ORIGINAL ARTICLE

Prevalence of Soil-transmitted Helminth, Hepatitis A, and *Helicobacter pylori* Infections among Municipal Solid Waste Workers in Baguio City

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ABSTRACT

Background and Objectives. Municipal solid waste workers (MSWWs) are important in the city's waste management. With these vital contributions, they face unique occupational hazards and health risks. This study aims to determine the prevalence of occupational infections, such as soil-transmitted helminth infections (STHI) and hepatitis A virus (HAV), as well as the occurrence of *Helicobacter pylori* infection among the MSWWs of Baguio City.

Methods. This cross-sectional analytic study collected data from volunteer MSWWs using a questionnaire to gather information on age, duration of employment, use of gloves in the workplace, and hand hygiene practices. Stool samples were obtained from participants and were analyzed for STHI using the Formalin Ether Concentration Technique (FECT). *H. pylori* infection was detected using the SD Bioline rapid antigen test kit on stool samples while blood samples were collected and tested for HAV antibodies using the Aria IgG/IgM rapid test kit.

Results. Of the 44 volunteer MSWWs tested, 25 were infected with hazardous pathogens. Specifically, six workers (13.6%) were infected with STHI, four (9.1%) were infected with HAV and 15 (34.1%) were infected with *H. pylori*. Among those infected with STHI, *Ascaris lumbricoides* and *Endolimax nana* were the predominant species, each with a prevalence rate of 33.3%. In contrast, *Blastocystis hominis* and hookworm infections each had a prevalence rate of 16.7%. A significant association was found between STHI prevalence and the preference for alcohol hand rubs over hand washing, with a p-value of 0.008.

Conclusion. The analysis revealed a significant association between the prevalence of STHI and the preference for alcohol hand rubs over hand washing, suggesting that MSWWs may have a false sense of security regarding their hygiene practices. The findings revealed the critical importance of proper hand washing in preventing STHI. Future research should expand data collection to encompass a broader range of socio-demographic, environmental, and lifestyle factors that may influence infection rates. Additionally, including a control group of individuals not exposed to waste management could help differentiate between factors specific to waste handling and those related to other occupations. This study emphasizes the need for collaborative efforts among researchers, public health authorities, and waste management agencies to enhance the health and safety of MSWWs while addressing broader public health concerns related to waste management practices.

Keywords: Soil-transmitted helminth (STH), Hepatitis A virus (HAV), Helicobacter pylori

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INTRODUCTION

MSWWs are responsible for the collection, handling, and disposal of various waste materials from residential, commercial, and industrial sources, including hazardous and non-hazardous waste.[1,2] Due to the nature of their work, they are exposed to many occupational and environmental hazards, like hazardous chemicals, infectious organisms, and potentially harmful materials. Consequently, these workers are at an elevated risk of contracting various infections, which include those caused by soil-transmitted helminth infections (STHI), hepatitis A virus (HAV), and *Helicobacter pylori*.[3-5]

STHI are among the most common public health problems associated with poor sanitation and lack of personal hygiene.[6] These infections result from ingesting parasite eggs in fecal-contaminated environments and from larval skin penetration. They particularly affect MSWWs, who may neglect proper hand hygiene and personal protective equipment (PPE).[7] The prevalence of STHI among MSWWs varies by country. For instance, a study in Ibadan, Nigeria, found an infection rate of 19.8% whereas nearly half of MSWWs in Alexandria, Egypt, were reported to be infected.[8,9] Additionally, workers with over 20 years of experience showed a higher prevalence, indicating increased risk from long-term exposure.[10] Implementing proper hand hygiene, such as washing hands with soap before meals and after handling waste, can significantly reduce STHI among these workers.[11]

HAV is a global concern, with over 100 million new cases annually, primarily causing acute hepatitis. It spreads through contaminated food and water, as well as person-to-person contact via intravenous drug use, oral-anal sexual activity, and blood transfusions.[12-14] Among MSWWs, the risk of HAV infection is heightened due to activities that promote the fecal-oral route, such as eating without proper hand washing after handling waste.[15] A meta-analysis revealed a 56.7% seroprevalence of HAV among sanitary workers, indicating a significant occupational risk for hepatitis infections that necessitates mitigation efforts.[16]

H. pylori is a common human pathogen that colonizes the stomach and contributes to the development of adenocarcinoma and stomach cancer.[17] It infects up to 50% of the world's population, spreading through oral-oral, fecal-oral, or gastric-oral routes.[18,19] Epidemiologic factors among waste workers, such as exposure to human excrement, saliva, and other fluids in collected waste, can increase their risk of acquiring *H. pylori* infection due to non-adherence to hygiene protocols after handling contaminated waste.[20] This occupational exposure may predispose MSWWs to an increased risk of developing stomach cancer.[21]

The study population for this research comprises volunteer MSWWs. In the Philippines, particularly in Baguio City, MSWWs face elevated risks of acquiring different types of illness or infections compared to the general population or other professions for several reasons. Since most of the MSWWs are employed on a volunteer, contractual, or seasonal basis, many do not have stable income or benefits like annual medical check-ups as well as prioritization when it comes to health care and access to PPE and because of this, the volunteer MSWWs are not able to at least know their health status and whether they are infected or not with these infectious agents.[22] Moreover Baguio City is a highly urbanized area with a rapidly growing population projected to approach 500,000. Baguio City faces significant challenges in waste management and sanitation due to its dense population and status as a major tourist destination and educational hub, leading to substantial waste generation. This situation places additional strain on existing waste management systems and heightens the risk of occupational exposure to infectious agents for MSWWs.[23] The city's solid waste management is overseen by the City General Services Office (CGSO), responsible for planning, implementing, and monitoring waste management programs. This office operates under the local government, ensuring that waste collection processes are effectively executed through a structured organizational framework. Still, uncontrolled environmental factors such as intense rainfalls, which Baguio City experiences many times a year, and some of the highest rainfall levels in the country, averaging about 4,000 mm annually, further endanger MSWWs by causing flash floods and landslides, exposing them to contaminated water and waste.[24] The combination of challenges in employment status for the volunteer MSWWs, significant waste generation due to rapid urbanization, and uncontrolled environmental factors contributes to an environment conducive to the spread of infectious disease, making it critical to address these issues for the health of both MSWWs and the broader community.

OBJECTIVES

Many global studies have investigated STHI, HAV, and *H. pylori* infection prevalence and risks among MSWWs. However, no known research has examined these infections among MSWWs in the Philippines, and previous works focused only on a single infection, while this study included three types. Information on the spread of these infections due to waste handling and exposure to waste in the Philippines is limited. Thus, this study aimed to assess the prevalence of STHI, HAV, and *H. pylori* infections among MSWWs in Baguio City and investigate associated risk factors linked to these diseases as mentioned in previous research. Specifically, this study aimed to:

1. determine the prevalence of STHI, HAV, and *H. pylori* infections among selected MSWWs in Baguio City; and
2. investigate the association between the following variables and STHI, HAV, and *H. pylori* infection prevalence among MSWWs.
    a. age
    b. duration of employment
    c. use of gloves
    d. hand hygiene practices

METHODS

Study Design

A cross-sectional analytic study assessed the prevalence of STHI, HAV, and *H. pylori* infections among MSWWs recruited from April to May 2023. The study also analyzed the association between the prevalence rates for these infections and the known risk factors.

Study Population and Sample Size

The study population is volunteer MSWWs in Baguio City.[22] Due to their small number, total enumeration was employed to enroll participants in the study. Initially, 70 participants were identified by CGSO; however, after applying the inclusion and exclusion criteria, only 47 eligible volunteer MSWWs were invited. Of these, three participants withdrew, due to conflicting work schedules and personal commitments, resulting in a final total of 44 participants. The inclusion criteria specified that participants must be active volunteer MSWWs aged 18 to 60 working for at least six months and were stationed in Baguio City. Individuals taking anti-diarrheal medications, anthelminthic drugs, mineral oil-based laxatives, or antimicrobial and antiviral agents within two weeks before sample collection were excluded to avoid potential interference with diagnostic tests. It was clear to the participants that they had the right to withdraw their consent at any research stage.

Study Setting

Baguio City, a highly urbanized area in northern Philippines, is situated at an elevation of approximately 1,540 meters and has a temperate climate with average annual rainfall of around 4,000 mm. Urbanization poses challenges to waste management and sanitation, creating public health risks for MSWWs. With a population density of about 1,000 persons per square kilometer, waste generation is high, further straining waste management systems. Seasonal heavy rainfall (May to October) can lead to flooding and contamination of waste materials, highlighting the occupational hazards faced by MSWWs.[23]

Data and Sample Collection Procedure

Ethical approval for the study was obtained from the Saint Louis University Research Ethics Committee (Protocol No. SLU-REC 2023-005). A formal letter was submitted to CEPMO. During data collection, the researcher explained the study information and informed consent forms (ICF) to potential participants, outlining their involvement and noting that results may be published. Participants received a copy of the ICF, which assured them of confidentiality. They were encouraged to read the materials thoroughly and could seek clarification from the researcher or trusted individuals. If they needed more time, they could take the information home and return at their convenience to decide on participation. A structured interview questionnaire collected data on participants' age, employment duration, glove use during waste collection, and hand-washing practices. The questionnaire in Tagalog and Ilocano underwent content validity and reliability testing. Each interview lasted 5-10 minutes. Following the interview, blood collection was conducted at two sites within the CGSO and Waste Transfer Station. The researcher, a registered medical technologist trained in venepuncture, collected blood samples using a closed-system procedure. Samples were labelled with a three-digit code corresponding to the participant's stool sample and interview questionnaire code.

An Excel sheet containing participant names and sample codes was secured with a passcode accessible only to the researcher. Disposable materials were properly disposed of. Participants received an illustrated stool specimen collection kit and were instructed to submit samples within 24 hours. Stool specimens were inspected for contamination before acceptance, and all blood and stool samples were immediately transported to a clinical laboratory for testing. Confidentiality was maintained throughout the research process. All data were stored in encrypted files accessible only to the researchers. Stools, blood samples, and used test kits were disposed of following the laboratory's bio hazardous waste disposal protocols.

Processing of Blood Samples

Whole blood samples were tested for Hepatitis A IgG/IgM antibodies using the Aria Hepatitis A test kit. Two drops (about 100 μL) of the blood sample were placed in the sample well, followed by the buffer in the buffer well. Results were read after ten minutes. This method offered high accuracy, ease of use, and rapid detection. The cut-off value of the test kit used is ≥1.00 for a positive result suggesting the presence of the analyte, while result of ≤1.00 is negative which suggests its absence. Positive samples were retested in duplicate before final interpretation. After testing, blood samples were stored in a refrigerator, and used test kits were disposed of according to laboratory protocols. The researcher performed the tests, and another medical technologist validated the results.

Processing of Stool Specimen

Stool specimens were processed within 24 hours of receipt. FECT was used to detect STHs due to its simplicity and cost-effectiveness in separating and identifying parasites. The stool-formalin mixture was strained, centrifuged, and re-suspended before microscopic analysis by three medical technologists.[25] The remaining stool samples were tested for *Helicobacter pylori* antigen using the SD *H. pylori* rapid antigen test kit. A portion of the stool sample was collected using a sterile swab, inserted into the sample collection tube with assay diluent, and left to settle for five minutes. The test device was removed from the foil pouch, and three drops (about 100 μL) of the sample were added to the test device well. Results were interpreted after 10-15 minutes. All results above the cut-off value were considered positive.

The performance sensitivity of the kit is 98.4%, while its specificity is 100%. Another medical technologist validated the test results.

Statistical Analysis

Frequency and percentage were used to determine the prevalence of STHI, HAV, and *H. pylori* infections among the MSWWs. At the same time, the Chi-squared test was utilized to determine the correlation between the prevalence of the different infections to each variable (age, duration of employment, usage of gloves, and hand hygiene practices). Since total enumeration was employed, the statistical analysis results do not serve to infer broader conclusions but pertain specifically to the study participants.

RESULTS

This study recruited 44 consenting volunteer MSWWs in Baguio City. Table 1 displays key trends in the socio-demographic profile of participants. Notably, over one-third (38.64%) are aged 18-29, while 31.82% are 40 or older, and 27.27% fall within the 30-39 age range. Most participants (52.27%) have 2 to 9 years of work experience.

Table 2 presents the prevalence of microbial infections among volunteer MSWWs in Baguio City, highlighting a rate of 34.1% for *H. pylori* infection, 13.6% for STHI, and 9.1% for HAV infection. The breakdown of STHI reveals varying infection rates among different helminths and protozoan species. Notably, *E. nana* and *A. lumbricoides* each exhibited a rate of 33.3%, while Hookworm and *B. hominis* had lower rates of 16.7%.

Table 3 presents the analysis of associations between age, duration of work, and other relevant parameters with infection rates of STHI, HAV, and *H. pylori* among volunteer MSWWs. For STHI, no significant associations were found with age (p=0.771), duration of work (p=0.993), glove usage (p=0.237), or hand washing frequency (p=0.333). However, a trend toward significance was observed for hand washing before eating (p=0.054) and a significant association with the preference for alcohol-based hand rubs over hand washing (p=0.008).

Similarly, HAV infection rates showed no significant associations with age (p=0.761), duration of work (p=0.628), glove usage (p=0.347), or hand washing frequency (p=0.481). Although hand washing before eating or drinking was not significantly associated with HAV infection (p=0.909),

Table 1. Socio-demographic Characteristics of MSWWs

Characteristics	Frequency (n=44)	Percentage (%)
Age (years)		
18-29	17	38.64
30-39	12	27.27
≥40	15	31.82
Duration of work (years)		
≤1	7	15.91
2-9	23	52.27
10-19	14	27.27

Table 2. Prevalence of Microbial Infections among MSWWs

Microbial Infections		Positive	Percentage (%)
Infection	STHI	6	13.6
	Hepa A	4	9.1
	H. pylori infection	15	34.1

Table 3. Association of STHI, HAV and *H. pylori* Prevalence to the Socio-demographic Profile and other Parameters

Variable		STI		HAV		*H. pylori*	
		No. of positives (%)	*P* value	No. of positives (%)	*P* value	No. of positives (%)	*P* value
Age	18-29	3 (6.82)	0.771	1 (2.27)	0.761	5 (11.36)	0.390
	30-39	1 (2.27)		1 (2.27)		6 (13.63)	
	≥40	2 (4.55)		2 (4.55)		4 (7.27)	
Duration of work	≤1	1 (2.27)	0.993	1 (2.27)	0.628	2 (4.55)	0.762
	2-9	3 (6.82)		1 (2.27)		9 (20.45)	
	≥10	2 (4.55)		2 (4.55)		4 (7.27)	
I use gloves while working	Yes	3 (6.82)	0.237	2 (4.55)	0.347	11 (25)	0.763
	No	3 (6.82)		2 (4.55)		4 (7.27)	
Frequency of hand washing	Most of the time	1 (2.27)	0.333	2 (4.55)	0.481	5 (11.36)	0.939
	Rarely	5 (11.36)		2 (4.55)		10 (22.73)	
I wash my hands with soap before eating	Yes	3 (6.82)	0.054*	3 (6.82)	0.909	12 (27.27)	0.951
	No	3 (6.82)		1 (2.27)		3 (6.82)	
I prefer alcohol over hand washing	Yes	4 (7.27)	0.008*	2 (4.55)	0.124	3 (6.82)	0.957
	No	3 (6.82)		2 (4.55)		12 (27.27)	

Results were compared using chi-square test.
**Statistically significant at P ≤0.05*

there was a trend suggesting a potential influence from the preference for alcohol-based hand rubs (p=0.124).

Regarding *H. pylori* infection, no significant associations were found with age (p=0.390), duration of work (p=0.762), glove usage (p=0.763), hand washing frequency (p=0.939), hand washing with soap before eating or drinking (p=0.951), or preference for alcohol hand rubs (p=0.957). These findings suggest that the socio-demographic factors and relevant parameters examined may not significantly determine infection risks among MSWWs in this study.

DISCUSSION

The socio-demographic profile of this study reveals a relatively young workforce, with an average age of 31, which is significant for understanding infection prevalence. While younger individuals generally exhibit greater physical resilience and may be less susceptible to some health risks, this demographic may also lack experience and have lower awareness of occupational health and safety practices, increasing their vulnerability to infections.[26,27]

The prevalence of STHI among MSWWs in this study is 13.6%, indicating a significant health concern. This rate varies widely in other studies; for instance, a study in Nigeria found that 94.3% of refuse disposal workers were infected with at least one parasitic species, while a Ghanaian study reported a much lower rate of 1.5% among treated waste handlers.[7,28] In Brazil, 47.8% of recyclable material collectors were infected with helminths.[29] The higher prevalence rates in these studies compared to the current findings may be due to differences in participant numbers or environmental conditions.

While examining the association between STHI rates and various socio-demographic factors among MSWWs, no statistically significant associations were found, except for a preference for alcohol hand rubs over hand washing. These results align with and contradict previous research exploring the lack of significant associations between STHI and such factors. This challenges common beliefs about the influences on STHI among MSWWs, suggesting that traditional factors like age, work duration, glove use, and hand hygiene practices may not be as critical as previously thought.

Additionally, the lack of significant associations may be related to several interrelated factors. STHI often exhibits over dispersion, where a small percentage of the population harbors many worms, making demographic factors less relevant for predicting infection rates.[30] Environmental conditions, such as soil quality, moisture, and sanitation practices, can significantly impact transmission dynamics, often overshadowing individual behaviors like hand washing.[31]

Interestingly, a preference for alcohol hand rubs was associated with increased STHI prevalence. This preference may create a false sense of security among MSWWs, leading to inadequate hand hygiene practices. Alcohol hand rubs do not replace proper hand washing, especially in environments exposed to contaminated soil or waste.[32] Moreover, this preference may reflect convenience and accessibility, influencing overall hand hygiene practices. With a full understanding of the limitations of alcohol hand rubs, MSWWs may pay attention to essential hand-washing practices, increasing their susceptibility to infection.[33]

Consequently, researchers are encouraged to explore factors beyond traditional demographics to identify critical influences on STHI transmission, such as environmental conditions, access to healthcare, and broader socio-economic factors. By expanding the scope of investigation, a more comprehensive understanding of the complex dynamics at play can be developed, leading to more effective interventions.

The implications of STHI among MSWWs are significant for both affected individuals and public health. Chronic STHI can lead to various health issues, including gastrointestinal symptoms, malnutrition, and anemia.[34] For MSWWs, these health impacts can reduce productivity, increase absenteeism, and decrease quality of life, ultimately affecting their livelihoods and economic well-being. Furthermore, STHI among MSWWs may serve as a potential transmission source to the broader community, particularly where waste workers reside near residential neighborhoods.[35]

Interventions should include comprehensive health education programs to raise awareness among MSWWs about the risks associated with helminth infections and the importance of preventive measures. This could involve training sessions on proper sanitation practices, personal hygiene, and using PPE to minimize helminth transmission in waste management settings. Regular screening programs should also be established, and improved diagnostic strategies should be used to detect helminth infections early.[36]

The prevalence of HAV among MSWWs in this study (9.1%) is significantly lower than in previous research. For example, a study of waste collectors in Greece reported a 61% infection rate, compared to just 27% in a control group. This notable difference may stem from variations in geographic and environmental conditions, such as sanitation levels and public health infrastructure, which likely influence transmission rates.[15]

Occupational exposure to waste is an independent risk factor for HAV among MSWWs. However, this study found no significant association between HAV infection and factors like hand hygiene practices, age, duration of work, or glove use. While infected MSWWs preferred alcohol hand rubs for convenience, these products are less effective against HAV, a non-enveloped virus that requires thorough hand washing with soap for proper inactivation.[37,38]

The absence of significant correlations in this research contrasts with prior studies suggesting that older workers and those with longer employment durations had higher infection rates. This discrepancy may be due to geographic differences, sampling methods, or work conditions. It indicates that traditional risk factors may not be the primary determinants of HAV infection among MSWWs, allowing for a more targeted approach in public health interventions.

Additionally, this finding suggests that existing hygiene practices may effectively reduce risks, highlighting the need to reinforce these measures rather than completely overhaul them. Furthermore, HAV's high infectivity and potential asymptomatic nature in younger individuals imply that exposure to contaminated materials could pose a greater risk than demographic or behavioral factors alone.[39]

The study revealed a concerning prevalence rate of *H. pylori* infection at 34.1%, aligning with global estimates that bacterial infections were responsible for approximately 7.7 million deaths worldwide in 2019, with *H. pylori* being a major contributor to gastritis and gastric cancer.[40,41]

However, the study found no statistically significant associations between *H. pylori* infection and factors such as age, duration of work, glove use, hand hygiene practices, or alcohol hand rubs among MSWWs. This suggests that these demographic and hygiene-related factors may not significantly influence *H. pylori* transmission, which primarily occurs through oral-oral or fecal-oral routes rather than through direct contact with contaminated surfaces.

The lack of significant associations could be attributed to the asymptomatic nature of many *H. pylori* infections, particularly in younger individuals, which can obscure potential correlations. Additionally, unmeasured factors such as dietary habits, living conditions, and access to healthcare may significantly impact infection rates but should have been included in the study.[42] Previous researches have reported no significant association between socio-demographic factors and *H. pylori i*nfection, indicating that environmental and lifestyle factors may be more critical than individual behaviors or characteristics.[43,44]

These findings highlight the complexity of *H. pylori* transmission dynamics and suggest that focusing solely on traditional risk factors may not adequately address the broader determinants of infection risk among MSWWs. The absence of significant associations is encouraging, indicating that traditional risk factors may not be as impactful as previously thought. This opens the door for more targeted approaches in future interventions, encouraging researchers to explore broader socio-economic and environmental influences on *H. pylori* transmission while emphasizing the importance of maintaining and improving current hygiene practices to benefit workers and their communities.[44]

CONCLUSION

This study assessed the prevalence of STHI, HAV, and *H. pylori* infections among MSWWs in Baguio City, revealing critical insights into the health risks faced by this occupational group. The findings showed a 13.6% prevalence of STHI, highlighting an urgent need for regular screening and education on transmission prevention. Notably, the analysis identified a significant association between infection rates and the preference for alcohol hand rubs over hand washing. This preference may foster a false sense of security, leading to inadequate hand hygiene practices that increase the risk of STHI, especially in environments with exposure to contaminated soil or waste. Future research should investigate additional variables influencing STHI rates, utilizing qualitative methods.

The study also reported a 9.1% prevalence of HAV infections among MSWWs. Although no significant associations were found with age, work duration, glove use, or hand hygiene practices, the noted trend towards alcohol-based hand rubs underscores the necessity of proper hand washing, particularly since these rubs are ineffective against non-enveloped viruses like HAV. Longitudinal studies tracking changes in hand hygiene practices and the sustainability of interventions are warranted.

A concerning 34.1% prevalence rate of *H. pylori* infection was observed, with no significant associations identified with socio-demographic factors or other parameters. As previous research shows, this indicates the complex nature of *H. pylori* transmission, which is influenced by environmental and lifestyle factors. Routine screening for *H. pylori* using non-invasive methods, such as stool antigen tests, is recommended, along with ensuring access to effective treatment for infected individuals. Future research should broaden data collection to encompass a broader range of socio-demographic and environmental factors affecting *H. pylori* rates and include control groups not exposed to waste management environments.

This study emphasizes the urgent need for preventive measures and effective hand hygiene promotion among MSWWs. Recommendations include implementing targeted strategies such as training on proper hand hygiene techniques and providing adequate hand washing facilities in the workplace. Furthermore, exploring the knowledge and awareness of proper hygiene practices among MSWWs can yield valuable insights for enhancing interventions. Collaborative efforts among researchers, public health authorities, and waste management agencies are essential to effectively address the challenges of infectious diseases in this vulnerable occupational group.

Statement of Authorship

Both authors certified fulfillment of ICMJE authorship criteria.

Author Disclosure

Both authors declared no conflicts of interest.

Funding Source

None.

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