Short Communication

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Prevalence and distribution of intestinal parasitic infections in taeniasis endemic area of North Sumatera, Indonesia

Hemma Yulfi[1*], Dewi M. Darlan[1], Merina Panggabean[1], Yunilda Andriyani[1], Muhammad F. Rozi[2] and Toni Wandra[3]

[1]Department of Parasitology, Faculty of Medicine, Universitas Sumatera Utara, Medan, Indonesia; [2]Department of Internal Medicine, Faculty of Medicine, Universitas Gadjah Mada, Yogyakarta, Indonesia; [3]Directorate of Postgraduate, Sari Mutiara Indonesia University, Medan, Indonesia

*Corresponding author: hemma@usu.ac.id

Abstract

A group of helminthic and intestinal protozoa causes intestinal parasitic infections (IPIs), affecting more than 2.5 billion people worldwide. IPIs are diseases closely associated with poor hygiene and sanitation, concentrated in underdeveloped regions and among populations with low socioeconomic status. Consequently, most prevalence is in Sub-Saharan Africa and Asia, with local habits or risk factors that could affect its prevalence. The aim of this study was to determine how hygienic practices, sanitation, and local behavior of eating raw meat (*hinasumba*) contributed to the prevalence of IPI. A cross-sectional study was conducted in the Simalungun District of North Sumatera Province, involving 428 people of Batak Simalungun. There were 15 villages randomly selected across the district based on the local registry, which consequently, non-purposive sampling was conducted. Face-to-face interviews assessed various risk factors, such as demographic characteristics, water source, traditional raw meat consumption, or *hinasumba* as local risk factors, hygienic practices, and sanitation. The findings indicated that an overall prevalence rate of IPI was 42.9%, consisting of 87.5% with helminthic infection and 12.5% with protozoal infection. More than half of IPI cases were associated with *Taenia* sp. infections (21.8%), followed by hookworms' infections with a 6.1% positivity rate. Based on multivariate analysis, farming and consuming traditional delicacies, namely *hinasumba*, increased the likelihood of IPI occurrence among the population by 1.7 and 3 times, respectively. It can be concluded that the high prevalence of taeniasis in the study area was associated with local behavior and *hinasumba* consumption, which may contribute to determining the dominance of specific IPI species.

Keywords: Helminth, protozoa, traditional, taeniasis, intestinal

Introduction

In the group of neglected tropical diseases (NTDs), intestinal parasitic infection (IPI) is the most predominant communicable disease that is widely spread across the globe. IPI encompasses a spectrum of diseases caused by intestinal protozoa and helminths [1]. It typically shares common risk factors that contribute to its endemicity in affected regions [2]. Most infections occur in the developing world, particularly among individuals living below the poverty line and children, who are more susceptible to significant morbidity. Furthermore, the clinical manifestations associated with IPI are non-specific, including symptoms such as watery diarrhea or dysentery form, nausea, vomiting, and anemia [3,4].

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IPI has impacted 2.5 billion people globally, with 450 million demonstrated symptoms, while an uncertain number of carriers remain asymptomatic. Meanwhile, annual deaths associated with IPIs is counted more than 200,000 cases [5]. Soil-transmitted helminths (STH), as a part of IPIs, affect 1.5 billion infections worldwide, accounting for 24% of the world's population [6]. The morbidities associated with IPI include impaired cognitive performance, reduced quality of life, and nutritional deficiencies. In addition, there is a distinct regional and local distribution of IPI species, which is commonly associated with existing local risk factors, lifestyle, and socioeconomic status. In Indonesia, the prevalence of IPIs varies by region and ranges from 45–65% for STH and 20–32% for protozoal infection. These infections affect vulnerable populations, including preschool and school-aged children, as well as pregnant women. Moreover, a high rate of IPI cases is observed among malnourished individuals, further decreasing their quality of life [7-11].

The transmission routes of different IPI pathogens vary based on their life cycle, often dictated by their specific infective stage. Protozoa, as a unicellular organism, can complete their proliferation within a single host. Conversely, helminths are more complex organisms with multi-step life cycles, where they transform into fertilized eggs as the infective stage and proliferate into mature forms within various parts of the human body [12,13]. For example, hookworms have a larval stage as the infective stage, which is transmitted through skin penetration. Understanding these multi-step processes, including the life cycle and infective stage or mature form, is crucial for eradicating and reducing parasitic burden among vulnerable populations [14].

There is a discrepancy in IPI epidemiology across different regions in Indonesia. Simalungun District is one of the major endemic regions for taeniasis, along with Samosir, Bali, and Papua [15]. In Simalungun, the prevalence of pig consumption and pig farming is high, which correlates with a higher predicted prevalence of taeniasis. The causative species of IPIs have become more predominant, particularly zoonotic helminthiasis caused by *Taenia* sp. [16]. *Taenia* sp. is a zoonotic disease distinct from other IPI species due to its different transmission routes and life cycle, which necessitates different strategies to manage the transmission. Therefore, the aim of this study was to evaluate the prevalence and distribution of intestinal parasitic infections, as well as associated risk factors such as sanitation, hygienic practices, and local behavior, in the North Sumatra region, where taeniasis has become endemic.

Methods

Study design and sample collection

This cross-sectional study was performed between August and October 2023 among the native population of Simalungun District, Batak Simalungun, North Sumatera Province, Indonesia (02°36'05''–03°18'14'' north latitude and 98°32'03''–99°35'03'' east latitude). There were 15 involved villages spanned randomly through a convenient sampling method of official listing in the local government documentation. The sample size was determined using the minimum sample size formula for a cross-sectional study (estimated prevalence 20%; based on Indonesia's latest prevalence of STH and 95% level of confidence) [18,19]. The minimum sample size was 450 individuals.

Primary data was collected through face-to-face interviews using closed questions about selected risk factors (water source, eating raw vegetables, washing hands before eating, having antihelminthic within the past six months, using footwear, occupation, and eating pork raw meat or a traditional delicacy of Bataknese people referred to as *hinasumba*). Other variables were also included, such as demographic characteristics (age and gender) and a history of antihelminthic medication within the previous six months. Children under 18 must obtain parental consent to be enrolled in this study. Respondents suspected of having taeniasis would be followed through with antihelminthics and laxatives to expel the proglottid, monitored by a local health officer, and confirmed by parasitologists.

Sample stool analysis

Stool samples were collected from the respondents to determine their IPI status. A stool sample was stored in fecal containers preserved using 2.5% potassium dichromate and refrigerated at 3–4°Celsius. Subsequently, 1 gram of fecal samples was mixed with 10% formalin and centrifuged.

Direct smear examination with Lugol staining was used for helminths, while acid-fast staining was employed to identify intestinal protozoal oocysts. Helminth eggs were identified based on species characteristics and confirmed positive if a parasitologist observed an egg morphology. These preparations were examined under a low microscope with a magnification of 100 times and a high power of 400 times magnification. All parasitological examinations were conducted in the Department of Parasitology, Faculty of Medicine, Universitas Sumatera Utara, Medan, Indonesia, by two parasitologists who conducted interpretation in the laboratory unit, and the findings suggested there was no discrepancy between both examiners for egg morphology in each fecal sample.

Data analysis

Multiple univariate and bivariate analyses were conducted to weigh the significance of potential risk factors. Multivariable logistic regression was performed to determine IPI determinants by including all available variables. The enter method was employed to determine the most significant risk factor regarding the prevalence of IPI, with a *p*-value of less than 0.05 considered significant. The final model demonstrated the potential risk factors associated with IPI prevalence among these native communities. Data was analyzed using SPSS version 23.0 [20].

Results

A total of 428 participants joined the survey, revealing an overall prevalence of IPI in the study population at 43% (n=184). The mean age of participants was 40.5 years old, and the maximum and minimum ages were 71 and 2 years old, respectively. IPI was predominant among older adults over 40 years old. All other demographic characteristics are depicted in **Table 1**. *Taenia* sp. emerged as the predominant IPI species within this population, constituting 50.5% (93/184) of all infecting intestinal parasitic pathogens, including 74 (79.6 %) participants with *Taenia* sp. caused single infection and 19 (20.4%) individuals with mixed infection, including 17 co-occurring with hookworms and two with *Blastocystis* sp. The prevalence rate of taeniasis was 21.8% (93/428) among participants. The second most prevalent identified organism was hookworm, with a prevalence of 12.2%, consisting of 26 (6,1%) participants with single hookworm infection, 17 (4.0%) individuals contracted with taeniasis and hookworms, and nine (2.1%) participants infected by hookworm and *Trichuris trichiura*. These co-infections accounted for 28.2% (52/184) of all IPIs in the examined area. A total of 7.3% of participants exhibited double infection caused by protozoa and helminth infection.

Table 1. Distribution of study population based on age, gender, and status of intestinal parasites (n=428)

Characteristics	Frequency	Percentage
Age (years)		
<18	85	19.9
18–40	126	29.4
>40	217	50.7
Sex		
Male	209	48.8
Female	219	51.2
Intestinal parasites		
Negative	244	57.0
Ascaris lumbricoides (Al)	9	2.1
Trichuris trichiura (Tt)	20	4.7
Hookworms (Hw)	26	6.1
Taenia sp.	74	17.3
Giardia (Gl)	4	0.9
Enterobius (Ev)	3	0.7
Blastocystis (Bh)	13	3.0
Entamoeba	4	0.9
Mix Al+Tt	3	0.7
Mix Hw+Tt	9	2.1
Mix Hw+*Taenia* sp.	17	4.0
Mix Bh+*Taenia* sp.	2	0.5

A bivariate analysis of proposed risk factors indicated that participants aged below 18 years old, previous consumption of anti-helminthic medication, using footwear, being a farmer, and *hinasumba* consumption were associated with IPI. However, subsequent multivariate analysis identified only two risk factors were significantly associated with increasing IPI prevalence: engaging in farming and consumption of *hinasumba* were associated with an adjusted odds ratio (AOR) of 1.72 (95%CI: 1.08–2.75) and 3.12 times (95%CI: 1.99–4.89), respectively. Bivariate and multivariate analyses are presented in **Table 2**.

Table 2. Bivariate and multivariate analysis of risk factors associated with intestinal parasitic infections (n=428)

Risk factors	Intestinal parasitic infections (IPIs)		Odds ratio (95%CI)	Adjusted odds ratio (95%CI)
	No, n (%)	Yes, n (%)		
Age (years)				
<18	61 (71.8)	24 (28.2)	2.22 (1.32–3.73) *	0.64 (0.33–1.22)
≥18	183 (53.4)	160 (46.6)		
Sex				
Male	113 (54.1)	96 (45.9)	0.79 (0.54–1.16)	1.00 (0.66–1.52)
Female	131 (59.8)	88 (40.2)		
Water source				
Closed	122 (57.3)	91 (42.7)	0.90 (0.27–3.00)	1.12 (0.73–1.72)
Open	122 (56.7)	93 (43.3)		
Eating raw vegetables				
No	6 (54.5)	5 (45.5)	0.90 (0.27–3.00)	1.12 (0.31–4.12)
Yes	238 (57.1)	179 (42.9)		
Washing hands before eating				
No	13 (65.0)	7 (35.0)	1.42 (0.56–3.64)	0.45 (0.16–1.25)
Yes	231 (56.6)	177 (43.4)		
Having anti-helminthic within six months				
No	145 (52.0)	134 (48.0)	0.55 (0.36–0.83) *	0.98 (0.59–1.65)
Yes	99 (66.4)	50 (33.6)		
Using footwear				
No	74 (65.5)	39 (34.5)	1.43 (1.02–2.01) *	1.09 (0.66–1.78)
Yes	170 (54.0)	145(46.0)		
Occupation				
Farmer	110 (48.5)	117 (51.5)	1.51 (1.21–1.88) *	1.72 (1.08–2.75) *
Non-farmer	134 (66.7)	67 (33.3)		
Eating raw meat (*Hinasumba*)				
Yes	61 (39.4)	94 (60.6)	1.53 (1.30–1.81) *	3.12 (1.99–4.89) *
No	183 (67.0)	90 (33.0)		

* Statistically significant ($p<0.05$)

Discussion

This study found that helminthiasis remains the prevalent IPI, comprising 12.5% (23/184) protozoa infection and 87.5% (161/184) helminthiasis. Taeniasis continues to be the most common IPI among the population, accounting for 50.8% of all IPI occurrences and has 21.7% of the prevalence rate. There were only a few cases of intestinal protozoal infections in this region, with an infection rate below 6%. The most prevalent protozoal infection is opportunistic blastocytosis, with only eight participants contracted pathogenic protozoal infection caused by *Entamoeba sp.* or *Giardia sp*. While helminthiasis and protozoal infection share different risk factors, addressing both types of infections requires similar public health interventions to promote eradication [21]. These interventions include improved personal and food hygiene, sanitation, and socioeconomic status. Improving potential risk factors could alleviate the burden of both intestinal protozoa and helminthiasis among the population at the same time [22].

In this study, taeniasis had a higher prevalence than in the previous survey, with only 3.4% and 2.2% prevalence rates in the Samosir District, a neighboring region [15]. In Bali, taeniasis occurred in 12.1% of cases during the eight-year study period [15, 23]. However, the prevalence rate in Simalungun was obtained from a single measure, with 21.7% of taeniasis among the study participants. The emergence of taeniasis in the study area can be attributed to several reasons, such as poor sanitation and personal hygiene, concentrated pig farming and pig consumers, and

Simalungun traditional delicacy of *hinasumba* (minced raw pork meat). Additionally, the higher population in Simalungun compared to the Samosir district may contribute to this increased prevalence [16,24]. Hookworm infection is the second most common IPI, supported by the moist and warm conditions that provide a conducive environment for helminth larvae development and survival [25]. Furthermore, most people in the district work as farmers in rice fields and palm oil plantations, which prolongs the soil contact time and increases the risk of infection.

Farming and the local traditional habit, namely *hinasumba*, were found to increase IPI infection by 1.7 and 3.1 times, respectively. Although various studies have identified specific risk factors that increase the likelihood of individuals contracting IPI related to hygienic practices and sanitation, particularly the access to clean water [2,3,26], this study emphasizes the context of local risk factors that could also determine which IPI species infecting the local population. In this study, more than half of the participants (53%) were farmers who mostly worked at palm oil plantations. Being a farmer increased IPI occurrence by 1.7 times. This study did not evaluate the working conditions of the farming activities; nevertheless, the descriptive analysis demonstrated that more than 50% lacked proper gear for farming activities and did not use foot cover. Since hookworm is the second most prevalent IPI, this behavior could increase the prevalence of IPI among farmers. Other conditions, such as lack of access to clean water and knowledge about parasitic infection, open source of water, and socioeconomic status, also play a role in determining IPI infection status in this group [27,28].

Generally, factors such as socioeconomic status and education level play major roles in infection status by enhancing positive knowledge, attitude, and practice (KAP) for proper hygiene and sanitation. Young age, female, malnutrition, low socioeconomic status, illiteracy, lack of access to clean water, and tropical climate increase the risk of individuals getting infected with IPIs [29]. Furthermore, a systematic review of food handlers emphasized that hygiene education intervention for high-risk populations can reduce the IPI burden, finding that the carrier population had an overall IPI rate of 25.77% with less knowledge of infection [30].

Eating *hinasumba* has been found to significantly impact the occurrence of IPIs among these communities. Several studies have confirmed that local activities and habits can affect the infecting species [31-34]. A systematic review has concluded that IPI is a lifestyle disease, and adopting healthy behaviors and avoiding undercooked food are the most effective ways to reduce the risk of infections [32]. A population-based survey found that eating raw fish significantly increased the risk of contracting IPI, particularly the species of *Opisthorchis viverrine* [31]. This survey also showed that the recent use of anti-helminthic medication within the previous six months was not associated with IPI, while other risk factors, such as eating raw fish or meat, were more strongly associated with the infection. Therefore, it is clear that local habits and food types play a significant role in determining the species of IPI that infect individuals in specific areas.

This study has several limitations. First, the cross-sectional design cannot delineate the direct causality of IPI prevalence and the relationship between each proposed risk factor. However, the significant results and increased risk of the analysis offer valuable guidance for local authorities in making some interventions. Second, the study did not collect quantitative data on parasite burden. Third, no cultures for intestinal parasites were performed, as blastocytosis was considered to have a low incidence in the study location. Lastly, the study did not evaluate molecular identification for *Taenia* sp. because the lineage of *T. asiatica* is wholly predominant in the neighboring region [35].

Conclusion

Intestinal parasitic infections contribute to a significant burden of infectious diseases in vulnerable populations. Consuming the traditional delicacy of *hinasumba* (raw pork meat) and engaging in farming activities increased the risk of individuals getting IPIs, especially taeniasis. It is essential to implement public health measures tailored to the local risk factors associated with IPI. Local authorities should raise awareness among the local population about the risks associated with this tradition and encourage them to avoid it. They should also provide educational initiatives to promote the use of protective gear during farming to prevent STH infection.

Ethics approval

This study has received ethical approval from the local health research ethical committee of the Faculty of Medicine, Universitas Sumatera Utara (Reference Number: 979/KEPK/USU/2023).

Competing interests

All the authors declare that there are no conflicts of interest.

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Underlying data

Derived data supporting the findings of this study are available from the corresponding author on request.

How to cite

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