Research Article

Assessment of Knowledge, Attitude, and Practice about Biomedical Waste Management and Associated Factors among the Healthcare Professionals at Debre Markos Town Healthcare Facilities, Northwest Ethiopia

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Background. Healthcare activities restore health and save lives at the same time; however, they can generate hazardous biomedical wastes to a human being or the environment. Generation and disposal of biomedical wastes have become an emerging problem worldwide. Objective. To assess knowledge, attitude, and practice about biomedical waste management and associated factors among healthcare professionals in Debre Markos town healthcare facilities, northwest Ethiopia. Methods. A cross-sectional study was employed, and data were collected through structured self-administered questionnaire and observational checklist. Data were entered into the Epi-data 3.1 software and exported into SPSS version 20 for analysis. Bivariate and multivariate logistic regression analyses were computed. Variables with a P value of <0.05 in the multivariate logistic regression analysis were considered to explain the presence of statistically significant associations. Result. Among 296 healthcare professionals studied, 168 (56.8%), 196 (66.2%), and 229 (77.4%) had adequate knowledge, favorable attitude, and adequate practice score, respectively. Regarding associated factors, MSc and MD+ (AOR: 4.95, 95% CI: (1.37, 149.52)), BSc holders (AOR: 2.53, 95%CI: (1.47, 4.38)), and availability of color-coded bins (AOR: 7.68, 95%CI: (3.30, 17.89)) were identified more likely to contribute for adequate knowledge, favorable attitude, and adequate practice score, respectively. Conclusion. The level of knowledge, attitude, and practice scores were not satisfactory. Majority of the healthcare professionals did not access biomedical waste management training. Educational level, use of visual aid, and availability of color-coded bins in the department were identified as a factor for biomedical waste management. Regular training should be given to healthcare professionals.

1. Background

During the healthcare delivery process, healthcare establishments can inevitably generate hazardous biomedical wastes (BMWs) to a human being or the environment [1]. These wastes are broadly categorized as general (non-hazardous) and hazardous waste. General waste is constituted 85% of the total waste while the remaining 15% is a hazardous waste [2]. There are currently several terms used to describe wastes generated from the healthcare establishments such as clinical waste, healthcare waste, infectious waste, medical waste and biomedical waste are typically encountered [3]. However, BMW is the most frequently used term in most articles. So, in this study, we used this term to represent wastes originated from the healthcare facilities (HCFs). Biomedical waste is generated during diagnosis, treatment or immunization of human beings which mainly includes syringes, needles, ampoules, dressing materials,
Biomedical waste management and evaluation studies conducted so far in different parts of Ethiopia reported a high proportion of hazardous BMW generation rates. However, little was reported about the level of knowledge, attitude, practice scores, and associated factors among HCPs who have key roles to ensure effective BMWM. Measuring the level of knowledge, evaluating the attitude, and assessing the practice of healthcare providers and associated factors on BMWM are the key objectives to consider for safe healthcare practice. Therefore, this study is aimed at filling this gap and recommending policymakers to design and implement appropriate intervention to improve safe BMWM in HCFs.

2. Materials and Methods

2.1. Study Area and Setting. The study was conducted in Debre Markos town which is located in Amhara regional state at a distance of 300 kilometers from Addis Ababa to the northwest and 265 kilometers from Bahir Dar to the southeast. According to the Ethiopian Central Statistical Agency (CSA) report [28], the town has a population of 119,000. Among these, 97.1%, 1.7%, and 1.1% were Orthodox Christian, Muslim, and Protestant Christian religion followers, respectively. The three largest ethnic groups in the town were Amhara (97.12%), Tigrinya (1.29%), and Oromo (0.67%) [29]. One referral hospital, 4 health centers, and 12 clinics are found within the town. The hospital has 5 inpatient wards (gynecological, surgical, medical, pediatric, and eye unit) with a total of 400 beds. During 2016/17, the hospital has 35 doctors, 144 nurses, 25 midwives, and 33 laboratory professionals and currently serves 5 million inhabitants in its catchment area [30]. Health centers and clinics have 57 nurses, 24 health officers, 23 laboratory professionals, and 11 midwives, and they currently provide basic health services for the town and nearby areas.

2.2. Study Design and Period. An institution-based cross-sectional study was employed from November 2016 to June 2017.

2.3. Sample Size and Sampling Technique. A total of 296 HCPs were studied from 12 HCFs (1 hospital, 4 health centers, and 7 clinics) after excluding those study participants who did not fulfil the eligibility criteria. For this study, an entire population sampling technique (survey) was employed. This sampling technique was used because the number of the study population in the HCFs was small which is manageable for data collection and analysis.

2.4. Eligibility Criteria. All HCPs of the five health professions (medical, laboratory, nurse, health officer, and midwifery) who have at least one year of work experience and permanently employed among Debre Markos town HCFs were studied. Study participants who were available during the data collection period and willing to take part in the study were included. These HCPs were selected because they are mainly involved in the generation, segregation, and management of BMWs than other HCPs. They frequently handle/work with high-risk BMWs who become at risk of occupational health hazards and play a key role to protect the community.

2.5. Data Collection Tools and Procedure

2.5.1. Data Collection Tools. Structured self-administered questionnaire and observational checklist were used to collect the data. The questionnaire was developed through a review of the available scientific literatures and national [9–11] and international [2] BMWM guidelines. The questionnaire consisted of four sections (sociodemographic and HCF related factors, knowledge, attitude, and practice).
2.5.2. **Data Collection Procedure.** Two trained data collectors (medical laboratory technologist and clinical nurse) were assigned for the data collection process, and the medium of language for data collection was English. Written informed consent containing questionnaires was distributed as hard copy for the study participants. Then data collectors collected completed questionnaires from the study participants, and questionnaires were checked for completeness. Incomplete questionnaires were taken back to the study participants for completion. After completion of the questionnaires, data collectors filled individual observational checklists while the study participants were providing healthcare services. Finally, observational checklists and questionnaires were labeled with HCF and individual identification code numbers and attached together accordingly. After completion of all questionnaires and individual observational checklists, facility observation was conducted using the predetermined structured observational checklist.

2.6. **Methods of Measurement (Scoring).** All questions of the questionnaire and observational checklist were close-ended. The questionnaire consisted of knowledge, attitude, and practice domains.

1. **Knowledge Domain.** This domain consisted of 21 multiple-choice questions and each question had either three or four possible options. Knowledge questions were scored either "1" or "0" for the correct and incorrect response, respectively. The total knowledge score for each study participant was computed, and the possible score could range from 0 to 21. Then, the overall knowledge score was computed by summation of all the individual study participants' total knowledge scores. Finally, the mean score was calculated by dividing the overall knowledge score by the number of study participants (296). Knowledge scores below and above or equal to the mean score were assigned for inadequate and adequate knowledge, respectively [23, 31].

2. **Attitude Domain.** It comprised of 16 Likert items. A five-point Likert scale of measurement was used to represent scores, as such "Strongly Disagree," "Disagree," "Neutral," "Agree," and "Strongly Agree" and were given numerical scores 1, 2, 3, 4, and 5, respectively. For negatively phrased statements, scores were reversely coded during the data entry period as 5, 4, 3, 2, and 1. Then, the composite score for each study participant was computed which could range from 16 to 80. The overall attitude score was calculated by adding all the study participants’ attitude scores, and the mean score was computed by dividing the overall attitude score by the number of study participants (296). Finally, attitude scores below the mean and above or equal to mean score were assigned for unfavorable and favorable attitude, respectively [31].

3. **Practice Domain.** Nine multiple-choice practice questions were used, and they were dichotomized by giving "1" or "0" point for correct and incorrect responses, respectively. Likewise, knowledge and attitude questions, for practice questions total individual and overall practice scores were calculated. Then, the mean score was calculated by dividing the overall practice score by the number of study participants (296). Practice scores below the mean and above or equal to the mean score were assigned for inadequate and adequate practice, respectively [31].

2.7. **Data Quality Control.** Data collection tools were validated with 10% of the study population who were not included in the final study. According to the pilot survey, the contents of the data collection tools were slightly modified and suggestions from different persons were included. Training was given for data collectors. Timely supervision of data collectors was done by the investigators.

2.8. **Data Management and Analysis.** Data were entered into Epi-data 3.1 software and then exported to SPSS (Statistical Package for Social Sciences) version 20 for analysis. Descriptive statistics were calculated through cross-tabulation. Bivariate and multivariate logistic regression analyses were computed to identify predictor variables with the statistically significant association. A standard (Enter) method was used for variable selection for the multivariate logistic regression analysis, which means all variables with a P value of ≤0.2 in the bivariate analysis were pooled into the multivariate logistic regression analysis. Variables with a P value of <0.05 in the multivariate logistic regression analysis were used to explain the presence of statistically significant associations between the predictor and outcome variables. Finally, Odds Ratio (OR) with 95% confidence interval (CI) was used to determine the strength of association.

2.9. **Ethical Considerations.** Ethical approval was obtained from the Departmental Research and Ethics Review Committee (DRERC) of the Department of Medical Laboratory Sciences, Addis Ababa University. Official letters were written from east Gojjam Zonal health department to HCFs, and permission was obtained from the HCFs.

3. **Results**

3.1. **Sociodemographic and HCF-Related Characteristics.** Two hundred ninety-six study participants were included from 12 HCFs. Among these, 197 (66.6%), 69 (23.3%), and 30 (10.1%) were from the hospital, health centers, and clinics, respectively. The mean age of the study participants was 30.46 ± 6.64 years. Less than one-third (30.7%) of the study participants were vaccinated for hepatitis B virus. Regarding previous training, only 109 (36.8%) had taken BMWM training. One hundred seventy-seven (59.8%) of the study participants got information from the guideline. Sixty-nine (23.3%) of the study participants had encountered needlestick/sharps injuries preceding 12 months of the data collection period. Most (97%) of the HCPs respond the availability of sufficient quantity gloves and 81.4% of the respondents also disclosed the availability all types...
In this study, HCPs with adequate knowledge score were 168 (56.8%). One hundred sixty-nine (57.1%) of the study participants identified the biohazard symbol. Regarding knowledge on segregation of BMWs, 235 (79.4%), 217 (73.3%), and 253 (85.5%) of the study participants were aware that general, infectious, and sharp wastes should be placed in a black, yellow, and safety box, respectively. In addition, 254 (85.8%) of them were aware that a safety box should be filled only a maximum of 3/4th. Only twenty-nine (9.8%) of the study participants knew the maximum storage time of infectious wastes before treatment or disposal. Two hundred eighteen (73.6%) of them knew 72 hours as a maximum time delay to start HIV postexposure prophylaxis. All doctors were concerned about needlestick injury than other healthcare professionals. About 46% of health officers did not consider all BMW as hazardous (Table 1).

3.2.2.2. Attitude of Study Participants. One hundred ninety-six (66.2%) of the study participants had favorable attitude score on BMW. The mean attitude score of Likert items ranged from 3.80 to 4.45. In addition, 161 (45.9%) of the study participants strongly agreed to the statement "BMW should be segregated into different categories at the source" and 191 (58.1%) study participants agreed to the statement "safe BMW is an issue involving a teamwork." However, to make similar attitude score category with other studies, the five-point Likert scale of measurement was categorized into a three-level Likert scale. Which means strongly disagree and disagree were merged and labeled as disagree; similarly, strongly agree and agree were merged and labeled as agree, whereas neutral remained as it was (Table 3).

3.2.3. Practice of Study Participants. In this study, 229 (77.4%) of the study participants had adequate practice score and 174 (58.8%) used a visual aid in their department/section. Regarding the use of personal protective equipment, 277 (94%) and 288 (97%) of the study participants have always used gloves and gown, respectively, while they were handling BMWs. Two hundred eighty-eight (79.1%) of the study participants practiced labeling BMW containers. With respect to segregation of BMWs, 275 (92.9%) of the study participants segregated BMWs at the source of generation. However, only 261 (88.2%) of them followed color coding segregation. Among these, 228 (77%), 198 (66.9%), and 247 (83.4%) of them put general, infectious, and sharp wastes into the black bin, yellow bin, and safety box, respectively. More specifically, 26 (83.9%), 140 (85.9%), 27 (100%), 45 (91.8%), and 23 (88.5%) doctors, nurses, midwives, laboratory professionals, and health officers, respectively, followed color coding segregation.

3.2.4. Observational Result. Slightly above three-fourths (76%) of the study participants practiced BMW segregation at the source, and 225 (75%) of them used biohazard symbol-labeled safety boxes for sharp waste segregation. In this study, 70 (23.6%) and 69 (23.3%) of the study participants were working with yellow and black bins containing mixed wastes, respectively. Similarly, one-fourth (25%) of the study participants were working with at least one unlabelled BMW containers, and 65 (22%) HCPs were observed using more than 3/4th filled infectious waste containers. Regarding HCF observation, most (91.7%) of them used puncture-resistant bins to store BMWs temporarily, whereas the other used the incinerator chamber. All HCFs treated BMWs on-site. Among these, 11 (91.7%) used incineration and the remaining used open burning. From the empirical observation, most non-governmental healthcare facilities’ incinerators had remnants of incompletely burned BMWs. Most (91.7%) of the HCFs disposed of the ash in the placenta pit, latrine opening, or open ground.

### Table 1: Sociodemographic and HCF-related factors for BMW at Debre Markos town HCFs, 2017 (n = 296).

| Sociodemographic and HCF-related variables | Variable category | Study participant, n (%) |
|-------------------------------------------|-------------------|--------------------------|
| Gender                                    | Male              | 177 (59.8)               |
|                                           | Female            | 119 (40.2)               |
| Age of respondents                        | ≤25 years         | 44 (14.9)                |
|                                           | 26–30 years       | 159 (53.7)               |
|                                           | 31–35 years       | 42 (14.2)                |
|                                           | >35 years         | 42 (14.2)                |
|                                           | Missing           | 9 (3)                    |
| Educational level                         | MSc and MD+       | 20 (6.8)                 |
|                                           | BSc               | 170 (57.4)               |
|                                           | Diploma           | 106 (35.8)               |
| Job category                              | Medical doctor    | 31 (10.5)                |
|                                           | Nurse             | 163 (55.1)               |
|                                           | Midwife           | 27 (9.1)                 |
|                                           | Laboratory profes- |
|                                           | Professional      | 49 (16.6)                |
|                                           | Health officer    | 26 (8.8)                 |
| Working department/section #              | OPD               | 102 (34.5)               |
|                                           | Ward              | 93 (31.4)                |
|                                           | Laboratory room   | 48 (16.2)                |
|                                           | Emergency         | 64 (21.6)                |
|                                           | Others            | 72 (24.3)                |
| Work experience                           | 1–5 years         | 143 (48.3)               |
|                                           | 6–10 years        | 98 (33.1)                |
|                                           | >10 years         | 49 (16.6)                |
|                                           | Missing           | 6 (2)                    |
| Working hours per day                     | ≤8 hours          | 2 (2)                    |
|                                           | >8 hours          | 249 (84.1)               |
|                                           | Missing           | 35 (11.8)                |
|                                           | 6 (2)             |                          |
| Availability of waste management guideline| Yes               | 159 (51.6)               |
|                                           | No                | 101 (34.1)               |
|                                           | Not sure          | 36 (12.2)                |
| Availability of BMW committee in the fac- |
|    tility                                 | Yes               | 188 (63.5)               |
|                                           | No                | 57 (19.3)                |
|                                           | Not sure          | 51 (17.2)                |

# denotes multiple response question; MD+: medical specialists.
other predictor variables were held constant (Table 4). Compared with the respective reference groups, given that more likely to contribute for adequate knowledge score (AOR: 2.28, 95% CI: (1.18, 4.42)) of the study participants were (AOR: 2.09, 95% CI: (1.09, 4.00)), and practice score (AOR: 14, 95% CI: (1.37, 149.52)), working in another department (AOR: 2.22, 95% CI: (1.03, 4.77)), attitude score (AOR: 14, 95% CI: (1.37, 149.52)), working in another de-
partment (AOR: 2.22, 95% CI: (1.03, 4.77)), attitude score

### Table 2: Frequency of study participants among each knowledge item question at Debre Markos town HCFs, 2017 (n = 296).

| Variables | Doctor (n = 31) | Nurse (n = 163) | Midwife (n = 27) | Laboratory (n = 49) | Health officer (n = 26) |
|-----------|----------------|----------------|----------------|---------------------|------------------------|
| Does your facility generate BMWs? | 24 (77.4) | 129 (79.1) | 24 (88.9) | 43 (87.8) | 24 (92.3) |
| Do you know about BMWM? | 24 (77.4) | 113 (69.3) | 20 (74.1) | 38 (77.6) | 24 (92.3) |
| Is there any health hazard associated with BMWs? | 30 (96.8) | 148 (90.8) | 24 (88.9) | 43 (87.8) | 24 (92.3) |
| Is needlestick/sharp injury a concern? | 31 (100) | 147 (90.2) | 25 (92.6) | 43 (87.8) | 25 (96.2) |
| Does wearing personal protective equipment reduce the risk of infection? | 29 (93.5) | 149 (91.4) | 26 (96.3) | 47 (95.9) | 25 (96.2) |
| Are all BMWs hazardous? | 23 (74.2) | 99 (60.7) | 21 (77.8) | 40 (81.6) | 14 (53.8) |
| Are body fluid contaminated items considered as BMWs? | 31 (100) | 134 (82.2) | 26 (96.3) | 45 (91.8) | 23 (88.5) |
| Do you know about color coding segregation of BMWs? | 26 (83.9) | 120 (73.6) | 21 (77.8) | 40 (81.6) | 20 (76.9) |
| Should infectious waste containers be labeled with a biohazard symbol? | 24 (77.4) | 126 (77.3) | 23 (85.2) | 35 (71.4) | 25 (96.2) |
| Should BMWs be segregated at the point of generation? | 25 (80.6) | 137 (84.0) | 22 (81.5) | 40 (81.6) | 24 (92.3) |
| Does disinfection of BMWs decrease infection transmission? | 27(87.1) | 159 (97.5) | 27 (100) | 47 (95.9) | 26 (100) |
| Do we need to close BMW containers while transport? | 27 (87.1) | 127 (77.9) | 21 (77.8) | 38 (77.6) | 24 (92.3) |
| Do we need to secure BMWs awaiting treatment/disposal? | 26 (83.9) | 132(81) | 24 (88.9) | 39 (79.6) | 19 (73.1) |
| Do you know about BMW disposal methods? | 23 (74.2) | 98 (60.1) | 21 (77.8) | 33 (67.3) | 22 (84.6) |

\( n (%) \) is the proportion of study participants who correctly answered each knowledge question; BMW: biomedical waste; BMWM: biomedical waste management.

### Table 3: Frequency distribution of study participants among each Likert item of BWM at Debre Markos town HCFs, 2017 (n = 296).

| Predictor variables | Disagree, n (%) | Neutral, n (%) | Agree, n (%) |
|---------------------|----------------|---------------|--------------|
| Improperly managed BMWs may cause infection | 37 (12.5) | 7 (2.4) | 252 (85.1) |
| Proper BMW handling is an issue | 34 (11.5) | 12 (4.1) | 259 (87.5) |
| Safe BMWM need a teamwork | 25 (8.4) | 1 (0.3) | 268 (90.5) |
| HIV may be transmitted through BMWs | 27 (9.1) | 1 (0.3) | 268 (90.5) |
| HIV postexposure prophylaxis help to prevent the development of HIV infection | 32 (10.8) | 8 (2.7) | 256 (86.5) |
| HBV may be transmitted through BMWs | 14 (4.7) | 8 (2.7) | 274 (92.6) |
| HCV may be transmitted through BMWs | 41 (13.9) | 34 (11.5) | 221 (74.7) |
| BMWs do not transmit any infectious diseases | 24 (8.1) | 12 (4.1) | 260 (87.8) |
| BMWs should be segregated into different categories at the point of generation | 41 (13.9) | 14 (4.7) | 241 (81.4) |
| BMW segregation facilitates safe handling | 40 (13.5) | 8 (2.7) | 248 (83.8) |
| Labelling BMW containers have no significance | 52 (17.6) | 12 (4.1) | 232 (78.4) |
| Proper BMW disposal is important to prevent infection transmission | 23 (7.8) | 2 (0.7) | 271 (91.6) |
| BMW disinfection can reduce the chance of contracting the infection | 32 (10.8) | 10 (3.4) | 254 (85.8) |
| Wearing personal protective equipment helps to reduce the risk of infection | 25 (8.4) | 5 (1.7) | 266 (89.9) |
| BMWM add extra burden of work | 83 (28.0) | 21 (7.1) | 192 (64.9) |
| Biohazardous wastes should be disinfected before disposal | 59 (19.9) | 21 (7.1) | 216 (73.0) |

### 3.3. Associated Factors

#### 3.3.1. Factors Associated with Knowledge

In the bivariate analysis, age group, job category, and information sourced from the guideline were marginal, whereas educational level, presence of BMWM committee, working experience, previous training, presence of BMWM guideline, attitude, and practice scores of study participants showed a statistically significant association with the knowledge score. After adjustment of possible confounds, however, MSc and MD (AOR: 14, 95% CI: (1.37, 149.52)), working in another department (AOR: 2.22, 95% CI: (1.03, 4.77)), attitude score (AOR: 2.09, 95% CI: (1.09, 4.00)), and practice score (AOR: 2.28, 95% CI: (1.18, 4.42)) of the study participants were more likely to contribute for adequate knowledge score compared with the respective reference groups given that other predictor variables were held constant (Table 4).

#### 3.3.2. Factors Associated with Attitude

In the bivariate analysis, sex, and type of HCF were marginal, whereas information source from the guideline, educational level, previous training, and knowledge scores of the study participants showed a statistically significant association with the attitude score. After adjustment of possible confounds, however, information source from guideline (AOR: 1.82, 95% CI: (1.07, 3.10)) and BSc holders (AOR: 2.53, 95% CI: (1.47, 4.38)) was more likely to be contributed for favorable attitude score compared with the reference groups given that other predictor variables were held constant (Table 5).

#### 3.3.3. Factors Associated with Practice

In the bivariate analysis, working department and job category of study participants were marginal, whereas the presence of guideline, educational level, previous training, use of visual management.
aid, and presence of color-coded bins in the department showed a statistically significant association. After adjustment of possible confounds, use of visual aid and availability of all the three types of color-coded bins in the department (AOR: 5.34, 95% CI: (2.87, 9.95), and AOR: 7.68, 95% CI: (3.30, 17.89), respectively) were more likely to contribute to adequate BMWM practice given that other predictor variables were constant (Table 6).

### 4. Discussion

Healthcare facilities have a responsibility to protect the environment and public health. Thus, providing training for HCPs for effective BMWM is a very critical step. However, in this study, only 36.8% of the study participants were trained on BMWM which is lower than 61.6% and 46.9% studies conducted in Bangladesh and Gondar town, respectively [32, 33]. This result was, however, more or less similar to a study conducted in Adama, Ethiopia 31% [16].

Regarding incidence of needlestick/sharp injuries, about 23.3% cases occurred during the previous 12 months preceding the data collection time, which is better than 51% and 30.8% studies conducted in Nigeria and Gondar town, respectively [34, 35]. However, a similar study (25%) was found in Gondar town with a different time period [35].

According to the World Health Organization and Ethiopian Food, Medicine and Healthcare Administration
## Table 5: Bivariate and multivariate logistic regression analysis of factors against attitude scores of study participants at Debre Markos town HCFs, 2017 (n = 296).

| Variables                        | Attitude                     | COR (95% CI) | P value | AOR (95% CI) | P value |
|----------------------------------|------------------------------|--------------|---------|--------------|---------|
| Sex                              |                              |              |         |              |         |
| Male                             | 52                           | 125          | 1.63 (10.26, 2.65) | 0.051  |
| Female                           | 48                           | 71           | 1       |              |         |
| Information source from guideline|                              |              |         |              |         |
| Yes                              | 48                           | 129          | 2.09 (1.28, 3.41) | 0.003*  | 1.82 (1.07, 3.10) | 0.028*  |
| No                               | 52                           | 67           | 1       |              |         |
| Educational level                |                              |              |         |              |         |
| MSc and MD*                      | 4                            | 16           | 3.85 (1.21, 12.29) | 0.023*  |
| BSc                              | 44                           | 126          | 2.76 (1.65, 4.60) | 0.001*  | 2.53 (1.47, 4.38) | 0.001*  |
| Diploma                          | 52                           | 54           | 1       |              |         |
| Type of facility                 |                              |              |         |              |         |
| Hospital                         | 57                           | 140          | 1.64 (0.74, 3.62) | 0.200  |
| Health center                    | 31                           | 38           | 0.82 (0.34, 1.95) | 0.650  |
| Clinic                           | 12                           | 18           | 1       |              |         |
| Training                         |                              |              |         |              |         |
| Yes                              | 27                           | 82           | 1.2 (0.32, 0.86) | 0.010*  | 1.4 (0.26, 0.80) | 0.006*  |
| No                               | 53                           | 134          | 1       |              |         |
| Knowledge score                  |                              |              |         |              |         |
| Inadequate                       | 38                           | 49           | 0.54 (0.32, 0.91) | 0.021*  | 0.44 (0.25, 0.78) | 0.005*  |
| Adequate                         | 62                           | 147          | 1       |              |         |

FA: favorable attitude; UA: unfavorable attitude; MD*: medical specialists; MSc: master of science; BSc: bachelor of science; COR: crude odds ratio; AOR: adjusted odds ratio; CI: confidence interval; * statistically significant at a P value of <0.05.

## Table 6: Bivariate and multivariate logistic regression analysis of factors against practice scores of study participants at Debre Markos town HCFs, 2017.

| Variables                        | Practice                     | COR (95% CI) | P value | AOR (95% CI) | P value |
|----------------------------------|------------------------------|--------------|---------|--------------|---------|
| Working department               |                              |              |         |              |         |
| OPD                              | Yes                          | 44           | 58      | 0.63 (0.39, 1.04) | 0.070  |
|                                 | No                           | 63           | 131     | 1            |         |
| Ward                             | Yes                          | 28           | 65      | 1.48 (0.88, 2.50) | 0.144  |
|                                 | No                           | 79           | 124     | 1            |         |
| Laboratory                       | Yes                          | 22           | 26      | 1.48 (0.88, 2.50) | 0.144  |
|                                 | No                           | 85           | 163     | 1            |         |
| Information source from guideline|                              |              |         |              |         |
| Guideline                        | Yes                          | 58           | 119     | 1.44 (0.89, 2.32) | 0.141  |
|                                 | No                           | 49           | 70      | 1            |         |
| Training                         | Yes                          | 41           | 101     | 1.85 (0.14, 3.0) | 0.013*  |
|                                 | No                           | 66           | 88      | 1            |         |
| Others                           | Yes                          | 31           | 34      | 0.54 (0.31, 0.94) | 0.030*  |
|                                 | No                           | 76           | 155     | 1            |         |
| Educational level                |                              |              |         |              |         |
| MSc and MD*                      | 6                            | 14           | 0.92 (0.32, 2.62) | 0.877  |
| BSc                              | 71                           | 99           | 0.55 (0.33, 0.93) | 0.025*  |
| Diploma                          | 30                           | 76           | 1       |              |         |
| Job category                     |                              |              |         |              |         |
| Doctor                           | 16                           | 15           | 0.50 (0.17, 1.45) | 0.200  |
| Nurse                            | 50                           | 113          | 1.2 (0.50, 2.87) | 0.687  |
| Midwife                          | 9                            | 18           | 1.10 (0.34, 3.30) | 0.922  |
| Laboratory                       | 23                           | 26           | 0.60 (0.22, 1.60) | 0.306  |
| Health officer                   | 9                            | 17           | 1       |              |         |
| Previous training                |                              |              |         |              |         |
| Yes                              | 28                           | 81           | 2.12 (1.26, 3.55) | 0.005*  |
| No                               | 79                           | 108          | 1       |              |         |
| Use of visual aid                |                              |              |         |              |         |
| Yes                              | 35                           | 139          | 5.72 (3.41, 9.59) | 0.001*  | 5.34 (2.87, 9.95) | 0.001*  |
| No                               | 72                           | 50           | 1       |              |         |
| Presence of BMWM committee       |                              |              |         |              |         |
| Yes                              | 55                           | 133          | 2.25 (1.37, 3.67) | 0.001*  |
| No                               | 52                           | 56           | 1       |              |         |
| Availability of guideline        |                              |              |         |              |         |
| Yes                              | 44                           | 115          | 2.23 (1.37, 3.61) | 0.001*  |
| No                               | 63                           | 74           | 1       |              |         |
| Availability of color-coded bins |                              |              |         |              |         |
| Yes                              | 64                           | 177          | 9.91 (4.92, 20.0) | 0.001*  | 7.68 (3.30, 17.89) | 0.001*  |
| No                               | 43                           | 12           | 1       |              |         |
| Knowledge group                  |                              |              |         |              |         |
| Inadequate                       | 41                           | 46           | 0.52 (0.31, 0.86) | 0.012*  |
| Adequate                         | 66                           | 143          | 1       |              |         |

AP: adequate practice; IP: inadequate practice; OPD: outpatient department; MD*: medical specialists; MSc: master of science; BSc: bachelor of science; COR: crude odds ratio; AOR: adjusted odds ratio; CI: confidence interval; * statistically significant at a P value of <0.05.
Adequate knowledge is vital for appropriate BMWM practice. However, in this study, only 56.8% of the study participants had adequate knowledge score, which is better than 45% and 40.5% studies conducted in Nigeria and Sri Lanka, respectively [37, 38]. A better result was found in Pakistan where 96% of the study participants had good knowledge score [39]. This could be due to the difference in availability and utilization of waste management guidelines among the facilities, providing training opportunity for HCPs, national health sector strategy difference, or it might be due to academic performance difference of study participants. As a minimum standard, a three-bin system of BMW segregation has been established in Ethiopia [9, 10]. However, only 77.2% of the study participants had knowledge of color coding segregation which is lower than 92.3% of a report from India [31]. About 72.6%, 78.3%, and 86.3% study participants were able to identify that general, infectious, and sharp wastes should be placed in black, yellow, and a safety box, respectively. According to guidelines, infectious waste containers should be labeled with a biohazard symbol [2, 9–11]. However, only half (53.6%) of study participants were able to identify the biohazard symbol which is similar to a study in India (54.4%) [40]. However, a better result was found in Nainital city in India where the majority of HCFs (85.5%) were able to identify a symbol of biohazards [23].

Attitude of Study Participants. The overall favorable attitude score of HCPs was 62.1% which is more or less comparable with 59.9% in a study conducted at Gondar town [41]. Similarly, the majority of study participants in Sri Lanka and almost all studied participants in the Tripura state of India had favorable attitude [31, 38]. However, this study was better than a study from Nigeria [37]. This could be due to methodological difference or commitment of healthcare staff for waste management. With regard to waste segregation and treatment, about 86.3% and 74.6% study participants agreed that BMWs should be segregated at the source and disinfected before disposal, respectively. A similar study was found in India in which about 88.1% study participants agreed on segregation of BMWs at the source [31].

Practice of Study Participants. Adequate practice score of the study participants was 78.9%, which is better than 31.5% and 74.8% in studies conducted in Ethiopia and Sri Lanka [33, 38], respectively. However, a better result was found from Pakistan where 94.3% of the study participants had adequate practice [39]. This could be due to lack of training, HCPs commitment, motivation, and enforcement from concerned bodies or ignorance of HCPs for BMWM. The highest practice score was noted among midwives (92.6%); however, the list was disappointingly among medical doctors (58.1%). One could ask if over qualification leads to ignorance. However, it is more or less comparable to a study from Bangladesh, where 44% of medical doctors studied had adequate practice [42]. Similarly, a study conducted in India indicated that the highest adequate practice score was among Nurses (97.3%) followed by doctors (77.8) [43]. Probably this difference could be due to the accessibility of BMWM equipment, training opportunity, and guidelines. Bio-medical waste segregation is the most critical step for proper waste management, and it should be done at the point of generation using color-coded bins [2]. All hazardous wastes should be segregated at the point of generation [2, 9–11]; however, in this study, only 88.2% of HCPs were segregated at the source at the source of generation.

Treatment and Disposal. Most studied HCFs (91.7%) used puncture-resistant containers for BMW storage until treatment or disposal, and the remaining used the incinerator chamber as a temporary waste storage means. These practices are not in line with the national guideline requirement where all HCFs should have separate waste storage facilities for hazardous BMWs [10]. In most HCFs, waste treatment was done according to the volume of waste collected rather than the time of storage [10]. Two HCFs (16.7%) burn all types of BMWs in an unprotected environment. Most HCFs (91.7%) did not have specifically designed ash pit, and they dispose of either in placenta pit, latrine opening, or open dumping. These are bad activities which are strongly prohibited and are out of the guidelines recommendation [2, 9, 10].

Limitations of the Study. In this study, liquid BMWs were not assessed due to financial constraint. Since the study was conducted in a limited geographical area, it could not be generalized at a national level. Similarly, BMW generation rates among studied facilities were not measured due to financial constraint. Healthcare facility observation was conducted at one point in time, which may have an implication of the study.

Conclusion and Recommendation

In this study, HCPs level of knowledge, attitude, and practice scores is low. The majority of the studied HCPs did not access BMWM training. Similarly, about half of them did not access BMWM guidelines in their department. Educational level, use of visual aid, and availability of all the three types of color-coded bins in the department/working section were identified as a key factor for effective BMWM. Regular waste management training should be given for HCPs, and they should have access to BMWM guidelines in their department/healthcare delivery section. In addition, periodic and comprehensive studies should be conducted.
Abbreviations

BSc: Bachelor of sciences  
HCFs: Healthcare facilities  
HCPs: Healthcare professionals  
BMW: Biomedical waste  
BMWM: Biomedical waste management  
OPD: Outpatient department  
MSc: Masters of sciences  
COR: Crude odds ratio  
AOR: Adjusted odds ratio  
CI: Confidence interval  
AK: Adequate knowledge  
IK: Inadequate knowledge  
FA: Favorable attitude  
UA: Unfavorable attitude  
AP: Adequate practice  
IP: Inadequate practice.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

Authors’ Contributions

Teshiwal Deress participated in idea conception, proposal development, data collection supervision, writing the manuscript, and communicating the manuscript. Fatuma Hassen participated in proposal development, data collection, and writing the manuscript. Kasaw Adane participated in data collection and writing the manuscript. Aster Tsegaye participated in idea conception, proposal development, data collection, and writing the manuscript.

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Supplementary Materials

Questionnaire and observational checklist. (Supplementary Materials)

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