

Brief Report

Exposure risk assessment of the municipal waste collection activities during COVID-19 pandemic

Loganathan Salvaraji,¹ Mohammad Saffree Jeffree,¹ Richard Avoi,¹ Azman Atil,^{1,2}
Hazelina Mohd Akhir,¹ Shamsul Bahari Bin Shamsudin,¹ Khamisah Awang Lukman^{1,3}

¹Community and Family Medicine Department, Faculty of Medicine and Health Science, Universiti Malaysia Sabah, Kota Kinabalu, Sabah; ²Department of Community Health, Universiti Kebangsaan Malaysia Medical Centre, Kuala Lumpur; ³Center for Occupational Safety and Health, Universiti Malaysia Sabah, Kota Kinabalu, Sabah, Malaysia

Abstract

An increasing amount of waste concurrently further extends the risk of exposure to hazardous material among waste collectors. In light of the COVID-19 crisis, municipal waste collectors are one of the most at-risk groups of SARS-Cov-2 exposure. Risk assessment included hazard identification, evaluation of existing control level at the workplace, estimation of likelihood and severity of hazard, risk determination, and control measure recommendations. Five waste collection activities were identified and reviewed. High-risk exposure includes collection of garbage, mechanical manipulation of compactor lorries and unloading of garbage at the disposal site. There is poor practice of personal hygiene and unestablished continuous monitoring of personal protective equipment supplies. The preventive measures in the waste collection industry are influenced by several factors. Until the preventive measures are adopted into practice and adapted according to each company's requirements, biological agents continue to be risk factor to the health workers.

Introduction

Waste collectors play a vital role in communities by keeping the environment clean and healthy. They collect accumulated solid waste, green waste, and compost, as well as recycle goods and multiform items from residential areas, business centres, industrial companies, and public parks.¹ Nevertheless, this practice varies depending on the city and the degree of waste separation. In Beijing, there are almost 100,000 waste collectors able to collect 4 million tons of trash and to further help in recycling reusable items.² The average amount of waste produced in Malaysia doubled from 0.5 to 0.8 kg/person/day to 1.7 kg/person/day in 2003,³ and it is predicated that by 2020, the amount of waste will have

increased to 31,000 tons.⁴

The main purpose of conducting risk assessment at workplaces is to evaluate all possible causes that can harm employees, and then to implement control measures to minimize such hazardous exposures.⁵ Carrying out an exposure risk assessment is not an easy task, because the diversity of the agents varies, which are able to reproduce and replicate continuously in the environment. Even in low concentrations, these agents can cause mortality or a detrimental impact on health. To date, no occupational exposure limits have been set for health surveillance. Furthermore, biological agents are invisible and are difficult to identify.⁶ It is impossible to capture the true prevalence of disease among waste collectors. However, the prevalence of respiratory diseases such as allergic alveolitis, allergic bronchopulmonary aspergillosis, occupational asthma and abnormalities in lung function, gastro-intestinal problems, and skin complaints has increased over the years.⁷ The current COVID-19 crisis has highlighted that waste collectors are one of the most at-risk groups of SARS-Cov-2 exposure, second only to healthcare workers.⁸ The life span of SARS-CoV-2, and revealed that droplets containing the virus are able to survive for almost three days on plastic, stainless steel, copper and cardboard.⁹ This has resulted in concern regarding contaminated face masks that are thrown away as general waste.¹⁰ Moreover, waste management is an essential service, which is continuously needed all around cities, even in areas categorized as hotspots for COVID-19.

In view of greater exposure in this field, there is also a significant association between leptospirosis and contact with the environment, such as contaminated food, soil, and water.¹¹ Almost 6% of waste collectors are polymerase chain reaction positive for leptospirosis,¹² which, if left untreated, has a 5%-40% risk of mortality due to an increase in the severity of leptospirosis.¹³ Besides this, waste collectors are at risk of contracting Hepatitis B virus, especially those that frequently sustain sharp injuries,^{14,15} as tetanus spores in the environment can enter the human body

Significance for public health

Infectious diseases among waste collectors can provoke significant detrimental consequences and mortality if left untreated. Comprehensive analysis of waste collection activity is unavailable to pinpoint the potential uncertainty of transmission of infectious agents from polluted environment. The decrees of this study are crucial for the Public Health Division and Municipal Council to evaluate the strength of health promotion and level of prevention measures at the workplace. This knowledge is pivotal for the organization to focus on the precise issues and execute necessary risk control measures. In due time, morbidity and mortality due to occupational exposure to possible infectious agents in the working environment can be averted and dwindled.

through punch wounds, lacerations, or abrasions.¹⁶ Furthermore, clean stagnant water can provide a breeding site for mosquitos, which can transmit dengue virus when they bite waste collectors at work.¹⁷ The link between workers and biological agents can be explained in a cycle known as the chain of transmission. The biological agent's reservoir is the first encounter in this cycle, from which the agent leaves through a portal to be transmitted into the host via inhalation, ingestion, or absorption. In order to minimize the risk of infection, one or several control measures should be implemented to break the chain. Proper and adequate control measures ensure the physical and mental health of workers are kept the best they can be. Hence, they are able to perform waste collection activities without any difficulty and are more productive at work. Employers can reduce any financial burden by avoiding unnecessary expenses and property losses.^{18,19} Indirectly, workers feel motivated as their safety and welfare are taken care of by their employers.²⁰

Hence, this study reviews every step of waste collection activity to determine the exposure risk level of biological hazards (including the risk of exposure to SARS-CoV-2), and assesses the current control measures in workplaces. This article also recommends health and safety control measures that are as practicable as possible so as to minimize the duration of any exposures. It could be useful to intensify preventive actions and agency collaboration to curb future incidences of occupational diseases. This study has the potential to be further expanded into large-scale research projects in municipal councils from other areas.

Design and Methods

A descriptive study design was applied to assess the risk of biological hazards in waste management activities. There are 317 waste collectors and divided into 58 teams. The team assigned to particular compactor lorry according to their working hours. More than 20% of the team was assessed for exposure to biological hazards during waste collection activity. The group of assessors consisted of a waste management officer, a safety and health officer, and an occupational health doctor, who conducted the risk assessment. The team had authority and permission to converge and generate data, and they applied a mixed method approach, combining key information from interviews, document analysis, secondary data analyses, and interpretation related to biological hazards in the workplace.

There were three sections in the risk assessment form (*i.e.*, hazard identification, risk assessment, and risk control). Hazard identification involved a list of work activities, potential biological hazards, and health effects of workers in contact biological hazards. The risk assessment included existing control levels in the workplace, the likelihood of the occurrence of a hazard, the severity of a hazard, and a risk score. Each part of the likelihood and severity was adjusted on a scale of 0-5. Likelihood is defined as the frequency of the event occurring during a work activity, the scale of which ranged from 5 (most likely), 4 (good chance of occurring), 3 (might occur in future), 2 (has not been occur after many years) and 1 (practically impossible). Meanwhile, the severity reflects the health effect, property damage, and environmental impact due to exposure to a hazard, which ranges from 5 (catastrophic), 4 (one single fatality), 3 (non-fatal injury), 2 (minor) and 1 (negligible). The likelihood and the severity were multiplied to establish a risk score. Finally, the risk score is categorized into high risk (risk score=15-25), medium risk (risk score=5-12) and low risk (risk score=1-4). Lastly, the team of experts recommended additional control measure to reduce the risk level.

The job description for waste management was extracted from standard operation procedure (SOP) documents. Each work activity was organized into the risk assessment form so as to be evaluated. The investigator had discussions with employers and employees to gain more information and to understand the waste management work activities. External information such as complaints, hospitalization, medical certificates, accidents, injuries, and near misses were taken into consideration during the assessment. This study focused on biological agents and the possible risk of contact of workers when performing their job tasks. The risk assessment was conducted in order to measure the magnitude and priority of the biological hazards, and the analysis of likelihood and severity was based on the existing control levels of organizations. The risk level was obtained by multiplying the likelihood and the severity, which was either low, medium, or high. Risk control was defined as the action taken to eliminate or inactivate a hazard, and control measures must be as practicable as possible to minimize the risk of adverse health effect or property and environmental damage.

All subjects gave their informed consent for inclusion before they participated in the study. The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Ethics Committee. Approval to conduct the study was obtained from the Medical Research Ethics Committee, Faculty of Medicine and Health Science, University Malaysia Sabah (JKetika 3/19), and formal permission from the municipal council. The study was conducted after consent was obtained from participants. There is no conflict of interest in this study.

Results and Discussion

Five waste collection activities were identified and reviewed by the team (Figure 1). The three work activities categorized as having a high risk of exposure to biological hazards were the collection of the garbage (*i.e.*, picking up, carrying, and lifting), mechanical manipulation to store garbage in compactor lorries and unloading of garbage at disposal site (Table 1). Meanwhile, inspecting compactor lorries and moving to a designated working location are categorized as having a low risk of exposure to biological hazards (Table 2).

The activity of collecting garbage, such as picking up, carrying, and lifting garbage, has the highest risk of biological transmission in the workplace. Picking up garbage is the first instance in which workers come into direct contact with contaminated rubbish or animals. Subsequent activities, such as carrying and lifting garbage, also possess a similar risk of exposure. Workers with open wounds or skin diseases are at further risk of becoming infected. For example, lesions on the skin or on the mucous membrane of the mouth, nose, and eyes providing entry sites into the human body for biological hazards.⁷ For those who have open wounds of eczema, there is a need to avoid any potential contact with contaminated water by applying waterproof bandages.²¹ Furthermore, carrying out medical surveillance is highly recommended in order to establish and maintain the positive physical and immune state of workers.

Furthermore, workers also have high-risk exposure to biological agents during manipulation of compactor lorries, through which contaminated air droplets are dispersed into the air. A recent study proved that viruses are able to survive for a few days on plastic, stainless steel, copper, and cardboard.⁹ However, the spread of infection depends on several factors, such as the temperature, humidity, wind, and human immunity.²² Appropriate personal protective equipment, especially masks, is essential to hinder the inhalation of contaminated droplets of viruses such as COVID-19,

which causes lower respiratory tract infection. Nevertheless, studies on specific types of respiratory protection for waste collectors is needed, adapting such protection to individual working conditions and environments. Basic knowledge on respiratory infection is able to increase the awareness and importance of personal hygiene among waste collectors, such as hand hygiene and avoiding touching the eyes, nose, or mouth. Social distancing is challenging as workers tend to move around yet maintaining a 1 metre distance from one another can minimize exposure.

Risk assessments enable to analyse the possible risk level of hazards and to implement appropriate control measures in order to minimize health effects or property damage. Authorities are able to conduct inspections of waste and recycling companies to gather wider data in the field of occupational health and safety.²³ However, capturing accurate data on occupational disease is extremely challenging due to numerous factors, such as the commitment, awareness, the culture of safety, and teamwork.²⁴ The provision of health education on biological agents is essential in order to prevent the spread of infection. Airborne droplets constitute a risk of transmission during supervisor briefings or from contact with inanimate objects while performing job tasks. However, the practice of safety in the workplace is inadequate as a result of

poor knowledge and attitude.^{25,26} Thus, occupational infectious diseases can be avoidable by cultivating personal hygiene and sanitation measures such as covering wounds, frequent washing of hands, and showering after work.²⁷

Using personal protective equipment is the least effective control method in the hierarchy, yet is widely practiced.²⁸ Employers provide personal protective equipment to workers in order to comply with the Occupational Safety and Health Act 1994. However, the continuity and monitoring of supplying personal protective equipment is still scant. Employment status as a daily or permanent worker probably affects accessibility to personal protective equipment. A local study reported that 57% of respondents disagreed that workers frequently use personal protective equipment, while 33% claim to use personal protective equipment, and the remaining 10% appear to be neutral; meanwhile, workers unable to access personal protective equipment reflect poor practice of safety in the workplace.²⁹

The above-highlighted measures act as a secondary barrier to protect exposure of the mucous membranes or skin, which serve as potential entry sites for biological agents that can infect the human body. To break the chain of transmission, it is essential to eliminate the contact between workers and contaminated rubbish. Solid



Figure 1. Municipal waste collectors performing waste collection activities. A) Inspection of a compactor lorry. B) Moving to a designated location. C) Collection of garbage. D) Manipulation of a compactor lorry. E) Unloading garbage at the disposal site.

Table 1. High-risk exposure to biological hazards during waste collection activities.

No.	Work activity	1. Hazard identification		Existing risk control (if any)	2. Risk analysis			3. Risk control Recommended control measures
		Hazard	Cause/effect		L	S	R	
1	Picking up garbage; carrying garbage; lifting garbage.	Biological: A bacterium, virus, fungus, parasite, or toxin acquired after contact with contaminated garbage or from insect bites.	(1) Bacteria leptospirosis, c holera, dysentery, tetanus. (2) Viral - HVA, HBV, and HCV. (3) Skin- dermatitis, cellulitis, and abscesses. (4) Vector-borne diseases - dengue and Japanese encephalitis. (5) Anaphylactic shock -venom and allergens.	Administrative: (1) Worker is advised to strictly adhere to using personal protective equipment. (2) First aid box kept in vehicles. (3) A worker with an injury or wound is referred to the clinic. (4) Worker is advised to wash hands after work. (1) Cut-resistant gloves. (2) Uniform. (3) Safety boots.	5	4	20	Engineering: (1) Pick up a stick to reduce contact. (2) Install a hand wash corner. (3) Use a roller to shift garbage. Administrative: (1) Carry out medical surveillance. (2) Keep hand sanitizer in each compactor lorry. (3) Supervisor to ensure worker covers wound with a water-resistant bandage. (4) Provide sufficient PPE to workers. (5) Provide health education on biological hazards once a year.
2	Mechanical manipulation of compactor lorry to store garbage.	Biological: Contaminated droplets are dispersed into the air during mechanical garbage storage.	(1) URTI - acute pharyngitis and acute laryngitis. (2) LRTI - pneumonia, bronchitis, COVID-19, adenovirus, and norovirus. (3) Anaphylactic shock -allergens.	Administrative: (1) Worker is advised to strictly adhere to using PPE. (2) Maintain personal hygiene (i.e., wash hands after work and following cough etiquette). PPE: (1) Cut-resistant gloves. (2) Uniform. (3) Safety boots. (4) Masks.	4	4	16	Administrative: (1) Provide health education on biological hazards.
3	Unload and remove all garbage collected at the disposal site.	Biological: A bacterium, fungus, parasite, or toxin is acquired after contact with contaminated garbage.	(1) Bacteria - Leptospirosis, cholera, dysentery, and tetanus. (2) Viral - HVA, HBV, and HCV. (3) Skin - dermatitis, cellulitis, and abscesses. (4) Vector-borne diseases -dengue and Japanese encephalitis. (5) Anaphylactic shock -venom and allergens.	Administrative: (1) Supervisor to ensure worker is fit to work, and to refer unwell workers to the clinic. (2) Buddy system. (3) Shift working system. PPE: (1) Gloves. (2) Uniform. (3) Boots.	4	4	16	Engineering: (1) Install a button system to operate the hydraulic pump. (1) Provide safety training on handling the hydraulic pump once a year. (2) Provide a health surveillance program once a year.

L, likelihood; S, severity; R, risk score; HAV, hepatitis A virus; HBV, hepatitis B virus; HCV, hepatitis C virus; URTI, upper respiratory tract infection; LRTI, lower respiratory tract infection; PPE, personal protective equipment.

Table 2. Low-risk exposure during waste collection activities.

No.	Work activity	1. Hazard identification		Existing risk control (if any)	2. Risk analysis			3. Risk control Recommended control measures
		Hazard	Which can cause/effect		L	S	R	
1	Assist in inspecting the compactor lorry and report the results to the lorry driver.	Biological: Unclean lorry transmits microorganisms when in contact with body parts.	(1) Bacteria - Leptospirosis, cholera, dysentery, and tetanus. (2) Viral - HVA, HBV, and HCV. (3) Skin - dermatitis, cellulitis, and abscesses.	Administrative: (1) Compactor lorries are washed after disposing of garbage. (2) Workers with dermatitis are referred to the clinic. (3) Management are informed of history of any allergies or medical conditions. PPE: (1) Gloves. (2) Uniform. (3) Safety boots.	1	4	4	Administrative: (1) Keep hand sanitizer in each vehicle. (2) Supervisor to ensure worker covers wound with a waterproof bandage.
2	Move to the location as assigned by the supervisor.	Biology: Contact with sick workers.	(1) URTI - cute pharyngitis and acute laryngitis. (2) LRTI - pneumonia, bronchitis, COVID-19, and tuberculosis.	Administrative: (1) Fever surveillance is carried out. (2) Sick workers are referred to the clinic. (3) Masks are worn.	1	3	3	Administrative: (1) Provide health education (including hand hygiene and cough etiquette). (2) Practice social distancing 1 meter apart from each other. (3) Talk about awareness and preventing respiratory diseases in the workplace once a year.

L, likelihood; S, severity; R, risk score; HAV, hepatitis A virus; HBV, hepatitis B virus; HCV, hepatitis C virus; URTI, upper respiratory tract infection; LRTI, lower respiratory tract infection; PPE, personal protective equipment.

waste landfill requires additional measures in terms of education regarding safety, engineering control, and further evaluation of hazards.³⁰ Engineering modifications of compactor lorries with lifting garbage bin equipment or a hand washing corner should be considered. In the Netherlands, the government addressed biological hazards and implemented guidelines to limit the amount of garbage collection and the duration of periods of work, and an underground storage system with an automated mechanical arm was introduced to carry the container.³¹

Specific jobs require designated health surveillance to assess the physiological and clinical presentation of workers prior to commencement or periodically.³² However, medical practitioners have no specific checklist or medical surveillance format for workers in the waste management industry. Baseline readings of the liver and renal function are important to monitor for biological agents such as *Leptospira* that target the liver and kidneys.¹³ A health effect survey among rubbish collectors reported that 28% had a skin disease, 38% had a respiratory disease, and 60% had a fever, sore throat, and cough. The longer the duration of employment, the more significant the difference in the occurrence of skin and respiratory diseases.³³ Thus, periodic medical surveillance is necessary to screen and detect early any medical conditions in order to prevent mortality and morbidity.

During the study, it is impracticable to quantify or identify a specific biological hazard in an outdoor working activity because varies biological agents present in the environment. However, this study will be helpful for future paper to actually list health status or incidence rates of diseases of the workers within each grouping. This study also provide baseline data against which future post-implementation papers can be compared. Hence, finding of this study shared with safety and health department of the organization to implement the control measures as recommended confer to risk assessment. Safety and health officer advised to monitor the progress of the control measure for certain period of time and reassess again. Concurrently, the safety and health prevention practice at workplace need to be improve step by step adapting to latest standard operation procedures by the legal authority.

Conclusions and recommendation

Workers in the waste management industry are at significant risk for contracting infectious diseases, because their job exposes them to contaminated working environments. It is important to conduct regular risk assessments in order to analyse each working activity and to implement control measures so as to break the chain of transmission. Any breach of safety during garbage picking has the highest risk of transmitting biological agents. Besides this, close contact with sick workers during briefings and checking unclean compactor lorries further increase the risk of contracting infectious diseases. The preventive measures in the waste collection industry are influenced by several factors, such as the commitment of management, financial allocation, the availability of technology and intervention, and policy. Nevertheless, it is important to ensure and monitor the safety awareness, personal hygiene, and personal protective equipment use of workers. Periodic medical surveillance must include relevant parameters for the early screening and detection of infectious disease. Until the above preventive measures are adopted into practice and adapted according to each company's requirements, biological agents continue to be risk factor to the health workers in this industry.

Correspondence: Mohammad Saffree Jeffree, Community and Family Medicine Department, Faculty of Medicine and Health Science, Universiti Malaysia Sabah, Kota Kinabalu, Sabah, Malaysia. E-mail: saffree@ums.edu.my

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