

Study on Occupational Health Hazards of Municipal Solid Waste Workers - A Review

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ABSTRACT

Occupational health hazards refer to possible adverse health impacts one undergoes in their working environment. Annually 2.1 billion tons of waste is produced around the world which is usually managed by municipal solid waste workers (MSW) or municipal workers. Managing the waste produced is not an easy task as they work tirelessly. The municipal workers undergo many occupational hazards due to their poor working conditions, poor health and hygiene facilities, lack of proper protective equipment, and less or zero knowledge of proper waste management techniques. The occupational risks include biological risks from pathogens and pathogen-carrying agents such as viruses, bacteria, flies, and rodents; chemical risks from wastes such as biomedical wastes, soaps and detergents, and other poisonous substances and physiological risks due to their working conditions and heavy physiological activity. The health problems of municipal solid waste workers can be classified into musculoskeletal, respiratory, headaches, and dermatological and gastrointestinal problems. Prolonged exposure may lead to problems such as allergies, stomach pain, asthma, and other diseases. Poor working conditions, education, and socioeconomic conditions also act as factors that increase the risk of occupational hazards. This article emphasizes on the types of various health impacts through which municipal workers undergo throughout their work.

Keywords: Occupational, MSW workers, Musculoskeletal, Socioeconomic, Pathogens, Physiological

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Received: 25 November 2022

Accepted: 01 March 2023

INTRODUCTION

Waste is any material that is discarded after first use or is unusable, worthless, or damaged. This includes hazardous waste, municipal solid waste (household waste), radioactive waste, etc (Patil & Kamble, 2017). Urban areas are generating more solid waste than ever before thanks to population growth and economic development (Jayakrishnan *et al.*, 2013). In developing countries, hazardous wastes are often dumped directly into the environment threatening human health and the ecosystem. However, with so many different sources of waste, it appears to be a difficult process for governments to regulate the growing problem of hazardous compounds in the environment (Enger & Smith, 2004). These tasks are often performed by workers known as community laborers. The garbage that is discharged for collection is frequently thrown directly on the ground in poor nations instead of being stored in closed containers, necessitating manual shoveling, or it is placed in open containers that need to be picked up manually (Jayakrishnan *et al.*, 2013).

India has 2.9 billion urban dwellers, each of whom emits 0.64 kg of municipal solid waste (MSW) every day. About 3 billion people live in the world now, producing 1.2 kilograms per person every day. By 2025, there will likely be 4.3 billion urban

residents and 1.42 kilograms of MSW produced daily per person. India is a nation with a sizable rural population. By 2026, however, it is anticipated that 40% of Indians would reside in urban areas. Currently, it is projected that the country's urban areas produce 48 million tons of solid trash and 4,400 million cubic meters of liquid waste each year (Joshi & Ahmed, 2016; Mankani, 2020). The nature of the garbage being handled, the emissions from those materials, and the tools being utilized expose workers and waste collectors to a variety of dangers, health concerns, and accidents (Nasufi *et al.*, 2019).

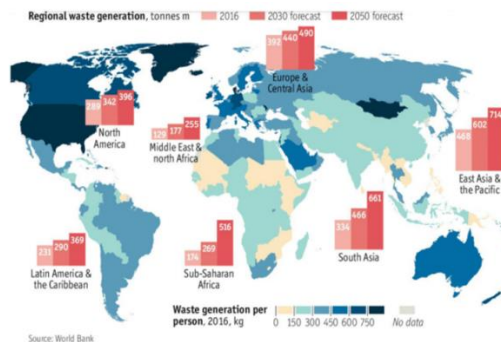


Figure 1. Present scenarios and future projections of waste production (Kumar & Agrawal, 2020)

According to the latest data, **Figure 1** shows that the average amount of waste produced per person ranges from 150 to 300 grams. The World Bank also provides comparisons of the current conditions and future projections for several regions of the world. According to the World Bank in 2015, the average waste generation in 2016 ranged from 0.09-0.60 kg per person per day in lower-income areas, 0.16-0.79 kg for the lower-middle income group, and 0.1-1.2 kg for the upper-middle income group. According to projections from the years 2016–2050, this global trend in regional garbage generation will continue to double as seen in the image above (Kumar & Agrawal, 2020).

Street sweepers dealing with waste and dirt face many hazards (Dutkiewicz, 1997; Krajewski *et al.*, 2002). In most countries, whether developing, emerging, or industrialized, road cleaning is often done manually by individuals or groups. Sweeping can be done with a push broom, as it is common in developing countries, or mechanically, such as with a leaf blower (Van Kampen *et al.*, 2020). Street sweeping is one of the most common works for disadvantaged people in India (Jhony *et al.*, 2014). Nigerian research also revealed that 30% of street sweepers had no formal education (Wahab & Ogunlola, 2014). The majority of the 70 street cleaners from Kenya who participated in the study had minimal knowledge of occupational health risks and safety, such as the spread of infections (Sabde & Zodpey, 2008).

The involvement of city officials is necessary to improve the quality of service delivery, which will raise citizens' socioeconomic standing (Mhlanga *et al.*, 2019). Their poor, unsanitary living conditions in urban slums and the nature of their work expose them to potentially harmful bioaerosols that could transmit various diseases are also factors. Large numbers of fleas, unpleasant odors, and lack of proper protective equipment in landfills make the work environment even more unsanitary (Chandramohan *et al.*, 2010).



Figure 2. Open Waste dumping at Kudzanai market, Bangladesh (Jerie, 2016)

A study on Safaikaramcharis in Mumbai describes the various interconnected elements of the vicious cycle that maintains successive generations of safaikaramcharis in the same line of work. Caste is the first component. The second is addiction, where virtually all safaikaramcharis rely on drinking, smoking, chewing tobacco, or other drugs as coping mechanisms for employment. The third factor is health. Poor health increases absenteeism and leads to the fourth factor: Debt. Government policies shape the sixth factor, and the final factor is how the safaikaramcharis view themselves and their line of work (Salve *et al.*, 2019).

Occupational hazards

A risk or hazard experienced at work is referred to as an occupational hazard. Chemical dangers, biological hazards, psychological hazards, and physical hazards are the most common types (Koul & Dogra, 2022). Occupational health is defined as maintaining employees' levels of physical, mental, and social well-being at the highest levels across all occupations while keeping workplace health-related harmful effects at the lowest levels, putting into practice preventative measures to lessen those harms, and placing employees in positions that are compatible with their physical, psychological, and anatomical makeup (David & Jeyaratnam, 2002).

Occupational health hazards

An estimated 2.3 million waste pickers annually die from the negative effects of their job worldwide, with an estimated 270 million suffering from occupational injuries, accidents, and diseases (Lissah *et al.*, 2022). Risks can arise at any point during the process, including during transportation, at the locations where waste is collected from households, and during recycling or disposal. The way the workers handle the materials and the equipment they use accounts for occupational risks and accidents (Porta *et al.*, 2009).

Waste collectors around the world suffer from serious public health issues including work-related injuries, fatigue, morbidity effects, and disease accidents (Lasota & Hankiewicz, 2020). Unfortunately, data indicates that household waste collectors are less safeguarded against work-related hazards, either actively or passively, throughout the collection and movement to final disposal locations (Gbekor, 2003; Cointreau, 2006; Porta *et al.*, 2009).

The social stigma associated with waste pickers was found to be a major issue in India (Snel, 1999). The socioeconomic standing and unfavorable working circumstances of the garbage collectors have been noted (De Croon *et al.*, 2005). Discrimination against waste management personnel continues to persist, even in Japan (Tateda, 2008). In Palestine (Melhem, 2004) and Nigeria, the socioeconomic status of domestic waste collectors was found to be low. This indicates that most of the workers collected household waste only as a last resort when there were no other alternatives in the absence of other alternatives (Inyang, 2007).

Table 1. Risks to which workers are commonly posed (Nasufi *et al.*, 2022) (H- High risk, M - moderate risk, L - low risk)

Sl.No	Condition	Hazard	Risk
1	Mechanical Hazards	Catching hands or parts of clothing in moving parts of the truck, during placing the containers on the holders	H

		Detaching the container from the truck supports and pushing the worker	H
		Slipping or missing the stand on the back of the truck when getting on or off	H
		Slipping due to not wearing proper non-slip shoes	H
		Falling when getting on or off the truck while it is moving	H
2	Hazards due to the characteristics of the terrain work	Slippery and dirty handrails can cause falls when climbing onto the garbage truck stand	H
		Moving on wet or uneven surfaces when picking up, carrying to the truck, and emptying trash cans	L
		Moving past scattered or scattered municipal waste	L
		Danger due to dog attack when working outdoors	H
3	Chemical Hazards	Inhalation of unpleasant odors, dangerous volatile substances, gases, or dust during garbage collection	M
4	Physical harm	Noise generated by the waste collection truck as well as other sources of noise	L
5	Climatic condition	Outdoor work, exposure to high or low temperatures, wind, rain, snow, and other sources of noise.	H
6	Biological hazard	Infectious agents, microorganisms, allergens and bacteria, hazardous waste, and other decomposed substances	H
		Manual lifting of garbage cans and placing them in position for emptying in the garbage truck	H
7	Psycho-Physiological exertions	Exertions due to a non-physiological state of the body associated with prolonged standing	M
		Bending, pushing, and pulling when lifting bins and picking up scattered rubbish	M
		Stress due to performing heavy physical work with increased intensity	M
		Activities during increased workload, shift work, overtime work	M
8	Organization of work	Lack of education about the safety of one's workplace and the importance of taking care of oneself and one's colleagues	H

Threats to the environment include a lack of understanding and awareness of the health risks associated with garbage, a lack of an appropriate mechanism for disposal, and the indiscriminate placement of waste everywhere (such as along roadsides, riverbanks, and drains). Workers in the waste industry had a variety of illnesses and health issues. They frequently have respiratory symptoms, headaches, musculoskeletal symptoms like fatigue, backaches, and bodily discomfort, as well as runny nose, sneezing, and coughing. Similarly to this, skin rashes, vomiting, and diarrhea are regular issues faced by waste pickers (Raj, 2018).

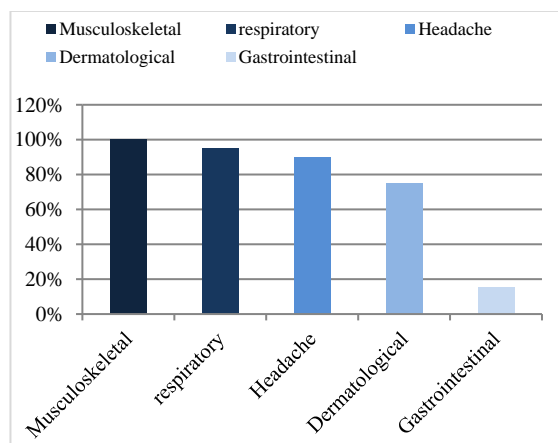


Figure 3. Health problems in solid waste collecting workers during work

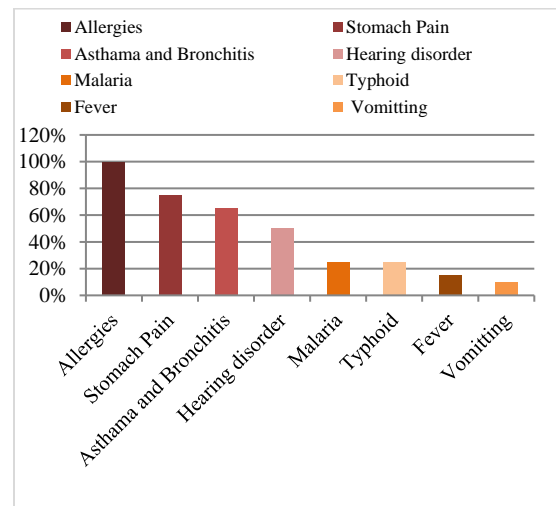


Figure 4. Health problems in solid waste collecting workers after completion of work (Patil & Kamble, 2017).

Out of the municipal workers chosen for the study by Patil and Kamble in 2017, it is seen that during their work, health-related problems are reported by them. These include respiratory symptoms like phlegm, asphyxiation, cough, and wheezing; musculoskeletal symptoms like wrist pain back pain, and wrist pain in all workers, 90% symptoms of dermatological symptoms like rashes and itching, 75% symptoms of headache

problems, and 15% symptoms of gas (nausea and diarrhea). Allergies were reported by all workers, cough, and colds in 75%, asthma, and bronchitis lungs in 65%, and hearing disorders were reported by 50% of workers; these conditions may be brought on by exposure to offensive odors, road dust, and traffic noise. 25% of workers had malaria and 10% had typhoid, while 15% had a fever and 10% had vomiting issues.

Musculoskeletal disorders

Waste collection is a physically demanding job, which is the reason for high prevalence rate of musculoskeletal disorders (Ewis *et al.*, 2013). Musculoskeletal and ergonomic risks are injuries caused by improper body motions. Damage can occur during waste collection as the effect of strenuous physical labor, such as hauling the waste and pushing carts and heavy bags of recyclables (Scheneck *et al.*, 2019).

With age, human physiological processes alter. Older cleaning and trash employees, like older individuals in general, have a weak sense of balance, a constrained ability to perceive, and a lack of judgment in harmful situations. A worker may lose balance and fall if they are unable to balance themselves after slipping, which can result in several injuries. In research looking at injuries from street cleaning occupations in Korea from 2009 to 2011, these correlations were identified (Jeong, 2017). In affluent nations, automated trucks are utilized to pick up and dump trash cans utilizing hydraulic lifts (Snel, 1999).

In musculoskeletal disorders, Low back (22%) and shoulders (15%) were the most commonly affected body parts among waste collectors, followed by the neck (7%) and knee (6.7%), and then the thighs and elbows (5.8% each) (Abou *et al.*, 2012).

Respiratory disorders

There may be a connection between working at open dumps and an increase in respiratory illnesses and faulty lung function tests, according to studies conducted in various nations (Porta *et al.*, 2009). Exposure to biologically active substances, gases, bioaerosols, and dust with high concentrations of organic content such as bacteria and fungi is linked to an increased risk of respiratory disease (Jayakrishnan *et al.*, 2013). Other risks

could include exposure to bioaerosols from biomass plants or organic composting facilities, where concentrations of microbes have been measured to be up to thousands of times higher than the atmosphere (Poole & Basu, 2017).

Manual waste collection and street sweeping may cause a variety of diseases related to respiration, including dermatitis, diarrhea, allergic broncho-pulmonary mycosis, hypersensitivity pneumonitis, rhinitis, and irritation of the mucous membranes. Gases such as hydrogen sulfide, methane, ammonia, and carbon monoxide are frequently exposed by workers. Using information from a cross-sectional survey of 273 street sweepers in India, additional analysis was done. The authors observed chronic respiratory morbidity while accounting for several risk factors, including age, sex, socioeconomic position, length of employment, smoking habit, type of home, location, cooking fuel, and pets (Sabde & Zodpey, 2008). According to a study by Singh and Ladusingh in 2017 the municipal workers were more prone to chronic bronchitis (Singh & Ladusingh 2017). These findings show that these workers may have had lower lung capacities due to exposure to pathogens from municipal waste, road dust, pulling heavy vehicles packed with solid trash, and lifting waste container bins. These findings demonstrate that these employees' lung capacity had decreased, and they also have asthma, bronchitis, and other lung conditions (Patil & Kamble, 2017).

Infections

According to the study, waste handlers had a high frequency of nail infections. 47% of people had infections in their nails on their fingers or toes, with the majority of these infections being fungal and lesions having subsequent bacterial infections that were made worse by frequent soaking brought on by direct contact with garbage (Jayakrishnan *et al.*, 2013). The dengue-carrying mosquito *Aedes aegypti* prefers breeding in containers, tires, and tin cans found in trash heaps that contain small, clean water pools. The physicochemical properties of coconut shells, as opposed to plastics and pots, enhance mosquito development; these shells were abundant in the solid waste of these areas (Jayakrishnan *et al.*, 2013).

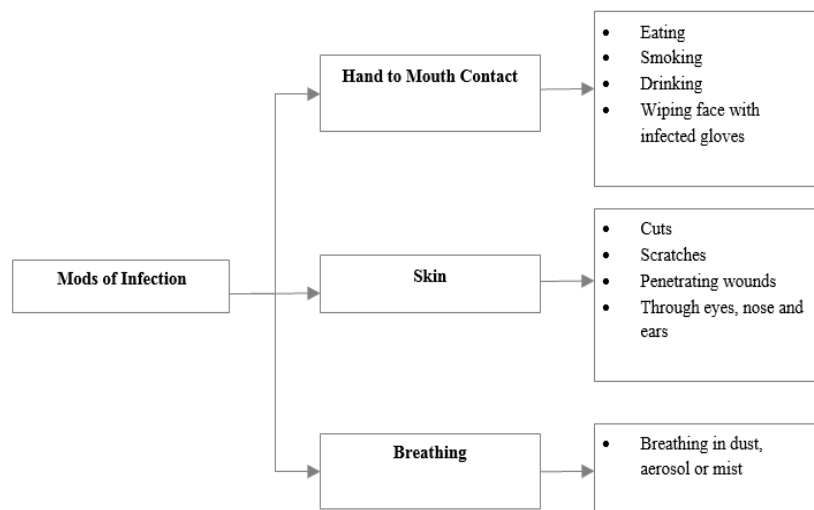


Figure 5. The ways of entry for the various infectious agents (Tiwari, 2008)

The reproduction rate of disease vectors like the Diptera and cockroaches has been aided by open space dumping in business backyards and makeshift pit dumping (Diptera). The *Muscadomestica* (housefly) and a species of tropical green blowfly were the two fly species that were most significant from the perspective of disease transmission seen in the enterprise dumping locations (*Chrysomya*). Over a temperature of 20 C to 30 C, *Muscadomestica* can develop in less than two weeks after the eggs are laid and habitat on solid, wet, and decaying organic waste (*Tchobanoglous et al., 1993*). The biological risks that garbage pickers in landfills encounter include diseases brought on by consuming contaminated food (*Almoslim & Ibrahim, 2020; Phan et al., 2020*) and water, contacting the animal flesh, feces, blood, or other body fluids, and dead or alive diseased animals like rats (*Schenck et al., 2019*). Vectors like flies and mosquitoes breed inside the landfill during the summer and spread to other areas (*Chandramohan et al., 2010*).

Table 2. Common diseases among waste workers are spread by infection (*Tiwari, 2008*)

Leptospirosis	Leptospirosis is a serious occupational illness that can affect anyone who comes into touch with animals or an animal's excrement. The likelihood of infection at one's place of employment is correlated with the atmosphere in which the worker works and the organism's compatibility with that environment.
Hepatitis	The most common disease that can be prevented with a vaccine is the hepatitis A (HA) virus. Acute hepatitis A is associated with significant morbidity and a corresponding burden economically, even though it is typically self-limiting. A few research suggested that sewage workers had higher HAV antibody titers.
Helicobacter pylori	Studies have shown that sewage employees have a higher chance of developing stomach cancer. The bacteria <i>Helicobacter pylori</i> , which is now regarded as a class I carcinogen, has emerged over the past ten years as one of the major risk factors for stomach cancer.

Dermatological problems

89% and 15%, respectively, of Indians from Bombay and Calcutta had eye problems (*Jathli, 2012*). The most common eye issues were burning, redness, and itching of the eyes. An earlier study found a temporal connection (6 18%) and a strong association (relative risk 1.7) between this occupation and eye illness (*Jayakrishnan et al., 2013*). According to a study, genito-urinary symptoms are more common among women employees in the state than in men (25% vs. 33.5%), and they can be brought on by infections of the urinary or reproductive tract. Reduced water intake and delayed bladder emptying were revealed to be risk variables (OR 1.1 2.1) for related urinary symptoms in previous research on female workers (*Jayakrishnan et al., 2013*).

To dispose of rags in the streets, the city corporations are given permanent and temporary containers in pits made of plastic and cement. However, individuals simply discard their trash in public areas like street corners and by the side of the road

without segregation. Because of this, garbage separation is a huge task for waste collectors, who are currently suffering from a lot of accidents. Most of them do not adhere to safety precautions including donning gloves, boots, helmets, paint, and complete shirts (*Arivanandan & Jaiswal, 2020*).

Gastrointestinal problems

In 2017, many cross-sectional investigations by *Poole & Basu* revealed that these workers had more ocular, nasal, respiratory, cutaneous, and gastrointestinal complaints (*Poole & Basu, 2017*). In a survey of 276 trash recycling workers in Denmark, 58 (21%) of them reported experiencing nausea at least once a month (*Ivens et al., 1997*). A total of 37 out of 274 people (13%) reported having diarrhea, with the female group exhibiting higher symptoms than the male counterparts. Gastroenteritis can result from sanitary workers not practicing good hygiene and ingesting viruses like rotaviruses and adenoviruses. The individual may display the warning signs and symptoms including nausea, vomiting, and diarrhea with water (*Pintakham & Siriwong, 2015*).

In a study on gastrointestinal problems, indigestion, flatulence, worm infestation, and diarrhea were the most prevalent symptoms (65.3%, 38.4%, 24.5%, and 22.2%, respectively) (*Mahajan et al., 2017*). The exposed group had significantly more gastrointestinal problems. There were frequent reports of stomach cramps, diarrhea, dyspepsia, vomiting, or dysentery (*Abd El-Wahab et al., 2014*).

Other health problems

Cadmium, which has toxicological qualities from its similarities to zinc, is present in the wastes produced by the industries, including pb and zn batteries, PVC, and detergent boxes. In the human body, cadmium builds up and affects several organs, including the liver, lungs, placenta, brain, kidneys, and bones (osteomalacia and osteoporosis). Hepatic, hematological, and immunological impacts as well as reproductive and developmental toxicity are other forms of harm that have been noted (*Jerie, 2016*).

Gases, pressurized gases, toxic chemicals, and air pollution are considered chemical dangers since they can cause neurological disorders, skin problems, respiratory issues, and kidney and liver ailments (*Jerie, 2016*). Researchers note that burning waste can produce gases and smoke, either as a method of management of it or to recover the metals embedded in electronic cables (*Mathema et al., 2017*).

CONCLUSION

Around the world, 2.1 billion tons of waste are thrown out per year. The amount of waste production is expected to reach 3.4 billion tons by the year 2050. The rapidly increasing population is the reason for ever-increasing waste production. The municipal workers or solid waste workers work tirelessly in managing the waste produced. Their work has contributed a lot to humanity by controlling various diseases such as Malaria and Cholera that could have affected a large group of the population. These people work in hazardous environments and have to go through challenging situations. Lack of protective equipment, basic facilities, and safety measures increase the risk of exposure to various dangerous hazardous substances. Additionally, they have to face social discrimination

since the waste collection is considered a lower-level job. In most countries, they are considered daily wage workers and devoid of many healthcare and hygiene facilities. They live in poor conditions which lack basic facilities which increase the risk of exposure to some potential health hazards. Till today no thorough research has been carried out related to the management of solid waste in a safe manner and condition of municipal workers. Some underdeveloped and developing countries are still in search of effective waste-to-energy technologies. A developing nation needs to implement an economically viable and tested waste management system. If the workers continue using the same old methods then using protective gear will not make a major difference in their health levels. Converting the traditional methods into more modern and engineered solutions should be the main goal of research. The work-related health service should include monitoring before placement and monitored throughout the work.

ACKNOWLEDGMENTS: None

CONFLICT OF INTEREST: None

FINANCIAL SUPPORT: None

ETHICS STATEMENT: None

REFERENCES

- Abd El-Wahab, E. W., Eassa, S. M., Lotfi, S. E., El Masry, S. A., Shatat, H. Z., & Kotkat, A. M. (2014). Adverse health problems among municipality workers in Alexandria (Egypt). *International Journal of Preventive Medicine*, 5(5), 545-556. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4050674/pdf/IJPVM-5-545.pdf>
- Abou-ElWafa, H. S., El-Bestar, S. F., El-Gilany, A. H., & Awad, E. E. S. (2012). Musculoskeletal disorders among municipal solid waste collectors in Mansoura, Egypt: a cross-sectional study. *BMJ Open*, 2(5), 1338-1346. doi:10.1136/bmjopen-2012-001338
- Almoslim, H., & Ibrahim, S. (2020). Anorexic: impact of complement protein along with additional food consumption and exercise on Ectomorphism and energy variable amongst males. *Pharmacophore*, 11(4), 83-87.
- Arivanandan, M., & Jaiswal, A. (2020). Occupational Health and Safety of Workers in Municipal Solid Waste Management System. *International Journal of Clinical Studies and Medical Case Reports*, 2(5), 1-4. <https://ijclinmedcasereports.com/ijcmcr-rw-id-00049/doi:10.46998/IJCMCR.2020.02.000049>
- Chandramohan, A., Ravichandran, C., & Sivasankar, V. (2010). Solid waste, its health impairments and role of rag pickers in Tiruchirappalli city, Tamil Nadu, Southern India. *Waste Management and Research*, 28(10), 951-958. doi:10.1177/0734242x09352705
- Cointreau, S. (2006). Occupational and Environmental Health Issues of Solid Waste Management Special Emphasis on Middle- and Lower-Income Countries. *World Bank Group*, 1(1). <https://documents.worldbank.org/en/publication/documents-reports/documentdetail/679351468143072645/occupational-and-environmental-health-issues-of-solid-waste-management-special-emphasis-on-middle-and-lower-income-countries>
- David, K., & Jeyaratnam, J. (2002). *Occupational health: Oxford textbook of Public Health*, 4th Edition. Ed: Detels R, McEwen J, Beaglehole R, T Heizo; Oxford University Press 2002.
- De Croon, E., Sluiter, J., Kuijer, P. P., & Frings-Dresen, M. (2005). The effect of office concepts on worker health and performance: a systematic review of the literature. *Ergonomics*, 48(2), 119-134. <https://pubmed.ncbi.nlm.nih.gov/15764312/doi:10.1080/00140130512331319409>
- Dutkiewicz, J., (1997). Bacteria and fungi in organic dust as potential health hazard. *Annals of Agricultural Environmental Medicine*, 4, 11-16.
- Enger, E. D., & Smith, B. F. (2004), A study of interrelationships. *Environmental Science*. Edward E. Bartell. California, USA.
- Ewis, A. A., Rahma, M. A., Mohamed, E. S., Hifnawy, T. M., & Arafa, A. E. (2013). Occupational Health-Related Morbidities Among Street Sweepers And Waste Collectors At Beni-Suef, Egypt. *Egyptian Journal of Occupational Medicine*, 37(1), 79-94. doi:10.21608/ejom.2013.773
- Gbekor, A. (2003). Domestic waste management. *Ghana Environmental Protection Agency (EPA) Newsletter*, 47(5), 12-17.
- Inyang, M. P. (2007). Educating young people against risky sexual behaviors. Education for Social Transformation. *Ibadan University Press*, 8(2), 290-300. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2584331/>
- Ivens, U. I., Ebbehøj, N., Poulsen, O. M., & Skov, T. (1997). Gastrointestinal symptoms among waste recycling workers. *Annals of Agricultural and Environmental Medicine*, 4(1), 153-157. https://www.academia.edu/71073066/Gastrointestinal_symptoms_among_waste_recycling_workers
- Jaitli, H. (2012). Health Problems. A Rapid Assessment Survey of the Health and Environmental Impacts of Solid Waste Recycling. *Centre for Study in Man and Environment*, 1(1), 36-42. https://pria.org/knowledge_resource/A_Rapid_Assessment_Survey_of_the_Health_and_Environment_Impacts_of_Solid_Waste_Recycling_2.pdf
- Jayakrishnan, T., Jeeja, M. C., & Bhaskar, R. (2013). Occupational health problems of municipal solid waste management workers in India. *International Journal of Environmental Health Engineering*, 2(1), 42. <http://www.ijehe.org/text.asp?2013/2/1/42/122430/doi:10.4103/2277-9183.122430>
- Jeong, B. Y. (2017). Occupational deaths and injuries by the types of street cleaning process. *International Journal of Occupational Safety and Ergonomics*, 23(1), 76-82. doi:10.1080/10803548.2016.1199500
- Jerie, S. (2016). Occupational risks associated with solid waste management in the informal sector of Gweru,

- Zimbabwe. *Journal of Environmental and Public Health*, 2016(1), 1-14. doi:10.1155/2016/9024160
- Johny, S. S., Dhanyakumar, G., & Samuel, T. V. (2014). Chronic Exposure to Dust and Lung Function Impairment: A Study on Female Sweepers in India. *National Journal of Physiology Pharmacy and Pharmacology*, 4(1), 15-24. <https://www.njppp.com/fulltext/28-1368076597.pdf>. doi:10.5455/njppp.njppp.2014.4.140620131
- Joshi, R., & Ahmed, S. (2016). Status and challenges of municipal solid waste management in India: A review. *Cogent Environmental Science*, 2(1), 1139434. <https://www.tandfonline.com/doi/full/10.1080/23311843.2016.1139434>. doi:10.1080/23311843.2016.1139434
- Koul, V., & Dogra, S. (2022). Occupational hazards in prosthodontics amongst Interns. *International Journal of Health Sciences*, 6(S5), 1679-1681. <https://www.neliti.com/publications/431293/occupational-hazards-in-prosthodontics-amongst-interns>doi:10.53730/ijhs.v6n5S5.8959
- Krajewski, J. A., Tarkowski, S., Cyprowski, M., Szarapińska-Kwaszewska, J., & Dudkiewicz, B. (2002). Occupational exposure to organic dust associated with municipal waste collection and management. *International Journal of Occupational Medicine and Environmental Health*, 15(3), 289-301.
- Kumar, A., & Agrawal, A. (2020). Recent trends in solid waste management status, challenges, and potential for the future Indian cities—A review. *Current Research in Environmental Sustainability*, 2(1), 100011. doi:10.1016/j.crsust.2020.100011
- Lasota, A. M., & Hankiewicz, K. (2020). Self-reported fatigue and health complaints of refuse collectors. *Central European Journal of Operations Research*, 28(2), 633-643. doi:10.1007/s10100-019-00637-w
- Lissah, S. Y., Ayanore, M. A., Krugu, J. K., Aberese-Ako, M., & Ruitter, R. A. (2022). Our Work, Our Health, No One's Concern": Domestic Waste Collectors' Perceptions of Occupational Safety and Self-Reported Health Issues in an Urban Town in Ghana. *International Journal of Environmental Research and Public Health*, 19(11), 6539-6557. <https://www.mdpi.com/1660-4601/19/11/6539>doi:10.3390/ijerph19116539
- Mahajan, S. M., Pawar, K. H., Jadhav, V. S., & Magare, A. R. (2017). Health Status of Sanitary Workers of Municipal Corporation of Aurangabad City. *Indian Journal of Preventive Medicine*, 5(2), 90-96. doi:10.21088/ijpm.2321.5917.5217.7
- Mankani, R. (2020). Challenges of Solid Waste Management in India. *Ajanta- ISSN 2277-5730*, 7(1), 91-98.
- Mathema, M., Shadung, J. M., & Chris, L. (2017). A review of the working conditions and health status of waste pickers at some landfill sites in the city of tshwane metropolitan municipality, South Africa. *Advances in Applied Science Research*, 8(3), 90-97. <https://www.primescholars.com/abstract/a-review-of-the-working-conditions-and-health-status-of-waste-pickers-at-some-landfill-sites-in-the-city-of-tshwane-metr-90473.html>
- Melhem, Y. (2004). The antecedents of customer-contact employees' empowerment. *Employee Relations*, 26(1), 72-93. <https://www.emerald.com/insight/content/doi/10.1108/01425450410506913/full/html>
- Mhlanga, T. S., Mjoli, T. Q., & Chamisa, S. F. (2019). Personality and job engagement among municipal workers in the Eastern Cape province, South Africa. *SA Journal of Human Resource Management*, 17(1), 1-11. <https://www.doi.org/%E2%80%8B10.4102/sajhrm.v17i0.1188>
- Nasufi, H., Lutovska, M., & Mijakovski, V. (2019). Knowledge assessment of waste management workers in debar regarding occupational safety and health. *XII International Conference on Industrial Engineering and Environmental Protection 2022 (IIZS 2022)*, Zrenjanin, Serbia. The University of Novi sad- Technical Faculty, 6, 343-348.
- Patil, P. V., & Kamble, R. K. (2017). Occupational health hazards in municipal solid waste collecting workers of Chandrapur city, Central India. *International Journal of Environment*, 6(1), 46-57. <https://www.nepjol.info/index.php/IJE/article/view/17358>doi:10.3126/ije.v6i2.17358
- Phan, N. H. D., Nguyen, T. T., Tran, T. B. H., Vo, N. T., Le, T. T. T., Quang, M. T., Le, T. A. H., & Lao, T. D. (2020). Exploring the PCR assay for detecting tropomyosin: major allergen in shrimp-derived ingredient in the food. *Pharmacophore*, 11(2), 53-57.
- Pintakham, K., & Siriwong, W. (2016). Prevalence and Risk Factors Associated with Musculoskeletal Discomfort among Street Sweepers in Chiang Rai Province, Thailand. *IOSR Journal of Environmental Science, Toxicology and Food Technology*, 9(7), 15-18. <https://he01.tci-thaijo.org/index.php/jhealthres/article/view/77941>DOI: 10.9790/2402-09721518
- Poole, C. J. M., & Basu, S. (2017). Systematic Review: Occupational illness in the waste and recycling sector. *Occupational Medicine*, 67(8), 626-636. <https://academic.oup.com/occmed/article/67/8/626/4641845>doi:10.1093/occmed/kqx153
- Porta, D., Milani, S., Lazzarino, A. I., Perucci, C. A., & Forastiere, F. (2009). Systematic review of epidemiological studies on health effects associated with management of solid waste. *Environmental Health*, 8(1), 1-14. <https://rdcu.be/c6Dnb>doi:10.1186/1476-069X-8-60
- Raj, Y. (2018). Waste workers and occupational health risks. *International Journal of Occupational Safety and Health*, 8(2), 1-3. doi:10.3126/ijosh.v8i2.23328
- Sabde, Y. D., & Zodpey, S. P. (2008). A study of morbidity pattern in street sweepers: a cross-sectional study. *Indian Journal of Community Medicine*, 33(4), 224-228. <https://pubmed.ncbi.nlm.nih.gov/19876494/>doi:10.4103/0970-0218.43226
- Salve, P. S., Chokhandre, P., & Bansod, D. W. (2019). Substance use among municipal solid waste workers in Mumbai: A cross-sectional comparative study. *Journal of Substance Use*, 24(4), 432-438. <https://www.tandfonline.com/doi/full/10.1080/14659891.2019.1595195>. doi:10.1080/14659891.2019.1595195

- Schenck, C. J., Blaauw, P. F., Viljoen, J. M., & Swart, E. C. (2019). Exploring the potential health risks faced by waste pickers on landfills in South Africa: a socio-ecological perspective. *International Journal of Environmental Research and Public Health*, 16(11), 2059-2080. doi:10.3390/ijerph16112059
- Singh, M., & Ladusingh, L. (2017). Factors associated with chronic bronchitis among municipal sanitary workers in Varanasi, India. *Asian Journal of Epidemiology*, 10, 101-107. doi:10.3923/aje.2017.101.107
- Snel, M. (1999). Integration of the formal and informal sector-waste disposal in Hyderabad, India. *Waterlines*, 17(3), 27-28.
<https://practicalactionpublishing.com/article/742/integration-of-the-formal-and-informal-sector-waste-disposal-in-hyderabad-india>
- Tateda, M. (2008). Commentary: identifying the fundamental key to improving the social status of waste management workers by examining the history of nursing. *Environmental Practice*, 10(2), 66-74. doi:10.1017/S1466046608080101
- Tchobanoglous, G., Theisen, H., & Vigil, S. A. (1993). *Integrated Solid Waste Management: Engineering Principle and Management Issue*. Edition: 1993; McGraw-Hill, New York, ©1993
- Tiwari, R. R. (2008). Occupational health hazards in sewage and sanitary workers. *Indian Journal of Occupational and Environmental Medicine*, 12(3), 112-115. doi:10.4103%2F0019-5278.44691
- Van Kampen, V., Hoffmeyer, F., Seifert, C., Brüning, T., & Bünger, J. (2020). Occupational health hazards of street cleaners—a literature review considering prevention practices at the workplace. *International Journal of Occupational Medicine and Environmental Health*, 33(6), 701-732. doi:10.13075/ijomeh.1896.01576
- Wahab, B., & Ogunlola, B. (2014). The Nature and challenges of street sweeping in Ado-Ekiti. *African Journal for the Psychological Study of Social Issues*, 7(3), 145-167. <http://ajpssi.org/index.php/ajpssi/article/view/128>