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# Healthcare Waste Management Practices and Its Associated Factors Among Healthcare Workers in Health Facilities in Ethiopia: A Systematic Review and Meta-analysis

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## ABSTRACT

**INTRODUCTION:** Waste Management Practices have garnered growing interest in hospitals, research facilities, and laboratories over the past few years. However, there seems to be noticeable absence of a comprehensive understanding regarding research on waste management practices in health facilities among healthcare workers.

**OBJECTIVE:** This study aimed to determine the prevalence and factors associated with healthcare waste management practices among healthcare workers in Ethiopia.

**METHODS:** The search was performed by using the Web of Science (WoS) database, PubMed, and the Cochrane Library. To assess the presence of publication bias, by using funnel plots, contour-enhanced funnel plots, trim and fill analysis, and Begg and Egger regression test. A significance level of  $P \leq .05$  was used to indicate potential publication bias. Heterogeneity between studies was assessed using the I<sup>2</sup> statistics.

**RESULTS:** From retrieved original studies, 15 studies were included in the meta-analysis with a total of  $n = 5260$  healthcare workers. The pooled prevalence of waste management practices in Ethiopia was 52.86% (95% CI = 51.57, 54.15), with significant heterogeneity observed between studies ( $I^2 = 97.0\%$ ;  $P \leq .001$ ). Sub-group analysis based on regional distribution in Ethiopia revealed that the highest prevalence of waste management practices was observed in Southern Nation and Nationalities and People's Region with 61.9% (95% CI = 52.953, 64.449).

**CONCLUSIONS:** This systematic review and meta-analysis revealed that the pooled prevalence of waste management practices among healthcare workers in Ethiopia was notably low. Training and the presence of guidelines were significantly associated with waste management practices. The healthcare facilities have improved access to and availability of policies related to waste management and the Ministry of Health promotes their use through various means, including training for healthcare professionals.

**KEYWORDS:** Healthcare, waste management, practices, healthcare worker, systematic review, meta-analysis, health facilities

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## Introduction

Everywhere, there is a significant issue with how garbage is disposed of in healthcare facilities. The majority of healthcare facilities in underdeveloped nations still dump their trash in uncontrolled, open dumps.<sup>1</sup> Patients, healthcare professionals, and the environment may all be at risk for health problems as a result of improper management of healthcare waste.<sup>2</sup>

A contaminated needle that is carelessly handled carries a 1 in 3 risk of developing hepatitis B infection, 1 in 30 for hepatitis C infection, and 1 in 300 for HIV infection.<sup>3</sup> For instance, the World Health Organization estimated that injections from contaminated syringes caused 260 000 cases of human immunodeficiency virus infection, or 5% of all new infections, and 21 million cases of hepatitis B virus infection, accounting for 40% of all new infections.<sup>3,4</sup>

Poor waste management techniques in healthcare facilities are linked to a high disease burden that causes prolonged hospital stays, long-term disabilities, an increase in the resistance of bacteria to antibiotics, a significant rise in the cost of care for patients and their families, and avoidable deaths.<sup>5,6</sup>

Ethiopia now has more healthcare facilities than ever before, allowing it to address both the population's fundamental healthcare needs and the Sustainable Development Goals (SDGs). The majority of the healthcare facilities assessed in several Ethiopian research had inadequate waste disposal practices. This discrepancy may result from poor worker training at the production site as well as insufficient oversight of waste management systems.<sup>7</sup>

Even though there are uniform standards and laws throughout Ethiopia, healthcare waste has not received the attention it



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needs, and there is little data, especially regarding worker habits, to support this.<sup>8</sup> The way waste is handled in healthcare facilities is influenced by various factors. The lack of colored garbage bags, the absence of policymakers who support healthcare waste management practices at healthcare institutions, inadequate awareness of waste management practices, and a lack of training in this area are some of the factors that hamper implementation.<sup>6,9</sup>

The research carried out in health centers and hospitals in Ethiopia primarily focused on the generation of healthcare waste, and did not consider its management practices.<sup>5,6</sup> To the best of our knowledge, there has been no systematic review and meta-analysis conducted in Ethiopia regarding healthcare waste management practices among healthcare workers in healthcare facilities. Therefore, we sought to summarize available data on the prevalence and factors associated with healthcare waste management practices among healthcare workers in healthcare facilities in Ethiopia. Because healthcare waste management practices have become a cross-cutting public health issue.

The outcome of this study will provide important input for policymakers, thereby enhancing the implementation of good practices in healthcare waste management through various mechanisms that incorporate practice into conservation and in-service training of healthcare providers.

## Methods

### *Searching strategies and sources of information*

The search was carried out on the WoS, one of the significant databases to conduct systematic review and meta-analysis. Others like PubMed, Web of Science, Scopus, and African Journals Online were the databases used to find the study papers. Protocol for this systematic review was registered in PROSPERO by CRD42023427383. Searching strategies were established by using Boolean operators (“OR” or “AND”) and the following key terms and phrases: waste management, health care workers, waste management practice, and Ethiopia.

The search strategy made in PubMed was: Search (((((((OR (“Delivery of health care”[MeSH Terms]) OR (“Therapeutics”[MeSH Terms]) OR (“Practice” [MeSH Terms]) OR (“Health personnel”[MeSH Terms] OR (“occupational groups”[MeSH Terms])) OR (“Health facilities”[MeSH Terms])) AND (Healthcare facilities [tw] OR hospitals OR clinics)) AND (Health care worker [tw] OR health professional [tw] OR medical professional))) AND (Practice [tw])) AND (Waste management [tw] OR waste treatment))((Health care [Tw])) AND (Ethiopia. We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) standards when conducting the systematic review<sup>10</sup> (Supplemental File 1).

### *PECO frameworks*

*Population.* Healthcare workers in health facilities.

*Exposure.* The likelihood of healthcare waste management practices among Ethiopian healthcare personnel is significantly influenced by exposure. These elements include guidelines, training in waste management, and the level of health professionals’ understanding.

*Context.* Ethiopia.

*Condition.* Waste management practices.

*Outcome measurement.* The primary outcome of the study was the determination of the pooled prevalence of waste management practices. The secondary objective was to identify the factors that influence waste management practices among healthcare workers in institutional settings. The study utilized binary results and odds ratios derived from primary research as the basis for analysis.

### *Inclusion criteria and exclusion criteria*

This study aimed to examine the prevalence of Healthcare waste management practices among healthcare workers in Ethiopia. The inclusion criteria for this review were studies that reported the prevalence of Healthcare waste management practices in health facilities among healthcare workers in Ethiopia and full-text articles written in English. Both published and unpublished articles were included, as were studies that used probability, and non-probability sampling methods.

However, the present study excluded research articles that focus on waste management practices outside the healthcare sector. Additionally, articles that were not fully accessible despite multiple attempts to contact the original authors via email were excluded from the analysis. The reason for this exclusion was that the content of these articles could not be assessed due to the lack of complete texts. In addition, studies where it was difficult to extract the required data were also excluded. Furthermore, this systematic review and meta-analysis specifically excluded studies conducted in developed countries and those that relied on multiple studies.

### *Study selection and abstraction*

The retrieved publications were exported to Reference Manager Software, and duplicate studies were eliminated using Endnote software. The abstract and the full text were reviewed by the 2 independent reviewers. The author’s name, year of publication, study setting, study design, region, sample size, presence of guidelines, color-coded waste container, training, and knowledge were extracted for risk factor assessment and dissemination of healthcare waste management practices among healthcare workers in healthcare facilities in Ethiopia. Based on a specific article selection criterion, the dispute was settled. Two independent authors created a consistent data extraction format in Microsoft Excel that was used to extract

the data. Any disagreements that arose during the extraction were talked out.

### *Quality assessment*

The level of quality of the studies was evaluated by 3 separate authors. The quality assessment checklist from the Joanna Briggs Institute (JBI) was utilized.<sup>11</sup> All 3 authors talked and settled any differences of opinion. There are 8 parameters on the critical assessment checklist, with the options yes, no, uncertain, and not applicable. Are the following questions involved with the parameter? (1) Where are the inclusion criteria for the sample clearly stated? (2) Were the study participants and the environment adequately described? (3) Were the exposure measurements valid and reliable? (4) Were objective, accepted criteria used to measure the condition? (5) Were confounding factors identified? (6) Were strategies to deal with confounding factors stated? (7) Were the outcomes measurements valid and reliable? (8) Were the results measured? (9) Were the results measured? (10) Were the results analyzed statistically appropriately? Studies were deemed low risk when they achieved quality evaluation indicators scores of 50% or higher (Supplemental File 2).

### *Risk of bias assessment*

We applied the guidance from Hoy et al<sup>12</sup> to assess the risk of bias by measuring internal and external validity against 10 criteria. The instrument covered the following topics: (1) population representation; (2) sampling frame; (3) participant selection techniques; (4) non-response bias; (5) data collection directly from subjects; (6) acceptance of case definition; (7) reliability and validity of study instruments; (8) type of data collection; (9) length of prevalence period; and (10) sufficiency of numerator and denominator. Each component received either a low or high risk of bias rating. Articles with a high risk of bias were those using ambiguous data-collecting assessment tools. Finally, the number of studies with a high risk of bias was used to determine the overall risk of bias rating: low (2), moderate (3-4), and high (5) (Supplemental File 3).

### *Statistical analysis*

The data were exported to STATA software version 14 for analysis after all pertinent findings were extracted and entered into a Microsoft Excel spreadsheet. Using a 95% confidence interval, the pooled prevalence of waste management practices was determined. With  $P < .05$  suggesting potential publication bias, publication bias was examined using a funnel chart and more objectively using Begg and Eggers regression tests. The Cochrane  $Q$  statistic was used to assess if there was study heterogeneity. This study-to-study heterogeneity was measured using  $I^2$ , where values of 0, 25%, 50%, and 75%, respectively, denoted no, low, medium, and high heterogeneity. A random

effect model was utilized for analysis to estimate the pooled estimate of waste management practices, and a forest plot was employed to visually analysis the presence of heterogeneity. By region, sub-group analysis was conducted. To determine the impact of a single study on the pooled prevalence from the meta-analysis, a sensitivity analysis was carried out. Text, tables, and graphics were used to present the study's findings.

## **Results**

### *Search outcomes*

A combined total of 56 and 3417 articles from the database and manual searching were identified. Following the removal of duplicate research, a final selection of 1548 studies underwent thorough screening of their titles and abstracts. Subsequently, 113 articles were assessed for full-text articles, as 1132 studies were excluded due to title and abstract concerns. Upon reading the complete texts, 98 articles were excluded from the review due to their reporting of findings exclusively from developing countries and their lack of complete titles. Ultimately, this review incorporated 15 studies that met the established criteria (Figure 1).

### *Description of included studies*

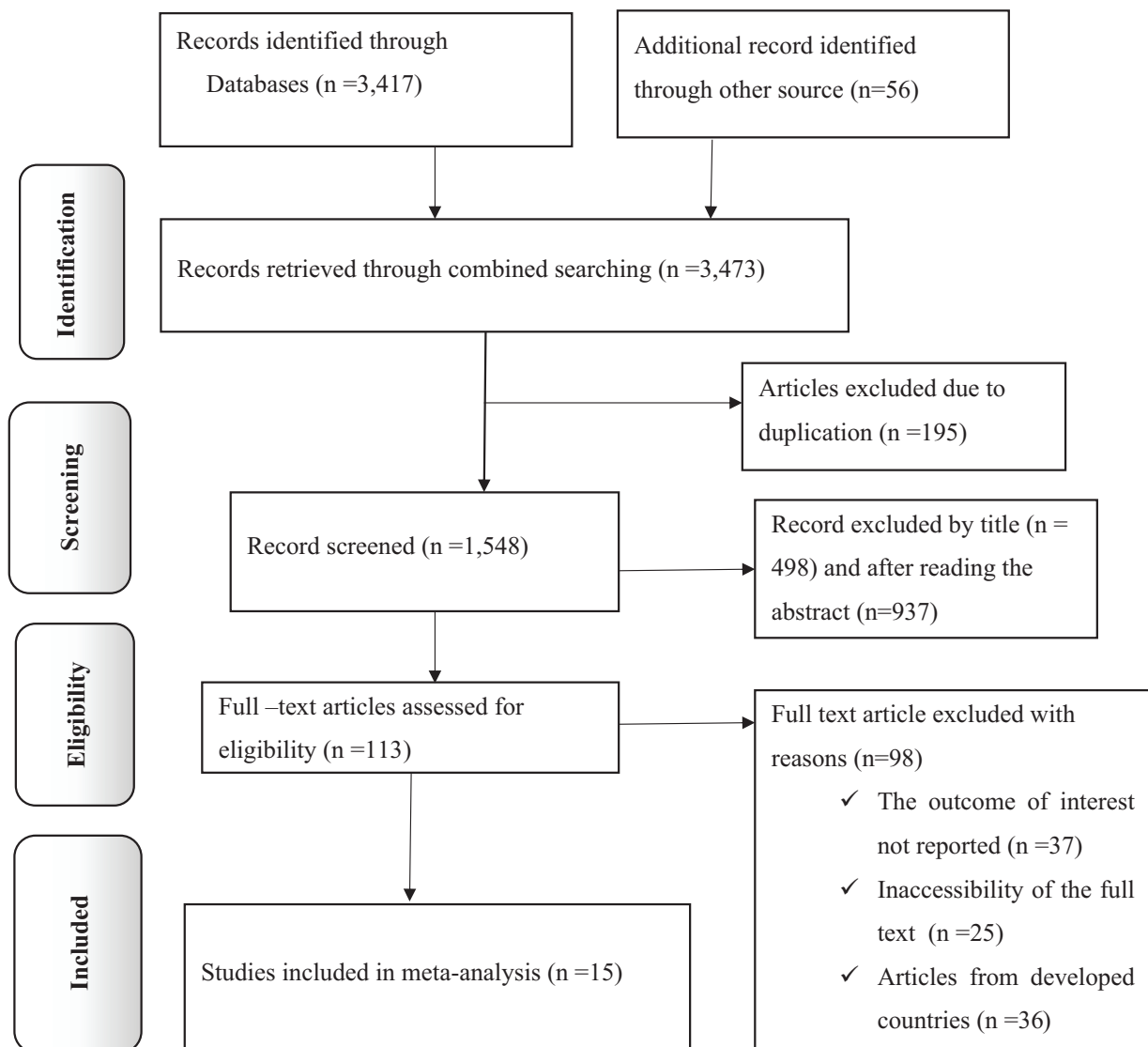
Table 1 shows the characteristics of all studies included in this analysis. The table provides information on the author's name, year of publication, study design, sample size, region, and related factors, such as the presence of guidelines, color-coded waste containers, training, and knowledge of waste management practices in healthcare facilities in Ethiopia. A total of 15 studies were included in this analysis with a sample size of 5260, 3 of which were conducted in Addis Ababa,<sup>13-15</sup> 7 in the Amahara region,<sup>16-22</sup> 2 in Oromia,<sup>23,24</sup> and 1 each in Somalia, Dirediwa and South Nation Nationalities and People (SNNP).<sup>25-27</sup> The Joanna Briggs Institute (JBI) quality assessment checklist was used to assess the quality of the studies, and all studies were found to be at low risk of bias (Table 1).

The earliest research was conducted in 2012 by Yenesew et al<sup>19</sup> in the city of Gondar in the Amahara region. In contrast, the most recent study from 2022 covered Addis Ababa, Dirediwa, and Oromia.<sup>13-15,23,26</sup> A cross-sectional study design was chosen as the methodology for all of these studies. Sample sizes ranged from 42 to 636 participants.

Notably, a study conducted in the Amahara region found the highest proportion of people adopting good practices at 77.4%.

### *The pooled prevalence of healthcare waste management practices in Ethiopia*

The lowest prevalence of healthcare waste management practice in Ethiopia was 31.5%, which was reported from Gondar town in the Amhara region,<sup>16</sup> whereas the highest prevalence



**Figure 1.** PRISMA diagram showing studies used for Systematic Review and Meta-analysis of the waste management practices in Ethiopia.

was 77.4%,<sup>17</sup> reported from a study done by Debre-Markos. Overall, the pooled prevalence of healthcare waste management practices among healthcare workers in Ethiopia was 52.86% (95% CI: 51.57, 54.15) (Figure 2). The  $I^2$  statistic test for heterogeneity indicated that the studies differed significantly ( $I^2=97.0\%$ ;  $P\leq .001$ ). Hence, we used a DerSimonian and Laird random effects model to estimate the pooled prevalence of healthcare waste management practices among healthcare workers in health facilities (Figure 2).

#### Handling heterogeneities between studies

**Subgroup analysis.** The presence of heterogeneity between studies was noted, prompting the implementation of a subgroup analysis to determine the origin of the heterogeneity based on the region of the studies. Despite these efforts, significant heterogeneity remained between studies. Notably, the study conducted in Southern Nation and Nationalities and People's Region (SNNPR) had the highest prevalence of healthcare

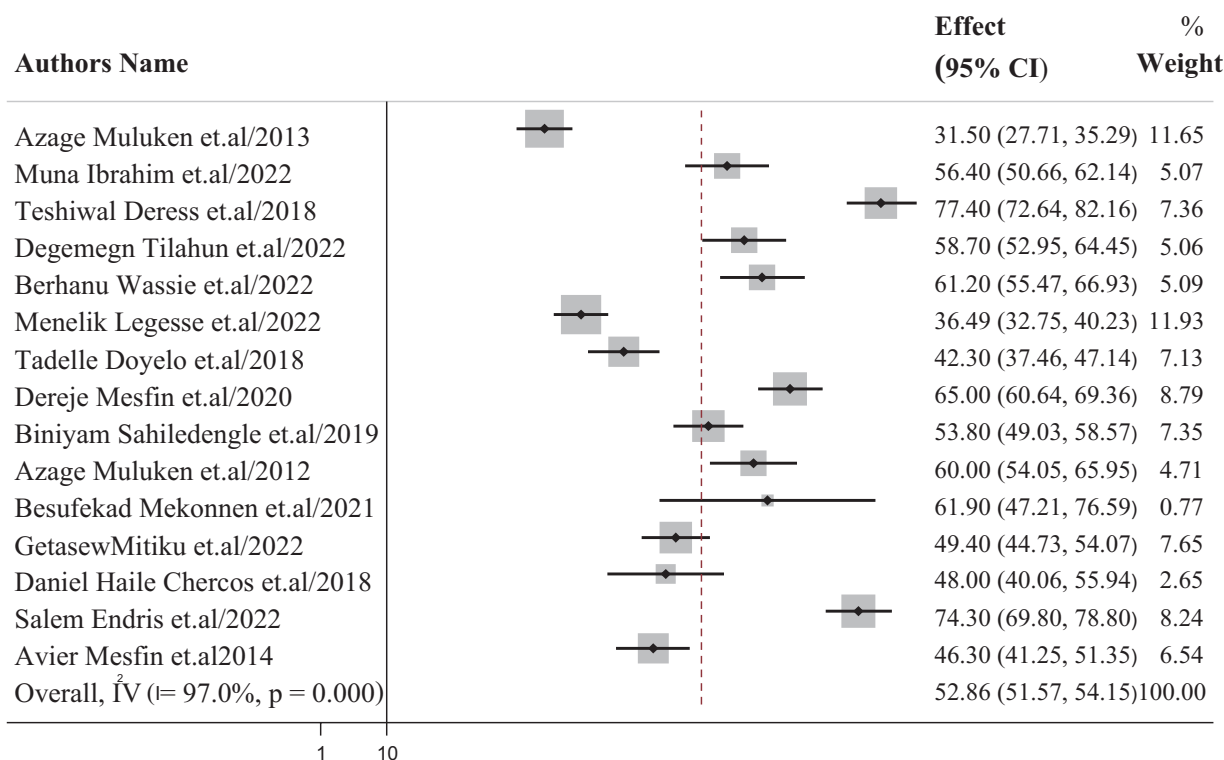
waste management practices at 61.9% (95% CI=47.213, 76.587) while, the lowest prevalence of healthcare waste management practices was in Somalia region, Ethiopia with a prevalence rate of 42.300% (95% CI= 37.459, 47.141) (Table 2).

**Sensitivity analysis.** Leave-one-out sensitivity analysis was performed to address the possible impact of any particular study on the overall pooled effect. There was no significant influence of any specific study on the overall prevalence of waste management practice among healthcare workers in Ethiopia (52.86%) (Table 3).

**Publication bias.** Using a funnel plot and an Egger and Begg regression test with a 5% significant level, publication bias was evaluated. No statistical evidence of publication bias was found. A funnel plot indicated considerable symmetry in the distribution, but the scientific Begg and Egger tests did not reach statistical significance with  $P$ -values of .553 and .215, respectively (Figure 3).

**Table 1.** Characteristics of studies included in the systematic review and meta-analysis on the level of waste management practices of health care workers toward health facilities in Ethiopia.

AUTHORS NAME	YEAR/ PUBLICATION	STUDY AREA	REGION	STUDY DESIGN	SAMPLE SIZE	PREVALENCE	STUDY QUALITY
Wassie et al <sup>13</sup>	2022	Addis Abeba	Addis Abeba	Cross-sectional	278	61.2	Low risk
Tadesse and Dolamo <sup>14</sup>	2022	Addis Abeba	Addis Abeba	Cross-sectional	636	36.49	Low risk
Endris et al <sup>15</sup>	2022	Addis Abeba	Addis Abeba	Cross-sectional	362	74.2	Low risk
Deress et al <sup>16</sup>	2018	Debre- Markos Town	Amahara	Cross-sectional	296	77.4	Low risk
Muluken et al <sup>17</sup>	2013	Gondar Town	Amahara	Cross-sectional	578	31.5	Low risk
Assemu et al <sup>18</sup>	2020	Bahir/D. City	Amahara	Cross-sectional	460	65	Low risk
Yenesew et al <sup>19</sup>	2012	Gondar	Amahara	Cross-sectional	260	60	Low risk
Mitiku et al <sup>20</sup>	2022	Metropolitan cities	Amahara	Cross-sectional	440	49.4	Low risk
Chercos et al <sup>21</sup>	2018	University/G Hospital	Amhara	Cross-sectional	152	48	Low risk
Mesfin et al <sup>22</sup>	2014	University/G Hospital	Amhara	Cross-sectional	374	46.3	Low risk
Tilahun et al <sup>23</sup>	2022	Ilu Aba Bor zone	Oromia	Cross-sectional	282	58.7	Low risk
Sahiledengle <sup>24</sup>	2019	Bale zone	Oromia	Cross-sectional	420	53.8	Low risk
Birhanu <sup>25</sup>	2018	Jigjiga town	Somalia	Cross-sectional	400	42.3	Low risk
Ibrahim et al <sup>26</sup>	2023	Dirediwa	Dirediwa	Cross-sectional	280	56.4	Low risk
Mekonnen et al <sup>27</sup>	2021	Tebi.Hospital	SNNPR	Cross-sectional	42	61.9	Low risk



**Figure 2.** Forest plot for the pooled level of good practices among healthcare workers in Ethiopia.

**Table 2.** Sub-group pooled prevalence of waste management practices among healthcare workers in Ethiopia (n=15).

VARIABLE	REGION/CITY ADMINISTRATION	INCLUDED STUDIES	SAMPLE SIZE	RANDOM EFFECT (95% CI)
Region	SNNPS	1	42	61.9 (47.213, 76.587)
	Addis Abeba	3	1276	57.296 (33.022, 81.570)
	Dirediwa	1	280	56.400 (50.663, 62.137)
	Oromia	2	702	55.977 (51.205, 60.749)
	Amhara	7	2560	53.946 (41.444, 66.449)
	Somalia	1	400	42.300 (37.459, 47.141)

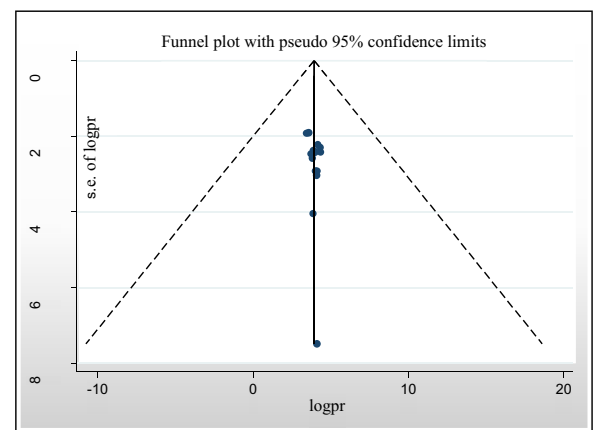
**Table 3.** Sensitivity analysis for the prevalence of health care waste management practices in Ethiopia.

STUDY OMITTED	POOLED ESTIMATE	95% CI
Azage Muluken et al. (2013)	56.44	(49.46, 63.43)
Muna Ibrahim et al. (2022)	54.63	(46.61, 62.65)
Teshiwal Deress et al. (2018)	53.07	(45.95, 60.19)
Degemegn Tilahun et al. (2022)	54.46	(46.46, 62.46)
Berhanu Wassie et al. (2022)	54.28	(46.32, 62.25)
Menelik Legesse et al. (2022)	56.08	(48.53, 63.64)
Tadelle Doyelo et al. (2018)	55.65	(47.69, 63.61)
Dereje Mesfin et al. (2020)	53.99	(46.09, 61.91)
Biniyam Sahiledengle et al. (2019)	54.82	(46.68, 62.96)
Azage Muluken et al. (2012)	54.37	(46.40, 62.35)
Besufekad Mekonnen et al. (2021)	54.33	(46.54, 62.10)
Getasew Mitiku et al. (2022)	55.13	(47.01, 63.27)
Daniel Haile Chercos et al. (2018)	55.21	(47.30, 63.12)
Salem Endris et al. (2022)	53.30	(45.10, 60.60)
Avier Mesfin et al. (2014)	55.36	(47.32, 63.40)
<b>Overall</b>	<b>52.86</b>	<b>(47.20, 62.28)</b>

### Determinants of waste management practices in Ethiopia

The association between healthcare waste management practice and the availability of guidelines in healthcare facilities was evaluated by using 4 studies.<sup>13,18,23,26</sup> The result revealed that the pooled effect of having guidelines in healthcare facilities was significantly associated with the healthcare waste management practice. Healthcare providers who had guidelines were 3.55 times more likely good practice healthcare waste management in health facilities (OR=3.55, 95% CI=1.92, 6.59). Moderate heterogeneity was detected across the studies ( $I^2=68.2%$ ,  $P=.024$ ); as a result, we used a random effect model (Figure 4).

The association between healthcare waste management practice and training was evaluated by using 6 studies.<sup>15,17,19,20,23,26</sup>

**Figure 3.** Funnel plots for publication bias of good level of waste management practices among health care workers in Ethiopia.

The result revealed that the pooled effect of having training was significantly associated with the healthcare waste management practice in health facilities. Healthcare personnel who had taken healthcare waste management practice training were 3.49 times more likely to practice good healthcare waste management (OR=3.49, 95% CI=1.95, 6.25). High heterogeneity was detected across the studies ( $I^2=86.3%$ ,  $P=.001$ ); as a result, we used a random effect model (Figure 5).

Lastly, the 4 studies revealed that having a good knowledge of healthcare waste management was insignificantly associated with its practices.<sup>17,19,23,26</sup> Since there was low heterogeneity, we used a random effect model ( $I^2=0.00%$ ,  $P=.427$ ) (Figure 6).

### Discussion

This study aimed to assess the pooled prevalence of waste management practices and associated factors among healthcare workers in Ethiopia. To the best of our knowledge, this meta-analysis is the first of its kind to identify the comprehensive range of waste management practices in healthcare facilities and the factors influencing them in Ethiopia. The results of this study have significant implications for clinicians and policymakers as they can use these findings to improve the availability of infection prevention and control technologies and reduce disease transmission in healthcare settings.

In addition, the study in Ethiopia found that there is no clear strategic document from any national authority that guides the

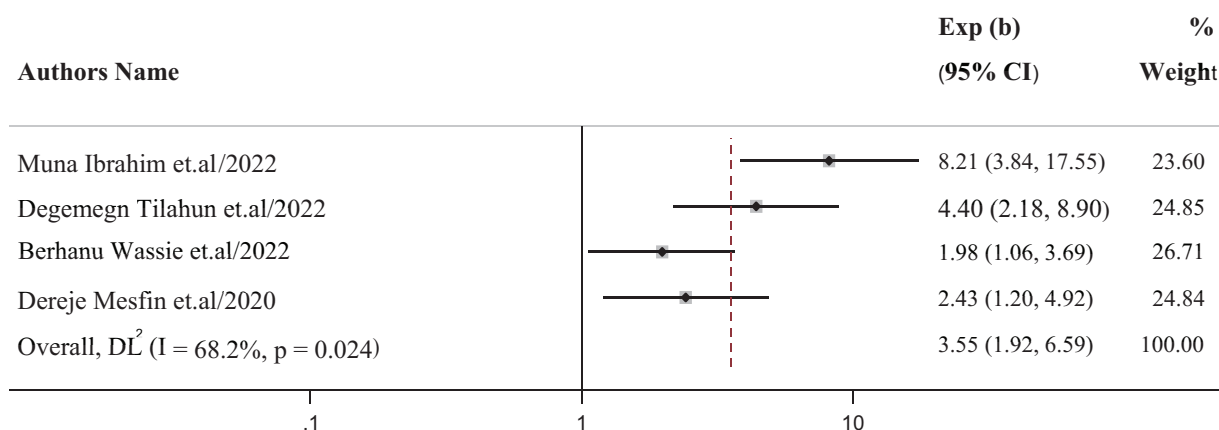


Figure 4. Forest plot showing the association between waste management practices and guideline availability in the health facility.

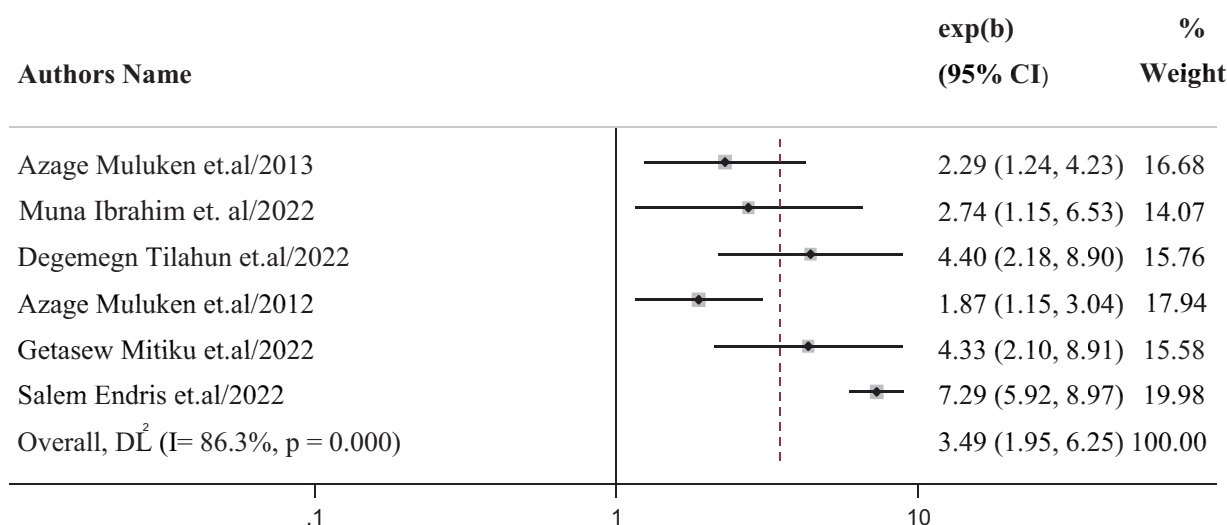


Figure 5. Forest plot showing the association between health care waste management practices and having training on the health care workers.

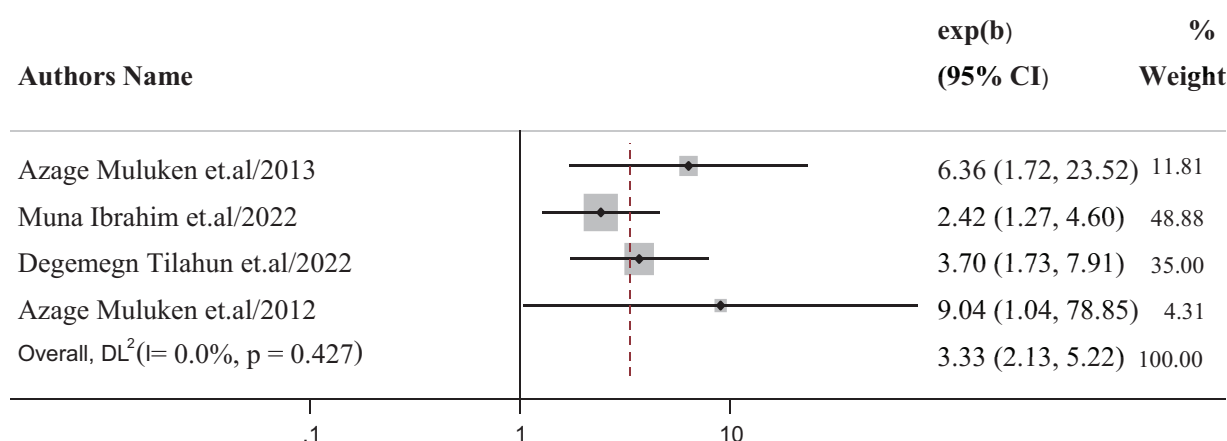


Figure 6. Forest plot showing the association between healthcare waste management practices and having good knowledge.

management of healthcare waste practices. To address this issue, the researcher assessed the current status of HCW management practices in public health facilities. The result of this study has significant implications for the contribution of new information

to the existing literature and assists decision-makers in formulating an effective system. To achieve this, the study aimed to conduct a systematic meta-analysis of the current HCW management practices in healthcare facilities (HCFs), provide



recommendations for improving the existing policies, and evaluate the feasibility of implementing integrated waste management practices in evaluating healthcare.

The pooled estimate of waste practices among healthcare workers in Ethiopia was found to be 52.86% (with a 95% CI = 51.57, 54.15). This finding was in line with a study finding in Nigeria (52.2%)<sup>28</sup> and South Africa (Natal) 53.9%.<sup>29</sup>

However, it is important to note that this finding is significantly higher than the results obtained from studies conducted in Uganda (28.0%)<sup>30</sup> and Tunisia (25%).<sup>31</sup> The observed disparities in waste management practices across different countries can be attributed to several factors. Firstly, variations in sample size and accessibility to waste management practices may have influenced the results. Additionally, differences in the management principles adopted by each country could have contributed to the discrepancies observed. Furthermore, variations in the duration of the studies and the level of emphasis placed on waste practices in healthcare facilities may have also played a role in the observed differences.

Similarly, the outcome of this study was found to be lower compared to a study carried out in Pretoria, South Africa, which reported a rate of 82.2%.<sup>32</sup> The disparity between these studies may be attributed to differences in the implementation of healthcare waste management practices within healthcare facilities and the willingness of healthcare providers to adopt such practices. Furthermore, discrepancies in the incorporation of care training, protocols, and actual practice could also contribute to this variation.

According to the subgroup analysis, the Southern Nation and Nationalities and People's Region (SNNPR) in Ethiopia had the highest pooled prevalence of healthcare waste management practices at 61.9%. This number is significantly higher than the prevalence rates reported in studies in Nigeria and Tunisia.<sup>28,31</sup> The observed variation in prevalence rates may be attributed to differences in the dissemination of information related to waste disposal practices among healthcare workers in different regions. Therefore, it is imperative to examine the underlying reasons for these differences by comparing the methods of information dissemination in different regions. Additionally, it would be beneficial to examine interventions implemented in countries with lower prevalence rates to identify best practices and promising interventions that can be implemented in Ethiopia. Furthermore, the leave-one-out sensitivity analysis was performed to address the possible impact of any particular study on the overall pooled effect. There was no significant influence of any specific study on the overall prevalence of waste management practice among healthcare workers in Ethiopia.

This study found that healthcare providers who received waste management training were 3.49 times more likely to have good waste management practices in healthcare facilities than the references. This result is supported by a study in Nigeria.<sup>28</sup> The possible explanation might be that trained healthcare workers enable them to use the tool as needed. This highlights the need for pre-service and in-service training on infection prevention and control for healthcare providers.

Furthermore, the availability of training is positively correlated with the satisfaction of healthcare workers.

In this study, having good knowledge about healthcare workers was insignificantly associated with waste management practice. This finding was supported by a study finding in Nigeria.<sup>33</sup> This might be a result of the healthcare providers' increased confidence in their ability to manage waste in healthcare facilities as their knowledge increases. Furthermore, there are a variety of precautions and stages involved, so only individuals with sufficient understanding can do it effectively. However, this finding was in contrast with a study finding in South Africa, which revealed that knowledge has no association with waste management practices.<sup>29</sup>

Furthermore, the practices of healthcare waste management among healthcare personnel were strongly correlated with the availability of guidelines for healthcare institutions. Those healthcare providers with a positively used guideline toward waste management were 3.55 times more likely to utilize or practice for the minimization of infection in the health facilities. This result was consistent with research in Nigeria,<sup>29</sup> Kumasi, Ghana,<sup>34</sup> and Distt.Peshawar.<sup>35</sup> This could be explained by the idea that having a favorable availability of guidelines about waste management could lead to an interest in learning more about it, which would then enable the care providers to use it when necessary.

### Strengths and Limitations of the Study

We carried out comprehensive literature search and included studies using predetermined criteria to lessen selection bias. We missed some key information because only English-language publications and some databases were searched. Preprint articles, which have not yet received peer review, were also included. As a result, technique biases could exist, and the research's conclusion could change in the future.

### Conclusion

This systematic review and meta-analysis revealed that the pooled prevalence of waste management practices among healthcare workers in Ethiopia was notably low. Furthermore, within specific sub-groups, the highest prevalence of healthcare waste management practices was observed in the Southern Nation and Nationalities and People's Region (SNNPR), and the lowest prevalence of healthcare waste management practices was in the Somalia region.

The present study found a significant association between waste management practice and both the provision of waste management system training and the availability of guidelines. The results suggest that efforts to improve waste management in healthcare facilities should prioritize the strengthening of in-service training and continuous professional development programs to address knowledge gaps among healthcare workers. Additionally, it is recommended that healthcare facilities have improved access to and availability of policies related to waste management and that the Ministry of Health promote

their use through various means, including training for health-care professionals.

### Acknowledgements

We would like to acknowledge Wolaita Sodo University for providing the materials used for the work.

### Author Contributions

YAA, and KAG initiated the research, conceptualized, searched articles, screened based on the eligibility criteria, and did the statistical analysis of this manuscript. YAA, and KAG participated in data extraction and screening. YAA contributed to statistical analysis and writing-up of the manuscript draft. YAA finalized the manuscript and communicated with the journal. All authors read and approved the final draft of the manuscript.

### Availability of Data and Materials

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request. Furthermore, the corresponding author (YA) will be contacted if someone wants to request the dataset for this study.

### Ethical Approval and Consent to Participate

Not applicable.

### Consent for Publication

Not applicable.

### Research Registration Number

Not applicable.

### Supplemental Material

Supplemental material for this article is available online.

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