
Determinants of Disease Risks Among Waste Pickers: The Role of PPE Availability, Compliance, Workplace Conditions, and Worker Behavior

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Abstract . Waste pickers face a high risk of diseases due to exposure to waste and would exacerbated by limited use of personal protective equipment (PPE) and inadequate working conditions. This study is part of a community service program aimed at improving health protection for workers in the informal sector. A quantitative cross-sectional design using Structural Equation Modeling-Partial Least Squares (SEM-PLS) was employed. Data were collected at the Arista Langgeng waste scrapper site in 2025 through structured questionnaires and field observations involving 33 waste pickers. The analysis was performed using SmartPLS software with the bootstrapping technique to test the significance of relationships among variables. Results showed that PPE availability and compliance significantly affected workers' attitudes ($\beta = 0.301$; $p = 0.008$) and practices ($\beta = 0.595$; $p = 0.000$). Environmental conditions strongly influenced attitudes ($\beta = 0.518$; $p = 0.000$). Attitude was linked to typhoid risk ($\beta = 0.515$; $p = 0.005$), while practice affected diarrhea risk ($\beta = 0.389$; $p = 0.009$). PPE use indirectly reduced these risks through attitude and practice as mediators. In conclusion, promoting PPE availability and compliance among Arista Langgeng waste pickers is vital for reducing diarrhea and typhoid risk through improved occupational health behavior.

Keywords: Personal Protective Equipment, Waste Sorter, Environmental Health, Occupational Diseases, Health Education, Workplace Safety

INTRODUCTION

Environmental health is a crucial aspect that determines the quality of life of communities, where environmental, sociocultural, and economic factors have been proven to exert significant influence [1]. An unhealthy environment can increase the risk of various diseases, as poor sanitation conditions and the lack of hygienic behavior may lead to chronic health impacts [2]. Waste

management remains one of the main challenges in the field of environmental sanitation in Indonesia. Population growth, urbanization, and changing consumption patterns have contributed to a significant increase in waste generation each year [3]. However, this increase has not been accompanied by adequate waste management systems, either in terms of technical capacity, policy implementation, or public awareness. As a result, pollution which is broadly defined as the discharge of human-derived waste into the atmosphere, terrestrial environments, and aquatic systems, continues to pose an urgent and profound threat to global human health. Inadequate waste management practices remain a major contributor to this problem, leading to the contamination of air, soil, and water resources [4]. Consequently, environmental degradation intensifies, and the risk of public health problems such as respiratory diseases, waterborne infections, and other pollution-related illnesses continues to rise [5]. Waste contains various toxic substances, such as heavy metals, insecticides, and other harmful materials, which can pose a risk of chronic digestive disorders to individuals who come into direct contact with it [6]. Environmental pollution resulting from poor waste management may trigger the emergence of various environment-related diseases, including both infectious diseases and chronic illnesses caused by long-term exposure.

The impacts of suboptimal inorganic waste management extend beyond environmental pollution and pose serious public health risks. Accumulated inorganic waste can serve as breeding grounds for disease vectors, generate leachate contamination, deteriorate environmental aesthetics, and contribute to environmentally related diseases such as diarrhea, skin infections, and vector-borne illnesses [7]. Poor waste management has also been linked to an increased risk of dengue fever and other infectious diseases that thrive in unhealthy environments [8,9]. Therefore, inadequate waste management not only degrades environmental quality but also amplifies occupational health risks among waste pickers, highlighting the importance of personal protective equipment availability, compliance, and safe workplace conditions.

Within the waste management chain, the group most vulnerable to health risks is the workers directly involved in waste sorting activities. Waste pickers play a crucial role in recycling and resource recovery by collecting and segregating recyclable materials, however, they frequently operate without protective equipment, institutional support, or access to essential health services and labor protections [10,11]. The waste sorting process requires close contact with various types of waste, thereby increasing the likelihood of exposure to dust, gases, pathogenic microorganisms, and sharp objects. It exposes workers to physical, biological, and chemical risks, increasing their vulnerability to work-related illnesses [12]. This condition makes waste pickers highly susceptible to various health problems [13]. Common health complaints include acute respiratory infections (ARI), skin disorders, helminthiasis, and chronic respiratory symptoms, which may develop into more serious diseases if not properly managed [14,15].

Several previous studies have shown that exposure to waste and low compliance with the use of personal protective equipment (PPE) are associated with an increased incidence of skin diseases and infections among waste workers [16]. Poor personal hygiene practices, limited sanitation facilities, and inadequate working conditions further exacerbate the situation. Humid, dusty, and unsanitary work environments significantly contribute to the high risk of diseases experienced by waste pickers [17,18]. Therefore, improving occupational safety through the consistent use of PPE, better hygiene facilities, and supportive workplace policies is essential to protect waste workers from preventable health risks.

Monitoring environmental quality and promoting hygienic behaviors are essential measures to prevent various environment-related diseases [19]. An unhealthy environment is highly susceptible to contamination by diarrheal pathogens, and when combined with unhygienic food and water

consumption, it can lead to the occurrence of diarrhea [20]. This is particularly relevant in occupations with a high risk of exposure to pollutants, such as among waste pickers. Workers suffering from infectious diseases may transmit infections to family members at home, while reduced productivity due to illness can impact socioeconomic conditions. The poor health status of waste pickers is primarily attributed to their low-income levels, hazardous working conditions, and lack of awareness regarding occupational safety training and preventive measures [21]. Therefore, the health issues of waste pickers should be regarded as a serious public health concern. Efforts to improve occupational health and safety (OHS), provide adequate facilities and infrastructure, strengthen personal hygiene practices, and enforce strict compliance with PPE use are strategic steps to protect this vulnerable group and support the development of a healthier and more sustainable waste management system [22,23].

Although the use of personal protective equipment (PPE) has been proven effective in protecting workers from direct exposure to hazardous substances, the level of availability and compliance in its use remains relatively low in the field. Simple PPE such as masks, gloves, aprons, and rubber boots play an important role in reducing the risk of occupational diseases, particularly those related to exposure to solid waste, dust, and pathogenic microorganisms. However, in reality, these protective tools are not used consistently by waste pickers. The low utilization of PPE is generally influenced by several factors, including limited availability, lack of knowledge about its importance, entrenched work habits, and perceptions that wearing PPE reduces comfort during work [24].

Previous studies have extensively highlighted the health impacts experienced by workers due to waste exposure, ranging from skin diseases to respiratory disorders. However, comprehensive analyses examining the interrelationships among PPE availability, compliance with its use, working environmental conditions, and worker behavior in relation to disease risk among waste pickers particularly at the waste collection level remain limited. In fact, these factors interact with one another and collectively can either increase or reduce the level of health risks faced by workers.

Beyond individual-level interventions, broader waste management strategies at the community level are also essential to reduce environmental health risks. Communities are encouraged to improve household waste management by applying circular economy principles, which promote efficient resource use and contribute to the creation of healthier environments [25]. Furthermore, establishing a clear and standardized framework for waste management programs, including waste bank systems, is crucial to strengthen program consistency, enhance operational effectiveness, and support sustainable and comprehensive waste management [26].

Based on these conditions, this study focuses on analyzing the influence of PPE availability and compliance, working environmental conditions, and worker behavior on the risk of disease among waste pickers at scrap collection sites. By conducting a more comprehensive assessment, this study is expected to provide meaningful contributions to strengthening occupational health protection efforts within the informal sector, which has often been neglected. Furthermore, the findings are anticipated to serve as a foundation for developing strategies to prevent work-related environmental diseases, strengthen occupational health and environmental safety policies, and contribute to achieving the Sustainable Development Goals (SDGs), particularly in the areas of health and the environment.

METHODS

This study employed a quantitative research design with an observational analytic approach using a cross-sectional method. This design was selected to describe the relationships among variables at a single point in time. The study population consisted of all waste pickers working at the Arista

Langgeng scrap collection site in Sidoarjo. A total of 33 respondents were included as samples, selected based on the following inclusion criteria: (1) actively working for at least six months and (2) willing to sign informed consent. Due to the limited population, all workers who met the inclusion criteria were included as study participants (total sampling).

Data were collected using structured questionnaires and observation sheets. The questionnaire instrument was developed based on the indicators of each research variable using a 5-point Likert scale. Validity and reliability tests were conducted prior to data collection, showing that all items were valid ($r \text{ count} > r \text{ table}$) and reliable (Cronbach's $\alpha > 0.7$), indicating that the instrument was suitable for use. The disease risk variables (diarrhea and typhoid) were measured based on symptoms self-reported by respondents, rather than through clinical or laboratory confirmation. In addition, several indicator items within the Attitude and Practice constructs were reverse-scored during data processing, so that a higher composite score on these constructs reflects a less protective orientation toward occupational health and safety.

The study variables included: (1) availability and compliance with the use of personal protective equipment (PPE), (2) environmental conditions of waste sorting sites, (3) worker behavior, and (4) disease risk. Data were analyzed in stages using SmartPLS 4 software, which included: (1) measurement model testing (convergent validity, discriminant validity, composite reliability, and average variance extracted [AVE]); (2) structural model testing (R^2 , Q^2 , and f^2); and (3) path analysis using the bootstrapping method to assess the significance of both direct and indirect effects among variables.

RESULT

The results of this study describe the relationships among the availability and compliance of personal protective equipment (PPE) use, environmental conditions at waste sorting sites, and worker behavior in relation to disease risk. Conceptually, consistent PPE use is considered to play a role in shaping safer attitudes and practices, while adequate working environmental conditions are expected to support the development of appropriate work behaviors. Meanwhile, workers' knowledge, attitudes, and practices are positioned as behavioral factors that serve as important mediators influencing the occurrence of infectious diseases, particularly diarrhea and typhoid. To examine these relationships, path analysis was conducted using the Structural Equation Modeling--Partial Least Squares (SEM-PLS) approach with the bootstrapping method through SmartPLS software, allowing for the assessment of both direct and indirect effects among variables. The results of the analysis are presented in the following figures and tables, providing an empirical overview of the role of each factor in reducing disease risk within the work environment.

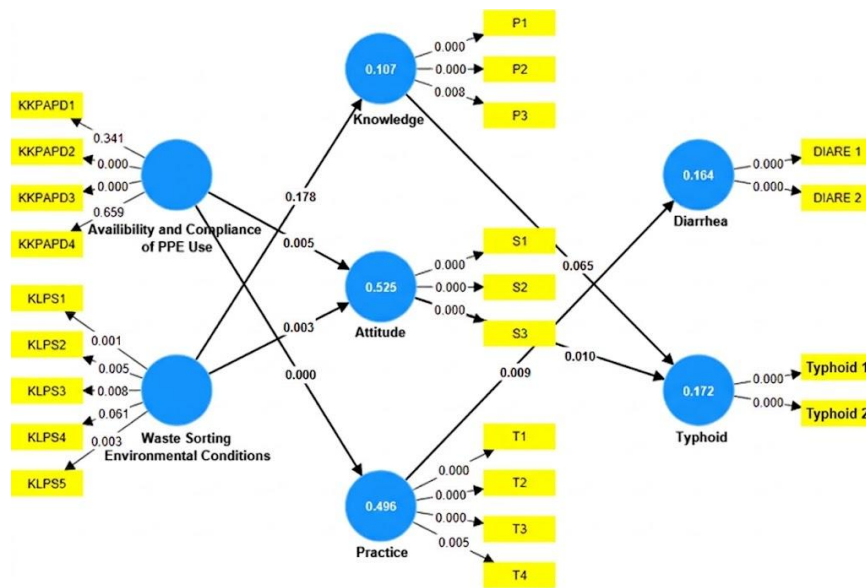


Figure 1. Results of Inner Model Analysis of the Influence of Availability and Compliance of PPE Use

Table 1. Bootstrapping Analysis of the Effects of Availability and Compliance of Personal Protective Equipment (PPE) Use, Waste Sorting Environmental Conditions, and Worker Behavior on Disease Risk

No.	Hypothesis	Path Coefficient	P values
1.	Availability and Compliance of PPE Use → Attitude	0.301	0.008*
2.	Availability and Compliance of PPE Use → Practice	0.595	0.000*
3.	Waste Sorting Environmental Conditions → Knowledge	0.289	0.124
4.	Waste Sorting Environmental Conditions → Attitude	0.518	0.000*
5.	Knowledge → Typhoid	-0.411	0.070
6.	Attitude → Typhoid	0.515	0.005*
7.	Practice → Diarrhea	0.389	0.009*

Source: Primary data, 2025

Based on the results of the direct influence analysis, it was found that the availability and compliance of the use of personal protective equipment (PPE) has a significant effect on attitudes ($\beta=0,301$; $p=0,008$) and worker actions ($\beta=0,595$; $p=0,000$). This finding shows that when PPE is available and used consistently, it is able to form a positive attitude and improve appropriate actions in carrying out work. Furthermore, the environmental conditions of waste sorting have a significant effect on attitudes ($\beta=0,518$; $p=0,000$), but not on workers' knowledge ($\beta=0,289$; $p=0,124$), which indicates that aspects of a good work environment affect attitude formation more than knowledge increase. Worker knowledge does not have a significant effect on the risk of Typhoid ($\beta=-0,411$; $p=0,070$), while attitudes actually show a significant effect on the risk of Typhoid ($\beta=0,515$; $p=0,005$). Because the Attitude items were reverse-scored, a higher score reflects a less protective attitude, so this positive coefficient is consistent with the interpretation that a less protective attitude increases the risk of the disease. In addition, worker actions have a significant effect on the risk of Diarrhea ($\beta=0,389$; $p=0,009$). Because the Practice items were also reverse-scored, a higher score reflects less protective practice, which explains why this positive coefficient corresponds to increased diarrhea risk among workers with less protective practices, underscoring the importance of proper work behavior to

reduce the risk of infection. Increased compliance with the use of PPE and the creation of a conducive work environment play a very important role in shaping workers' attitudes and actions, which ultimately contributes to reducing the risk of disease in the workplace.

Table 2. Inner Model Analysis of the Total Indirect Effects of Availability and Compliance of Personal Protective Equipment (PPE) Use, Waste Sorting Environmental Conditions, and Worker Behavior on Disease Risk

No.	Hypothesis	Path Coefficient	P values
1.	Availability and Compliance of PPE Use → Diarrhea	0.232	0.017*
2.	Availability and Compliance of PPE Use → Typhoid	0.155	0.045*

Source: Primary data, 2025

The results of the analysis of total indirect effects showed that the availability and compliance of the use of personal protective equipment (APD) had a significant effect on the risk of Diarrhea ($\beta=0,232$; $p=0,017$) and the risk of Typhoid ($\beta=0,155$; $p=0,045$) through the intermediate variable. This shows that although the effect does not occur directly, the consistent use of PPE still makes a meaningful contribution in reducing the risk of disease through the path of worker attitudes and actions. The indirect influence of the use of PPE on the risk of disease is evidence of the importance of establishing good work behavior as a mediator in disease prevention efforts in the work environment.

Table 3. Inner Model Analysis of the Specific Indirect Effects of Availability and Compliance of Personal Protective Equipment (PPE) Use, Waste Sorting Environmental Conditions, and Worker Behavior on Disease Risk

No.	Hypothesis	Path Coefficient	P values
1.	Availability and Compliance with the Use of PPE → Attitude → Typhoid	0.155	0.045*
2.	Availability and Compliance with the Use of PPE → Practice → Diarrhea	0.232	0.017*

Source: Primary data, 2025

Based on the results of the analysis of specific indirect effects, it was found that the availability and compliance of the use of personal protective equipment (PPE) has a significant effect on the risk of Typhoid through attitude ($\beta=0,155$; $p=0,045$), as well as on the risk of Diarrhea through action ($\beta=0,232$; $p=0,017$). This finding shows that the effect of using PPE on the risk of disease is not only direct, but also works specifically through the path of workers' attitudes and actions. That is, the existence and utilization of PPE encourages a more positive attitude and more appropriate action, which ultimately reduces the risk of disease. Attitudes and actions are important mediators in the relationship between the use of PPE and the risk of disease, so that interventions that not only provide PPE, but also form correct work behavior, are very necessary to reduce the incidence of Typhoid and Diarrhea in the work environment.

Table 4. R-Square Analysis of the Influence of Availability and Compliance of Personal Protective Equipment (PPE) Use, Waste Sorting Environmental Conditions, and Worker Behavior on Disease Risk

Variable	R-square	R-square Adjusted
Knowledge	0.083	0.054
Attitude	0.424	0.386
Practice	0.354	0.333
Diarrhea	0.152	0.124
Typhoid	0.170	0.115

Source: Primary data, 2025

The results of the R-square value analysis show that the free variable has the greatest contribution in explaining the attitude ($R^2 = 0,424$) and action ($R^2 = 0,354$) of workers. This indicates that the availability of PPE and environmental conditions are quite strongly affecting work behavior. Meanwhile, knowledge has a low R^2 (0,083), indicating the weak influence of free variables. For disease risk variables, both Diarrhea ($R^2 = 0,152$) and Typhoid ($R^2 = 0,170$) have low predictive values, indicating that other factors outside the model are likely to play a greater role. This shows that this model is effective in explaining work behavior, but it is not optimal in predicting the overall risk of disease.

DISCUSSION

This study confirms that the availability and compliance of personal protective equipment (PPE) use significantly affect the attitudes and practice of waste pickers, thereby reducing the risk of diarrheal and typhoid diseases. These results are consistent with previous research highlighting that consistent PPE use is associated with decreased incidence of health complaints caused by occupational exposure [14,15]. Similarly, Wardani and Azizah [27] found that the use of PPE among medical waste handlers was still below standard, where workers commonly used only surgical masks, gloves, and head coverings without protective aprons. Such limited compliance and incomplete PPE use can increase the risk of infectious disease [28].

Other studies among waste pickers and garbage collectors have also reported that knowledge, attitude, and compliance with PPE use are closely associated with reductions in health complaints such as skin diseases, acute respiratory infections, and diarrhea [29]. Environmental and occupational conditions play a major role in shaping workers' attitudes and behaviors [30]. Which in this context it will influence their susceptibility to infectious diseases. These findings reinforce our results that protective behavior through consistent PPE use not only prevents infectious diseases from direct waste contact but also shields workers from dust, gases, and microorganisms in their daily work environment. Thus, consistent PPE use remains a key factor in reducing the risk of occupational diseases in the informal waste management sector. PPE including gloves, boots, and protective clothing, should be selected based on the physical and chemical properties of materials handled and the suitability for workers' conditions. Standard gloves, for instance, may not prevent chemical absorption through the skin; hence, appropriate gloves must be chosen for specific occupational tasks to ensure optimal protection [31].

Furthermore, this study emphasizes that the waste sorting environment significantly affects workers attitudes, although it does not directly enhance knowledge. A study by Gusrianti and Nailul [18] found that a well-organized work environment and adequate sanitation facilities were associated

with increased worker compliance in PPE use. Similarly, Hariyanti et al. [32] reported that workplace comfort and safety play crucial roles in shaping positive attitudes toward occupational safety. Studi Hasliza et al. [19] also demonstrated that poor environmental quality such as high levels of pollution-- contributes significantly to increased public health risks. Poor environmental conditions have detrimental effects on the health of waste collectors and scavengers, increasing their vulnerability to various occupational diseases [33]. Therefore, improving workplace environmental conditions can strengthen protective behavior among workers in preventing waste-related diseases.

The implications of this study highlight that disease prevention among waste pickers cannot rely solely on PPE provision but must also be supported by clean and safe work environments, interactive health education to enhance awareness of PPE use, and long-term monitoring to ensure compliance. Amini et al. [34] similarly demonstrated that educational interventions based on the Health Belief Model (HBM) significantly improved adherence to infection control precautions among emergency medical staff, suggesting that structured behavioral training can effectively strengthen compliance with safety measures. Consistent with this behavioral perspective Houle et al. [35], who offers targeted recommendations for workers and employers regarding preventive strategies, encompassing work modifications, appropriate PPE use, adherence to hand hygiene protocols, and suitable treatment interventions. Hence, occupational health protection for informal sector workers must be implemented comprehensively through the integration of facility provision, healthy behavior development, and continuous supervision [36]. Similarly, Maneen et al. [37] emphasized that interventions focusing only on PPE distribution, without improving safety awareness, training, and supervisory support, are unlikely to achieve sustainable safety outcomes.

This study has limitations, including a relatively small sample size and disease variables limited to diarrhea and typhoid. Other factors such as work duration, nutritional status, and dust exposure should be examined in future studies. Long-term evaluations of PPE effectiveness and the integration of digital approaches in worker health monitoring are recommended as innovative strategies to strengthen the impact of occupational health programs.

CONCLUSION

This study demonstrates that the availability and compliance with the use of personal protective equipment (PPE), as well as workplace environmental conditions, significantly influence the attitudes and behaviors of waste pickers. Attitude and behavior were found to be significant mediating factors in reducing disease risk, particularly diarrhea and typhoid. Therefore, improving the availability of PPE, ensuring compliance with its proper use, and enhancing workplace environmental conditions are crucial steps in protecting the health of waste pickers. Based on these findings, continuous educational programs on the correct use of PPE during waste sorting activities are necessary to strengthen workers' protective behavior.

The results of this study also form part of a community service initiative that emphasizes the importance of an integrated intervention strategy combining facility provision, continuous education, and environmental control. This approach is expected to serve as a model for developing community-based health programs aimed at minimizing occupational disease risks while improving the overall health status of workers in the informal sector.

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REFERENCES

1. Fitri A, Sari K, Azizah R, Jalaludin J, Rahmawati I, Sulistyorini L, et al. A review of open defecation (OD) in Indonesia and the control with logic model. *Malays J Med Health Sci.* 2022;18(2):157-65.
2. Maruf MA, Azizah R, Sulistyorini L, Zakaria ZA, Hanisah N, Pawitra AS, et al. Management of organochlorine exposure to health risks in Asia - a review. 2021;17(3):332-40.
3. Wankhede P, Wanjari M. Health issues and impact of waste on municipal waste handlers: a review. *J Pharm Res Int.* 2021;33:577-81.
4. Singer M. Is pollution the primary driver of infectious syndemics? *Pathogens.* 2024;13(370):1-11.
5. Siddiqua A, Hahladakis JN, Ahmed W, Al Attiya KA. An overview of the environmental pollution and health effects associated with waste landfilling and open dumping. *Environ Sci Pollut Res.* 2022;29:58514-36.
6. Mulasari A, Husodo AH, Muhadjir N. Analisis situasi permasalahan sampah Kota Yogyakarta dan kebijakan penanggulangannya. *J Kesehat Masy.* 2016;11(2):96-106.
7. Sholehudin M, Azizah R, Sumantri A, Sham SM, Zakaria ZA, Latif MT. Analysis of heavy metals (cadmium, chromium, lead, manganese, and zinc) in well water in East Java Province. *Malays J Med Health Sci.* 2021;17(2):146-53.
8. Ruhardi A, Azizah R. An integrated behavioral model approach to the control of dengue hemorrhagic fever and the role of waste management: a systematic review. *Afr J Reprod Health.* 2024;28:464-81.
9. Azizah R, Mohamed AFH, Sulistyorini L, Mulia SA, Arfiani ND, Rahmawati A. Analysis of waste management effect on the climate related disease in Larangan Village, Sidoarjo. *Environ Anal Health Toxicol.* 2024;39(1):1-8.
10. Dada OT, Faniran GB, Ojo DB. Waste pickers' perception of occupational hazards and well-being in a Nigerian megacity. *Int J Environ Stud.* 2023;80(4):933-47.
11. Gutberlet J. Grassroots waste picker organizations addressing the UN sustainable development goals. *World Dev.* 2021;138:105195.
12. Melaku HS, Tiruneh MA. Occupational health conditions and associated factors among municipal solid waste collectors in Addis Ababa, Ethiopia. *Risk Manag Healthc Policy.* 2020;13:2415-23.
13. Astuti FA, Syafrudin, Susilowati I. Socioeconomic and public health impacts of waste management in Piyungan Landfill, Bantul-Indonesia. *J Kesehat Masy.* 2024;19(4):637-44.
14. Farsida F, Zulyanda M. Analisis penggunaan alat pelindung diri dalam penanganan sampah medis pada petugas cleaning service di RSUD Kabupaten Bekasi tahun 2016. *J Kesehat.* 2019;12(1):14-23.

15. Wibowo EA, Widyastuti, Betanursanti I, Puspitasari AF, Pamungkas KA. Evaluasi penggunaan alat pelindung diri (APD) dalam pemilahan sampah AMDK gelas plastik di Bank Sampah SiHatin. *J Pengabdian Masy Sains Teknol*. 2024;3(2):23-31.
16. Fajariani R, Vidyaningrum DU, Haryati S. Penggunaan alat pelindung diri dan keluhan penyakit kulit pada petugas pengangkut sampah. *Ikesma J Ilmu Kesehat Masy*. 2022;18(2):91-8.
17. Fitriandini LL, Adriyani R, Akliyah DM. Personal hygiene, pemakaian APD, dan kejadian dermatitis kontak iritan pada petugas pengangkut sampah. *Media Publikasi Promosi Kesehatan Indones*. 2024;7(5):1269-73.
18. Gusrianti, Nailul. Perilaku petugas sampah dalam pemakaian alat pelindung diri di TPA Air Dingin Kota Padang. *JUKEJ J Kesehat Jompa*. 2022;1(2):170-3.
19. Hasliza SR, Hamzah FM, Choy LK, Azizah R, Sulistyorini L, Yudhastuti R, et al. Ground-level particulate matter (PM2.5) concentration mapping in the central and south zones of Peninsular Malaysia using a geostatistical approach. *Sustainability*. 2023;15:16169.
20. Maliga I, Hasifah H, Rafi'ah, Lestari A, Sholihah NA. Analysis of basic environmental health facilities associated with risk factors of diarrhea among toddlers. *J Kesehat Masy*. 2022;18(2):274-82.
21. Singh K, Singla N, Sharma M, Singh J. Urban informal economy and vulnerabilities of domestic waste-pickers: a case of Chandigarh, India. *Waste Manag Res*. 2023;41(8):1360-71.
22. Kretchy JP, Dzodzomenyo M, Rheinlander T, Ayi I, Konradsen F, Fobil JN, et al. Exposure, protection and self-reported health problems among solid waste handlers in a coastal peri-urban community in Ghana. *Int J Public Health Epidemiol*. 2015;4(2):125-33.
23. Lissah SY, Ayanore MA, Krugu JK, Aberese-Ako M, Ruitter RAC. "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. *Int J Environ Res Public Health*. 2022;19(11):1-18.
24. Dwijaningtyas S, Widowati E, Pranoto, Saputra J, Wintara JA. Analysis of the obedience of personal protective equipment usage to prevent occupational disease among cosmetic workers. *J Kesehat Masy*. 2023;19(2):278-86.
25. Azizah R, Martini S, Sulistyorini L, Pawitra AS, Budijanto D, Nagari SS, et al. Association between climatic conditions, population density and COVID-19 in Indonesia. *Sains Malays*. 2021;50(3):879-87.
26. Sardjono W, Retnowardhani A, Azizah R. Analysis of application of Zachman framework for knowledge management systems success optimization. In: *Proceedings of the 2020 International Conference on Information Management and Technology (ICIMTech)*; 2020 Aug; p. 277-82.
27. Wardani RA, Azizah R. Management of solid medical waste on one of the COVID19 referral hospitals in Surabaya, East Java. *J Kesehat Lingkungan*. 2020;12(1 Spec Issue):38-44.
28. Brooks SK, Greenberg N, Wessely S, Rubin GJ. Factors affecting healthcare workers' compliance with social and behavioural infection control measures during emerging infectious disease outbreaks: rapid evidence review. *BMJ Open*. 2021;11(8):e049857.
29. Rahmagina N, Gusti A, Arlinda S. Hubungan personal hygiene dan penggunaan APD dengan keluhan penyakit kulit pada pemulung di TPA sampah. *J Sehat Mandiri*. 2024;19(2):289-99.
30. Dumitriu S, Bocean CG, Varzaru AA, Al-Floarei AT, Sperdea NM, Popescu FL, et al. The role of the workplace environment in shaping employees' well-being. *Sustainability*. 2025;17(6):2613.

31. Ramdan IM, Ilmiah SH, Firdaus AR. Occupational irritant contact dermatitis among shipyard workers in Samarinda, Indonesia. *J Kesehat Masy*. 2018;14(2):239-46.
32. Hariyanti CO, Budiono NDP, Inayah Z, Mindiharto S. The relationship between knowledge, attitude, and experience with behaviour of personal protective equipment (PPE) use among fishermen. *Ahmar Metastasis Health J*. 2025;5(1):54-63.
33. Munandar J, Mulasari SA. Environmental sanitation and hygiene on waste collector in TPA Piyungan Bantul Yogyakarta. *J Kesehat Masy*. 2019;15(2):171-8.
34. Amini R, Mohamadkhani M, Khodaveisi M, Karami M. Effect of health belief model-based education on infection control standard precautions in prehospita emergency staff: a clinical trial study. *Iran J Nurs Midwifery Res*. 2021;26(6):515-20.
35. Houle MC, Holness DL, DeKoven J. Occupational contact dermatitis: an individualized approach to the worker with dermatitis. *Curr Dermatol Rep*. 2021;10(4):182-91.
36. Black M, Karki J, Lee ACK, Makai P, Baral YR, Kritsotakis EI, et al. The health risks of informal waste workers in the Kathmandu Valley: a cross-sectional survey. *Public Health*. 2019;166:10-8.
37. Maneen S, Botha NN, Amoadu M, Ansah EW. Physical safety climate, safety practices and perceived well-being of informal solid waste collectors in the Cape Coast Metropolis. *Discov Soc Sci Health*. 2025;5(13).