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Occupational Health Hazards and Use of Personal Protective Equipment (PPE) among Plastic Recycling Workers in Bangladesh

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Abstract **Original Research Article**

Background: Plastic recycling is a crucial component of waste management in Bangladesh. However, workers in this industry face significant occupational health risks owing to exposure to toxic substances and hazardous working conditions. The inadequate use of personal protective equipment (PPE) further exacerbates these risks, increasing the likelihood of respiratory, musculoskeletal, and dermatological health issues. This study evaluated the occupational health hazards and PPE usage among plastic recycling workers in Bangladesh. ***Methods:*** This cross-sectional study was conducted from September to November 2024 in Matuail, Shonir Akhra, Jatrabari, and Pallabi, which are among the most prominent plastic recycling areas in Dhaka city. According to the selection criteria, 131 workers directly involved in plastic waste recycling were selected as respondents. Data were collected through structured face-to-face interviews, and statistical analyses were performed using SPSS software. ***Results:*** Musculoskeletal disorders were the most commonly reported health issues, followed by back pain (47.3%) and shoulder pain (29.8%). Respiratory problems, including chronic cough (19.1 %) and breathing difficulty (14.5 %), were frequently reported. Skin conditions, such as itchy skin (19.8 %) and rashes (13.7 %), were also observed. Although 74.0% of workers reported using PPE, the use of essential protective items, such as gloves (33.6%) and safety glasses (25.2%), remained low. ***Conclusion:*** Plastic recycling workers in Bangladesh face substantial occupational health risks, and limited PPE usage contributes to adverse health outcomes. Strengthening occupational health policies, enforcing personal protective equipment (PPE) compliance, and improving workplace safety practices are essential to mitigate these risks.

Keywords: Occupational health, plastic recycling workers, PPE, workplace safety, Bangladesh.

INTRODUCTION

The plastic recycling industry is a vital waste management component that helps decrease plastic pollution while preserving natural resources. Industrial development in the plastic sector is advancing quickly in Bangladesh because people use more plastic while their waste management systems are insufficient [1]. Workers participating in plastic recycling activities face multiple occupational health risks because the practice occurs informally and exposes them to toxic chemicals, airborne pollutants, and mechanical injuries [2, 3]. Workers in this profession risk developing various health issues that progress into long-term complications due to exposure to hazardous conditions [4]. Workplace safety standards and absent regulatory oversight enable increased exposure to health risks for these workers [5].

Research studies have proven that medical risks exist when operating waste recycling facilities. The research on how e-waste recyclers handle safety practices in Bangladesh showed that less than one-quarter of employees understood work-related risks correctly [6]. A research study investigating sanitation and waste workers detected that 60 percent failed to maintain stable usage of protective gear even though their work constantly exposed them to dangerous materials [7]. Workers fail to maintain adequate PPE practices because of several issues, which include limited funding for personal protective equipment, unavailability of workplace safety equipment and insufficient training about workplace health dangers [8]. The health risks informal recycling workers face in low- and middle-income countries (LMICs) are parallel to those documented in other LMICs, as reported in [9].

Occupational health and safety for plastic recycling workers require immediate attention for numerous crucial reasons. The first requirement ensures workplace safety meets fundamental human rights standards and international labor requirements [10]. The absence of proper worker safety measures leads to healthcare expenses, reduced productivity, and health threats to employees [3]. Hazardous substances present in the recycling industry create dual environmental and public health challenges through pollutant emissions, leading to contamination of air, water and soil [1, 4].

The field of occupational health hazards in waste management has expanded, yet research devoted to Bangladeshi plastic recycling workers remains limited. Research about plastic recycling hazards specific to workers functions primarily through studies of general waste management or electronic waste production without addressing plastic worker exposure risks differently [6, 8]. Bangladesh plastic recycling workers face occupational dangers, and protective equipment requirements will be examined in this research study.

This research examines how insufficient PPE access and worker ignorance about workplace risks increase health dangers for plastic recycling staff in Bangladesh. Addressing this problem remains critical for creating evidence-based interventions and policy recommendations that seek to improve occupational health safety within this crucial economic sector.

OBJECTIVE

The objective of this study was to assess occupational health hazards and the use of personal protective equipment (PPE) among plastic recycling workers in Bangladesh.

METHODOLOGY & MATERIALS

This cross-sectional study was conducted from September 2024 to November 2024 in Matuail, Shonir Akhra, Jatrabari, Pallabi, which are among the largest plastic recycling areas in Dhaka city. According to the selection criteria, 131 workers were chosen as respondents, and all of them were directly related to plastic waste recycling.

Inclusion criteria:

1. Both male and female workers.
2. Working in a plastic waste recycling area.
3. Willing to participate and will give informed written consent.

Exclusion criteria:

1. Severely ill.
2. Pregnant.
3. Not willing to participate and give informed written consent.

Data collection

Data for this study were collected through face-to-face interviews using a structured questionnaire. Participants were selected from plastic recycling facilities in Bangladesh and interviews were conducted in a confidential setting to ensure accurate responses. The questionnaire included sections on demographic information, occupational health symptoms, PPE usage, and workplace safety conditions. Trained interviewers facilitated data collection to minimize response bias. All participants provided informed consent before participation, and ethical guidelines were strictly followed throughout the data collection process.

Ethical consideration

Participation in this study was entirely voluntary, and workers had the freedom to choose whether to participate. Before each interview, participants were provided with a consent form, and the study's purpose and procedures were clearly explained to them. They were informed of their right to decline participation or refuse to answer any questions. Interviews were conducted only after participants provided written consent. All data were handled strictly, ensuring participants' privacy was protected, and their personal information remained undisclosed.

Statistical analysis of data

Data were analyzed using SPSS (version 26). Descriptive statistics, including frequencies and percentages, summarized demographic characteristics, PPE usage, and health issues. A p-value <0.05 was considered statistically significant. Results were presented in tables for clarity and to facilitate interpretation of key findings.

RESULTS

Table 1: Demographic Characteristics of Worker (n=131)

Variable		Frequency (n=131)	Percentage (%)
Age Group (years)	<18	13	9.9
	18-24	36	27.5
	25-34	29	22.1
	35-44	26	19.8
	45-54	16	12.2
	55-64	8	6.1

	≥65	3	2.3
Gender	Male	78	59.5
	Female	53	40.5

Table 1 presents the demographic characteristics of plastic recycling workers. The majority were male (59.5%), with females comprising 40.5%. Most workers were aged 18–24 years (27.5%), followed by those aged 25–34 years (22.1%) and 35–44 years (19.8%). A smaller proportion were aged 55 years or older (8.4%).

Table 2: Use of Personal Protective Equipment (PPE) among Workers (n=131)

PPE Type	Frequency (n=131)	Percentage (%)
Uses Any PPE	97	74.0
Specific PPE Items		
Mask	71	54.2
Gloves	44	33.6
Safety Glasses	33	25.2
Safety Boots	34	26.0
Helmet	3	2.3

Table 2 summarizes PPE usage among workers. While 74.0% reported using some form of PPE, specific item usage varied. Masks were the most commonly used (54.2%), followed by gloves (33.6%) and safety boots (26.0%). Safety glasses were worn by 25.2% of workers, whereas helmet use was minimal (2.3%).

Table 3: Prevalence of Occupational Health Problem among Workers (n=131)

Health Issue		Frequency (n=131)	Percentage (%)
Skin Problems	Redness of Skin	27	20.6
	Itchy Skin	26	19.8
	Skin Rashes	18	13.7
	Skin Ulcer	10	7.6
Respiratory Issues	Cough	25	19.1
	Breathing Difficulty	19	14.5
Musculoskeletal Issues	Back Pain	62	47.3
	Shoulder Pain	39	29.8
	Joint Pain	36	27.5
Ophthalmic issues	Red itchy eye	17	13
	Eye Injury	15	11.5
Hearing issue	Hearing loss	5	3.8
Gastrointestinal issue	Diarrhea	3	2.3
	Vomiting	9	6.9
	Stomach ache	12	9.2
Other Issues	Work-Related Injury	28	21.4
	Headache	44	33.6
	Fatigue	51	38.9

Table 3 outlines the reported occupational health issues. Musculoskeletal disorders were most common, with back pain (47.3%), shoulder pain (29.8%), and joint pain (27.5%) frequently reported. Fatigue (38.9%) and headaches (33.6%) were also prevalent. Respiratory issues included cough (19.1%) and breathing difficulty (14.5%). Skin problems, such as itchy skin (19.8%) and rashes (13.7%), were notable. Work-related injuries affected 21.4% of workers.

Table 4: Workplace Safety Conditions among Workers (n=131)

Workplace Factor	Frequency (n=131)	Percentage (%)
Good Air Ventilation	123	93.9
Leachate Exposure	71	54.2
Overtime Work	94	71.8
Break Time	127	96.9

Table 4 presents workplace safety conditions. Most workers (93.9%) reported good air ventilation, and 96.9% had designated break times. However, 54.2% experienced leachate exposure, and 71.8% worked overtime, indicating potential occupational hazards.

DISCUSSION

The research demonstrates that plastic recycling employees in Bangladesh face significant occupational safety risks because they frequently experience back and joint disorders, breathing difficulties, and skin problems. Most employees used personal protective equipment, but the implementation and quality of these tools were insufficient. The research supports previous studies on health risks related to waste recycling, emphasizing the necessity of implementing improved workplace safety protocols and enhanced PPE education for industrial workers.

About fifty percent of workers suffered from back pain, alongside several reports of pain throughout their joints and shoulders. Research from the past has validated these results among workers involved in plastic and electronic waste recycling operations. According to Das et al., plastic factory workers in Bangladesh develop chronic pain through three key factors, including repetitive movement and prolonged standing plus heavy lifting [11]. Munni *et al.,* documented musculoskeletal strain as the prominent occupational problem e-waste recyclers face [3]. Plastic recycling activities that require heavy physical work appear to expand the extent of worker health hazards beyond usual limits.

Respiratory problems created through chronic cough and breathing difficulties were recorded as significant health concerns. Findings from earlier investigations confirm that inhaling air pollutants leads to respiratory problems among workers in recycling facilities. Research by Yohannessen *et al.,* demonstrated equivalent patterns of respiratory issues among e-waste laborers in Chile [12]. According to Thompson *et al.*, plastic processing releases microplastic particles and hazardous chemicals when spread through the air [13]. Good ventilation conditions among workers indicate alternative workplace hazards that could explain their reported respiratory problems.

Many workers suffered from dermatological problems such as rash and itchy skin. The combination of unprotected contact with processing chemicals and improper glove utilization leads to skin irritations. According to Meem *et al.,* workers at the e-waste sites faced identical dermatological health problems [14]. The low rate of glove usage among workers partly explains why skin-related issues became prevalent even though some workers wore PPE.

A high number of workers experienced injuries throughout their shifts that involved damage to their eyes and deterioration of their hearing abilities. The research findings of Raghupathy *et al.,* supported injuries in Indian waste recyclers almost identically [15]. Staff wore PPE equipment, but the utilization of crucial protective equipment such as safety glasses and helmets remained scarce. Workplace safety remains at risk because healthcare workers fail to adhere to PPE guidelines. After all, protective equipment causes discomfort, lack of knowledge about protective equipment, or lack of access to the required equipment.

Various biological, clinical, and workplace factors could explain the documented health results in this study. The high rate of musculoskeletal disorders exists due to inadequate ergonomic standards combined with recurring manual labor and insufficient rest opportunities, which heightens both pain chronification and physical exhaustion risks. Laborers in recycling facilities face respiratory problems because they must endure airborne pollution from chemical fumes that do not disappear even with adequate ventilation systems. Workers fail to utilize proper PPE adequately because they are unaware of its importance and face economic limitations and discomfort when wearing PPE for long periods. According to Demichelis *et al.,* organizations must supply proper equipment and train workers to develop better PPE practices [16].

The research implications reach more than single-worker health because they demonstrate significant issues affecting industrial and public health conditions. The substantial number of occupational diseases motivates the immediate requirement for ongoing health assessments and prompt intervention methods assisted by specialized medical services. Workplace policies must receive active reinforcement because they guarantee compliance with PPE use and observance of safety protocols. Government oversight organizations should establish regulations for protective equipment standards while implementing training requirements and ongoing facility inspection schedules. Financial support programs and reimbursement to cover PPE costs would enhance workers' maintenance of safety guidelines.

Advanced engineering solutions, including improved ventilation systems, mechanization of sorting operations, and manufacturing equipment enclosed in units, would significantly decrease workers' exposure to hazardous materials. Mourshed *et al.,* recommended that plastic waste management in Bangladesh be supported with technological improvements that supplement manual recycling operations [17]. Safety education and staff decision-making participation create an environment where workers can focus on health preservation.

Limitations and Recommendations

The research design used a cross-sectional approach, restricting the ability to determine cause-and-effect relationships. A moderate number of participants combined with participant-submitted symptom reports introduced potential recall bias into the study results. Further research should perform long-term follow-up

investigations to evaluate the lasting health effects and intervention benefits. Monitoring air quality and chemical exposures at workplaces should be performed to detect particular hazardous substances. Companies within plastic recycling industries will enhance worker safety through stronger policies regarding occupational health while enforcing protective equipment requirements and running safety education programs to lower employee health threats

CONCLUSION

Plastic recycling workers in Bangladesh face multiple health risks, including musculoskeletal problems, breathing problems and skin conditions, due to insufficient personal protective equipment (PPE) usage. These workplace hazards continue due to substandard safety practices even though appropriate PPE exists. Reducing these occupational health risks requires better enforcement of workplace policies and PPE requirements and better conditions for workers. A combination of regulatory rules, engineered safety measures, and employee education programs will improve safety standards and decrease occupational illness rates in the sustainable plastic recycling sector.

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