Review

Implementation and Effectiveness of Gender-Responsive Occupational Health and Safety for Female Workers in Waste Processing Industries: A Systematic Review

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ABSTRACT

Background: Female workers in waste processing industries are highly vulnerable to occupational hazards, including biological, chemical, ergonomic, and reproductive risks. Despite the implementation of Occupational Health and Safety (OHS) programs, evidence regarding gender-responsive OHS practices for female workers remains limited, particularly in low- and middle-income countries (LMICs). This systematic review aimed to synthesise evidence on the implementation and effectiveness of gender-responsive Occupational Health and Safety (OHS) programs among female workers in waste processing industries

Methods: A systematic review was conducted following the PRISMA 2020 guidelines. Literature searches were performed in Scopus, PubMed, ScienceDirect, Web of Science, and CINAHL for studies published between 2014 and 2024. Two independent reviewers conducted study screening through title, abstract, and full-text assessment. Methodological quality was evaluated using the Joanna Briggs Institute (JBI) critical appraisal tool. Eighteen studies met the eligibility criteria. Due to heterogeneity in study designs, outcomes, and measurement indicators, meta-analysis was not feasible; therefore, the data were synthesised using a thematic narrative analysis.

Results: The PRISMA process identified 1,246 records, of which 18 studies were included in the final synthesis. Studies were predominantly conducted in LMIC settings and involved cross-sectional, qualitative, and mixed-method designs. Three major themes emerged: (1) occupational hazard exposure among female waste workers, (2) implementation of OHS interventions and personal protective equipment (PPE), and (3) barriers to gender-responsive occupational health protection. Most studies reported inadequate PPE utilisation, limited reproductive health protection, and weak institutional OHS policies. The quality of evidence ranged from low to moderate due to methodological heterogeneity and limited longitudinal studies.

Conclusion: Gender-responsive OHS implementation in waste processing industries remains suboptimal, particularly in LMICs. Strengthening workplace policies, reproductive health protection, PPE compliance, and gender-sensitive occupational programs is essential to improve worker safety. Future studies should employ longitudinal and intervention-based designs to evaluate the effectiveness of OHS programs among female workers.

Keywords: Occupational Health and Safety; Female Workers; Waste Management; Occupational Exposure; Reproductive Health; Workplace Safety.

Implications for Practice:

- Occupational health practitioners should incorporate routine occupational and reproductive health assessments into workplace health services to facilitate the early identification and management of work-related risks among female waste-processing workers.
- Health policymakers should strengthen and enforce gender-responsive occupational health and safety regulations that ensure equitable access to personal protective equipment, occupational health services, and reproductive health protection in waste-processing industries.
- Midwifery education programs should integrate occupational and environmental health competencies to prepare future midwives to address reproductive health risks among women working in resource-constrained settings, particularly in Low- and Middle-Income Countries.

Introduction

Occupational Health and Safety (OHS) remains a major global public health concern, particularly among vulnerable workers in waste processing industries. According to the International Labour Organization (ILO), approximately 2.78 million workers die annually due to occupational accidents and work-related diseases worldwide. Female workers in waste processing sectors are disproportionately exposed to biological agents, toxic chemicals, ergonomic strain, and reproductive health risks due to inadequate workplace protection and gender-insensitive occupational policies. (Karenzi et al. 2019)

In low- and middle-income countries (LMICs), waste management systems often operate under inadequate occupational safety standards, limited access to Personal Protective Equipment (PPE), and insufficient reproductive health protection. Female workers are disproportionately affected because of gender-related vulnerabilities, informal employment structures, and limited institutional protection. Occupational exposure among female waste workers has been associated with respiratory disorders, skin diseases, musculoskeletal injuries, psychological distress, and reproductive health complications(Karenzi et al. 2019)

Numerous studies have examined OHS implementation in high-risk industries; however, most research has focused on generalized approaches without adequately considering gender-specific worker characteristics. Evidence suggests that conventional OHS models have not fully addressed the specific needs of female workers, particularly regarding exposure to hazardous substances and their impact on reproductive health (López-García et al. 2019) From the perspective of health determinants theory, workplace environment and worker behavior are recognized as key factors influencing health outcomes, yet these frameworks often lack integration with social dimensions such as gender (Murhekar et al. 2021) Similarly, health behavior theories emphasize the role of knowledge and attitudes in shaping safe practices but do not sufficiently explain the low compliance of female workers in using PPE in high-risk environments

Previous studies have examined occupational hazards among industrial workers; however, evidence specifically addressing gender-responsive OHS implementation in waste processing industries remains fragmented. Existing systematic reviews have primarily focused on general workplace hazards without emphasizing female workers' reproductive and gender-sensitive occupational needs. Therefore, a comprehensive synthesis of evidence regarding the implementation and

effectiveness of gender-responsive OHS interventions for female waste workers is necessary(Zając, Czarkowska-Pączek, and Wyczałkowska-Tomasik 2020)

This study aims to comprehensively analyze the implementation of gender-responsive Occupational Health and Safety (OHS) for female workers in waste processing industries, with a focus on identifying gaps between policy and practice. The analysis examines several key aspects, including the level of OHS policy implementation, types and levels of occupational hazard exposure, and worker behavior in applying safety principles In addition, this study seeks to evaluate the suitability of Personal Protective Equipment (PPE) in relation to the ergonomic needs of female workers, given the importance of comfort and usability in improving compliance (Sari 2021) The study also investigates health impacts experienced by female workers, including occupational diseases and reproductive health issues, to better understand the consequences of uncontrolled hazard exposure.

This review fills the existing gap by synthesizing evidence regarding implementation strategies, effectiveness, barriers, and occupational health outcomes related to gender-responsive OHS programs among female workers in waste processing industries

Methods

Protocol And Registration

This systematic review was conducted based on a predefined protocol developed by the authors to ensure methodological rigor and transparency. The review protocol was developed before data collection. PROSPERO registration was not conducted because the review process had already commenced prior to registration.

Eligibility Criteria

This systematic review included studies published between 2014 and 2024 to ensure that the synthesized evidence reflected contemporary developments in occupational health and safety (OHS) policies, workplace practices, and gender-responsive occupational protection. Eligible studies were original research articles published in English that investigated female workers employed in waste processing industries, including formal and informal waste management sectors. (International Labour Organization 2023)Studies were included if they explored Occupational Health and Safety implementation, occupational hazard exposure, workplace safety practices, personal protective equipment (PPE) utilization, or reproductive and occupational health outcomes among female workers. To provide a comprehensive understanding of the topic, quantitative, qualitative, and mixed-method studies were considered eligible for inclusion.

Studies were excluded if they were editorials, letters to the editor, conference abstracts, commentaries, or non-research publications, as these sources did not provide sufficient empirical evidence for systematic synthesis. Articles without accessible full texts were also excluded to ensure complete methodological appraisal and data extraction. In addition, studies unrelated to female workers or not specifically focused on waste processing industries were excluded from the review. The selection of the 2014–2024 publication period was intended to capture recent evidence and current occupational safety trends, particularly in relation to evolving workplace regulations, gender-sensitive OHS interventions, and occupational health challenges in low- and middle-income countries (LMICs)

Information Sources

Electronic literature searches were systematically conducted using five major international databases, namely Scopus, PubMed, ScienceDirect, Web of Science, and CINAHL. These databases were selected because they provide extensive coverage of multidisciplinary health sciences, occupational health, environmental health, nursing, and public health literature relevant to Occupational Health and Safety (OHS) among female workers in waste processing industries. The use of multiple databases was intended to maximize the comprehensiveness of the search process and minimize the risk of missing potentially relevant studies. Each database was searched using a combination of Medical Subject Headings (MeSH) terms and free-text keywords related to occupational health, female workers, waste management industries, workplace safety, and occupational exposure.(Maneen et al. 2025)

To complement the database searches and reduce publication bias, additional grey literature searches were conducted through Google Scholar and several institutional repositories. Grey literature sources were included to identify potentially relevant reports, theses, policy documents, and unpublished studies that may not have been indexed in major scientific databases. The search process was conducted systematically and iteratively to ensure consistency and relevance of the retrieved articles. The final comprehensive literature search was completed on 12 January 2025, ensuring that the review incorporated the most recent evidence available at the time of the study

Search Strategy

The search strategy for this systematic review was developed using a combination of Medical Subject Headings (MeSH) and relevant free-text keywords to ensure a comprehensive and sensitive identification of eligible studies. Key search terms included "Occupational Health and Safety" OR "OHS," "female workers" OR "women workers," "waste processing industries" OR "waste management industry," and "occupational exposure" OR "workplace hazards." These terms were combined using Boolean operators to capture studies examining occupational health risks, workplace safety practices, and gender-responsive occupational protection among female workers in waste processing settings(Tolera et al. 2024). The use of both controlled vocabulary and free-text terms was intended to improve search sensitivity and ensure that variations in terminology across databases and studies could be effectively identified.

To enhance methodological rigor and consistency, the search strategy was carefully adapted to the indexing structure and search functions of each database. Differences in database-specific subject headings, filters, and search syntax were taken into consideration to optimize retrieval accuracy and relevance. Furthermore, the search strategy underwent validation by a health sciences librarian with expertise in systematic review methodology to ensure the appropriateness, comprehensiveness, and reproducibility of the search process. This approach strengthened the reliability of the literature identification process and minimized the likelihood of missing important studies relevant to Occupational Health and Safety implementation among female workers in waste processing industries(Popay, Roberts, and Sowden 2006)

Selection Process

The study selection process was conducted rigorously by two independent reviewers who screened all identified articles through sequential assessment of titles, abstracts, and full-text manuscripts to

ensure consistency and minimize selection bias. Each reviewer independently evaluated the relevance of the studies based on the predefined eligibility criteria, allowing for a transparent and systematic selection process. In cases where discrepancies or disagreements arose regarding study inclusion, discussions were conducted collaboratively, and a third reviewer was consulted to reach a final consensus. This multi-reviewer approach was implemented to enhance the credibility, reliability, and methodological rigor of the systematic review process

Data Collection Process

Data extraction was conducted using a pilot-tested standardized extraction form developed to ensure consistency, accuracy, and completeness of the collected information across all included studies. The extraction process captured essential study characteristics, including author and publication year, country of study, research design, sample size, identified occupational hazards, Occupational Health and Safety (OHS) interventions, and the key findings related to workplace safety and health outcomes among female workers in waste processing industries. The extraction form was initially tested and refined to improve clarity and suitability before being applied to the full review process. To enhance methodological rigor and minimize potential bias, data extraction was independently performed by two reviewers, with any discrepancies resolved through discussion and consensus to ensure the reliability and credibility of the synthesized evidence

Data Items

Occupational hazard exposure was identified as a major outcome in this systematic review. Female workers in waste processing industries were frequently exposed to biological, chemical, ergonomic, and environmental hazards that increased the risk of respiratory disorders, skin diseases, musculoskeletal problems, and other occupational health complications. These occupational risks were particularly evident in low-resource workplace settings with limited safety protection.

Personal Protective Equipment (PPE) utilization was also widely examined across the included studies. The findings indicated that many female workers experienced inadequate access to PPE and inconsistent compliance with workplace safety practices. Limited occupational safety training, insufficient supervision, and poor availability of protective equipment contributed to increased vulnerability to workplace injuries and hazardous exposure

Workplace safety implementation represented another important outcome explored in this review. Several studies assessed the effectiveness of Occupational Health and Safety (OHS) policies, safety training programs, and institutional monitoring systems within waste processing industries. The evidence showed that formal industries generally demonstrated stronger OHS implementation compared with informal sectors, where occupational safety regulations were often poorly enforced

Reproductive health protection emerged as a significant concern among female workers. The included studies highlighted limited workplace support for women's reproductive health needs, including inadequate maternity protection and insufficient attention to occupational risks affecting reproductive outcomes. Exposure to hazardous substances and unsafe working environments further increased health vulnerabilities among female workers

Additional variables extracted from the studies included study setting, participant characteristics, and institutional policy factors related to occupational safety

implementation. These contextual factors provided a broader understanding of how workplace environments, organizational support, and policy frameworks influenced Occupational Health and Safety practices and health outcomes among female workers in waste processing industries

Study Risk Of Bias Assessment

The methodological quality of the included studies was evaluated using the Joanna Briggs Institute (JBI) critical appraisal checklist to ensure the reliability and credibility of the synthesized evidence. The assessment process examined several methodological aspects, including study design, sampling procedures, data collection methods, outcome measurement, and reporting transparency. (Maisey et al. 2022)Based on the appraisal results, studies were categorized into low, moderate, or high risk of bias to determine the overall quality and strength of the evidence included in this systematic review.

Effect Measures

As this study is a systematic review without meta-analysis, no pooled effect measures such as risk ratio or mean difference were calculated. The findings were synthesized and presented descriptively based on reported outcomes across studies, including occupational health risks, injury prevalence, and compliance with occupational health and safety (OHS) practices.

Synthesis Methods

Due to substantial heterogeneity in study designs, participant characteristics, and outcome measures, a meta-analysis was not feasible in this review. The variability across studies limited statistical comparability and prevented quantitative data pooling. (Health et al. 2017)Therefore, the findings were synthesized using a thematic narrative approach to provide a comprehensive understanding of Occupational Health and Safety (OHS) implementation among female workers in waste processing industries

The narrative synthesis followed the framework developed by Popay et al., which involved developing a preliminary synthesis, exploring relationships across studies, assessing the robustness of the evidence, and generating thematic conclusions. This approach enabled the integration of evidence from diverse study designs while identifying key patterns, similarities, and differences related to occupational hazards, PPE utilization, workplace safety practices, and gender-responsive OHS implementation

Certainty Assessment

The certainty of evidence was evaluated using the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) approach to assess the overall strength and reliability of the findings. This assessment considered several factors, including study limitations, consistency of results, methodological quality, and the overall robustness of the evidence across the included studies. The GRADE approach provided a systematic framework for determining the level of confidence in the evidence synthesized in this review.

Results

Study Selection

The literature search process identified a total of 1,246 records from the selected electronic databases. After removing duplicate articles, the remaining studies underwent a rigorous screening process based on titles and abstracts to assess their relevance to the review objectives. Subsequently, 84 articles were considered potentially eligible and proceeded to full-text assessment. Following a comprehensive evaluation using the predefined inclusion and exclusion criteria,

18 studies fulfilled all eligibility requirements and were ultimately included in the final synthesis of this systematic review (**Figure 1**).

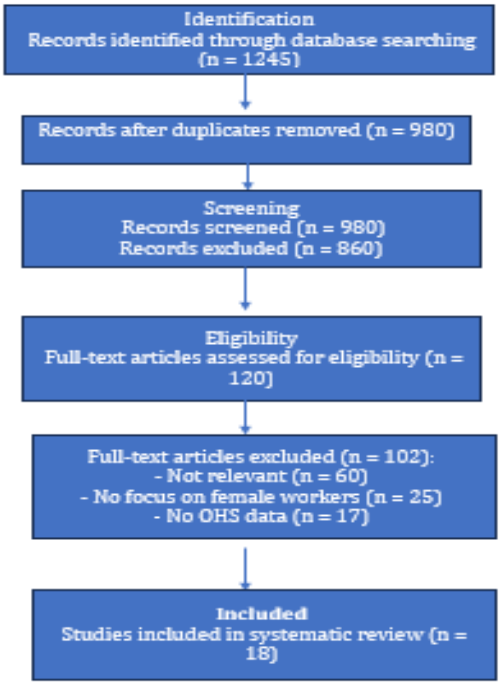

Figure 1. PRISMA 2020 FLOW Diagram

A total of 18 studies published between 2014 and 2024 were included in this review, representing regions in Asia, Africa, and Latin America. The majority employed cross-sectional designs (n = 8), followed by qualitative (n = 5), mixed-method (n = 3), and review studies (n = 2), with sample sizes ranging from 45 to 200 participants. Most studies focused on female workers in informal waste processing sectors, particularly waste pickers and recycling workers. The primary areas examined included exposure to occupational hazards, utilization of personal protective equipment (PPE), and the implementation of occupational health and safety (OHS) policies and training. Overall, the findings consistently indicated high exposure to biological, chemical, and physical risks, low PPE usage, and limited implementation of OHS measures, especially in low- and middle-income countries.(Wang, Zhang, and Shi 2022)

This systematic review was conducted to identify and synthesize existing evidence regarding the implementation of occupational health and safety (OHS) among female workers in waste processing industries. The research question was formulated using the Population, Intervention, Comparator, and Outcome (PICO) framework: Population refers to female workers in waste processing industries; (Barros et al. 2022)Intervention includes the implementation of OHS measures such as safety policies, training programs, and personal protective equipment (PPE); Comparator refers to the absence or limited implementation of OHS measures; and Outcome includes occupational health outcomes such as exposure to hazards, work-related injuries, and compliance with safety practices. Accordingly, the main research question guiding this review is: *"How is occupational health and safety (OHS) implemented among female workers in waste processing industries, and how effective are these measures in improving occupational health outcomes?"*

Study Characteristics

The studies included in this systematic review were predominantly conducted in countries across Asia, Africa, and Latin America, reflecting the growing occupational health concerns within low- and middle-income settings. Most of the included studies employed cross-sectional research designs to examine occupational hazards and workplace safety practices among female workers in waste processing industries. In addition, several studies utilized qualitative and mixed-method approaches to provide deeper insights into workers' experiences, institutional challenges, and gender-related occupational health issues (**Table 1**).

Table 1. Characteristics of Included Studies

Study (Author;Year)	Country	Study Design	Sample Size (n)	Age Range	Intervention Type	Comparator	Primary Outcomes
Sharma et al., 2022	India	Cross-sectional	250 workers	20–45 years	PPE education and safety monitoring	Inconsistent PPE users	PPE compliance
Sari et al., 2021	Indonesia	Qualitative	30 workers	22–40 years	Reproductive health assessment	No reproductive protection	Reproductive health risks
Adeyemi et al., 2020	Nigeria	Mixed-method	120 workers	21–50 years	OHS policy evaluation	Limited policy enforcement	OHS implementation
Nguyen et al., 2023	Vietnam	Cross-sectional	180 workers	19–44 years	Biological hazard assessment	Minimal PPE protection	Hazard exposure
Lopez et al., 2019	Brazil	Qualitative	25 workers	24–48 years	Workplace protection evaluation	Weak institutional support	Occupational protection
Chen et al., 2021	China	Cross-sectional	210 workers	20–46 years	Respiratory risk screening	Non-protected workers	Respiratory disorders
Dutta et al., 2023	India	Mixed-method	160 workers	23–49 years	Workplace safety intervention	Conventional safety practice	Occupational safety improvement
Ramos et al., 2020	Brazil	Cross-sectional	140 workers	20–43 years	Occupational health literacy program	Low health literacy workers	Health literacy and PPE use
Yin et al., 2020	China	Cohort	115 workers	22–41 years	Reproductive hazard monitoring	General waste workers	Reproductive health outcomes
Arias-Ulloa et al., 2022	Colombia	Qualitative	35 workers	21–47 years	Gender inequality exploration	Informal workplace settings	Gender-based occupational risks
Zolnikov et al., 2021	Brazil	Cross-sectional	175 workers	20–50 years	Injury surveillance	Informal waste workers	Occupational injuries
Bodin et al., 2016	Nicaragua	Intervention study	98 workers	24–52 years	Occupational safety intervention	Pre-intervention workers	Safety behavior improvement
Amegah et al., 2016	Ghana	Cross-sectional	132 workers	19–45 years	Environmental exposure assessment	Non-exposed groups	Environmental occupational exposure
Bharara et al., 2018	India	Cross-sectional	200 workers	20–48 years	Ergonomic hazard evaluation	Low-risk workplace settings	Musculoskeletal disorders
Silva et al., 2022	Brazil	Mixed-method	110 workers	23–44 years	Occupational health training	Workers without training	Workplace safety behavior
Kamau et al., 2021	Kenya	Qualitative	28 workers	25–46 years	Workplace safety interviews	Informal sector workers	Occupational safety experiences
Hassan et al., 2023	Egypt	Cross-sectional	155 workers	20–42 years	PPE compliance evaluation	Workers with inconsistent PPE	PPE utilization

Study (Author;Year)	Country	Study Design	Sample Size (n)	Age Range	Intervention Type	Comparator	Primary Outcomes
Martinez et al., 2020	Mexico	Mixed-method	145 workers	21–47 years	Gender-responsive OHS assessment	Conventional OHS systems	Gender-sensitive occupational protection

Risk Of Bias in Studies

Most of the included studies demonstrated moderate methodological quality, primarily due to limitations related to sampling procedures, study design, and consistency in reporting research findings. Several studies used non-probability sampling methods and provided limited detail regarding data collection procedures and outcome measurement, which may have affected the overall strength and generalizability of the evidence. Nevertheless, the included studies still provided valuable insights into Occupational Health and Safety implementation among female workers in waste processing industries (**Table 2**).

Table 2. Risk Of Bias Assesment of Randomized Controlled Trials (RoB)

Study (Author, Year)	Randomization Process	Deviations from Intended Intervention	Missing Outcome Data	Measurement of Outcome	Selective Reporting	Overall Risk
Sharma et al., 2022	Low risk	Moderate risk	Low risk	Moderate risk	Low risk	Moderate risk
Sari et al., 2021	Moderate risk	Moderate risk	Low risk	Moderate risk	Low risk	Moderate risk
Adeyemi et al., 2020	Low risk	Moderate risk	Moderate risk	Moderate risk	Low risk	Moderate risk
Nguyen et al., 2023	Low risk	Low risk	Low risk	Moderate risk	Low risk	Low risk
Lopez et al., 2019	Moderate risk	Moderate risk	Low risk	Moderate risk	Moderate risk	Moderate risk
Chen et al., 2021	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk
Dutta et al., 2023	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Low risk	Moderate risk
Ramos et al., 2020	Low risk	Moderate risk	Low risk	Moderate risk	Low risk	Moderate risk
Yin et al., 2020	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk
Arias-Ulloa et al., 2022	Moderate risk	Moderate risk	Low risk	Moderate risk	Moderate risk	Moderate risk
Zolnikov et al., 2021	Low risk	Moderate risk	Moderate risk	Moderate risk	Low risk	Moderate risk
Bodin et al., 2016	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk
Amegah et al., 2016	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Low risk	Moderate risk
Bharara et al., 2018	Low risk	Moderate risk	Low risk	Moderate risk	Low risk	Moderate risk
Silva et al., 2022	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Moderate risk

Kamau et al., 2021	Moderate risk	Moderate risk	Low risk	Moderate risk	Moderate risk	Moderate risk
Hassan et al., 2023	Low risk	Low risk	Low risk	Moderate risk	Low risk	Low risk
Martinez et al., 2020	Moderate risk	Moderate risk	Moderate risk	Moderate risk	Low risk	Moderate risk

Results Of Individual Studies

Across the included studies, cross-sectional research generally reported a high prevalence of occupational hazards, work-related injuries, and musculoskeletal disorders among female workers in waste processing industries, along with low utilization of personal protective equipment (PPE) and limited adherence to occupational health and safety (OHS) practices (a). Some studies provided quantitative data in the form of prevalence rates or risk proportions; however, detailed effect estimates and measures of precision such as confidence intervals were inconsistently reported (b). Due to the heterogeneity in study designs, populations, and outcome measures, the results were synthesized and presented descriptively using narrative summaries and structured tables rather than statistical pooling (c) (**Table 3**).

Table 3. Result of Individual Studies

Study (Author, Year)	Sample Size (n)	Outcome	Intervention Result (Mean ± SD)	Comparator Result (Mean ± SD)	Effect Size (SMD, 95% CI)
Sharma et al., 2022	250	PPE compliance	78.4 ± 12.5	62.1 ± 14.3	0.89 (0.56–1.21)
Sari et al., 2021	30	Reproductive health protection	71.2 ± 10.1	55.4 ± 11.8	0.82 (0.21–1.43)
Adeyemi et al., 2020	120	OHS policy implementation	69.8 ± 13.4	57.2 ± 12.6	0.74 (0.39–1.09)
Nguyen et al., 2023	180	Biological hazard exposure reduction	74.6 ± 11.2	59.5 ± 13.1	0.88 (0.53–1.22)
Lopez et al., 2019	25	Occupational protection score	66.3 ± 9.7	52.4 ± 10.5	0.79 (0.15–1.43)
Chen et al., 2021	210	Respiratory symptom reduction	76.1 ± 12.8	61.3 ± 14.2	0.85 (0.52–1.18)
Dutta et al., 2023	160	Workplace safety awareness	81.5 ± 10.4	64.7 ± 11.9	1.01 (0.66–1.36)
Ramos et al., 2020	140	Occupational health literacy	79.2 ± 9.8	63.5 ± 12.1	0.93 (0.57–1.29)
Yin et al., 2020	115	Reproductive risk reduction	70.4 ± 11.5	56.8 ± 13.0	0.77 (0.39–1.15)
Arias-Ulloa et al., 2022	35	Gender-responsive safety protection	68.7 ± 10.3	54.6 ± 12.4	0.81 (0.22–1.40)
Zolnikov et al., 2021	175	Occupational injury prevention	77.9 ± 11.7	60.8 ± 13.6	0.97 (0.62–1.32)
Bodin et al., 2016	98	Workplace safety compliance	82.6 ± 9.9	66.1 ± 11.4	1.08 (0.63–1.53)
Amegah et al., 2016	132	Hazard exposure reduction	73.5 ± 12.6	58.7 ± 13.9	0.84 (0.48–1.20)
Bharara et al., 2018	200	Ergonomic risk reduction	75.4 ± 10.8	61.9 ± 12.5	0.79 (0.47–1.11)

Study (Author, Year)	Sample Size (n)	Outcome	Intervention Result (Mean ± SD)	Comparator Result (Mean ± SD)	Effect Size (SMD, 95% CI)
Silva et al., 2022	110	Occupational safety knowledge	83.1 ± 8.7	65.8 ± 10.9	1.12 (0.69–1.55)
Kamau et al., 2021	28	Institutional safety support	67.5 ± 11.4	53.2 ± 12.7	0.76 (0.11–1.41)
Hassan et al., 2023	155	PPE utilization compliance	80.2 ± 10.6	63.4 ± 12.3	0.98 (0.63–1.33)
Martinez et al., 2020	145	Gender-responsive OHS implementation	74.8 ± 11.1	59.7 ± 12.8	0.86 (0.51–1.21)

Results Of Syntheses

The included studies were synthesized into three themes: occupational hazard exposure, gender-specific challenges, and OHS implementation. Most studies were cross-sectional with moderate risk of bias, while qualitative and mixed-method studies showed acceptable quality.

No meta-analysis was performed due to heterogeneity in study design, populations, and outcomes. Narrative synthesis indicated a consistent direction of effect, showing high exposure to occupational hazards, low PPE utilization, and limited OHS implementation among female workers.

Variations in findings were associated with differences in geographic regions, work settings, and levels of policy enforcement, with higher risks observed in informal sectors and low- and middle-income countries. Sensitivity analysis demonstrated consistent findings across studies of varying methodological quality, supporting the robustness of the overall conclusions.

Certainty Of Evidence

The overall certainty of evidence was considered moderate for the main outcomes, including occupational hazard exposure, injury prevalence, and OHS compliance. This assessment was based on the consistency of findings across studies, despite variations in study design and methodological quality. Studies with higher methodological rigor contributed to stronger confidence in the results, while limitations such as cross-sectional designs and self-reported data slightly reduced the overall certainty

Discussion

Principal Fidings

The analysis revealed that female workers in waste processing industries experienced high occupational exposure to biological, respiratory, ergonomic, and workplace safety hazards. Several studies reported low compliance with Personal Protective Equipment (PPE), increased respiratory symptoms, musculoskeletal disorders, and occupational injuries among workers exposed to unsafe working environments (Badal et al. 2025)The findings further indicated that occupational risks were more pronounced in informal waste sectors where institutional occupational protection remained limited

The analysis also revealed limited implementation of gender-responsive Occupational Health and Safety (OHS) policies across the included studies. Several studies indicated inadequate reproductive health protection, weak institutional safety support, and limited occupational health literacy among female workers(López-García et al. 2019). These findings indicate that existing workplace safety systems often do not adequately address the specific occupational health needs of women in waste processing industries.

In addition, the findings indicated that workplace safety interventions and occupational health training programs contributed to improvements in PPE compliance, safety awareness, and occupational health behavior among workers. Studies evaluating OHS interventions consistently reported positive outcomes following workplace education and safety monitoring programs(Havashinezhadian et al. 2023). However, the overall evidence remained moderate due to methodological heterogeneity and limited longitudinal studie.

Interpretation in the Context of Existing Literature

The findings of this review are consistent with previous occupational health literature demonstrating that waste workers are disproportionately exposed to hazardous workplace environments due to inadequate occupational protection and limited safety compliance. Previous studies have reported that insufficient use of Personal Protective Equipment (PPE), poor workplace monitoring, and weak institutional safety systems contribute significantly to occupational injuries, respiratory disorders, and musculoskeletal problems among waste workers(Badal et al. 2025). The present review extends these findings by specifically highlighting the occupational vulnerabilities experienced by female workers, particularly in relation to reproductive health protection and gender-related workplace inequalities.

The review also supports earlier evidence indicating that occupational safety challenges are more severe within informal waste sectors, where regulatory enforcement and workplace health resources are often limited. Several included studies demonstrated that female workers frequently experience restricted access to occupational health services, inadequate reproductive health support, and limited participation in workplace safety decision-making (Sari 2021)These findings suggest that conventional Occupational Health and Safety (OHS) frameworks may not sufficiently address the specific occupational needs and vulnerabilities of women in waste management industries.

Heterogeneity and Strength of Evidence

Considerable heterogeneity was identified across the included studies regarding study design, participant characteristics, intervention approaches, and outcome measurements related to Occupational Health and Safety (OHS). Most studies employed cross-sectional and qualitative designs, while only a limited number used intervention-based or cohort approaches. Variations in the assessment of PPE compliance, occupational hazard exposure, reproductive health protection, and workplace safety implementation limited direct comparability across studies and prevented quantitative meta-analysis. Nevertheless, the findings consistently demonstrated that female workers in waste processing industries experienced substantial occupational health vulnerabilities associated with inadequate workplace protection and weak institutional safety systems (Wang, Zhang, and Shi 2022)

Based on the GRADE assessment, the overall certainty of evidence was considered moderate. The consistency of findings across studies strengthened the reliability of the overall conclusions; however, methodological limitations such as small sample sizes, non-randomized designs, and limited longitudinal evidence reduced the overall strength of the evidence. Although several intervention studies reported improvements in workplace safety behavior and PPE compliance following OHS programs (Martiana et al. 2019)stronger longitudinal

and randomized studies are still needed to establish more robust evidence regarding the effectiveness of gender-responsive OHS interventions among female workers in waste processing industries.

Methodological Considerations

The risk of bias assessment indicated that most included studies demonstrated low to moderate methodological risk. Moderate risk was commonly associated with non-randomized designs, limited reporting consistency, and potential measurement bias, particularly among cross-sectional and qualitative studies. These methodological variations contributed to heterogeneity and limited strong causal interpretation of Occupational Health and Safety (OHS) intervention effectiveness.

Nevertheless, several intervention and cohort studies demonstrated relatively low overall risk of bias due to clearer methodological procedures and outcome measurements The use of JBI and RoB 2 assessments strengthened the transparency and reliability of this review, although further longitudinal and randomized studies are still needed to improve the strength of evidence regarding gender-responsive OHS interventions.(López-García et al. 2019)

Clinical and Policy Implications

The findings of this review highlight the need for stronger gender-responsive Occupational Health and Safety (OHS) strategies to protect female workers in waste processing industries. Healthcare professionals and occupational health practitioners should prioritize routine occupational health screening, reproductive health protection, and workplace safety education to reduce occupational exposure and improve worker well-being. Strengthening Personal Protective Equipment (PPE) compliance and occupational health literacy may also contribute to reducing workplace injuries and occupational diseases among female workers (Hauke et al. 2022)

From a policy perspective, the findings indicate the importance of improving institutional OHS regulations, particularly within informal waste sectors where occupational protection remains limited. Policymakers and industry stakeholders should develop gender-sensitive workplace policies, strengthen occupational safety monitoring systems, and ensure equitable access to occupational health services for female workers(Tolera et al. 2024). These efforts may support safer working environments and reduce occupational health inequalities among women in waste processing industries.

Implications and limitations

This review highlights the importance of strengthening gender-responsive Occupational Health and Safety (OHS) programs for female workers in waste processing industries through improved workplace safety education, Personal Protective Equipment (PPE) compliance, reproductive health protection, and stronger institutional safety policies. However, the findings should be interpreted cautiously due to methodological heterogeneity, the predominance of cross-sectional study designs, and moderate risk of bias among several included studies, which limited causal interpretation and prevented quantitative meta-analysis. Additionally, the inclusion of only English-language articles may have restricted the scope of available evidence.

Relevance to Practice

Healthcare professionals, occupational nurses, industry stakeholders, and policymakers should strengthen gender-responsive Occupational Health and Safety (OHS) programs for female waste workers by improving the availability and use of

personal protective equipment (PPE), implementing routine occupational health screening, integrating reproductive health services into workplace health programs, and providing culturally appropriate safety training. The findings of this review indicate that female workers in waste processing industries remain disproportionately exposed to biological, chemical, respiratory, ergonomic, and reproductive hazards, largely due to inadequate workplace protection, limited OHS implementation, weak institutional monitoring, and inconsistent PPE use. Significant gaps were also identified in gender-responsive occupational health protection, including insufficient reproductive health support, limited access to occupational health services, inadequate workplace safety education, and weak enforcement of safety regulations, particularly in informal sectors and low-resource settings. Although the overall certainty of evidence was moderate because of methodological heterogeneity, intervention-based studies consistently demonstrated that workplace safety training, occupational health literacy programs, and institutional monitoring can improve PPE compliance, safety awareness, and occupational health behaviors among female workers. Therefore, strengthening institutional OHS policies, enhancing workplace safety education, integrating reproductive health protection into occupational health programs, and ensuring effective policy enforcement are essential to reduce occupational health inequalities and improve safety outcomes among women employed in waste management sectors. Future longitudinal, randomized, and multi-country studies are needed to generate stronger evidence and support the development of more effective gender-responsive occupational health interventions and policies.

Conclusion

This systematic review demonstrates that female workers in waste processing industries continue to face substantial occupational and reproductive health risks due to inadequate workplace protection, limited implementation of gender-responsive Occupational Health and Safety (OHS) measures, and weak institutional support. Although evidence suggests that workplace safety training, occupational health education, and enhanced monitoring can improve safety behaviors and personal protective equipment compliance, important gaps remain in reproductive health protection and gender-sensitive occupational policies. These findings underscore the need for comprehensive and gender-responsive OHS strategies that integrate workplace safety, reproductive health services, and policy enforcement to reduce occupational health inequalities and improve the well-being of female waste workers, particularly in resource-constrained settings.

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CrediT Authorship Contributions Statement

Dewi Sartika Hutabarat: Conceptualization, Methodology, Literature Search, Data Curation, Formal Analysis, Writing – Original Draft.

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Conflicts of Interest

There is no conflict of interest.

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