Knowledge, attitude and practice towards bio-medical waste management among healthcare workers: a northern Saudi study

Ashokkumar Thirunavukkarasu [Corresp., 1] , **Ahmad Homoud Al-Hazmi** [1] , **Umar Farooq Dar** [1] , **Ahmed Mohammed Alruwaili** [2] , **Saleh Dhifallah Alsharari** [2] , **Fahad Adel Alazmi** [2] , **Saif Farhan Alruwaili** [2] , **Abdullah Mohammed Alarjan** [2]

[1] Department of Community and Family Medicine, College of Medicine, Al Jouf University, Sakaka, Aljouf, Saudi Arabia

[2] Medical student, College of Medicine, Al Jouf University, Sakaka, Aljouf, Saudi Arabia

Corresponding Author: Ashokkumar Thirunavukkarasu
Email address: ashokkumar@ju.edu.sa

Background: Health care workers (HCWs) involved in day-to-day care and other healthcare activities play a significant role in Biomedical waste (BMW) management. The World Health Organization stated some of the causes for the failure of BMW management, namely, lack of awareness of the health hazards related to BMW and inadequate trained HCWs in BMW management. The present study assessed knowledge, attitude, and practice (KAP) towards BMW management among the HCWs in northern Saudi Arabia.

Methodology: The present study assessed KAP through a self-administered and validated questionnaire. Using a multistage probability sampling method, 384 HCWs from different healthcare facilities participated in this survey. We performed binomial logistic regression analysis to find association between KAP subscales and sociodemographic characteristics. Spearman's correlation test was performed to find the strength and direction of correlation (*rho*) between KAP scores. **Results:** Of the population studied, high knowledge, attitude, and practice scores were found in 47.1%, 65.1%, and 49.5% of the HCWs, respectively. The present study found that knowledge score was significantly higher among the age group from 30 to 39 years (ref: age less than 30 years: AOR=2.25, 95%CI =1.05–4.85, p=0.04) and non- Saudi nationals (ref: Saudi: AOR=2.84, 95%CI=1.63–4.94, p<0.001) The attitude score towards BMW management was significantly lower among the HCWs working in tertiary care settings (ref: PHC: AOR = 0.38, 95%CI = 0.12–0.69, p = 0.01). Regarding the practice score, the male categories had a significantly higher score (ref: female: AOR=1.82, 95%CI =1.19 – 2.99, p=0.02), while pharmacist (ref: physicians: AOR=0.39, 95%CI =0.18–0.58, p=0.02) and lab technicians (ref: physicians: AOR=0.31, 95%CI=0.11–0.53, p=0.02) had a significant lower practice score. The test results revealed a weak positive correlation of knowledge with the attitude scores (rho=0.249, p=0.001), and a moderately strong positive correlation was found between attitude and practice

scores (rho=0.432, p=0.001). **Conclusion:** This study suggests that a regular training program for the HCWs on BMW management is necessary through symposiums, role play, interactive lectures, and other feasible training methods. Furthermore, a multicentric prospective exploratory study is to be conducted in other regions of the KSA to understand the region-specific training needs of HCWs.

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2 **Waste Management among Healthcare Workers: A**
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5 Ashokkumar Thirunavukkarasu[1], Ahmad Homoud Al-Hazmi[1], Umar Farooq Dar[1], Ahmed
6 Mohammed Alruwaili[2], Saleh Dhifallah Alsharari[2], Fahad Adel Alazmi [2], Saif Farhan
7 Alruwaili[2], Abdullah Mohammed Alarjan[2]
8
9 [1] Department of Community and Family Medicine, College of Medicine, Sakaka, Aljouf
10 Province, Saudi Arabia.
11 [2] Medical student, College of Medicine, Sakaka, Aljouf Province, Saudi Arabia.
12
13 Corresponding Author:
14 Dr. Ashokkumar Thirunavukkarasu MD
15 Department of Community and Family Medicine, College of Medicine, Sakaka, Aljouf Province,
16 Saudi Arabia 72388.
17 Email address: ashokkumar@ju.edu.sa, alternate email: jamlash@gmail.com
18 Telephone/Mobile: 00966 – 599 739619

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Abstract

Background:
Health care workers (HCWs) involved in day-to-day care and other healthcare activities play a significant role in Biomedical waste (BMW) management. The World Health Organization stated some of the causes for the failure of BMW management, namely, lack of awareness of the health hazards related to BMW and inadequate trained HCWs in BMW management. The present study assessed knowledge, attitude, and practice (KAP) towards BMW management among the HCWs in northern Saudi Arabia.

Methodology:
The present study assessed KAP through a self-administered and validated questionnaire. Using a multistage probability sampling method, 384 HCWs from different healthcare facilities participated in this survey. We performed binomial logistic regression analysis to find association between KAP subscales and sociodemographic characteristics. Spearman's correlation test was performed to find the strength and direction of correlation (*rho*) between KAP scores.

Results:
Of the population studied, high knowledge, attitude, and practice scores were found in 47.1%, 65.1%, and 49.5% of the HCWs, respectively. The present study found that knowledge score was significantly higher among the age group from 30 to 39 years (ref: age less than 30 years: AOR=2.25, 95%CI =1.05–4.85, p=0.04) and non- Saudi nationals (ref: Saudi: AOR=2.84, 95%CI=1.63–4.94, p<0.001) The attitude score towards BMW management was significantly lower among the HCWs working in tertiary care settings (ref: PHC: AOR = 0.38, 95%CI = 0.12– 0.69, p = 0.01). Regarding the practice score, the male categories had a significantly higher score (ref: female: AOR=1.82, 95%CI =1.19 – 2.99, p=0.02), while pharmacist (ref: physicians: AOR=0.39, 95%CI =0.18–0.58, p=0.02) and lab technicians (ref: physicians: AOR=0.31, 95%CI =0.11–0.53, p=0.02) had a significant lower practice score. The test results revealed a weak positive correlation of knowledge with the attitude scores (rho=0.249, p=0.001), and a moderately strong positive correlation was found between attitude and practice scores (rho=0.432, p=0.001).

Conclusion:
This study suggests that a regular training program for the HCWs on BMW management is necessary through symposiums, role play, interactive lectures, and other feasible training methods. Furthermore, a multicentric prospective exploratory study is to be conducted in other regions of the KSA to understand the region-specific training needs of HCWs.

Keywords: Biomedical waste, Knowledge, Attitude, Practice, Correlation, Healthcare workers.

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Introduction

86 Introduction
87 Biomedical waste (BMW) is defined as "any type of waste that is generated during diagnosis,
88 treatment, or research in humans and/or animals" (1). As per the World Health Organization
89 (WHO), around 85% of the total amount of waste generated during healthcare activities is non-
90 hazardous waste similar to domestic waste, and only 15% is considered hazardous waste that
91 includes various forms of waste such as human anatomical parts, blood and tissues, radiation
92 waste, chemo-toxic drugs, and broken medical equipment (2). BMW is commonly generated in
93 hospitals, primary health care facilities, medical colleges, research centers, and veterinary
94 hospitals (3, 4).
95 Advancement in medical care and the introduction of more advanced equipment has dramatically
96 increased the amount of waste generated per patient in healthcare facilities worldwide. Globally,
97 a large amount of health care waste generated everyday ranges from 0.9 kg/bed/day to 3
98 kg/bed/day. In the Kingdom of Saudi Arabia (KSA), the amount of health care generation is
99 reported as 1.66kg/bed/day (5). The WHO stated that around 16 billion injections are given every
100 year for treatment or immunization. Unfortunately, not all used needles and syringes are
101 disposed of as per the legislation and safety norms, leading to the risk of needle prick injury and
102 acquiring the related infection. This also provides opportunities for reuse (6). The COVID-19
103 pandemic worsens the existing healthcare waste burden as healthcare waste management during
104 the COVID-19 pandemic has faced several challenges due to increased production of infectious
105 waste, interruption of recycling strategy, and inadequate resources to handle increased waste
106 production (7-10).
107 Health care workers (HCWs) involved in day-to-day care to the patients and other health care
108 activities play a significant role in BMW management (11, 12). The WHO classifies these health
109 workers into several categories: general and specialist medical practitioners, nurses and
110 midwifery professionals, complementary medicine practitioners, pharmacists, physiotherapists,
111 etc. (13). The WHO stated some of the causes for the failure of BMW management, namely, lack
112 of awareness about the health hazards related to BMW, inadequate trained HCWs in BMW
113 management, lack of legislation and rules regarding waste management systems, inadequate
114 human and monetary resources (2).
115 In 2018, Deress T et al. conducted a study that assessed the KAP of healthcare professionals of
116 northwest Ethiopia towards BMW management and associated factors for good KAP scores.
117 They found that 56.8%, 66.2%, and 77.4% of the HCWs had good knowledge, attitude, and
118 practice scores, respectively. Regarding the associated factors, those who had higher level
119 qualifications and the availability of color-coded bins were more likely to have favorable KAP
120 scores (14). Another survey conducted by Jalal SM et al. during COVID-19 times that evaluated
121 the KAP toward BMW management among healthcare professionals stated that nearly a quarter

122   of healthcare professionals had poor knowledge regarding BMW management. The mean
123   knowledge scores were significantly higher among nurses and physicians than others (15).
124   In the KSA, infection control and BMW management are implemented uniformly in all
125   healthcare facilities according to ministry of health (MOH), KSA and Gulf Cooperation Council
126   Centre for Infection Control policies (16). The infection prevention and control departments have
127   primary responsibilities to train HCWs. All national HCWs seeking jobs in healthcare facilities
128   must clear the Saudi Commission for Health Specialties test to qualify for health sector jobs.
129   However, there are no specific requirements for separate and compulsory BMW management
130   and infection control training to apply for health sector jobs and contract renewal. Assessment of
131   knowledge, attitude, and practices (KAP) towards BMW among the HCWs are essential in
132   planning the training program for them towards BMW management to the extent they need (17-
133   19). So that they will dispose of the BMW according to the regulation implemented in their
134   hospitals, this will eventually decrease the health hazards that will arise from BMW (20, 21). To
135   the best of the authors' knowledge, there is limited data available in northern Saudi Arabia on
136   this topic. Therefore, the present study was planned to assess knowledge, attitude, and practice in
137   the management of biomedical waste among the HCWs of public healthcare facilities in Aljouf
138   province, KSA, to determine the influencing factors on knowledge, attitude, and practices among
139   them and to identify the correlation between the scores of knowledge, attitude, and practices.
140

141   **Participants & Methods**

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143   **Study design and setting:**
144   The present cross-sectional survey was conducted from December 2021 to February 2022 among
145   the HCWs from different healthcare facilities in Aljouf province, Saudi Arabia. The Aljouf
146   province is located in the northern regions of the KSA. The present study included the HCWs
147   working in the healthcare facilities under the ministry of health (MOH) for a minimum of one
148   year. Currently, in the KSA, healthcare is provided through four levels, namely, primary health
149   centers (PHC), general hospitals, specialty hospitals, and medical cities. There are 62 primary
150   health centers, 13 general hospitals, and 2 specialty hospitals in the Aljouf province under the
151   MOH, KSA. The HCWs from the infection control department and those not willing to
152   participate were excluded from the study. Also, those on vacation were excluded from the
153   sampling frame when selecting sample participants.

154

155   **Sample size and sampling method:**
156   We calculated the required sample for this study based on Cochran's sample size estimation
157   equation (n=z2pq/e2). In this formula, n is the number of participants required, z=1.96 in 95%
158   confidence interval, p=expected proportion, q=1-p, and e is 5% of margin of error. Since
159   previous studies reported different prevalence on this subject, we have taken 50% as the
160   expected proportion to obtain the maximum sample size. Applying the values mentioned above
161   in Cochran's equation, the estimated sample size for the present study was 384.

162   The research team applied the multistage probability proportional sampling (PPS) method to
163   select the required number of HCWs in each category. Firstly, we have included all the 62 PHCs
164   from the Aljouf province. Then a general hospital (from 13 hospitals) and a tertiary care hospital
165   (from 2 hospitals) in the Aljouf region were selected using the lot method. The required number
166   of participants was selected from each type of healthcare facility based on the total HCWs
167   registered in the facilities. After obtaining approval from selected healthcare facilities, we have
168   arranged the total HCWs according to the assigned numbers in the ascending order for each type
169   of healthcare facility. Finally, we have applied a systematic random sampling method according
170   to the allotted number to select the participants from each healthcare facility.
171

172   **Data collection methods:**
173   The present study data collection began after obtaining the required ethical clearance from the
174   regional ethics committee, Aljouf region (Local research ethics committee, Qurayat Health
175   Affairs, Ministry of Health, KSA: Approval number-116), and concerned healthcare facilities
176   authorities. The research team communicated with the selected participants for their availability
177   to collect data. Data collectors made three attempts to contact the selected participants in one
178   month. A selected participant who could not be reached despite three attempts in a month and
179   who was unwilling to participate was considered nonrespondent. The next HCW of the same
180   category was invited to participate in the survey in case of nonrespondent.
181

182   **Survey questionnaire:**
183   After briefing the study objectives and obtaining written informed consent from the participants
184   of the present study, we conducted the data collection process using a self-administered,
185   standard, validated questionnaire adapted from a previously published study (15). The research
186   team obtained written permission from the corresponding author of the study by Jalal SM et al.
187   to use and adapt/modify for local settings. After receiving the data collection tool (with the
188   necessary permission to adapt and modify) from the reference study author, the present research
189   team modified it to reduce the duration of the survey to improve the validity and reliability as
190   suggested by existing literatures (22, 23). We have followed the following steps to test the
191   validity and reliability of the adapted questionnaire before proceeding to collect data. Firstly, the
192   adapted tool is reviewed by the community medicine and infection control department experts
193   through a focus group discussion. Secondly, we have conducted a pilot study among thirty
194   different category HCWs in the local settings. All pilot study respondents acknowledged that the
195   data collection form was simple, clear, and easy to understand. Furthermore, there was no
196   missing data in all thirty completed forms. Cronbach's alpha (α) values for the knowledge,
197   attitude, and practice scores were 0.75, 0.83, and 0.86, which exhibited good internal consistency
198   in the current form of the data collection tool. A google form was created and given to the
199   selected participants in the personal digital device of the data collector. However, only the
200   principal investigator had the authorization to access and download the spreadsheet. The data
201   collection form consisted of two sections. The first section inquired about the participants'

202 background details, including age, gender, education status, marital status, nationality, HCW
203 category, and duration of work experience. In our study, HCWs were grouped into five
204 categories, namely, medical practitioners, nursing and midwifery professionals, laboratory
205 technicians, pharmacists, and others (this includes remaining all categories mentioned in the
206 classification of WHO) (13). We categorized the continuous data (age and duration of work
207 experience) as per the class interval. Since the Ph.D./Fellowship in education status category is
208 less than 30, as a rule of thumb, we combined it with masters and regrouped it into a master's and
209 above. A similar rule we have applied for the marital status for grouping. The second section
210 consisted of ten questions in knowledge, attitude, and practice categories. In the knowledge
211 section, we inquired about participants' knowledge regarding different forms and sources of
212 BMW, disposal methods, and hazards due to improper BMW management. Correct answers
213 were given as one mark in the knowledge category, and wrong answers were given zero marks.
214 In both attitude and practice categories, the participants responded on a 5-point Likert scale as
215 "strongly agree," "agree," "neutral," "disagree," and "strongly disagree," which were given scores
216 5, 4, 3, 2, and 1, respectively. Overall knowledge, attitude, and practice scores were interpreted
217 as high (score 80% and above), medium (60 to 79%), and low (less than 60%).

218

219 **Statistical analysis:**
220 The spreadsheet (excel) is exported to the statistical package for social science (SPSS) version 20
221 and coded as per the predefined coding sheet for further analysis. The present study's descriptive
222 statistics are presented as frequency (n) and proportion (%). In Saudi Arabia, the HCWs are
223 expected to have excellent/good knowledge ($\geq$ 80%) in infection control and other common
224 public health activities as they are the first in line in managing the BMW. Our categorization is
225 in accordance with the original Bloom's cut-off point for assessing KAP and is supported by
226 previous studies conducted among healthcare workers in the KSA and other parts of the world
227 (24-26). Additionally, we combined low and medium scores as a single category for further
228 analysis, and previous studies among the HCWs strongly support our categorization (26-28). The
229 association of the subscales' categories and sociodemographic characteristics was assessed by
230 Pearson's chi-square test. Furthermore, we performed binomial logistic regression analysis to
231 find the predictors for the subscales of KAP. In this technique, we adjusted the covariables of the
232 study to get an adjusted odds ratio (AOR) The Kolmogorov-Smirnov normality test (KS) of the
233 knowledge, attitude, and practice data did not meet the normality assumption. Therefore, we
234 have executed Spearman's correlation test to find the strength and direction of correlation (*rho*)
235 between knowledge, attitude, and practice scores (29). All statistical tests used in this study were
236 two-tailed and a p-value less than 0.05 was established as a statistically significant value.

237

238 # Results

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240 Table 1 depicts the sociodemographic characteristics of the respondents. Of the 384 participants,
241 the majority (59.9%) respondents were males, Saudi nationals (71.1%), married (46.1%), highest

242   education qualification as bachelor's degree (60.4%), and had 5 to 10 years of work experience
243   in the healthcare settings (34.6%). Of the sample studied, 35.9% of the HCWs were nurses and
244   midwiferies, 37.0% were working at general hospitals, and the mean (±SD) of the age of the
245   participants was 34.35 ± 9.5years.
246
247   Figure 1 presents the categorization (low/medium/high) of KAP scores. Of the 384 respondents,
248   high knowledge, attitude, and practice scores were found in 47.1%, 65.1%, and 49.5% of the
249   HCWs, respectively.
250
251   The cross-tabulation between knowledge score categories and sociodemographic characteristics
252   found a significant association between age groups (p=0.001), nationality (p=0.001), education
253   status (p=0.018), and work experience duration (p=0.01). Of the studied participants, high
254   knowledge was noticed among the HCWs aged 40 years and above (56.1%), who had higher
255   education qualifications (65.5%), and work experience of more than 10 years (58.1%) (Table 2).
256
257   The cross-tabulation between attitude score categories and sociodemographic characteristics is
258   presented in Table 3. Of the 384 samples analyzed, a significant association was found among
259   health care working settings (p=0.005) and work experience (p=0.001). No other
260   sociodemographic characteristics, including age, gender, nationality, marital status, education
261   and HCWs category had a significant association with the attitude score categories.
262
263   Cross-tabulation between practice score categories and sociodemographic characteristics found a
264   significant association between age groups (p=0.001), gender (p=0.008), nationality (p = 0.001),
265   marital status (p = 0.020), and duration of work experience (p=0.001) (Table 4).
266
267   Binomial logistic regression analysis on KAP subscales (low/medium vs high) and its association
268   with participants sociodemographic characteristics are presented in Table 5. The present study
269   found that knowledge score was significantly higher among the age group from 30 to 39 years
270   (ref: age less than 30 years: AOR=2.25, 95%CI =1.05–4.85, p=0.04), non- Saudi nationals (ref:
271   Saudi: AOR=2.84, 95%CI=1.63–4.94, p<0.001), and those with higher education (ref: diploma
272   holder: AOR for bachelors =1.98, 95% CI = 1.06-3.68, p = 0.04 and AOR for masters and above
273   =3.78, 95%CI=1.59-8.97, p = 0.03). The attitude score towards BMW management was
274   significantly lower among the HCWs working in tertiary care settings (ref: PHC: AOR = 0.38,
275   95%CI = 0.12–0.69, p = 0.01). Regarding the practice score, the male categories had a
276   significantly higher score (ref: female: AOR=1.82, 95%CI =1.19 – 2.99, p=0.02), while
277   pharmacist (ref: physicians: AOR=0.39, 95%CI =0.18–0.58, p=0.02) and lab technicians (ref:
278   physicians: AOR=0.31, 95%CI =0.11–0.53, p=0.02) had a significant lower practice score.
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281 The present study data did not meet the normality assumption criteria. Therefore, we have
282 executed Spearman's correlation test. The test results revealed a weak positive correlation of
283 knowledge with the attitude (rho=0.249, p =0.001) and practice scores (rho=0.104, p=0.042).
284 Also, a moderately strong positive correlation was found between attitude and practice scores
285 (rho=0.470, p = 0.001) (Table 6).
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Discussion
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289 Improper handling of medical waste generated at health care facilities may pose a serious threat
290 to the HCWs, common people and the surrounding environment, asserted by the WHO, UN, and
291 CDC (2, 30). Since the HCWs play an important role in regulated biomedical waste disposal, it is
292 important to have a high level of awareness. This emphasizes the importance of evaluating the
293 knowledge, attitude, and practice of HCWs with respect to BMW management and the factors
294 that influence them.
295
296 Knowledge is an essential resource in health science education, and inadequate knowledge may
297 lead to improper application of knowledge that may be detrimental to any healthcare
298 organization (31, 32). The present study results revealed that less than half (47.1%) of the
299 participants had high knowledge of medical waste management generated at their work settings.
300 Similar to our study findings, a recent survey conducted by Jalal SM in the Al-Hasa region of the
301 KSA also found that only 41% of the healthcare professionals had excellent knowledge of
302 biomedical waste disposal (15). Interestingly, surveys conducted in some other countries also
303 reported that a low proportion of the HCWs had favorable knowledge of healthcare handling and
304 disposal(14, 19, 33, 34). In contrast to our study, a study conducted by Kalyan et al. in the Hail
305 region of the KSA and Akkajit P et al. in Thailand stated that a higher proportion of healthcare
306 professionals had good knowledge (18, 35). The possible difference between our study and the
307 latter studies could be the inclusion of healthcare facilities. The present study included multiple
308 healthcare facilities (PHCs, general and tertiary hospitals), while later included outpatient clinics
309 and PHCs.
310
311 Our study found a significant association between knowledge category and age groups (ref: age
312 less than 30 years: AOR=2.25, 95%CI =1.05–4.85, p=0.04), nationality(ref: Saudi: AOR=2.84,
313 95%CI=1.63–4.94, p<0.001) , and education status (ref: diploma holder: AOR=3.78,
314 95%CI=1.59-8.97, p = 0.03) Other surveys conducted in the KSA, and other countries support
315 the present study results. Jalal SM et al. conducted a survey in 2021 which also revealed a
316 statistically significant association between the excellent knowledge category and the level of
317 education qualification, genders, and work experience (15). However, the present study did not
318 find a significant association between gender and knowledge category. Educational qualification
319 is one of the important factors that influence the ability to have high knowledge. The results of
320 the current study revealed that HCWs who had a higher level of education had a significantly

321   higher level of knowledge than diploma holders (ref: diploma holder: AOR=3.78, 95%CI=1.59-
322   8.97, p = 0.03). Similar to the current study findings, other surveys conducted by Reddy KL et
323   al., Dixit AM et al., and Deress T et al. also revealed a positive association among highly
324   qualified healthcare professionals (14, 18, 36). It is worth mentioning again that all national
325   HCWs working in healthcare facilities had to clear the Saudi Commission for Health Specialties
326   test to get eligible for health sector jobs. However, there are no specific requirements for separate
327   and compulsory BMW management and infection control training to apply for health sector job
328   and contract renewal. A study done by Al-Ahmar AM et al. reported that the majority of the
329   primary care professionals did not receive sufficient infection control training programs, which
330   affects their knowledge significantly (37). The Saudi government initiated Saudization for health
331   sector jobs and young Saudi graduates are entering the job market. This could be the possible
332   reason for the significant association between knowledge scores with the nationality and age
333   group (38, 39).
334
335   A positive attitude will guide the HCWs to follow the standards, protocols, and evidence-based
336   practices established by the healthcare organization (40, 41). This study found that nearly two-
337   thirds of the participants had a high attitude towards biomedical waste disposal (65.1%). Using
338   binomial logistic regression analysis, a significant association with attitude was found among
339   different work settings (ref: PHC: AOR=0.38, 95%CI = 0.12–0.69, p=0.01), and no other
340   sociodemographic variables were significantly associated with attitude. Identical to our study
341   findings, a study by Dalui A et al. also found that a high proportion of healthcare providers had
342   an excellent attitude towards BMW management (42). Another study conducted in Cairo, Egypt,
343   reported that the duration of work experience was not significantly associated with attitude (43).
344   Interestingly, some studies found that doctors had a higher positive attitude towards healthcare
345   waste disposal than nurses and other HCWs (18, 43, 44). These huge variations in the results
346   among different studies could be due to the variations in data collection tools, survey settings,
347   and cultural variations.
348
349   The present study results revealed that only half of the participants had high scores in practice.
350   Our study found a positive association with practice scores were found among male gender (ref:
351   female: AOR=1.82, 95%CI =1.19–2.99, p=0.02), and HCW category (ref: physicians:
352   AOR=0.39, 95%CI =0.18–0.58, p=0.02). Similar to our study, Reddy KL et al. also reported that
353   only 50% of the HCWs had excellent practice scores (18). In contrast to the present study results,
354   a survey conducted in Ethiopia reported that a higher proportion of HCWs had a satisfactory
355   practice score (14). In contrast to the current study findings, some other surveys found a positive
356   association of duration of work experience and older age with the practice scores (18, 35, 43).
357   Similar to this study results, some studies found a positive association with the type of HCW (42,
358   45). The present study's results revealed that BMW management practices were not significantly
359   associated with the marital status of the participants. Similarly, a study conducted by Desta M et
360   al. did not find an association between marital status and good practice (46). Interestingly, a

361   survey conducted in the KSA in 2021 on assessing KAP among the HCWs on the COVID-19
362   prevention found a significant association between marital status and appropriate practices
363   (p=0.024) (47).

364

365   The Spearman's rank correlation test results revealed a weak positive correlation of knowledge
366   with the attitude scores (rho=0.249, p=0.001), and a moderately strong positive correlation was
367   found between attitude and practice scores (rho=0.432, p=0.001). These findings reassert the
368   importance of association between KAP for the proper BMW management. Furthermore, our
369   results conclude that the HCW's favorable knowledge led to positive attitude and proper
370   practice. Our study results are supported by several studies that assessed KAP towards
371   healthcare waste management in different countries (18, 33, 35).

372

373   Even though the present study was conducted with the proper methodology and adequate sample
374   size among different HCWs working in multiple healthcare facilities, certain limitations are to be
375   noted on reading the results of this survey. Firstly, we assessed only the association through this
376   cross-sectional survey, not the causation and direction. Secondly, the possible bias associated
377   with the self-reported data could influence the results of this survey. Finally, this survey was
378   conducted in the northern region of the KSA, and therefore, the findings cannot be generalized to
379   the other areas of the KSA and other countries in the Middle East.

380

381   ## Conclusions

382

383   The present study assessed KAP towards BMW among healthcare providers working in different
384   healthcare facilities using a standard and validated tool. Our study revealed that less than half of
385   the participants had insufficient knowledge and practice scores, while one-third had low and
386   medium attitude scores. Furthermore, our results conclude that the HCW's good knowledge may
387   lead to a positive attitude and proper practice. The findings of this study suggest that a regular
388   training program for the HCWs on BMW management is necessary through symposiums, role-
389   play, interactive lectures, and other feasible training methods. These training programs can be
390   focused and targeted oriented to the HCWs category with low and medium scores in KAP.
391   Finally, a multicentric prospective exploratory study is to be conducted in other regions of the
392   KSA to understand the region-specific training needs of the HCWs.

393

394   ## Acknowledgements
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396   also extend our thanks to the healthcare facilities for facilitating data collection in their
397   healthcare settings. Finally, we wish to thank Dr. Bashayer Farhan ALruwailli, Assistant
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400 **References**

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Tables and Figure legends:

547 Table 1. Sociodemographic characteristics of the healthcare workers (HCWs) (n = 384)

548 Figure 1: Distribution of knowledge, attitude, and practice (KAP) scores categories among the
549 participants (n=384)
550 Table 2: Cross-tabulation between low/medium, high knowledge score categories and
551 sociodemographic characteristics (n=384)
552 Table 3: Cross-tabulation between low/medium, high attitude score categories and
553 sociodemographic characteristics (n=384)
554 Table 4: Cross-tabulation between low/medium, high practice score categories and
555 sociodemographic characteristics (n=384)
556 Table 5: Binomial logistic regression analysis on KAP subscales (low/medium vs high) and its
557 association with participants sociodemographic characteristics (n=384)
558 Table 6: Spearman's correlation analysis between KAP scores
559

Figure 1

Figure 1: Distribution of knowledge, attitude, and practice (KAP) Scores categories among the participants (n=384)
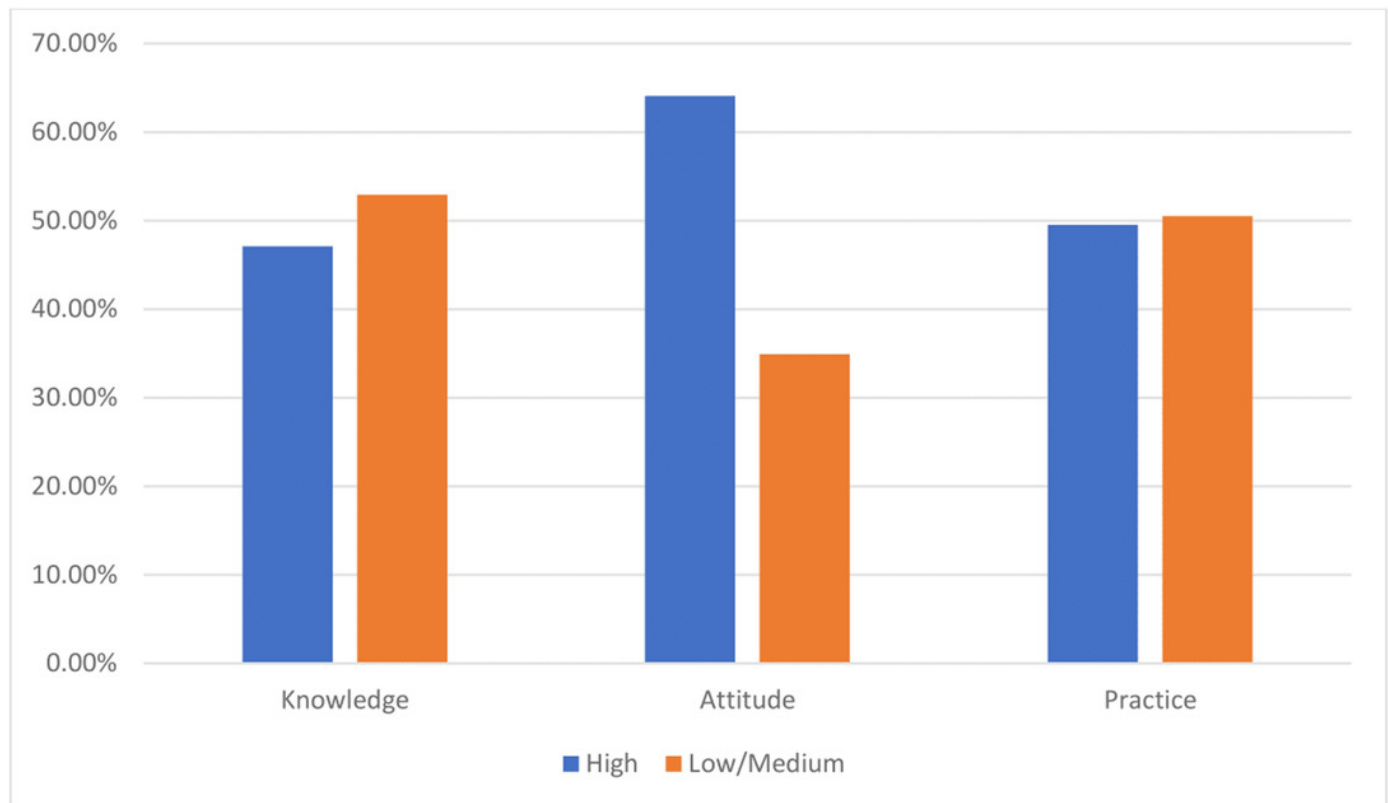
Table 1. Socio-demographic characteristics of the healthcare workers (HCWs) (n = 384)

1 Table 1. Socio-demographic characteristics of the healthcare workers (HCWs) (n = 384)

Variables	Frequency (n)	Proportion (%)
Age (in years)		
Mean ± SD	34.35 ± 9.5	
Less than 30	144	37.5
30 to 39	133	34.6
40 and above	107	27.9
Gender		
Male	230	59.9
Female	154	40.1
Nationality		
Saudi	273	71.1
Non-Saudi	111	28.9
Marital status		
Single	167	43.5
Married	177	46.1
Divorced/Widowed	40	10.4
Education		
Diploma	82	21.4
Bachelors	232	60.4
Masters and above	70	18.2
HCW category		
Physicians	116	30.2
Nursing and midwife	138	35.9
Pharmacist	48	12.5
Lab technicians	31	8.1
Other categories*	51	13.3
Work settings		
Primary health centers (PHC)	127	33.1
General hospital	142	37.0
Tertiary care hospital	115	39.9
Work experience (in years)		
Less than 5	127	33.1
5 to 10	133	34.6
More than 10	124	32.3

2 *Physiotherapist, Dentists, community health workers, radiology technicians, and Occupational health and hygiene
3 personnel

Table 2: Cross-tabulation between low/medium, high knowledge score categories and sociodemographic characteristics (n=384)

1   Table 2: Cross-tabulation between low/medium, high knowledge score categories and
2   sociodemographic characteristics (n=384)

Variables	Low/Medium n (%)	High n (%)	p - value
Age (in years) Less than 30 30 to 39 40 and above	100 (69.4) 56 (42.1) 47 (43.9)	44 (30.6) 77 (57.9) 60 (56.1)	0.001*
Gender Male Female	121 (52.6) 82 (53.2)	109 (47.4) 72 (46.8)	0.917
Nationality Saudi Non-Saudi	165 (60.4) 38 (34.2)	108 (39.6) 73 (65.8)	0.001*
Marital status Single Married Divorced/Widowed	106 (63.5) 75 (42.4) 22 (55.5)	61 (36.5) 102 (57.6) 18 (45)	0.090
Education Diploma Bachelors Masters and above	57 (69.5) 122 (52.6) 24 (34.3)	25 (30.5) 110 (47.4) 46 (65.7)	0.018*
HCW category Physicians Nursing and midwife Pharmacist Lab technicians Other categories	57 (49.1) 70 (50.7) 24 (50.0) 19 (61.3) 33 (64.7)	59 (50.9) 68 (49.3) 24 (50.0) 12 (38.7) 18 (35.3)	0.307
Work settings Primary health centers (PHC) General hospital Tertiary care hospital	70 (55.1) 80 (56.3) 53 (46.1)	57 (44.9) 62 (43.7) 62 (53.9	0.216
Work experience (in years) Less than 5 5 to 10 More than 10	85 (66.9) 66 (49.6) 52 (41.9)	42 (33.1) 67 (50.4) 72 (58.1)	0.001*

3   *Significant p-value (<0.05) from Ch-square test*

Table 3: Cross-tabulation between low/medium, high attitude score categories and sociodemographic characteristics (n=384)

1 Table 3: Cross-tabulation between low/medium, high attitude score categories and
2 sociodemographic characteristics

Variables	Low/Medium n (%)	High n (%)	p - value
Age (in years) Less than 30 30 to 39 40 and above	40 (27.8) 50 (37.6) 44 (41.1)	104 (72.2) 83 (62.4) 63 (58.9)	0.065
Gender Male Female	76 (33.0) 58 (37.7)	154 (67.0) 96 (62.3)	0.352
Nationality Saudi Non-Saudi	93 (34.1) 41 (36.9)	180 (65.9) 70 (63.1)	0.593
Marital status Single Married Divorced/Widowed	50 (29.9) 66 (37.3) 18 (45.0)	117 (70.1) 111 (62.7) 22 (55.0)	0.132
Education Diploma Bachelors Masters and above	32 (39.0) 80 (34.5) 22 (31.4)	50 (61.0) 152 (65.5) 48 (68.6)	0.606
HCW category Physicians Nursing and midwife Pharmacist Lab technicians Other categories	39 (33.6) 43 (31.2) 17 (35.4) 13 (41.9) 22 (43.1)	77 (66.4) 95 (68.8) 31 (64.6) 18 (58.1) 29 (56.9)	0.535
Work settings Primary health centers (PHC) General hospital Tertiary care hospital	32 (25.2) 50 (35.2) 52 (45.1)	95 (74.8) 92 (64.8) 63 (54.8)	0.005*
Work experience (in years) Less than 5 5 to 10 More than 10	31 (24.4) 64 (48.1) 39 (31.5)	96 (75.6) 69 (51.9) 85 (68.5)	0.001*

3 *Significant p-value (<0.05) from Ch-square test*

Table 4: Cross-tabulation between low/medium, high practice score categories and sociodemographic characteristics (n=384)

1 Table 4: Cross-tabulation between low/medium, high practice score categories and
2 sociodemographic characteristics (n = 384)

Variables	Low/Medium n (%)	High n (%)	p - value
Age (in years)			
Less than 30	52 (36.1)	92 (63.9)	
30 to 39	77 (57.9)	56 (42.1)	0.001*
40 and above	65 (60.7)	42 (39.3)	
Gender			
Male	97 (42.2)	133 (57.8)	0.008*
Female	97 (63.0)	57 (37.0)	
Nationality			0.001*
Saudi	110 (40.3)	163 (59.7)	
Non-Saudi	84 (75.7)	27 (24.3)	
Marital status			
Single	67 (40.1)	100 (59.9)	
Married	104 (58.8)	73 (41.2)	0.020*
Divorced/Widowed	23 (57.5)	17 (42.5)	
Education			
Diploma	32 (39.0)	50 (61.0)	0.092
Bachelors	129 (55.6)	103 (44.4)	
Masters and above	33 (47.1)	37 (52.9)	
HCW category			
Physicians	47 (40.5)	69 (59.5)	0.071
Nursing and midwife	76 (55.1)	62 (44.9)	
Pharmacist	29 (60.4)	19 (39.6)	
Lab technicians	18 (58.1)	13 (41.9)	
Other categories	24 (47.1)	27(52.9)	
Work settings			
Primary health centers (PHC)	71 (55.9)	56 (44.1)	0.323
General hospital	67 (47.2)	75 (52.8)	
Tertiary care hospital	56 (48.7)	59 (51.3)	
Work experience (in years)			
Less than 5	44 (34.6)	83 (65.4)	0.001*
5 to 10	81 (60.9)	52 (39.1)	
More than 10	69 (55.6)	55 (44.1)	

3 *Significant p-value (<0.05) from Ch-square test*

Table 5: Binomial logistic regression analysis on KAP subscales (low/medium vs high) and its association with participants sociodemographic characteristics (n=384)

1   Table 5: Binomial logistic regression analysis on KAP subscales (low/medium vs high) and its association with participants sociodemographic
2   characteristics (n = 384)

Variables	Total	Knowledge				Attitude				Practice			
		Low/ Medium n(%)	High n(%)	Adjusted OR (95% CI) **	p-value	Low/ Medium n(%)	High n(%)	Adjusted OR (95% CI) **	p-value	Low/ Medium n(%)	High n(%)	Adjusted OR (95% CI) **	p-value
Age (in years)													
Less than 30	144	100 (69.4)	44 (30.6)	Ref		40 (27.8)	104 (72.2)	Ref		52 (36.1)	92 (63.9)	Ref	
30 to 39	133	56 (42.1)	77 (57.9)	2.25 (1.05–4.85)	0.04*	50 (37.6)	83 (62.4)	0.99(0.46-2.13)	0.98	77 (57.9)	56 (42.1)	0.70 (0.33-1.52)	0.37
40 and above	107	47 (43.9)	60 (56.1)	1.38 (0.52–3.67)	0.52	44 (41.1)	63 (58.9)	0.39 (0.14-1.08)	0.07	65 (60.7)	42 (39.3)	0.50 (0.18-1.40)	0.19
Gender													
Female	154	82 (53.2)	72 (46.8)	Ref		58 (37.7)	96 (62.3)	Ref		97 (63.0)	57 (37.0)	Ref	
Male	230	121 (52.6)	109(47.4)	1.24 (0.76-2.05)	0.38	76 (33.0)	154 (67.0)	1.05 (0.64-1.74)	0.84	97 (42.2)	133 (57.8)	1.82 (1.10-2.99)	0.02*
Nationality													
Saudi	273	165 (60.4)	108 (39.6)	Ref		93 (34.1)	180 (65.9)	Ref		110 (40.3)	163 (59.7)	Ref	
Non-Saudi	111	38 (34.2)	73 (65.8)	2.84 (1.63-4.94)	0.00*	41 (36.9)	70 (63.1)	1.23 (0.71-2.14)	0.47	84 (75.7)	27 (24.3)	0.30 (0.17-1.52)	0.10
Marital status													
Single	167	106 (63.5)	61(36.5)	Ref		50 (29.9)	117 (70.1)	Ref		67 (40.1)	100 (59.9)	Ref	
Married	177	75 (42.4)	102 (57.6)	1.60 (0.95-2.69)	0.07	66 (37.3)	111 (62.7)	0.79 (0.46-1.35)	0.39	104 (58.8)	73 (41.2)	0.60(0.35-1.03)	0.06
Divorced/Widowed	40	22 (55.0)	18 (45.0)	0.87 (0.38-1.99)		18 (45.0)	22 (55.0)	0.58 (0.26-1.32)	0.19	23 (57.5)	17 (42.5)	0.82(0.35-1.90)	0.64
Education													
Diploma	82	57 (69.5)	25 (30.5)	Ref		32 (39.0)	50 (61.0)	Ref		32 (39.0)	50 (61.0)	Ref	
Bachelors	232	122 (52.6)	110 (47.4)	1.98 (1.06-3.68)	0.04*	80 (34.5)	152 (65.5)	1.23 (0.66-2.27)	0.52	129 (55.6)	103 (44.4)	0.41 (0.22-0.78)	0.01*
Masters and above	70	24 (34.3)	46 (65.7)	3.78 (1.59-8.97)	0.03*	22 (31.4)	48 (68.6)	2.13 (0.89-5.09)	0.09	33 (47.1)	37 (42.9)	0.47 (0.20-1.14)	0.09
HCW category													
Physicians	116	57 (49.1)	59 (50.9)	Ref		39 (33.6)	77 (66.4)	Ref		47 (40.5)	69 (59.5)	Ref	
Nursing and midwife	138	70 (50.7)	68 (49.3)	1.35 (0.73-2.49)	0.34	43 (31.2)	95 (68.8)	1.16 (0.62-2.16)	0.65	76 (55.1)	62 (44.9)	0.53 (0.28-1.01)	0.05
Pharmacist	48	24 (50.0)	24 (50.0)	1.30 (0.59-2.85)	0.51	17 (35.4)	31 (64.6)	1.28 (0.58-2.82)	0.55	29 (60.4)	19 (39.6)	0.39 (0.18-0.58)	0.02*
Lab technicians	31	19 (61.3)	12 (38.7)	1.12 (0.43-2.88)	0.82	13 (41.9)	18 (58.1)	1.09 (0.43-2.76)	0.86	18 (58.1)	13 (41.9)	0.31 (0.11-0.53)	0.02*
Other categories	51	33 (64.7)	18 (35.3)	0.88 (0.68-2.02)	0.76	22 (43.1)	29 (56.9)	0.96 (0.42-2.76)	0.92	24 (47.1)	27 (52.9)	0.60 (0.25-1.42)	0.25
Work settings													
PHC	127	70 (55.1)	57 (44.9)	Ref		32 (25.2)	95 (74.8)	Ref		71 (55.9)	56 (44.1)	Ref	
General hospital	142	80 (56.3)	62 (43.7)	0.98 (0.58-1.67)	0.94	50 (35.2)	92 (64.8)	0.61 (0.35-1.07)	0.08	67 (47.2)	75 (52.8)	1.63 (0.94-2.83)	0.08
Tertiary care hospital	115	53 (46.1)	62 (53.9)	1.30 (0.74-2.29)	0.37	52 (45.2)	63 (54.8)	0.38 (0.12-0.69)	0.01*	56 (48.7)	59 (51.3)	1.67 (0.92-3.02)	0.09
Work experience (years)													
Less than 5	127	85 (66.9)	42 (33.1)	Ref		31 (24.4)	96 (75.6)	Ref		44 (34.6)	83 (65.4)	Ref	
5 to 10	133	66 (49.6)	67 (50.4)	0.84 (0.39-1.77)	0.64	64 (48.1)	69 (51.9)	0.40 (1.91-0.85)	0.20	81 (60.9)	52 (39.1)	0.66 (0.32-1.37)	0.26
More than 10	124	52 (41.9)	72 (58.1)	0.99 (0.39-2.57)	0.99	39 (31.5)	85 (68.3)	1.43 (0.52-3.88)	0.49	69 (55.6)	55 (44.4)	1.14 (0.43-2.99)	0.79

3   *Significant association (p<0.05) **Variable adjusted in enter method: age, gender, nationality, marital status, education status, HCWs category, work setting,
4   and work experience

Table 6: Spearman's correlation analysis between KAP scores

1   Table 6: Spearman's correlation analysis between KAP scores

Variable	rho* / p - value
Knowledge – Attitude	.249 / 0.002**
Knowledge – Practice	.104/0.042**
Attitude – Practice	0.470/0.001**

3   *Spearman's rank correlation coefficient, ** significant at 0.05 level (2-tailed)*