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PERSONAL HYGIENE AS A RISK FACTORS OF HELMINTHIASIS AMONG PRIMARY SCHOOL STUDENTS IN ASIA AND AFRICA: A LITERATURE REVIEW

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Abstract

Introduction: *Helminthiasis becomes one of the infectious diseases included in neglected diseases that receive less attention and mostly occurred in tropical countries. The World Health Organization (WHO) in 2020 stated that helminthiasis spread throughout sub-Saharan Africa, America, China, and East Asia where 60% suffered by children. STH infections may result from poor hygiene in many school aged-children, especially in primary school. This article was written to analyze the personal hygiene of primary school children that may affect the incidence of helminthiasis.* ***Discussion:*** *An integrative literature review was conducted using databases, from Google Scholar, Pubmed, Research Gate, and Science Direct databases. It was 24 articles consisting of 20 articles published by international journals and 4 articles in Indonesian journals. Most of the infectious agents in Asia were Ascaris lumbricoides and Trichuris trichiura, while Ascaris lumbricoides, Hookworms, and Trichuris trichiura dominate in Africa. Poor personal hygiene may a risk of infection. For example, children in Asia do not cut their nails or wash their hands. While children in Africa do not wash their hands, walked barefoot, and conducted open defecation.* ***Conclusion:*** *Personal hygiene of primary school children has a positive effect on the incidence of helminthiasis in Asia and Africa with different prevalences. To prevent and control helminthiasis in school children, schools should provide education about personal hygiene, improve sanitary facilities, and routinely give anthelmintics every six months.*

INTRODUCTION

Helminthiasis becomes a global health problem that is still suffered by the world's population. The World Health Organization (WHO) in 2020, asserts that individuals infected with Soil-Transmitted Helminths (STH) amount to 24% of the global population (more than 1.5 billion cases). The number of Helminth infection cases in tropical and subtropical countries proportionally increases. Children are categorized as a susceptible population category. More than 267 million preschool children and 568 million school-aged children got an infection (1). The age of preschool children ranges from 60 months to 72 months, while that of school children is at least 6 years to 18 years old (2). Primary school children, their age is between at least 6 years to 12 years old (3).

Soil-Transmitted Helminths (STH) often cause helminth infection. The main types of parasites in human infection are *Ascaris lumbricoides* also known as roundworms, *Trichuris trichiura* also known as whipworms, and *Hookworm*s which include *Necator americanus* and *Duodenale ancylostoma* (1). Previous research in Laos, used samples of students' feces from100 schools, and it revealed that the prevalence of Soil-Transmitted Helminths (STH) was 1.20% (4). In Indonesia, a high prevalence of STH infections exists in some areas, ranging from 60% - 90% in a lower-middle economic-level group, especially with limited sanitation access (5). The majority of the most infected age groups are aged 5-14 years, and 21% of the infection cases attack elementary school-age children. Research in Palue Island, East Nusa Tenggara shows that 78% of the incidence of STH infection was found in 100 primary school children (6). Research in Kenya shows that the prevalence of STH infection among school-aged children is extremely high at 70.5% (7). According to a study in

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Cameroon, the prevalence of STH infections reached 10 million cases, which spread to all of Cameroon (8). The infections in school children need to be studied further.

STH infections may be the result of poor hygiene in many school-aged children, for example, not wearing footwear and not washing hands before meals (9). In developing countries, water, sanitation, and hygiene (WASH) become risk factors for infection in school-aged children (9). In line with the research in Ethiopia, the incidence of parasitic infections is caused by unavailable safe water, walking with bare feet, and parents, an education level (10). Hand washing facilities and environmental sanitary quality may contribute to the increase in helminth infections (11-12). In line with the research in Indonesia, factors related to helminth infection in children include the availability of sanitary facilities, types of housing floors house, defecation habits, hand washing after eating, and mother's knowledge (13). Therefore, hygiene behaviors in children are important to control and prevent infection transmission (14).

Helminth infection is a neglected chronic disease that has unclear clinical symptoms and may impact the future of children. Its impacts include child malnutrition problems, impaired development, and intelligence. Another impact is the increased susceptibility to a disease such as malaria, pulmonary TB, and anemia (15). As primary school children in developing countries are a vulnerable population to STH infections. Some activities that contribute to infection are playing with soil in schools, consuming snacks contaminated with worm eggs, and having poor living behavior such as hand and nail hygiene (16). As an infection that often infects school-aged children, some of the preventions that can be carried out include school-level interventions, and health education for children and also their parents. New methods that are more interesting to children are also needed such as comics and animation (17).

Soil-Transmitted Helminths (STH) are still a public health problem that needs to be analyzed. Hygiene behavior of elementary school children has to be under further identification and analysis to decrease the prevalence of STH in Asian and African countries. Literature review analysis of hygiene behavior and helminth infection in primary school children has not been found much compared to diarrhea, dengue fever, or mosquito nest eradication behavior. Therefore, this current literature review aims to analyze the effect of personal hygiene on helminth infections among primary school children in Asian and African countries.

DISCUSSION

An integrative literature review method was used to gain an understanding of the relationship of personal hygiene with helminth infections in school children by summarizing empirical facts obtained from scientific articles. The inclusion criteria for scientific article search are: that articles are derived from peer-reviewed journals; published from 2016 to 2021 in; English or Indonesian; conducted in the Continent of Asia and Africa; they are original research and case study articles on; personal hygiene and helminth infections in primary school children; they are full-text articles; accessible in open access journals; ranked at least Sinta indexed 3 or Scopus. The data sources used were obtained from Google Scholar, Pubmed, Research Gate, and Science Direct databases. Keywords for reference search, include hygiene behavior AND helminth infections AND school-age children. After screening and adjustment to research variables, 24 articles consisting of 21 articles published by international journals and four national articles which are published by national journals were analyzed. The research sites are in the Asian continent (Indonesia, India, Laos, Iran, Bangladesh, and China) and Africa (Kenya, Nigeria, Ethiopia, and Cameroon). Data analysis is done by reducing and comparing data on research variables with empirical/theoretical support, as well as presenting them through tables and describing in the form of sentences.

Helminth Infection Agent

Of the 24 articles examined, 20 articles were selected as they discussed the prevalence of STH in primary school children in Asian and African countries. The frequency of STH in primary school students varies among countries. The prevalence of STH in research sites in the Asian continent ranges from 7.6% to 57.24% and the highest prevalence is found in North Sumatera, Indonesia, especially in Tigapanah subdistrict of Karo Regency, especially in Suka village. However, the lowest exists in State Primary School 5 Delod Peken, Tabanan Regency, Bali Province, Indonesia (Table 1). Research in the African continent showed the prevalence of STH ranged from 11.6% to 70.5%. The Bamendjou Community in Cameroon's West Region has the lowest prevalence and the Mwea Irrigation Scheme, Kirinyaga County, Kenya has the highest prevalence

Infection is a disease with transmission through the soil is soil-transmitted helminths (STH). It can spread through larvae-contaminated food or contact with soil (18).

Table 1. Prevalence of STH in Asia and Africa

Asia			Africa		
Country	**Prevalence (%)**	**Helmint Infection Agent**	**Country**	**Prevalence (%)**	**Helminth Infection Agent**
Indonesia (Ayodhia Pitaloka Pasaribu, Anggraini Alam, Krisnanarta Sembiring, Syahril Pasaribu, Djatnika Setiabudi) (48)	57.24	*Ascaris lumbricoides* (40.7%), *Trichuris trichiura* 33.33%), *Hookwarms* (3.42%)	Kenya (Elizabeth Njambi, Dennis Magu, Janet Masaku, Collins Okoyo, Sammy M Njenga) (7)	70.5	*Schistosoma mansoni* (70.5%)
India (Akhilesh Gupta, Anita Shankar Acharya, Sanjeev Kumar Rasania, Tapas Kumar Ray, Sudhir Kumar Jain) (24)	54.8	*Ascaris lumbricoides* (54.4%) , *Trichuris trichiura* (4.8%)	Nigeria (Abe *et al.*) (49)	33.5	*Ascaris lumbricoides* (13%), *Trichuris trichiura* (7.5%), *Hookworm* (8.0%), *Schistosoma strecoralis* (2.50%)
Western Iran (Hossein Mahmoudvand, Ebrahim Badparva, Amal Khudair Khalaf, Massumeh Niazi, Mehrdad Khatami, Mohammad Reza Nazer) (33)	9.8	*Enterobius vermicularis* (15.8%), *Hymenolepis nana* (3.1%), *Ascaris lumbricoides* (0.3%)	Southern Ethiopia (Wondwosan Abera Gitore, Musa Mohammed Ali, Amanuel Yoseph, Adane Ermias M, Alemu Tamiso D) (28)	23.1	*Ascaris lumbricoides* (11.2%), *Trichuris trichiura* (4.5%), *Schistosoma Strecoralis* (3.8%), *Hookworm* (2.7%)
Bangladesh (Sadya Afroz, Smita Debsarma, Suborna Datta, Mir Masudur Rhaman, Masuda Mohsena) (31)	39.2	*A.lumbricoides* (23%), *Trichuris trichiura* (12.8%) and mixed infection (3.4%).	Northern Ethiopia (Awrajaw Dessie, Tesfey G.G, Berihu Kiros, Sintayehu Daba Wami, Daniel, Haile Chercos) (34)	29.9	*Entamoeba histolytica/dispar* (11.8%) and *Giardia lambia* (4.7%)
Southwestern China (Yang *et al.*) (17)	-	*Ascaris lumbricoides* (10.0%), *Trichuris trichiura (*25.2%) and *Cryptosporidium* (2.4%).	Nigeria (Vincent P. Gyang, Ting-Wu Chuang, Chien-Wei Liao, *et.al.*) (23)	70.8	*Entamoeba histolytica/dispar (25.3%) , Trichuris trichiura, Ascaris lumbricoides Hookwarms*
Indonesia (Umi Mahmudah) (51)	40.21	*Ascaris lumbricoides* (54.05%), *Trichuris trichiura* (2.70%), *Hookworm* (27.03%), and *Oxyuris* (5.41%)	Cameroon (Matsinkou Mba Rosine Ruth, Yamssi Cedric, Mbong Erica Malla, Noumedem Anangmo Christelle Nadia, Tateng Ngouateu Aime, Megwi Leonelle, and Vincent Khan Payne) (40)	11.6	*Ascaris lumbricoides* (6.1%), *Trichuris trichiura* (3.4%), *Hookworms* (3.0%), Strongyloides sp. (0.2%)
Indonesia (Ni Luh Gede Dian Ratna Dewi, Dewa Ayu Agus Sri Laksmi) (27)	7.6	*Trichuris trichiura* (55.6%), *Hookworm* (22.2%), *Enterobius vermicularis* (11.1%), and *Ascaris lumbricoides* (11.1%).	Northwest Ethiopia (Baye Sitotaw, Haileyesus Mekuriaw and Destaw Damtie) (22)	57.88	*Giardia lamblia* (19.95%), *Hookworms* (13.8%), *Schistosoma mansoni* (10.3%), *Entamoeba histolytica/dispar* (5.9%), *.Hymenolepis nana* (4.2%), *Taenia* (3%) and *Ascaris lumbricoides* (0.73%),
			Northwest Ethiopia (Chalachew Muluneh, Tadesse Hailu, and Getaneh Alemu) (39)	34.5	*Hookworm* (237/806), *Ascaris lumbricoides* (72/806), *Schistosoma marisoni* (20/806), *Enterobius vermicularis* (14/806), *Hymenolepis nana* (1/806)
			Kenya (Collins Okoyo, Suzy J. Campbell, Katherine Williams, Elses Simiyu, Chrispin Owaga, Charles Mwandawiro) (52)	12.9	*Ascaris lumbricoides* (9.7%), *Trichuris trichiura (*3.6%), *Hookworm* (1.0%), *Schistosoma mansoni* (2.2%), *Schistosoma haematobium* (0.3%)
			Northwest Ethiopia (Hiwot Hailu Amare, Bernt Lindtjørn) (53)	56	*Trichuris trichiura* (42.4%), *Ascaris lumbricoides* (18.7%)
			Southern Ethiopia (Asfaw *et. al.*) (54)	23.5	*Ascaris lumbricoides* (18.6%), *Trichuris trichiura* (9.2%), *Hookworms* (3.1%)
			Ethiopia (Awoke Aschale, Metadel Adane, Melaku Getachew, *et.al.*) (44)	32.2	*Entamoeba histolytica* (29.2%), *Giardia lamblia* (21.5%), *Ascaris lumbricoides* (18.5%), *Hymenolepis nana* (9.2%), *Enterobius vermicularis* (4.6%)
			Western Kenya (Janet Masaku, Doris W. Njomo, Ann Njoka, Collins Okoyo, Faith M. Mutungi and Sammy M. Njenga) (50)	17.0	*Schistosoma mansoni* (11,8%) , *Trichuris trichiura* (12.9%), *Ascaris lumbricoides* (8.3%), and *Hookworms* (1.2%).

Based on Table 1, the most commonly found infectious agents or parasites found in seven Asian research articles include *Ascaris lumbricoides* and *Trichuris trichiura*. While from 13 African research articles, some infectious agents are *Ascaris lumbricoides*, *Hookworm,* and *Trichuris trichiura*. In addition to these agents, several other infectious agents in both Asian and African countries include *Strongyloides strecoralis*, *Entamoeba histolytica/dispar*, *Schistosoma mansoni*, *Entrobius Vermicularis*, and *Hymenolepis nana.*

Ascaris lumbricoides is the most common parasite in humans. *Ascaris lumbricoides* infects between 807 million and 1.2 billion persons worldwide, and it is commonly called Soil-Transmitted Helminths. Open defecation behavior and the use of fertilizers from human waste can be risk factors for STH infection, especially if the person is infected. Worm eggs can fuse with the soil and grow into an infectious parasites. Another risky behavior is the lack of hand washing with soap resulting in worm contamination through fingers and consumption of unwashed/uncooked/unpeeled vegetables or fruits (19). Children with severe infections are at risk of intestinal blockage and impaired growth (19). The parasite mostly infects subtropical and tropical countries in Asia and Africa (20). The healing process due to infection with *Ascaris lumbricoides* can occur by itself caused the average life span of an adult parasite is only up to one year after it dies and is removed through the digestive tract (21).

Ascaris lumbricoides infection is found in studies conducted in several primary schools in Northwestern Ethiopia, with infection rates of 8.3 to 15.5% (22). Furthermore, a study in an urban slum located in Makoko and commercial capital, part of Lagos city, Nigeria, reveals that *Ascaris lumbricoides* infects more than 80% of school children with positive diatribes. It suggests *Ascaris lumbricoides* is the most infecting parasite in the region (23). A study in East Delhi, India with the samples of all school children between the ages of 6-14, displayed results that the prevalence of STH was found at 54,8% with *Ascaris lumbricoides* playing the highest prevalence role. The study stated that the risk factors for disability at the study site consisted of children's behavior, hygiene, and children's play environment, especially hand washing behavior (24).

Trichuris trichiura or Whipworm, also found in humans, is estimated to infect 604-795 million people worldwide. Whipworm infection is caused by the same factors as *Ascaris lumbricoides* through the feces of infected people. Infection due to the *Trichuris trichiura* parasite is called triuriasis, found especially in areas with the use of dirt-based fertilizers or Open Defecation Free (ODF) behavior. Its transmission may occur through the fecal-oral tract from one person to another (25). *Trichuris trichiura* eggs are at an infective level, in warm and humid climates favorable for their maturation process. It contributes to STH in tropical countries, especially in Asia, but rarely in Africa and South America (26). Likewise, a study at State Primary School 5 Delod Peken, Tabanan Regency, Bali Province, Indonesia, shows the most detected agent of the 105 samples of feces include *Trichuris trichiura* (55%) with 34.3% of children having poor personal hygiene (27). Research conducted in the Gedeo zone, Southern Ethiopia, successfully identifies characteristics of school children infected with *Trichuris trichiura* usually include loss of appetite, thin body, anemia, informal education of mother or caregiver, and lack or absence of school-eating program in school (28).

Hookworm is a human intestinal parasite, which is estimated to have infected 576-740 million people in the world. Hence populations in tropical countries are at risk if they have poor hygiene and sanitation. Meanwhile, some behaviors that can increase infection are a lack of hand washing habits using soap, the rare use of footwear when walking on the ground, and irregular nail clipping. In addition, it can also spread through soil contaminated by the feces of an infected person or through fertilizer (29). The research located in Musi Rawas Regency, South Sumatra, Indonesia obtains the results that *Hookworm* parasites became the most infecting school children in five primary school children in Tuah Negeri District, where parents working as farmers had the highest prevalence of STH (30). In line with research on schoolchildren from Jawi Primary School located in northwest Ethiopia, *Hookworm* is a parasite that infects schoolchildren the most (13.8%, $p = 0.042$) (22).

Helminth infection is bad for children's health and affects the intake, digestion, absorption, and metabolism of food. Some disadvantages caused by helminth infection are reduced protein, calories, and blood loss in the body. In addition, it can also slow the development of physical and cognitive ability, work productivity, and endurance of the body so infected people are very susceptible to various diseases (18). Helminth infection can cause chronic effects in children that have an impact on physical growth and cognitive development. Chronic effects can lead to chronic malnutrition which has uniting and decreases the physical growth of children (31).

Table 2. Personal Hygiene of Primary School Children

Personal Hygiene	Personal Hygiene based on Research Location		Number of Articles
	Asia's Research Country	Africa's Research Country	
Drinking water consumption behavior	Western Iran (Hossein Mahmoudvand, Ebrahim Badparva, Amal Khudair Khalaf, Massumeh Niazi, Mehrdad Khatami, Mohammad Reza Nazer) (33)	Nigeria (Vincent P. Gyang, Ting-Wu Chuang, Chien-Wei Liao, *et.al*) (23); Northwest Ethiopia (Chalachew Muluneh, Tadesse Hailu, and Getaneh Alemu) (39); Western Kenya (Janet Masaku, Doris W. Njomo, Ann Njoka, Collins Okoyo, Faith M. Mutungi and Sammy M. Njenga) (50); Northwest Ethiopia (Baye Sitotaw, Haileyesus Mekuriaw and Destaw Damtie*)* (22)	5
Vegetable and fruit consumption behavior	Bangladesh (Sadya Afroz, Smita Debsarma, Suborna Datta, Mir Masudur Rhaman, Masuda Mohsena) (31)	Nigeria (Vincent P. Gyang, Ting-Wu Chuang, Chien-Wei Liao, *et.al*) (23); Northwest Ethiopia (Chalachew Muluneh, Tadesse Hailu, and Getaneh Alemu) (39); Northwest Ethiopia (Hiwot Hailu Amare, Bernt Lindtjørn) (53); Northwest Ethiopia (Baye Sitotaw, Haileyesus Mekuriaw and Destaw Damtie*)* (22)	5
Nail clipping behavior	India (Akhilesh Gupta, Anita Shankar Acharya, Sanjeev Kumar Rasania, Tapas Kumar Ray, Sudhir Kumar Jain) (24); Indonesia (Liena Sofiana, Mayang Sumira Jewana Kelen) (45); Indonesia (Ayodhia Pitaloka Pasaribu, Anggraini Alam, Krisnanarta Sembiring, Syahril Pasaribu, Djatnika Setiabudi) (48); Northwest Ethiopia (Sadya Afroz, Smita Debsarma, Suborna Datta, Mir Masudur Rhaman, Masuda Mohsena) (31); Indonesia (Ni Luh Gede Dian Ratna Dewi, Dewa Ayu Agus Sri Laksmi) (27)	Northwest Ethiopia (Hiwot Hailu Amare, Bernt Lindtjørn) (53); Northern Ethiopia (Awrajaw Dessie, Tesfey G.G, Berihu Kiros, Sintayehu Daba Wami, Daniel, Haile Chercos) (34); Northwest Ethiopia (Baye Sitotaw, Haileyesus Mekuriaw and Destaw Damtie) (22)	8
Footwear use	India (Akhilesh Gupta, Anita Shankar Acharya, Sanjeev Kumar Rasania, Tapas Kumar Ray, Sudhir Kumar Jain) (24); Northwest Ethiopia (Sadya Afroz, Smita Debsarma, Suborna Datta, Mir Masudur Rhaman, Masuda Mohsena) (31); Indonesia (Ni Luh Gede Dian Ratna Dewi, Dewa Ayu Agus Sri Laksmi) (27)	Cameroon (Matsinkou Mba Rosine Ruth, Yamssi Cedric, Mbong Erica Malla, Noumedem Anangmo Christelle Nadia, Tateng Ngouateu Aime, Megwi Leonelle, and Vincent Khan Payne) (40); Northwest Ethiopia (Chalachew Muluneh, Tadesse Hailu, and Getaneh Alemu) (39); Kenya (Collins Okoyo, Suzy J. Campbell, Katherine Williams, Elses Simiyu, Chrispin Owaga, Charles Mwandawiro) (52); Western Kenya (Janet Masaku, Doris W. Njomo, Ann Njoka, Collins Okoyo, Faith M. Mutungi and Sammy M. Njenga) (50); Northwest Ethiopia (Baye Sitotaw, Haileyesus Mekuriaw and Destaw Damtie) (22)	8
Hand washing behavior	India (Akhilesh Gupta, Anita Shankar Acharya, Sanjeev Kumar Rasania, Tapas Kumar Ray, Sudhir Kumar Jain) (24); Western Iran (Hossein Mahmoudvand, Ebrahim Badparva, Amal Khudair Khalaf, Massumeh Niazi, Mehrdad Khatami, Mohammad Reza Nazer) (33); Indonesia (Liena Sofiana, Mayang Sumira Jewana Kelen) (45); Indonesia (Ayodhia Pitaloka Pasaribu, Anggraini Alam, Krisnanarta Sembiring, Syahril Pasaribu, Djatnika Setiabudi) (48); Laos (Anna N Chard, Joshua V Garn, Howard H Chang, Thomas Clasen, Matthew C Freeman) (4); Southwestern China (Yang *et al.,*) (17); Indonesia (Ni Luh Gede Dian Ratna Dewi, Dewa Ayu Agus Sri Laksmi) (27)	Cameroon (Matsinkou Mba Rosine Ruth, Yamssi Cedric, Mbong Erica Malla, Noumedem Anangmo Christelle Nadia, Tateng Ngouateu Aime, Megwi Leonelle, and Vincent Khan Payne) (40); Northwest Ethiopia (Chalachew Muluneh, Tadesse Hailu, and Getaneh Alemu) (39); Northwest Ethiopia (Hiwot Hailu Amare, Bernt Lindtjørn) (53); Ethiopia (Awoke Aschale, Metadel Adane, Melaku Getachew, *et.al.*) (44); Northern Ethiopia (Awrajaw Dessie, Tesfey G.G, Berihu Kiros, Sintayehu Daba Wami, Daniel, Haile Chercos) (34); Nigeria (Abe *et al.*) (49); Western Kenya (Janet Masaku, Doris W. Njomo, Ann Njoka, Collins Okoyo, Faith M. Mutungi and Sammy M. Njenga) (50); Northwest Ethiopia (Baye Sitotaw, Haileyesus Mekuriaw and Destaw Damtie) (22)	15
Defecation behaviour	India (Anju Damu Anje, Kondagunta Nagaraj, Chandrasekhar Vallepalli) (37); Indonesia (Liena Sofiana, Mayang Sumira Jewana Kelen) (45)	Ethiopia (Awoke Aschale, Metadel Adane, Melaku Getachew, *et.al.*) (44); Southern Ethiopia (Wondwosan Abera Gitore, Musa Mohammed Ali, Amanuel Yoseph, Adane Ermias M, Alemu Tamiso D) (28); Northern Ethiopia (Awrajaw Dessie, Tesfey G.G, Berihu Kiros, Sintayehu Daba Wami, Daniel, Haile Chercos) (34); Northwest Ethiopia (Baye Sitotaw, Haileyesus Mekuriaw and Destaw Damtie) (22)	6
Foot washing behavior		Cameroon (Matsinkou Mba Rosine Ruth, Yamssi Cedric, Mbong Erica Malla, Noumedem Anangmo Christelle Nadia, Tateng Ngouateu Aime, Megwi Leonelle, and Vincent Khan Payne) (40)	1
Contact with the ground	Indonesia (Ayodhia Pitaloka Pasaribu, Anggraini Alam, Krisnanarta Sembiring, Syahril Pasaribu, Djatnika Setiabudi) (48) ; Indonesia (Ni Luh Gede Dian Ratna Dewi, Dewa Ayu Agus Sri Laksmi) (27)	Northwest Ethiopia (Chalachew Muluneh, Tadesse Hailu, and Getaneh Alemu) (39); Southern Ethiopia (Asfaw *et al.,*) (54); Southern Ethiopia (Wondwosan Abera Gitore, Musa Mohammed Ali, Amanuel Yoseph, Adane Ermias M, Alemu Tamiso D) (28)	5
Pica consumption behavior	India (Akhilesh Gupta, Anita Shankar Acharya, Sanjeev Kumar Rasania, Tapas Kumar Ray, Sudhir Kumar Jain) (24); Southwestern China (Yang *et al.*) (17)	Western Kenya (Janet Masaku, Doris W. Njomo, Ann Njoka, Collins Okoyo, Faith M. Mutungi and Sammy M. Njenga) (50)	3

Personal Hygiene	Personal Hygiene based on Research Location		Number of Articles
	Asia's Research Country	Africa's Research Country	
Clean water use behavior		Kenya (Elizabeth Njambi, Dennis Magu, Janet Masaku, Collins Okoyo, Sammy M Njenga) (7); Nigeria (Abe *et al,*) (49); Nortwest Ethiopia (Zemichael Gizaw, Ayenew Addisu, Henok Dagne) (55)	3

Table 3. Journal Review

Author	Tittle	Method	Sample	Result	Summary
Elizabeth Njambi, Dennis Magu, Janet Masaku, Collins Okoyo, Sammy M Njenga (7)	Prevalence of Intestinal Parasitic Infections and Associated Water, Sanitation, and Hygiene Risk Factors among School Children in Mwea Irrigation Scheme, Kirinyaga County, Kenya	Cross-sectional study	180 primary school children	Use of footwear is not protective factor from infection. Hand washing following a bowel movement is related with a lower risk of infection worm by *S.mansoni*	Some personal hygiene factors become risk factors for infection, while hygienic behavior keeps people from infection
Eniola M Abe, Onyinye C Echeta, Onyinye C Echeta, *et.al.,* (49)	Helminthiasis among School-Age Children and Hygiene Conditions of Selected Schools in Lafia, Nasarawa State, Nigeria	Cross-sectional study	200 school children	No discernible difference in the STH infections is based on age or gender across schools. Sanitary conditions in poor schools may result in the absence of hand washing and water facilities, and trash bins.	There is showed no association of STH infection with personall hygiene
Zemichael Gizaw, Ayenew Addisu, Henok Dagne (55)	Effects of water, sanitation and hygiene (WASH) education on childhood intestinal parasitic infections in rural Dembiya, northwest Ethiopia: an uncontrolled beforeand-after intervention study	Cross sectiona study	302 primary school children	The percentage of families with home water treatment increased dramatically from 7.6% at the outset to 47%. The number of households that used sanitary latrines increased	Water sanitation improves from baseline to endline, resulting in a decrease in the prevalence of endline, however this was not statistically significant.
Anna N Chard, Joshua V Garn, Howard H Chang, Thomas Clasen, Matthew C Freeman (4)	Impact Of A School Based Water, Sanitation, And Hygiene Intervention On School Absence, Diarrhea, Respiratory Infection, And Soil-Transmitted Helminths: Results From The WASH HELPS Cluster-Randomized Trial	Case control study	100 primary school	STH' infection is higher in primary school children at 1.20% prevalence. Clean water facilities, and latrines are associated with the incidence of diarrhea and infection. Clean water may be improved through a school-hygiene program .	School water sanitation program can play a role in supporting students' personal hygiene .
Wondwosan Abera Gitore, Musa Mohammed Ali, Amanuel Yoseph, Adane Ermias M, Alemu Tamiso D (28)	Prevalence of Soil Transmitted Helminthes And Its Association With Water, Sanitation, Hygiene Among Schoolchildren and Barriers for Schools Level Prevention In Technology Villages of Hawassa University: Mixed Design	Cross-sectional study	1080 primary school children	Large family size, undistinguished toilets between men and women, unclean toilets, lack of knowledge about STH, and children who have traveled about 100 meters to get to the bathroom are the predictor of STH. There is a significant associated with indiscriminate defecation behavior and helminth infection (p=0.005)	STH prevalence can be reduced by improving the sanitation through clean waterprogram and frequent worm eradication in school children. It is also encouraged to increase the use of contemporary birth control methods to lower the family size .
Awrajaw Dessie, Tesfey G.G, Berihu Kiros, Sintayehu Daba Wami, Daniel, Haile Chercos (34)	Intestinal Parasitic Infections and Determinant Factors Among School-Age Children In Ethiopia: A Cross-Sectional Study	Cross-sectional study	422 children	Intestinal parasites are common in school-aged children (29.9%). Intestinal parasite infections are determined by unsanitary fingernails, open defecation and walking on barefoot,	Improving socio-economic status, sanitation facilities, health and hygiene promotion can be strategies to control infections in the regions.
Liena Sofiana, Mayang Sumira Jewana Kelen (45)	Factors Related to Soil Transmitted Helminth Infection on Primary School Children	Cross-sectional study	60 primary school children	Hand washing before meal or after defecation, walking barefoot behavior, and bowel behavior are related to STH infections.	There is a link between hygiene behavior and STH infection among primary school children.
Ayodhia Pitaloka Pasaribu, Anggraini Alam, Krisnanarta Sembiring, Syahril Pasaribu, Djatnika Setiabudi (48)	Prevalence And Risk Factors of Soiltransmitted Helminthiasis Among School Children Living In An Agricultural Area Of North Sumatera, Indonesia	Cross-sectional study	468 primary school children	Contact with feces has been proven to increase 7.53 times STH infection, whereas washing hands and visiting the restroom reduce the risk until 0.16 times.	The research located at Suka Village, Tigapanah Subdistrict shows, a two-year combined approach to personal cleanliness and worm medicine can minimize the incidence of STH infection in school children.
Anju Damu Anje, Kondagunta Nagaraj, Chandrasekhar Vallepalli (37)	School Environment and Sanitation: A Comparative Study	Cross-sectional study	16 schools	School environments and sanitation are less than optimal in urban and rural schools, sanitation facilities in urban schools are much better than rural schools. Toilets and urinals facilities in rural schools were inadequate, and not separated by gender, rubbish was openly disposed of, and ventilation was excellent with fresh air (68.75%).	In rural and urban public schools, the environment and sanitation are determined to be slightly better. It is critical to have adequate sanitation and facilities for water supply in every public schools.

Author	Tittle	Method	Sample	Result	Summary
Vincent P. Gyang, Ting-Wu Chuang, Chien-Wei Liao, *et.al.* (23)	Intestinal Parasitic Infections: Current Status and Associated Risk Factors Among School Aged Children In An Archetypal African Urban Slum In Nigeria	Cross-sectional study	384 children	Drinking uprocessed water becomes a means of protozoan infections in students, with an overall incidence of 86.2%.	To combat Intestinal Parasitic Infection (IPI) among children, regular mass worm eradication, health education, and consumption of safe drinkingwater are advised to practiced.
Matsinkou Mba Rosine Ruth, Yamssi Cedric, Mbong Erica Malla, Noumedem Anangmo Christelle Nadia, Tateng Ngouateu Aime, Megwi Leonelle, and Vincent Khan Payne (40)	Intestinal Helminth Infections and Associated Risk Factors among School-Aged Children of Bamendjou Community, West Region of Cameroon	Descriptive study	493 children	There is a strong link between illness and older children. About 1.2% prevalence of double parasitism occurred. Infection is associated with river water consumption and use of footwear.	Although a more holistic approach is needed to prevent re-infection, the comparatively low overall prevalence (11.6 %) implies that national worm eradication initiatives are effective.
Akhilesh Gupta, Anita Shankar Acharya, Sanjeev Kumar Rasania, Tapas Kumar Ray, Sudhir Kumar Jain (24)	Prevalence and Risk Factors of Soil Transmitted Helminth Infections in School Age Children (6–14 Years) – A Cross-Sectional Study in an Urban Resettlement Colony of Delhi	Cross-sectional study	250 school-age children	Children with poor handwashing behavior at school, before eating, eating pica, and unconytolled worm treatment had a higher risk of acquiring STH infection, according to the results of multivariable logistic regression analysis.	STH infection prevalence is extremely high, behavioral hygiene changes and mass worm eradication measures, are required to control STH.
Chalachew Muluneh, Tadesse Hailu, and Getaneh Alemu (39)	Prevalence and Associated Factors of Soil-Transmitted Infections among Children Living with and without Open Defecation Practices in Northwest Ethiopia: A Comparative Cross-Sectional Study	Comparative cross-sectional study	806 school-age children	Wearing open shoes, infrequently, playing on the ground, and using a meaningful associated ($p<0.01$) with an STH infection.	It is necessary to create an Open Defecation Free (ODF) environment and public awareness about personal hygiene must be strengthened.
Collins Okoyo, Suzy J. Campbell, Katherine Williams, Elses Simiyu, Chrispin Owaga, Charles Mwandawiro (52)	Prevalence, Intensity and Associated Risk Factors of Soil-Transmitted Helminth and Schistosome Infections in Kenya: Impact Assessment After Five Rounds of Mass Drug Administration in Kenya	Cross-sectional study	10800 school-age children	According to the multivariable analysis, no use of shoes ($p=0.007$), having a large number of household members ($p = 0.015$), and absence from school until two days or more ($p = 0.045$) are all related with elevated risk of STH infection. Furthermore, children under five are up to four times more likely to get STH infection ($p = 0.008$).	As a long-term infection control strategy, STH treatment programs should be provided to preschool-age children to improve their personal hygiene behavior.
Hiwot Hailu Amare, Bernt Lindtjørn (53)	Helminth Infections Among Rural Schoolchildren In Southern Ethiopia: A Cross Sectional Multilevel and Zero-Inflated Regression Model	Cross-sectional study	864 school-age children	The severity of *A.lumbricoides* infection increases with age in the ZINB model, and the infection may occur through nail. Handwashing with soap, worming therapy, and drinking water from protected sources have all been reported to protect people from worm infestations.	Some hygiene measures in rural Gedeo, include healthy and clean life behavior, the supply of clean water in schools and residences, and the reinforcement of worm eradication initiatives .
Hossein Mahmoudvand, Ebrahim Badparva, Amal Khudair Khalaf, Massumeh Niazi, Mehrdad Khatami, Mohammad Reza Nazer (33)	Prevalence and Associated Risk Factors of Intestinal Helminthic Infections in Children from Lorestan Province, Western Iran	Cross-sectional study	366 children	A statistical analysis reveals that the male sex, place of residence in rural regions, unregular handwashing before meal, consumption of raw and unwashed vegetables or fruits all substantially had a relationship with the incidence of intestinal worm parasites	Better environmental hygiene with good health education is critical to control of helminth infection
Mekuria Asnakew Asfaw, Tigist Gezmu, Teklu Wegayehu, Alemayehu Bekele, Zeleke Hailemariam, Nebiyu Masresha, Teshome GebreI (54)	Soil-Transmitted Helminth Infections Among Pre-School Aged Children in Gamo Gofa Zone, Southern Ethiopia: Prevalence, Intensity and Intervention Status	Cross-sectional study	2462 children	In total, 7.4% of Preschool-aged children (PSAC) has two different infection caused by STH species. Children used water from hand-dug wells (39.4%); had 30 minutes time to walk to water source (52.5%); did not purify drinking water (77.5%); and did not handwashing facilities (48.9%) at home.	Preschool-aged children (PSAC) outcomes are shown to be significant in STH infection, besides gaps in anti-STH therapies are also identified.
Awoke Aschale, Metadel Adane, Melaku Getachew, et.al (44)	Water, Sanitation, and Hygiene Conditions And Prevalence of Intestinal Parasitosis Among Primary School Children in Dessie City, Ethiopia	Cross-sectional study	407 primary school children	Maternal education , paternal education, occasional hand washing before meals , and lack of knowledge about personal hygiene are related to helminth infection among primary school children.	As a preventive intervention, health promotion on personal hygiene is recommended besides improving the quality of sanitation facilities.

Author	Tittle	Method	Sample	Result	Summary
Sadya Afroz, Smita Debsarma, Suborna Datta, Mir Masudur Rhaman, Masuda Mohsena (31)	Prevalence of Helminthic Infestations Among Bangladeshi Rural Children and Its Trend Since Mid-Seventies	Cross-sectional study	204 primary school children	House materials such as mud-floored, and straw-walled houses are related to an increase in helminth infestations. Risky behaviors commonly associated with worm infestations showed no difference between infected and uninfected children	The eradication program for the Sreepur Upazilla worm was not entirely successful. The incidence of parasitic infestations is influenced by poor socioeconomic status and a lack of knowledge about personal hygiene .
Dongjian Yang, Ya Yang, Yingjian Wang, Yu Yang, Shurong Dong,Yue Chen, Qingwu Jiang and Yibiao Zhou (17)	Prevalence and Risk Factors of *Ascaris lumbricoides*, *Trichuris trichiura* and Cryptosporidium Infections in Elementary School Children in Southwestern China: A School-Based Cross-Sectional Study	Cross-sectional study	321 primary school children	The higher risk of *Ascaris lumbricoides* infection is found in children who use household toilet or use river water, the presence of a household toilet is linked to lower risk of infection by *T. Trichiura*. On weekdays, children who ate meal for three time had decreased risk of contracting *Cryptosporidium*. Spring water consumption contributes to decreased risk of intestinal infection.	In order to prevent STH, school-based worm intervention programs must be paired with improved facilities such as sanitation, health education, and hygiene promotion
Janet Masaku, Doris W. Njomo, Ann Njoka, Collins Okoyo, Faith M. Mutungi and Sammy M. Njenga (50)	Soil-Transmitted Helminths and Schistosomiasis Among Pre-School Age Children in A Rural Setting if Busia County, Western Kenya: A Cross-Sectional Study Of Prevalence, and Associated Exposures	Comparative cross-sectional study	327 school-age children	Lack of a viable drinking water supply ($p = 0.002$) and walk on barefoot ($p = 0.028$) are significantly linked to STH infection, according to the univariable analysis. Daily behavior such as bathing/ swimming on the river is azzociated with *S. mansoni* infection as shown in the multivariable analysis.	To minimize the severity of infection among the Preschool-aged children (PSAC) group, a long-term mass medication is required. Furthermore, further research may be required to identify STH infection in Preschool-aged children (PSACs), particularly *T. Trichiura* infection.
Baye Sitotaw, Haileyesus Mekuriaw and Destaw Damtie (22)	Prevalence of Intestinal Parasitic Infections and Associated Risk Factors Among Jawi Primary School Children, Jawi Town, North- West Ethiopia	Cross-sectional study	406 school-age children	Variables related with risk of Intestinal Parasitic Infection (IPI) ($p<0.05$) include age, hand washing habits before eating, indiscriminate bowel behaviors, use of footwear, consumption of unwasher and raw vegetables, and fingernail hygiene and pruning practices.	The significant frequency of IPI among Jawi elementary school students warrants better health education on personal hygiene and sanitation.
Umi Mahmudah (51)	Hubungan Sanitasi Lingkungan Rumah Terhadap Kejadian Infeksi Kecacingan Pada Anak sekolah dasar	Cross-sectional study	74 primary school children	Infection rates are linked to the floor's type at home, access to clean water, and wastewater disposal facilities. Having a latrine is not linked to increased risk of infection among primary school children.	The frequency of infection in elementary school pupils has something to do with home sanitation
Ni Luh Gede Dian Ratna Dewi, Dewa Ayu Agus Sri Laksmi (27)	Hubungan Perilaku Higienitas Diri Dan Sanitasi Sekolah Dengan Infeksi Soil Transmitted Helminths Pada Siswa Kelas Iii-Vi Sekolah Dasar Negeri No. 5 Delod Peken Tabanan Tahun 2014	Cross-sectional study	105 primary school children	The majority of youngsters (65.7%) were classified as having good hygiene, while 34.3% had poor hygiene. There is a strong link of self-hygiene and STH infection ($p=0.012$), with hand washing ($p=0.001$) and dirt contact $p=0.003$).	The frequency of STH infection was low (7.6%), and *Trichuris trichiura* was the most hooked infecting worm (55.6%). The incidence of STH infection is related to hygiene behaviors of primary school children.

School Children's Behavior

One important factor that can affect an individual's health and quality of life is behavior (32). After reviewing the article, it shows that the personal hygiene of primary school children is determined by drinking water consumption behavior, raw vegetable consumption behavior, nail cutting behavior, footwear use, hand washing behavior, bowel washing behavior, foot washing behavior, contact with soil behavior, pica consumption behavior, and clean water use behavior. The personal hygiene of primary school children in Asia is mostly related to nail-clipping behavior and hand washing behavior. While those located in Africa mostly consider footwear use, hand washing behavior, and open defecation behavior as the risk of infections.

Behavior strongly determines one's potential to experience health problems or maintain the degree of health (32). Healthy behavior can improve the degree of health and conversely bad behaviors have an impact on health problems. Helminth infection cases in primary school-aged children are closely related to their personal hygiene. According to the Regulation of Minister of Health of the Republic of Indonesia Number 15 of 2017 on Countermeasures, unsanitary behavior such as open defecation, unclean hands especially before eating, walking barefoot, and consumption behavior of pica are distinguished from infection (18).

Based on Table 2, several personal hygienes discussed in the articles have been found to have a substantial relationship with the occurrence of infection in primary school children. Personal hygiene includes vegetable and fruit consumption behavior, nail clipping behavior, footwear use, defecation behavior, hand washing behavior before meals and after defecation, drinking water consumption, pica consumption behavior is abnormal behavior characterized by the habit of

consumption non-nutritious foods such as soil, sand, weeds, mud, and consumption of raw vegetables and fruit. In harmony with the research on Palue Island located in Sikka Regency, East Nusa Tenggara in Indonesia both studies show a relationship between primary school children's behavior and STH infection (6). Another study that is in line is a study located in Lorestan province, Iran shows results that children of the sex males, domicile in rural regions, poor hand washing behavior, consumption of unwashed/uncooked vegetables and fruits, are associated with the incidence of helminth infections (33). Below is some personal hygiene of primary school children that are often reviewed in the articles studied.

Nail Clipping Behavior

A significant association was found between the incidence of infection and nail clipping behavior of primary school children in Ethiopia (p = 0.009). The probability of infection caused by unclean hygiene reaches 72% of children because fecal-oral transmission is the most common way for the parasitic disease to spread. Unclean nails can enhance the incidence and severity of parasitic diseases (34).

Research in three primary schools in Sibolga, northern Sumatra, Indonesia demonstrates significant relationships between nail clipping and the incidence of infection (p = 0.009). Students who have dirty nails or do not cut them are at risk of being infected twice higher than students with clean nails (35). Similar results are shown that nail clipping behavior is one of the risk factors for helminth infections in primary school children (p = 0.000) located in Goro Primary School, Southwest Shewa, Ethiopia. Researchers have discovered a significant frequency of Hookworm, which infect school children in rural areas who sometimes wear footwear for walking and playing on the ground (36).

However, a study conducted at the Mangalam's Rural Health Training Centre (RHTC) and Chittoor district's urban area of Tirupati in Andhra Pradesh, India shows that nail clipping behavior and nail hygiene did not produce significant relationships (37). Similar results are found in a study from Tabanan District, Bali, Indonesia which reveals no significant association between nail hygiene in children with diatribe infection (p = 0.141), indicating those with poor nail hygiene were more at risk of being infected with diatribes (13.8%) compared to those with good nail hygiene (5.2%) (27).

Transmission of infection can occur with the intermediary of dirty hands and nails in which, the weekly growth of nails averages 0.5-1.5 mm. Helminth eggs or larvae worms can stick to the hands and hide in long nails. Hence, they can enter the body. Long and unclean nails become a nest to various microorganisms, including bacteria and worm eggs. Parents and schools must educate children to cut nails regularly (38). The provision of education is important as a prevention method, which must be done with multisector so that it can have a good impact on health.

Footwear Use and Play on the Ground

Use of the footwear is linked to an increased risk of infection (p = 0.00) in school children in Northwest Ethiopia's Bahir Dar Zuria District. It becomes a medium of exposure to helminth eggs if children contact the ground (39). Similar results are found in Kenya (p = 0.007). Children with intense play or contact with soil are often at risk of being contaminated with STH eggs if not using footwear. It is very effective in dispelling worm larvae to enter through the skin or minimize direct contact between skin and soil (7).

The use of footwear, a hygiene behavioral component is connected with the frequency of helminth infection in the study done in Bamendjou Community, Upper Plateaux Division, Western Cameroon (p = 0.04) (40). Similar research in Tuah Negeri, one of the subdistricts from Musi Rawas Regency including the province of South Sumatra, Indonesia mentions the incidence of helminth infection was found in primary school children who use less footwear (p = 0,000) (30).

Different results are obtained from research on rural primary school children in Sreepur Upazillawhich is included in Gazipur District, Dhaka, Bangladesh. It reveals no significant association between walking with bare feet and helminth infections (31). This is similar to a study in Tabanan District, Bali, Indonesia where no statistically significant association was found between these two variables (p = 0.333) despite more incidence of STH infections in children without footwear (20%) than in those with footwear (7%). Use of footwear and cleanliness of the classroom may minimize the risk of contracting with Soil-Transmitted Helminths especially *Hookworm* (27).

In a study from Bahir Dar Zuria District, Northwest Ethiopia, play behavior on the ground is one of the behaviors associated with helminth infection (p = 0.00). Children who played with soil were 4.62 times more at risk of developing STH infection than those who did not play on the ground. Helminth infection is proven to occur in children who play in the ground and mud, playing volleyball and football (39). The practice of not wearing shoes becomes one of many behaviors is having linked to *Hookworm*. *Hookworm* soil-borne larvae the body and attaches to the skin when one walks barefoot, especially on the soil. Children who walk barefoot had

three consecutive times and were twice as likely to be disinfected (22). So that using footwear in children is highly recommended, especially for those who often play on the ground. Parents should always pay attention to their children and be responsible for providing health education while at home.

Hand Washing Behavior

Research in Karlanpuri, East Delhi, India mentions the lack of hand washing behavior before eating posed 2.29 times the risk of harm (p = 0.029) (24). Similar results from research in Lorestan province, Western Iran also shows a significant association between not hand washing before eating with helminth infection incidence (p = <0,01). Of the 63 reported children who did not wash their hands, 13 were infected with one or more larvae species (33). Research in Nigeria, with the research locations in Cross River State with the samples of school-aged children in Calabar, shows that students who did not wash their hands before eating (p=0,000) are more prone to developing intestinal worms than those who wash their hands before eating (41). Research on Medebay Zana Wereda; North Western Tigray, Ethiopia states worms can survive in children's nails and infect through food (42). Hand washing behavior is the most significant behavior associated with the incidence of infections in school children. Lack of hand washing behavior before eating is a significant factor associated with infection (p = 0.029) (42).

The research was conducted in Manusak village of east Kupang district - Kupang Regency, Indonesia discusses the relationship of hand washing behavior with helminth infection incidence in children aged 6-12 years (p = 0.029) (43). According to research conducted in the northern Ethiopian Highlands, children who washed their hands routinely before eating at five primary schools were 2.2 times riskier to experience an infection that causes diatribes than children who wash their hands diligently (44). This is because the hands are a source of germs and bacteria that cause disease if they do not do that behavior, especially before they are eating or after getting to the toilet. Research in Nigeria, where locations in Cross River State with the samples of school-aged children in Calabar, also finds that did not wash hands after from the toilet was associated with a helminth infection (p = 0.028) (41). Research conducted in one of the schools in Sleman Regency, Indonesia named Moyudan Primary School, also reveals that there was a significant association of variable incidence of infection with the behavior of primary school children including not washing hands after defecation (p = 0.007) (45).

However, research conducted on primary school children in a rural school in Bangladesh's Sreepur Upazilla located in Gazipur District, Dhaka, discovers that hand washing before eating and after defecation had no significant association with infection in primary school children (31). Similar results are found in previous research in southwestern China's Puge County of the Liangshan Prefecture where proper hand washing before eating (p = 0.457) and after defecation (p = 0.414) was not related to the incidence of infection (17).

Parasites that cause diatribes can infest orally, either through the mouth or when a child sucks dirty fingers. Hand washing with soap must be instilled in primary school children as they prefer to play outdoor and often forget to wash their hands before eating. Hands and nails are a source of viruses and bacteria, so cleanliness should always be maintained. Hands look clean but they might contain thousands of viruses and bacteria. Hence, water and soap could eliminate viruses and bacteria (46). School children who practiced hand washing behavior had a 68% lower frequency of contracting the infection compared to those who did not wash their hands (34). Hand washing with soap can be one of the treatments to reduce infection transfer from feces to mouth. Hand washing behavior is mainly carried out five times including before meals, before preparing meals, after defecation, after booing a child, and after handling an animal (47).

Open Defecation Behavior

Research in northern Ethiopia with a specific location in Sebeya primary school shows a strong link between STH infection and primary school children's behavior, like open defecation (p = 0.005). School children who defecated improperly experience infection 2.82 times higher than children who did not (AOR=2.82, 95% CI 1.21, 7.45) (34). Children in Nigeria, where the specific location on Cross River State with the samples of school-aged children in Calabar was seven times at risk of contracting worm eggs (p = 0,000), are more likely to contain worm eggs in fecal samples than school children with latrine defecation behavior. *Ascaris lumbricoides* eggs were found in 21 of the 227 fecal samples tested. The high prevalence can be due to the long-life period of parasitic eggs, especially the intensity of contact with moist soil can be a medium for the spread of infection in children. Open defecation behavior supports the transmission of intestinal worms (41).

Research done in Hawassa University's technology village in Southern Ethiopia also finds significant statistical results between open defecation

behavior and helminth infection in primary school children (p = 0.005) (35). Primary school children in Moyudan Primary School with the specific grades 3, 4, and 5 in Sleman Regency, Indonesia reveal a relationship between infection in primary school children and behaviors including open defecation (p = 0.004) (49). The main source of infection is open defecation in any location, where worm eggs come out with feces. Feces with helminth eggs will pollute the environment and infect people through contact with feces-contaminated dust, hands, and water. Open defecated feces will pollute the soil and environment by stools containing worm eggs. Children can become infected because they often ingest worm eggs-contaminated dirt and touch worm eggs-contaminated hands (28). Primary school children who practiced open defecation in any place had twice the risk of infection than those who defecated in the family latrine (22).

However, previous research in Manusak village of east Kupang district - Kupang Regency, Indonesia shows no significant statistical relationship between open defecation behavior variables and primary school children with STH infection (p = 1,000) (43). Similar to the results of a study in Bunyala Sub-County, Western Kenya, where there was no significant association between children who defecate in the open due to not having latrines and school-aged children who are infected with STH (p = 0.297). Children without family latrines were at 1.31 times higher risk of infection compared to those who had family latrines at home (7). The water from open sewage potentially becomes a source of soil-borne disease by worm eggs. Worm eggs can develop into infective eggs in moist soil, and they can be ingested into human digestion through oral or fecal transmission. Besides, worm larvae can also enter the skin through bare feet on the ground (18). So, it is very necessary to provide education to children from an early age about the habit of defecating in the latrine and hand washing behavior, including after defecation.

Consumption Behavior

In addition to the above personal hygiene, there are also behaviors associated with STH infection in developing countries and the African continent. One of them is daily consumption behavior. A study in Oromia Regional State, Ethiopia with a specific location in Goro Elementary School, Goro Wereda, demonstrates that drinking water consumption behavior is also one of the hygiene behaviors associated with primary school children with STH infection (p = 0.002). Consumption of unsafe or unprotected water is usually more common due to frequent contact with sewage or flooding that contaminates the source of drinking water (36). Similar research in Western Kenya's rural setting of Busia County shows that consumption of unsafe drinking water may increase the prevalence of STH infection (p = 0.002) (50).

Another study in an urban resettlement colony located in East Delhi, India it discusses pica consumption behavior to be 8.23 times more risk to increase helminth infection in primary school children (p = 0.00) (24). Different results obtained from Western Kenya's rural areas of Busia County show no significant results between pica and STH infection (OR = 1.62, p = 0.205) (50). Pica is an eating disorder with sufferers who have a habit of eating food without nutritional content like soil. Other consumption behaviors were revealed by research in Lorestan Province, Western Iran reveals consumption of unwashed vegetables and fruit is associated with infection in children (33). The study is also aligned with research at north-west Ethiopia's Jawi Primary School, where school children who ate raw, unwashed vegetables and fruit had twice the chance of suffering from infection than those who did not (p = 0.012) (22). Lack of personal hygiene as well as poor environmental sanitation led to an increased risk of contracting parasitic infections. The education method that feels appropriate is to provide education to mothers because there are spearheads of the family who always prepare food every day, so it can be effective.

This study does not discuss in detail infectious agents, some articles reviewed do not list the percentage prevalence of infection in the locations studied, some articles only mention the percentage of the infection agent as a whole, and there is no mention each of infection agent, and not all articles discuss health measures to prevent and overcome the infection incidence, especially in primary school children.

CONCLUSION

There is a difference in the prevalence of STH in Asia and Africa, where African countries have a higher percentage of STH infections than Asian. The most common infectious agents in Asian countries are *Ascaris lumbricoides* and *Trichuris trichiura*. Many researchers in Africa have discovered infectious agents, which of them are *Ascaris lumbricoides*, *Hookworm*, and *Trichuris trichiura*. There is a significant association between personal hygiene with STH infection among primary school children in Asian and African countries. Hand washing behavior and nail clipping behavior becomes the most common variable associated with helminth infection in Asia. While the risk factors of infection in Africa include hand washing, footwear use, and open

defecation. To prevent and handle infection in school children, schools and parents need to perform some efforts such as providing education to primary school children, improving sanitary facilities, and routinely giving anthelmintics every six months.

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