide. Indonesia is one of the countries with the highest number of tuberculosis cases besides India, China, the Philippines, and Pakistan (World Health Organization, 2018). East Java Province is a province that has the third-largest TB incidence in Indonesia after West Java and Central Java, which is 56,445 cases (Ministry of Health, 2018). Jember Regency is the district with the second-largest TB incidence in East Java (Kementerian Kesehatan RI, 2018).

Indonesia is also an endemic area for worm infections, mainly soil-transmitted helminths (STH). Soil-transmitted helminths (STH) are a group of worms that are transmitted through soil media. The most common types of STH are roundworms (*Ascaris lumbricoides*), whipworms (*Trichuris trichiura*), and hookworms (*Necator americanus* and *Ancylostoma duodenale*) (Nugraha et al., 2019). Based on a survey by the Ministry of Health of the Republic of Indonesia (2015), the prevalence of worms at all ages of the Indonesian population ranges from 40-60%. The majority of worms in children throughout Indonesia is at a very high level, namely 30-90% (Depkes, 2015). A total of 109 incidents of STH infection were found in Jember Regency in 2016 (Dinkes Jember, 2016).

Soil-transmitted Helminth infection is closely related to environmental sanitation. The research conducted in Nusapati Village, Sungai Pinyuh District, Pontianak Regency showed a significant association between individual characteristics, personal hygiene, environmental sanitation, and personal protective equipment (PPE), and length of work with STH infection (Nurfalq et al., 2016). Ecological sanitation, which is closely related to worm infection, is clean water sources, feces disposal facilities in latrines, wastewater disposal facilities (SPAL), sewage disposal facilities, and house floors. Communities with poor defecation habits and clean water sources are in risk being infected with STH 23 times and four times greater

than people who have good defecation habits and clean water sources (Al-Muzaky et al., 2019). Lack of attention to personal hygiene and environmental sanitation allows co-infection of STH intestinal worms in someone who has had a previous infectious disease, such as a TB patient. Based on the Health Profile of Jember Regency (2016), there is 55.20% of the population have access to proper sanitation in Panti District; the rest still have inadequate sanitation so that it is a risk factor for environmental sanitation of Soil-Transmitted Helminth (STH) co-infection in tuberculosis patients in Panti District Jember Regency.

Soil-transmitted helminths infections can affect the course of the disease and treat TB patients' success. Intestinal worm infection is known to induce an increase in T-helper type 2 (Th-2) immune response characterized by interleukins IL-4, IL-5, IL-9, IL-10, and IL-13, eosinophilia, goblet cells, and mucosal mast cell hyperplasia and production of IgE and IgG 1 (in mice) and IgE and IgG4 (in humans). In the process of TB treatment, the body requires immunity to *M. tuberculosis* infection through a dominant T-helper type 1 (Th-1) response with minor contributions from Th17 cells and other accessory cells. Several studies have shown that an increase in Th-2 response will lead to a decrease in Th-1 response in patients with active TB who are infected with intestinal worms. As a result, there will be a decrease in immunity to *M. tuberculosis* and an increase in mycobacterial progression, which affects the success of TB treatment (Babu and Nutman, 2016).

Hookworm and whipworm infections also cause the patient to become anemic, affecting the patient's nutritional status. This anemia can exacerbate the symptoms of previous anemia due to the side effects of anti-tuberculosis drugs. Several studies have shown that TB patients with anemia increase the risk of treatment failure, recurrence of TB, and mortality. Several cases also show that anemia is closely related to increased TB patients' mortality (Isanaka et al., 2012). This worm infection can also decrease the condition of health, nutrition, intelligence, and productivity of sufferers, which in turn can reduce the quality of human resources and cause many losses (Sumanto, 2010). Not many studies on intestinal worm co-infection in TB patients have been conducted in Indonesia, especially in the Jember region. Therefore, research on soil-transmitted helminths

(STH) co-infection in tuberculosis sufferers and its association with environmental sanitation in Panti District, Jember Regency is necessary.

METHODS

This type of research was analytic observational with cross sectional design. The population in this study was all TB patients who undergone treatment in the Puskesmas Panti with total sampling technique. The variables studied were environmental sanitation and the incidence of STH co-infection. Data on the characteristics and environmental sanitation of respondents were obtained through a questionnaire, while the data on the incidence of STH coinfection were taken from examination of fecal samples collected by respondents who had agreed to the informed consent. The examination was carried out using qualitative sedimentation and flotation methods which were carried out at the Parasitology Laboratory of the Faculty of Medicine, University of Jember from September to November 2019. Furthermore, the data were analyzed using the Chi-Square or Fisher test. This research was conducted after receiving ethical clearance from the Ethics Committee of the Faculty of Medicine, University of Jember, No. 1.384 / H25.1.11 / KE / 2020.

RESULTS

As many as 49 TB patients who were currently undergoing treatment at the Puskesmas Panti, 32 were willing to become respondents, but only 25 people collected their fecal samples. The results of examination of fecal samples showed that as many as three of the 25 respondents (12%) were infected with STH. The results of stool examination can be seen in Table 1.

Table 1 Results of STH examination in feces

No	Examination results	N	Percentage (%)
1	Positive	3	12
2	Negative	22	88
Total		25	100

Data on the characteristics of respondents show that more female respondents than male respondents (52%). The results of the fecal

examination showed that all respondents who experienced STH coinfection were male. Also, all respondents infected with STH were patients in the productive age category. The respondents' educational degree characteristics varied from not attending school, SD, SMP, and SMA. Most cases of worms occurred in respondents with primary school education (67% of cases). Types of work of respondents infected with STH are private employees as much as 2 (66.7%) and labor 1 (33.3%). As many as 2 (66.7%) of all respondents infected with STH were TB status patients with new cases, and one person (33.3%) of respondents were TB patients with TB status with relapse cases. The research subjects' characteristics can be seen

Table 2 Distribution of Respondents

Respondent Characteristics	Positive	%	Negative	%
STH coinfection				
Gender				
1. Male	3	100,0	9	40,9
2. Female	0	0,0	13	59,1
Age				
1. < 15 years old	0	0,0	1	4,5
2. 15-65 years old	3	100,0	21	90,9
3. >65 years old	0	0,0	1	4,5
Education level				
1. No education	0	0,0	2	9,1
2. Elementary school	2	66,7	9	40,9
3. Junior high	0	0,0	4	18,2
4. Senior high	1	33,3	7	31,8
5. College	0	0,0	0	0,0
Type of work				
1. None	0	0,0	13	59,1
2. Farmer	0	0,0	5	22,7
3. Laborer	1	33,3	1	4,5
4. Private sector worker	2	66,7	2	9,1
5. Government employees	0	0,0	0	0,0
6. Other	0	0,0	1	4,5
Income (Rp)				
1. < 1 million	3	100,0	9	40,9
2. ≥ 1 million	0	0,0	13	59,1
Tuberculosis status				
1. New case	2	66,7	21	95,5
2. Relapse cases	1	33,3	1	4,5
3. Dropouts	0	0,0	0	0,0
4. MDR TB	0	0,0	0	0,0

in Table 2, while the stool examination results are presented in Table 3. Based on the results of the examination of fecal samples, the types of STH found consisted of *A. lumbricoides* worm infections as many as two people (66.7%) and mixed infections (*A. lumbricoides* and Hookworm) 1 person (33.3%).

Table 3 Distribution of STH Coinfection

No	Species of helminth	N	Percentage (%)
1	<i>A. lumbricoides</i>	2	66,7
2	<i>Hookworm</i>	0	0,0
3	<i>T. trichiura</i>	0	0,0
4	Mixed infection	1	33,3

Before analyzing the association between environmental sanitation and STH coinfection, the questionnaire's values were first tested for data normality using the analytical method of Shapiro Wilk. The normality test results showed that the data distribution was not expected ($p < 0.05$). For abnormal data distribution, the median is used to measure data concentration, resulting in conclusions on environmental sanitation as listed in Table 4.

Fisher's test results in this study showed a significance value of $p = 0.469$ ($p > 0.05$), so it can be concluded that there was no association between environmental sanitation and the incidence of STH coinfection in TB patients in Panti District, Jember Regency.

Table 4 Association between Environmental Sanitation and Incidence of STH Coinfection

No.	Characteristics	Incidence of STH Coinfection		P-value
		Positive (%)	Negative (%)	
1.	Good environmental sanitation	1 (33,3)	12 (54,5)	0,469
2.	Bad environmental sanitation	2 (66,7)	10 (45,5)	
Total		3 (100,0)	22 (100,0)	

The results showed that as many as 14 respondents had a lavatory, 15 respondents always defecated in it, 24 respondents had proper clean water facilities, 19 respondents had plaster or ceramic bathroom floors, and all respondents had

plaster or ceramic tile floors. Environmental sanitation component data for TB patients who were respondents in this study are presented in Table 5. as follows.

Table 5 Data for Environmental Sanitation Components

Environmental Sanitation	Positive		Negative	
	N	%	N	%
Lavatory ownership				
a. have a lavatory	1	4,0	13	52,0
b. does not have a lavatory	2	8,0	9	36,0
Bowel habits				
a. always defecating in the lavatory	2	8,0	13	52,0
b. not always defecating in the lavatory	1	4,0	9	36,0
Source of washing water				
a. eligible	3	12,0	21	84,0
b. not eligible	0	0,0	1	4,0

The source of bathwater				
a. eligible	3	12,0	21	84,0
b. not eligible	0	0,0	1	4,0
Source of drinking water				
a. eligible	3	12,0	21	84,0
b. not eligible	0	0,0	1	4,0
Type of floor of the house				
a. ceramics / plaster	3	12,0	22	88,0
b. soil	0	0,0	0	0,0
Bathroom floor type				
a. ceramics / plaster	2	8,0	17	68,0
b. soil	1	4,0	5	20,0

DISCUSSION

All respondents who experienced STH coinfection in this study were male respondents. The difference in the number of male and female respondents does not affect the occurrence of STH infection. The result is consistent with research conducted by Sandy et al. (2015), who explained that there was no significant association between gender and the incidence of STH infection in elementary school students in Papua.

Characteristics of respondents based on age show that all respondents infected with STH are in the productive age category (15-65 years). This result can occur due to high physical activity that is not followed by maintaining personal and environmental hygiene at that age range. Research conducted by Nurfaql et al. (2016) showed that there was no significant association between age and the incidence of STH infection ($p = 0.0910$) because STH can infect all age groups who have poor personal hygiene and sanitation (Jourdan et al., 2018).

The majority of respondents in this study had a low education level, namely, 17 respondents (68%). Two out of three respondents infected with STH were respondents with primary education degrees. Palgunadi (2015) explains that individuals who have a low level of education tend to be unable to maintain personal hygiene and find it difficult to implement Clean and Healthy Living Behaviors (PHBS). One way to overcome this problem is by providing promotional actions in counseling on clean and healthy living habits and maintaining environmental sanitation to avoid various infectious diseases such as STH.

In this study, respondents infected with STH have jobs as laborers and private employees with

less than 1 million income. This result is related to the respondents' socio-economic level, which also affects their ability to maintain good environmental sanitation and personal hygiene (Palgunadi, 2010).

Most of the TB patients infected with STH in this study were patients with new TB case status. This result may result from dysregulation of the immune system in a person infected with STH. Immune dysregulation occurs in the form of a decrease in the Th-1 immune response, which functions to attack *M. tuberculosis* due to an increase in the Th-2 immune response to weaken immunity against *M. tuberculosis* (Babu and Nutman, 2016).

The results of observations of fecal samples of TB sufferers in Panti District showed that 3 out of 25 respondents (12%) experienced STH coinfection. The types of STH that infected these respondents consisted of 2 single infections of *A. lumbricoides* and one mixed infection (*A. lumbricoides* and Hookworm). The worm species infecting the respondents the most was *A. lumbricoides*, accounting for 67% of cases. According to Sutanto et al.'s (2008) statement, this result states that *A. lumbricoides* is the most common parasite in humans. The prevalence of ascariasis both globally and in Indonesia is the highest among other worms. The highest prevalence of ascariasis in Indonesia reaches 90% (Laskey, 2019).

We found mixed infections (*A. lumbricoides* and Hookworm) in this study in one respondent. This double infection indicates that the respondent's level of environmental sanitation is not good. This result is evidenced by the respondent's questionnaire results that do not fulfill one of the indicators of healthy feces disposal facilities, namely not having a private toilet and defecating habits that are not

always in the toilet (in rivers or gardens). The habit of defecating that is not always in the lavatory can increase STH contamination of the surrounding soil and water.

The results of Fisher's test in this study showed a significance value (p-value) of 0.469 ($p > 0.05$), so it can be concluded that there is no association between environmental sanitation and the incidence of STH coinfection in TB patients in Panti District, Jember Regency. The results of this study are consistent with research conducted by Kundaian et al. (2012), which showed that there was no significant association between environmental sanitation and STH infection ($p > 0.05$). Research conducted by Martila et al. (2016) also stated that there was no significant association between environmental sanitation and the incidence of soil-borne worms in elementary school students in Palu City. Although the statistical test results show no association between the two variables, it does not mean that environmental sanitation does not affect worm infestation. This result is because worms are an environmentally based disease caused by a bad environment. Lack of adequate sanitation causes the environment to be contaminated by feces containing worm eggs.

This study's results are not following the research conducted by Nurindasari (2019), which states that there is a significant association between environmental sanitation and STH infection incidence ($p = 0.008$), even though it uses the same environmental sanitation indicators. This result is due to the difference in the proportion of positive and negative samples. In a study conducted by Nurindasari (2019), 19 positive samples (38.78%) were found from the 49 samples collected. This figure is much higher than examining the fecal sample of respondents in this study, which only found three positive samples (12%) of 25 respondents. In this study, most TB patients had good environmental sanitation, so the incidence of STH infection was very low (12%). Poor environmental sanitation in some TB patients, especially the absence of lavatory and not always defecating in the lavatory, can cause the environment to become contaminated with STH eggs and larvae, resulting in transmission to other individuals. This contamination is indicated by the majority of TB patients who are positively infected by STH have poor environmental sanitation (66.7%).

The characteristics of environmental sanitation among TB patients in Panti District included in the category of good sanitation were 13 respondents (52%), while 12 respondents (48%) had poor sanitation. These results indicate that the difference between the two is minimal, namely only one respondent. Respondents with poor sanitation also have a high chance of being infected with STH (8%). Poor sanitation can be a source of worm infection in humans, such as the habit of defecating in the toilet, direct contact with the bathroom floor's soil, and worm eggs' entry through contaminated food water. The study results were based on the answers to the questionnaire conducted by interview. No observations were made in the TB patient's home to ensure the answers' correctness, which were the study's limitations.

One TB patient infected with STH (33.3%) had good environmental sanitation. This can happen because it is not balanced with the behavior of maintaining cleanliness and low socio-economic factors. STH infection can also be influenced by various other factors, such as personal hygiene and socio-economic conditions. A person's hygiene can be assessed from the habit of washing hands, maintaining cleanliness and cutting nails regularly, eating raw food, using personal protective equipment during work or play such as footwear, masks, and gloves (Ali et al., 2016). Individual hygiene indicators that correlate with worm infections include the habit of washing hands before eating and after defecating, nail hygiene, and defecating behavior in the lavatory (Dewi and Laksmi, 2017). A study shows that a combination of washing hands with soap and trimming nails every week can reduce the rate of STH reinfection (Nery et al., 2019). Someone who is not used to cutting nails has a 5.1 times higher chance of infection than people who regularly cut their nails (Novianty et al., 2018).

Other factors that could affect the incidence of STH infection in this study were not taking soil samples, not measuring soil moisture, not asking about personal hygiene, and the habit of using personal protective equipment (PPE) to respondents. Soil samples are important to study because the soil is the medium used to convert fertilized eggs into infective. Soil contamination by STH can negatively impact the environment because it can be a source of pollution for water and plants that live around it (Muttaqien, 2018). Research conducted by Baidowi

et al. (2019) also showed a significant association between PPE use and STH infection status, so it is important to study it. Questions regarding environmental sanitation in this study are also less comprehensive, for example, not asking about waste disposal facilities and wastewater disposal channels (SPAL) (Kusumawardani, 2018).

CONCLUSION

The incidence of worm infection co-infection in TB patients in Panti Subdistrict, Jember Regency was 12% and was caused by two Soil-Transmitted Helminths species, namely *A. lumbricoides* and Hookworm. Most of the environmental sanitation for TB patients in Panti Subdistrict, Jember Regency, was right. The results showed that 54.5% of respondents had adequate ecological sanitation. There was no significant association between environmental sanitation and the incidence of worms co-infection in TB patients in Panti District, Jember Regency.

SUGGESTION

For TB patients in Panti Subdistrict, Jember Regency, it is necessary to receive regular deworming therapy and always maintain adequate environmental sanitation even though the prevalence is low, preventing worm co-infection.

For further research, research on personal hygiene factors related to intestinal worm infections can be carried out to help the government improve the success of TB treatment in Jember Regency.

REFERENCES

- Ali, M. K., S. Karanja, dan M. Karama. (2017). Factors associated with tuberculosis treatment outcomes among tuberculosis patients attending tuberculosis treatment centres in 2016-2017 in mogadishu, somalia. *Pan African Medical Journal*. 3(1): 24-32.
- Ali, R. U., Zulkarnaini, dan D. Affandi. (2016). Hubungan Personal Hygiene dan Sanitasi Lingkungan dengan Angka Kejadian Kecacangan (*Soil Transmitted Helminth*) Pada Petani Sayur di Kelurahan Maharatu Kecamatan Marpoyan Damai Kota Pekanbaru. *Dinamika Lingkungan Indonesia*. 28:1–14.
- Al-Muzaky, A. H., B. Hermansyah, E. Suswati, Y. Armiyanti, dan Y. Nurdian. (2019). Hubungan perilaku hidup bersih dan sehat dengan kejadian infestasi soil-transmitted helminths pada pekerja perkebunan kopi sumber wadung kabupaten jember. *Jurnal Kedokteran Dan Kesehatan/ : Publikasi Ilmiah Fakultas Kedokteran Universitas Sriwijaya*. 6(1):7–15.
- Babu, S. dan T. B. Nutman. (2016). Helminth-Tuberculosis Co-Infection: An Immunologic Perspective. *Trends in Immunology*. 37(9): 597-607
- Baidowi, I. I., Y. Armiyanti, Z. Febianti, Y. Nurdian, dan B. Hermansyah. (2019). The Correlation Between The Use of Personal Protective Equipment (PPE) and Soil-Transmitted Helminths Infection In The Workers of Kaliputih Plantation Jember Regency. *Journal of Agromedicine and Medical Sciences*. 5(2):8.
- Dewi, N. L. G. D. D. dan D. A. A. S. Laksmi. (2017). Hubungan Perilaku Higienitas Diri Dan Sanitasi Sekolah Dengan Infeksi Soil Transmitted Helminths Pada Siswa Kelas Iii-Iv Sekolah Dasar Negeri No. 5 Delod Peken Tabanan Tahun 2014 Program Studi Pendidikan Dokter , Bagian Parasitologi Fakultas Kedokteran U. *E-Jurnal Medika*. 6(5):5–8.
- Isanaka, S., F. Mugusi, W. Urassa, W. C. Willett, R. J. Bosch, E. Villamor, D. Spiegelman, C. Duggan, dan W. W. Fawzi. (2012). Iron deficiency and anemia predict mortality in patients with tuberculosis. *The Journal of Nutrition*. 142(2):350–357.
- Jourdan, P. M., P. H. L. Lamberton, A. Fenwick, dan D. G. Addiss. (2018). Soil-transmitted helminth infections. *The Lancet*. 391(10117):252–265.
- Kementrian Kesehatan RI. (2018). *Profil Kesehatan Indonesia*. Jakarta: Kementrian Kesehatan RI.
- Kundaian, F., J. M. L. Umboh, dan B. J. Kepel. (2012). Hubungan Antara Sanitasi Lingkungan Dengan Infestasi Cacing Pada Murid Sekolah Dasar di Desa Teling Kecamatan Tombariri Kabupaten Minahasa. *KESMAS*. 1(1):21–27.
- Kusumawardani, N. A. (2018). Hubungan Sanitasi Lingkungan dengan Kejadian Infeksi Soil Transmitted Helminths (STH) pada Anak Sekolah Dasar di Kabupaten Jember. *Skripsi*. Jember: Universitas Jember.
- Laskey, A. D. (2019). *Ascaris Lumbricoides*. <https://emedicine.medscape.com/article/788398-overview#showall> [Diakses pada November 4, 2019].
- Martila, S. Sandy, dan N. Paembonan. (2016). Hubungan Higiene Perorangan dengan Kejadian Kecacangan pada Murid SD Negeri Abe Pantai Jayapura. *Jurnal Plasma*. 1(2):87–96.
- Muttaqien, M. A. (2018). Identifikasi Kontaminasi Tanah oleh Telur dan Larva *Soil Transmitted Helminths* di Daerah Perkebunan Gunung Pasang Kabupaten Jember. *Skripsi*. Jember: Universitas Jember.
- Nery, S. V., A. J. Pickering, E. Abate, A. Asmare, L. Barrett, J. B. Chung, D. A. P. Bundy, T. Clasen, A. C. A. Clements, J. M. C. Jr, A. Ercumen, S. Crowley, O. Cumming, M. C. Freeman, R. Haque, B. Mengistu, W. E. Oswald, R. L. Pullan, R. G Oliveira, K. E. Owen,

- dan J. L. Walson. (2019). The role of water , sanitation and hygiene interventions in reducing soil transmitted helminths: interpreting the evidence and identifying next steps. *Parasites & Vectors*. 12(273):1–8.
- Novianty, S., Y. Dimiyati, S. Pasaribu, dan A. P. Pasaribu. (2018). Risk Factors For Soil-Transmitted Helminthiasis In Preschool Children Living In Farmland , North Sumatera , Indonesia. *Tropical Medicine*. 2018(6706413):1–6.
- Nugraha, T. I., R. Semiarty, dan N. Irawati. (2019). Hubungan sanitasi lingkungan dan personal hygiene dengan infeksi soil transmitted helminths (sth) pada anak. *Jurnal Kesehatan Andalas*. 8(3):590–598.
- Nundrisari, D. 2019. Hubungan Antara Sanitasi Lingkungan dan Higiene Perseorangan dengan Kejadian Infeksi Soil-Transmitted Helminthes pada Pekerja Perkebunan Garahan Kidul. *Skripsi*. Jember: Universitas Jember.
- Nurfalq, D. K. F., I. Saleh, dan Rochmawati. (2016). Hubungan karakteristik individu, sanitasi lingkungan rumah, personal hygiene, penggunaan apd dan lama bekerja dengan kejadian infestasi sth. *Jurnal STH*. 1(1): 1-9
- Palgunadi, B.U. (2010). *Faktor-Faktor yang Mempengaruhi Kejadian Kecacingan yang Disebabkan oleh Soil-transmitted Helminths di Indonesia*. Surabaya: Fakultas Kedokteran Universitas Wijaya Kusuma
- Sandy, S., S. Sumarni, dan Soeyoko. (2015). ANALISIS model faktor risiko yang mempengaruhi infeksi kecacingan yang ditularkan melalui tanah pada siswa sekolah dasar di distrik arso kabupaten keerom, papua. *Media Litbngkes*. 25(1):1–14.
- Shahverdi, E. dan M. Khani. (2017). Epidemiology of pulmonary tuberculosis. *Austin Tuberc Res Treat*. 2(1):1005.
- Sumanto, D. (2010). Faktor Risiko Infeksi Cacing Tambang Pada Anak Sekolah (Studi Kasus Kontrol Di Desa Rejosari, Karangawen, Demak). *Tesis*. Semarang: Universitas Diponegoro.
- Sutanto, I., I. S. Ismid, P. K. Sjarifuddin, dan S. Sungkar. (2015). *Buku Ajar Parasitologi Kedokteran*. Edisi 4. Badan Penerbit FKUI.
- World Health Organization. (2018). *Global Tuberculosis Report 2018*. France.