

Short Report

Occupational health hazard exposure and health problems among solid waste collectors in Phayao Province, Northern Thailand

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ABSTRACT

This is a cross-sectional study on solid waste collectors (SWCs) who are potentially exposed to various occupational health hazards leading to health risks. This study was conducted on 107 solid waste collectors who had completed structured questionnaire interviews between October to December 2019. Data analysis was performed using the STATA software (14.1 version). The majority (93.5%) of SWCs were employed temporarily. Among the total solid waste collectors, 72% of them had occupational health symptoms. This study showed that most SWCs suffered from different types of occupational health symptoms such as musculoskeletal pain and injuries (59.7%), respiratory symptoms (23.4%), head, eyes, and ears symptoms (7.8%), skin symptoms (5.2%), and gastrointestinal symptoms (3.9%). High level of health hazards exposure ($OR_{adj} = 5.87$, 95%CI = 1.80 – 19.03), shift hours 12 am to 10 am ($OR_{adj} = 25.38$, 95%CI = 2.29 – 280.81), and work experience ≥ 10 years ($OR_{adj} = 13.06$, 95%CI=1.41 – 121.13) were significantly associated with occupational health problems. Thus, providing occupational safety training and personal protective equipment support in the working environment, including giving knowledge about health hazards and awareness and promoting annual medical checkups, should be considered.

Key words: health hazards, solid waste collection, musculoskeletal disorders, illness experiences, workplace environment

INTRODUCTION

Urban development, population growth and industrialization have contributed to increased substantial waste growth; it is therefore of grave concern to better manage the solid waste generated in developing countries.^{1, 2} Municipal Solid Waste Workers (MSWWs) play an essential role in the effectiveness of the waste management strategy planned by the local government authorities, such as a municipality, to ensure the country's cleanliness.^{3, 4} Also, waste collection is the first process of waste management, in which the solid waste is transferred from the point of disposal to the point of treatment.⁵ It is associated with different aspects that are part of the various types of waste handling activities, starting from the waste collection, transportation, sorting, processing, and disposing of by the local municipality's solid waste management.^{6, 7} MSWWs are responsible for role curbside service waste collection from households and commercial areas. The waste is typically placed on the ground directly, thus requiring to be shoveled by hand, or it is left in plastic bags or containers to be picked up by hands.⁸ Manual collecting and lifting of the waste container or bags are of serious concern owing to the associated occupational risks; it contains a variety of contaminants, such as the residues of chemicals, waste oils, vector-borne disease-causing flies, and other bioaerosol contaminants and emissions from the degradation of the putrescible fraction of municipal solid waste, that may lead to the spread of various diseases as a result of the daily exposure to work-related hazards.^{6, 9, 10} Therefore, solid waste management procedures in developing countries are associated with health risks. MSWWs worldwide have been reported to

experience occupational related hazards such as musculoskeletal disorders, gastrointestinal, respiratory, allergy, skin diseases, and other injuries such as cuts and lacerations that are caused by work-related accidents.¹¹⁻¹³ A study conducted in Egypt Abd El-Wahab et al.¹¹, notes that MSWWs had respiratory, gastrointestinal, musculoskeletal, and skin morbidities. Musculoskeletal disorders (MSDs) and injuries (IRs) are significant as they affect the quality of life as well as cause an increased economic burden due to the high productivity demand and job losses.^{2, 14}

Thus, working environment-related occupational health hazards and municipal solid waste workers' safety is a major occupational health concerns worldwide, especially in developing countries.^{12, 14} Further, such problems account for major treatment costs, and the susceptibility of such groups is a significant concern.² In the study, the municipal solid waste workers in Florida were found that to be exposed to musculoskeletal disorder and dermal injury risks.¹⁵ In addition, injury among municipal solid waste collectors in the Addis Ababa city not using personal protective equipment were 2.6 higher (95% CI: 1.48-4.63).¹⁶ Additionally, a study reported a higher prevalence of respiratory symptoms and a more significant decrease in lung function in MSWWs.^{17, 18} Although, previously, the studies waste collector in Chiang Mai province, Thailand have reported exposure to flexed wrist from lifting trash bag/bin (86.9%), waste odor (85.4%), and sunlight (71.9%),¹⁹ However, the study of occupational exposure is limited in Thailand. Hence, this study investigates the factors associated with solid waste collectors' occupational health problems in Phayao Province, Northern Thailand. The results help in suggesting working environments to prevent

occupational hazards health and ensure safety.

METHODS

Study design and sample size

A cross-sectional study was conducted between October and December 2019 among municipal solid waste workers (MSWWs) in the municipality office in four districts in Local Administrative Organizations (LAOs) in the Phayao Province. This study has a small population; the final Solid Waste Collectors (SWCs) among the eligible and voluntary participants was 107 persons who met the following inclusion criteria; 1) Thai nationality and able to communicate the

meaning and understand the Thai language, 2) at least one year's work experience 3) worked with curbside collection service including lifting and loading waste from containers at the pickup location, transferring waste to the collection vehicle, segregating waste in the rear of the trucks to transfer to the local municipality disposal site, lifting and loading waste from containers at the pickup location and transferring it to the collection vehicle, and segregating waste into broad categories in the rear of the trucks for more than eight hours daily, and 4) willing to participate in the research (see **Figure 1**). The exclusion criteria were; 1) have had an underlying disease or previous occupation that caused occupational health problems during the past year and 2) vehicle drivers.



Figure 1 The nature of solid waste collectors' work is segregating waste in the rear of the truck's curbside collection service. (photographed by Sarawut Sangkham).

Data collection

In this study, a structured questionnaire was used for data collection. There is a test of the trials of the tools

among the SWCs that was not a sample of this research consisted of 30 people obtained with Cronbach's alpha coefficient to determine the questionnaire's reliability,

such that internal consistency has indicated by values of 0.89, and was using the Standard Nordic Questionnaire for the analysis of musculoskeletal symptoms²⁰, which those participants were interviewed face-to-face interview conducted approximately 20 minutes per person at the workers' reporting on these workers by the questionnaire consisted of four parts, namely: (i) sociodemographic characteristics; (ii) occupational health hazards exposure; (iii) personal protective behavior and safety practices and (iv) health problem.

Data and statistical analyses

Data were coded, entered on the machine, and evaluated using version 14 of STATA (Stata Corp LP., Texas, USA 2015). Average, standard deviation, median, minimum-maximum, frequencies, and percentages were the descriptive statistics that were presented. Any variable whose univariable test result showed a *p*-value of less than 0.25 was included in the first multivariable model, and the chi-squared test assessed the likelihood ratio. Then, a multivariable model containing all covariates identified was used to assess the importance of each covariate using the *p*-value of its Wald statistic by the backward elimination technique, which accounts for confounding factors and other important factors that need further analysis, and for determining the odds ratio (OR) of various risk factors at a 95% confident interval. The significance level (*p*-value) was set to be below 0.05.

Optional definition

Municipality under the local Administrative Organizations (LAOs) in the Phayao Province had two types: the Muang municipality (Muang and Dok Khamtai municipality) and subdistrict municipalities.

Solid waste collectors (SWCs): The person responsible for collecting the

garbage in the back of the vehicle collecting garbage for at least one year under the supervision of a Local Administrative Organizations in Phayao Province.

Occupational health hazards exposure (OHHEs): Health hazard exposed to while working including physical hazards, chemical hazards, biological hazards, biomechanical hazards, and social psychological hazards.

Occupational health problems (OHPs): Health problems during the last year including gastrointestinal symptoms, head, eyes, ears symptoms, musculoskeletal symptoms, and/or injuries, respiratory symptoms, or skin symptoms.

Ethical considerations

The study was registered by the Human Ethics Committee of the University of Phayao. Project No. 2/117/61 was the Ethical Clearance certificate (February 18, 2019). Permission was sought from the mayor of the municipality's authorities to perform the study.

RESULTS

Sociodemographic characteristics

A total of 107 (100% men) SWCs were part of the survey. The average age of the SWCs was 46.9 years. 42.1% of the workers were <40 years of age, followed by 36.4% who were in the range of 40–49 years, and 21.5% who were above the age of 50. Most of the SWCs were married (57.0%), followed by 39.3% who were single, and 3.7% who were widowers. It's understood that most of them (69.2%) were part of households having more than four persons and 30.8% belonged to households below four persons. Regarding the question on the educational background of the SWCs in the study, it was found that 49.5% had high school level education, 42.1% had primary school education, and 8.4% had a diploma or higher level of education. Most

of the SWCs (72.9%) received a salary of less than USD 297.03 (THB < 9000) as shown in **Table 1**.

Table 1 Sociodemographic characteristics of solid waste collectors (n = 107).

Sociodemographic characteristics	Frequency (n)	Percent (%)
Age (years)		
< 40	45	42.1
40 – 49	39	36.4
> 50	23	21.5
Mean ± S.D.	46.9 ± 7.3	
Marital status		
Single	42	39.3
Married	61	57.0
Windowed	4	3.7
Education level		
Primary school	45	42.1
High school	53	49.5
Diploma or above	9	8.4
Income (USD)*		
< 297	78	72.9
≥ 297	29	27.1
Mean ± S.D.	296.0 ± 37.9	
Median (min – max)	297.0 (231.0 – 429.0)	
Member in household (persons)		
< 4	33	30.8
≥ 4	74	69.2
Mean ± S.D.	4.0 ± 1.6	

* 1 USD was approximately = 30.3 THB.

Municipal solid waste collectors and nature of works

The majority of the SWCs (93.5%) had positions as temporary employees in municipalities, and 6.5% of them were government and permanent employees. The average work experience among SWCs was 6.3 years. Most of the workers, 58.0%, had work experience below five years, followed by 22.4%, whose work experience ranged from five to nine years, and 19.6% who had above ten years of work experience. It was understood that 72.9% of the SWCs worked for more than six hours per day and 27.1%

worked for less than six hours per day. The average working time of SWCs was 6.2 hrs. At present, day to day shifts are operated in three shifts; a large number (56.1%) work in the first shift from 7 am to 4 pm. 29.0% work in the second shift, which is from 5 am to 12 pm, and 14.9% work in the thirds shift from 12 am to 10 am. The study showed that 72.0% of the solid waste collectors were lifting above 150 times per day, and 28.0% were lifting below 150 times per day. The average frequency of lifting was 208.3 times per day. The weight of lifting each time with containers, bags,

materials, and others for SWCs an average was 57.7 kg per time. 70.1% was the weight of lifting above 30 kg/times, and 29.9% was

the weight of lifted below 30 kg/times, as shown in **Table 2**.

Table 2 Work history and work environment (n = 107)

Work history and work environment	Frequency (n)	Percent (%)
Position		
Government and permanent employees	7	6.5
Temporary employees	100	93.5
Work experience (years)		
< 5	62	58.0
5 – 9	24	22.4
≥ 10	21	19.6
Mean ± S.D.	6.3 ± 6.2	
Median (min – max)	4 (1 – 31)	
Shift hours		
7 am to 4 pm	60	56.1
12 am to 10 am	16	14.9
5 am to 12 pm	31	29.0
Working time (hours)		
< 6	29	27.1
≥ 6	78	72.9
Mean ± S.D.	6.2 ± 1.6	
Median (min – max)	6 (3 – 12)	
Frequency of lifting (time/day)		
< 150	30	28.0
≥ 150	77	72.0
Mean ± S.D.	208.3 ± 108.7	
Median (min – max)	200 (10 – 500)	
Weight of lifting (kg)		
< 30	32	29.9
≥ 30	75	70.1
Mean ± S.D.	57.7 ± 72.9	
Median (min – max)	30 (10 – 500)	

Health problem and factors associated with occupational health problems

Among the total solid waste collectors, 72.0% of them had occupational health symptoms. This SWCs self-reported that they had musculoskeletal pain and injuries (59.7%), respiratory symptoms (23.4%), head, eyes, and ears symptoms (7.8%), skin symptoms (5.2%), and gastrointestinal symptoms (3.9%). **Table 3**

The study factors associated with occupational health symptoms found that SWCs who had above ten years of work experience were 13.06 times more likely to have occupational health problems than those who had less than five years' experience ($OR_{adj} = 13.06$, 95%CI = 1.41 – 121.13). SWCs who had shift hours between 12 am to 10 am were $OR_{adj} = 25.38$ (95%CI = 2.29 – 280.81) more likely to

have occupational health problems than those who had shift hours from 7 am to 4 pm. SWCs who had a high level of health hazards exposures were $OR_{adj} = 5.87$

(95%CI = 1.80 – 19.03) more likely to have occupational health problems than those with a low level of health hazards exposure.

Table 3 Crude and adjusted odds ratios from univariable and multivariable analysis of study occupational health problems among SWCs.

Variables	Occupational health problems		Crude odds ratio (95%CI)	Adjusted odds ratio (95%CI)
	Yes (%)	No (%)		
Age (years)				
≤ 40	35 (45.45)	19 (63.33)	1	1
41 – 49	28 (36.36)	2 (6.67)	7.60 (1.63 – 35.43)*	6.70 (0.95 – 47.52)
≥ 50	9 (18.18)	14 (30.00)	0.84 (0.31 – 2.31)	0.14 (0.02 – 0.78)*
Education level				
Primary school	34 (44.16)	11 (36.67)	1	1
High school	40 (51.95)	13 (43.33)	1.00 (0.40 – 2.51)	2.26 (0.62 – 8.28)
Diploma or above	3 (3.90)	6 (20.00)	0.16 (0.03 – 0.76)*	0.12 (0.02 – 0.89)
Income (USD)				
< 297	59 (76.62)	19 (63.33)	0.53 (0.21 – 1.31)	-
≥ 297	18 (23.38)	11 (36.67)	1	
Work experience (years)				
< 4	27 (35.06)	13 (43.33)	1	1
4 – 9	32 (41.56)	14 (46.67)	1.10 (0.44 – 2.74)	1.14 (0.33 – 3.93)
≥ 10	18 (23.38)	3 (10.00)	2.89 (0.72 – 11.60)	13.06 (1.41 – 121.13)*
Shift hours				
7 am to 4 pm	38 (49.35)	22 (73.33)	1	1
12 am to 10 am	14 (18.18)	2 (6.67)	4.05 (0.84 – 19.52)	25.38 (2.29 – 280.81)**
5 am to 12 pm	25 (32.47)	6 (20.00)	2.41 (0.86 – 6.79)	3.14 (0.73 – 13.39)
Working time (hours)				
< 6	20 (25.97)	9 (30.00)	1	1
≥ 6	57 (74.03)	21 (70.00)	1.22 (0.48 – 3.10)	0.55 (0.15 – 2.03)
Level of health hazards exposure (score)				
Low	17 (22.08)	16 (53.33)	1	1
High	60 (77.92)	14 (46.67)	4.03 (1.64 – 9.90)**	5.87 (1.80 – 19.03)**
Level of PPE behavior and safety practices (score)				
Poor	4 (5.19)	1 (3.33)	0.63 (0.07 – 5.87)	0.60 (0.04 – 8.57)
Good	73 (94.81)	29 (96.67)	1	1

Note: 1 = Reference; * = $p < 0.05$; ** = $p < 0.01$

DISCUSSION

They engage temporary employees in municipalities, as in the study, it was found that participants who have below five years of work experience. Similarly, a study was conducted among municipal solid waste workers in India who had less than five years of work experiences.²¹ This study found that overall 77 (72.0%) had health problems in the past years, which could be considered higher as compared to the studies conducted in Addis Ababa, Ethiopia (51.2%).²² This study showed that most SWCs suffered from different types of occupational health symptoms such as musculoskeletal pain and injuries 46 (59.7%), respiratory symptoms 18 (23.4%), head, eyes, and ears symptoms 6 (7.8%), skin symptoms 4 (5.2%), and gastrointestinal symptoms 3 (3.9%). Our study has found that the level of health hazards exposure, shift hours, work experience, and age were significantly associated with occupational health problems. Like India, the MSW collected in Thailand is generally a mixed waste and is non-segregated.² Thus, workers handling mixed waste, compost, and recycling products face some health problems.²³ Therefore, mixed waste without sorting people who are most affected is a garbage collector, which, if not careful to protect yourself, will increase the risk of infection, leading to the development of chronic diseases that affect the health of the whole system.

Our study of the SWCs has found that musculoskeletal pain and injuries (59.7%) were higher than the studies done in Addis Ababa, Ethiopia (21.8%)²², and Alexandria, Egypt (3.2%).¹¹ In contrast, the study in Egypt found that a higher prevalence of MSDs complaints (60.8%) among MSWWs, particularly 22.5% waste collectors were reported to have had lower back pain (LBP)²⁴ and 89.1% and 92.5%,

were reported to have LBP in Shiraz city⁷ and Ankara²⁵, respectively. Our study found that SWCs had a frequency of lifting above 150 times/day, and the weight of lifting more than 30 kg/day was 72.0% and 70.1%, respectively. For example, solid waste collectors are required to perform repeated heavy physical activity such as heavy lifting, frequent lifting, carrying, pulling/pushing of bags and containers of heavy objects^{26, 27}, that involve static muscle contraction and thus increases the risk of musculoskeletal damages.¹¹ Moreover, it was observed that the most prevent form of injury in SWCs was falling, which usually happens when they hang from the rear of the truck during transportation and there is a high risk of the workers falling when the vehicle is driving at high speeds.⁴ Therefore, musculoskeletal disorders are occupational health hazards among municipal solid waste workers, especially in developing countries that lack self-protective work. Lack of such provision often leads to exposure of such workers to various health problems. However, some individual factors (age, body weight, and waste collecting duration), physical demands (lifting containers/bag, pulling/pushing waste containers, walking along with container/bags carriage, and jumping up/down on the vehicle) were the most significant risk factors influencing the development of MSDs.²⁷

Additionally, they have found that increased health risk mostly due to mostly, waste collection work is associated with various physical, chemical, and biological hazards.⁵ The results found that SWCs have respiratory symptoms (23.4%), head, eyes, and ears symptoms (7.8%), skin symptoms (5.2%), and gastrointestinal symptoms (3.9%). Several studies highlight the elevated risks of respiratory, dermal, and gastrointestinal problems among municipal waste workers due to the exposure to dust, micro-organisms, and microbial toxins at their

workplace.^{15, 23, 28} Similarly, a study among waste-loaders in Mumbai indicated that the prevalence of musculoskeletal disorders (MSDs), injury, eye, and skin infections was significantly higher for waste-loaders.^{14,29} For instance, among domestic waste collectors it was found that the workers had complaints about eyes (29.0%)³⁰, and 19.0% of waste-loaders in Mumbai had significantly raised the eye's risk.²⁹ Additionally, a study done among India's municipal solid waste workers revealed the prevalence of respiratory symptoms and allergies.⁶ Therefore, exposure to bioaerosols while lifting containers or bags may lead to respiratory symptoms. Substantial evidence is available that exposure to bioaerosols exceeds recommendations³¹, especially, in case of household waste collectors who are exposed daily to significantly higher bioaerosols concentrations³² due to waste non-segregation, which can generate bioaerosol from biodegradation within the container. Therefore, solid waste collectors' may exposure to molds and fungus spores, abundant on discarded food packaging, which are recognized biological sources that lead to respiratory diseases, mucous membrane irritation, and allergies.²³ In addition, a study done in the Ruhr area, Germany, indicated that employment duration in the waste collection was associated with an increased prevalence of cough.³⁰ Therefore, the MSWs handling processes and waste collection may expose them to bioaerosols from organic dust, and such exposure may precipitate the onset of respiratory problems (acute and chronic health effects).^{30, 33-36} Thus, it was demonstrated that MSWs is the occupation with the highest risk for fatal occupational injuries and illness, much higher than for the general workforce.^{37, 38} They are also exposed to many pathogens (bacteria, fungi, viruses, parasites), toxic substances (endotoxins and beta-glucans),

chemicals that come from the waste itself and its decomposition.^{17,39} Our study also found that 3.9% of SWCs had intestinal symptoms, and revealed that those workers had suffered from skin symptoms (5.2%). These results found that it is a small percentage; however, inadequate, and improper PPE, as evidenced by the torn or makeshift protective clothing such as the gloves, may increase the health risks.

Our study showed that a high level of health hazard exposure, age, and education level was significantly associated with health problems. Moreover, it was found that the SWCs shift hour range of 12 am to 10 am was significantly associated with occupational health problems. Therefore, working outside of regular working hours may be at risk from environmental and work environment factors such as nighttime working; exposure to occupational health risk might be due to staying for a long time as SWCs, which may increase exposure health hazard factors. Similarly, studies done in Addis Ababa city¹⁶ and Melaku and Tiruneh²², showed that work experiences were significantly associated with health problems. Therefore, exposure to physical hazards, chemical hazards, biological hazards, biomechanical hazards, and social psychological hazards may lead to both acute and chronic illness. However, the level of health risk or severity may vary on relevant factors, such as age, experience, exposure time threat to occupational health exposure and personal character factors, therefore, the confounding factors such as previous occupations, smoking habits, alcohol drinking, body mass index (BMI), and congenital disease or other factors that may influence or may be related with occupational health problems need to be studied in the future.

LIMITATIONS OF THE STUDY

The study's limitations result from the occupational health hazards assessment. Therefore, the source of information and factors of the disorder may not represent the whole population of SWCs. The assessment is also conducted through interviews; recall bias in reporting health problems experienced over the previous year could have occurred. There is no medical diagnosis from the physician, and therefore there may be some errors in the data.

CONCLUSIONS

Our study showed that 72.0% of SWCs reported that occupational problems, most SWCs had musculoskeletal pain and injuries (59.7%), respiratory symptoms (23.4%), head, eyes, and ears symptoms (7.8%), skin symptoms (5.2%), and gastrointestinal symptoms (3.9%) in past years. The results find that high level of health hazards exposure ($OR_{adj} = 5.87$, 95%CI = 1.80 – 19.03), shift hours 12 am to 10 am ($OR_{adj} = 25.38$, 95%CI = 2.29 – 280.81), and work experience ≥ 10 years ($OR_{adj} = 13.06$, 95%CI=1.41 – 121.13) were significantly associated with occupational health problems among SWCs. SWCs is an occupation where there is a risk of being exposed to health threats from various hazards from working environments with multiple health problems and vulnerable to occupational health. Therefore, this study's results can serve as supporting information for municipal administrators in policymaking or making guidelines for working to reduce the risk of exposure of SWCs to occupational health hazards to prevent work-related illnesses and injuries. Furthermore, using personnel protective equipment should be promoted, and safety

training should be enhanced to promote the quality of working life among SWCs.

RECOMMENDATIONS

–The solid waste collector must have an annual health check.

–SWCs should be directed to improve posture in order to reduce and prevent muscle injury.

–The authorities should provide personal protective equipment to operate the following minimum standards and alcohol solution and soap for handwashing after work end.

–The LAOs in public health and environment division should organize training to provide advice and guidance on the use of hazardous protective equipment and the right way of taking care of their health in their work to resolve accidents and health problems.

–Further research should measure environmental factors such as radiation, dust concentrations, and bioaerosols while studying the relationship with health symptoms.

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CONFLICT OF INTEREST STATEMENT

There are no conflicts of interest.

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