International Journal of General Medicine

Dovepress
Taylor & Francis Group

Open Access Full Text Article

ORIGINAL RESEARCH

# Knowledge and Practices of Insulin Injection and Medical Waste Disposal Among Patients with Diabetes in Al-Ahsa, Saudi Arabia: a Cross-Sectional Study

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**Background:** Diabetes mellitus is a serious global health issue with increasing incidence at all income levels. Insulin injections are frequently administered improperly. Proper disposal of sharps is commonly overlooked when using an injection technique.

**Aim:** This study explores the knowledge and factors associated with insulin injection techniques among patients with diabetes. A study was also conducted to analyze the knowledge and practices of patients with diabetes regarding the disposal of medical waste.

**Materials and Methods:** A cross-sectional study employing a questionnaire-based survey was conducted at two sites within Al-Ahsa, Saudi Arabia. Eligibility criteria comprised men and non-pregnant women aged 18 years or older diagnosed with either type 1 or type 2 diabetes who administered insulin via insulin pens or syringes. The descriptives were presented and a chi-square test was used to study the association. All the data were analyzed using Jamovi software.

**Results:** A significant association of knowledge was found with the duration of diabetes mellitus (p=0.031) and the source of insulin injection training (p=0.014). A positive correlation between participants' knowledge and practice ($r = 0.221$, $p < 0.05$) was observed. Participants' insulin injection practices reveal that 66.2% (n = 235) demonstrated good or safe practices, 33.8% (n = 117) exhibited average or potentially needing improvement practices, and 0.8% (n = 3) displayed poor injection practices. A mixed picture of medical waste disposal practices among the participants has been observed, with 30% (n = 106) exhibiting good or safe practices, 64% (n = 228) moderate practices, and nearly 6% (n = 21) of participants reported employing poor disposal practices.

**Conclusion:** This study showed that insulin injection and medical waste disposal practices need to be improved. Most of the patients come under the average medical waste disposal practice category. More awareness campaigns and counselling sessions are crucial to improve the practices.

**Keywords:** healthcare workers, insulin injection, medical waste disposal, patient with diabetes, patient education, knowledge & practice

## Introduction

Chronic hyperglycemia, a hallmark of diabetes mellitus, is associated with potential damage to various organ systems. Type 2 diabetes, driven by insulin resistance or deficiency, constitutes the majority of cases, showcasing a dramatic increase over the past three decades across all income-level countries. Its rise highlights a significant global health challenge. Conversely, type 1 diabetes, characterized by absolute insulin deficiency, typically presents earlier in life. Both

Received: 14 May 2024
Accepted: 13 March 2025
Published: 3 April 2025

types necessitate effective management to mitigate long-term complications. The criticality of affordable treatment access, including insulin, is underscored by its lifesaving potential. Achieving the globally agreed-upon target of halting the rise in diabetes by 2025 necessitates concerted efforts towards prevention and early intervention.[1]

Diabetes mellitus exhibits a concerningly rapid trend of global expansion, with several nations experiencing epidemic levels of the disease, which further signifies a pressing public health challenge.[2] In 2017, the geographic distribution of the diabetic burden varied across countries, with the highest prevalence observed in China, India, the United States, Indonesia and Mexico and the most deaths reported in India, China, Indonesia, the United States, and Mexico.[3]

537 million adults (20–79 years) are affected by diabetes worldwide. Four in five people with diabetes (81%) live in low-income and middle-income countries. There are 6.7 million Diabetes associated deaths in 2021–1 every 5 seconds. Diabetes is associated with an estimated USD 966 billion in global health expenditure in 2021. This represents a 316% increase over the last 15 years.[4]

Diabetes cases have risen from 7% to 14% between 1990 and 2022, with approximately 450 million adults remain untreated, the majority in low- and middle-income countries (LMICs).[5] The Southeast Asia and Eastern Mediterranean regions face the highest prevalence, with about 20% of adults affected, while treatment rates remain low, with fewer than 40% receiving glucose-lowering medications.[5]

The disease is associated with 1.5 demarcated fatalities annually. As per the World Health Organisation (WHO) in 2023,[1] there has been a persistent increase in the incidence and prevalence of diabetes in recent decades. According to WHO data from 2022, there was a 3% increase in diabetes-related death rates across all age categories between 2000 and 2019. According to a projection,[6] 9.3% of people globally will have diabetes in 2019. It is expected to rise to 10.2% by 2030 and 10.9% (or 700 million residents) by 2045. In particular, it is noted that Saudi Arabia is in the top ten countries in the world, with a prevalence rate of around 24%.[7] There is a significant deficiency in public knowledge about Diabetes mellitus, its risk factors, and its consequences across Saudi Arabia.[8]

The primary approach to managing diabetes predominantly involves administering insulin at home. Various medical tools such as needles, pens, and syringes for insulin are employed as components of self-care practices.[9] Patients with diabetes prescribed insulin are typically advised to self-monitor blood glucose (SMBG) utilizing a glucometer and lancets. This enables regular monitoring of blood glucose levels and subsequent self-adjustment of insulin doses as necessary.[10] This process commonly necessitates transitioning to using insulin in a higher regularity involving an increased frequency of injections to attain improved glycemic control.[11] Consequently, these procedures generate a significant quantity of waste with sharp edges within household settings. Given the escalating prevalence and utilization of insulin therapy and SMBG, patients with diabetes, particularly those with Type 2 diabetes mellitus reliant on insulin, are recognized as prominent consumers of medical sharps within community settings.[12]

World Health Organization has defined wastes with sharp edges as "Items that could cause cuts or puncture wounds, including needles, hypodermic needles, scalpel, and other blades, knives, infusion sets, saws, broken glass, and nails".[13]

Appropriate sharps disposal represents a crucial yet frequently overlooked aspect of correct injection practices.[14] Home-based medical care is experiencing global advancement.[15] Although this development brings undeniable health benefits to the population, the consequent production of medical waste within households presents fresh hurdles for municipal solid waste management systems, particularly in developing nations.[16,17] Insufficient handling of hazardous medical waste poses environmental and public health risks.[18]

Incorrect insulin injection technique is frequently observed, with potential implications for glycemic variability and subsequent compromise of both short- and long-term health outcomes.[19] While regulations regarding the handling and disposal of medical sharps in healthcare facilities are well-established, attention toward sharps generated within household and community environments remains relatively inadequate. This issue is particularly worrisome, specifically in numerous rising nations where resources are limited and waste disposal infrastructures are inadequate.[20]

Each day, diabetic patients generate thousands of items of sharps waste and potentially infectious waste in their home environments.[21] In the community, sharps waste disposal has become a public health and environmental health concern.[22]

The improper disposal of sharps waste by patients with diabetes has become a major issue worldwide.[23] Patients with diabetes are under-informed about how to dispose of sharps waste at home.[24]

Diabetes has traditionally been associated with complications and economic burdens.[25] There has been little discussion of how diabetes self-management affects the environment and public health.[26] Patient education on self-injection techniques does not always include proper disposal of medical sharps, resulting in potentially unsafe disposal practices.[27] It is not just environmental contamination that is caused by improper disposal of sharps waste, but also a great danger to those who inadvertently dispose of household waste in this manner.[28,29]

The World Health Organization has identified Saudi Arabia as the second-highest nation in the Middle East and seventh globally in terms of diabetes prevalence. Approximately 7 million individuals within the population are patients with diabetes, with nearly 3 million classified as having pre-diabetes.[30] As per WHO reports from 2016, the prevalence of diabetes among the Saudi population was recorded at 14.7%, with rates of 13.8% among females and 14.7% among males, contributing to 5% of overall deaths in Saudi Arabia.[31]

Local studies further underscore this issue, with a cross-sectional examination of the Al kharj region's population revealing a diabetes prevalence of 3.8% among females and 9.2% among males.[32] The prevalence of individuals with high risk of developing Type-2 Diabetes Mellitus in Saudi Arabia is 7.5%.[33] Al Ahsa area in Saudi Arabia was the subject of a previous study where insulin pens and insulin syringes were found to be used in unsafe ways. Paying more attention to the patient's unsafe practices is important.[34]

Consequently, this research investigates the techniques employed by participants in insulin administration and the factors influencing such practices. Additionally, it seeks to assess knowledge and adherence to protocols for the disposal of medical waste among patients suffering with diabetes.

## Objectives

1. To assess the knowledge of patients with diabetes regarding insulin injection techniques and safe disposal of medical sharps.
2. To evaluate the practices of insulin administration and medical sharps disposal among patients with diabetes.

# Materials and Methods

Study Design and Population: A cross-sectional study employing a questionnaire-based survey was conducted at two sites within Al Ahsa, Saudi Arabia, namely, (1) primary healthcare centers and (2) the Diabetic Center at King Fahd Hospital. Eligibility criteria comprised non-pregnant individuals aged 18 years or older diagnosed with either type 1 or type 2 diabetes who administered insulin via insulin pens or syringes.

## Ethical Approval

The Ethics Committee approved the research protocol at the IRB of King Faisal University.

KFU-REC-2022-FEB-EA000461, and the IRB of King Fahd Hofuf Hospital KFHH No.

(H-05-HS-065). IRB Log No: 70-EP-2022. The study was conducted from March 2022 to January 2023 and informed consent was obtained from the patients for participation in this study complies with the Declaration of Helsinki.

## Data Collection Instrument

The questionnaire was developed following a comprehensive review of pertinent literature, drawing insights from relevant articles and studies.[35–37] Initially drafted in English, the questionnaire underwent translation into the local language (Arabic) and subsequent back-translation into English to verify semantic accuracy. Before formal data collection, the questionnaire underwent a pretest phase (pilot study) involving 22 participants to identify potential issues and refine its content. Data from this pretest phase were excluded from the final analysis, and necessary adjustments were made to the questionnaire based on feedback, ensuring its appropriateness for subsequent data collection endeavours. The Cronbach alpha obtained was 0.79, which is considered good for the questionnaire's reliability. Five experts— four faculty members and a senior nurse—confirmed the questionnaire's content validity.

The questionnaire was administered in an interview format, consisting of three distinct sections and a total of 40 questions. The initial section comprised 10 questions about demographic details, encompassing variables such as age, gender, educational attainment, and the frequency of daily injections. The subsequent segment encompassed 17 questions

focused on the participants' comprehension of diabetes mellitus and insulin injection processes. The third section encompassed 8 queries concerning the participants' insulin injection practices and techniques. The final segment comprised 5 inquiries concerning the method employed for waste disposal after injection.

A scoring system was implemented to assess the knowledge, technical skills, and disposal practices related to insulin injection among the surveyed patients. Each correct response to the 29 questions garnered one point, yielding a maximum score for each section of the questionnaire. The total score was then calculated to provide an overview of the participants' knowledge and practices. The following operational definitions are utilized to categorize the knowledge and practice behavior of participants:[38]

## Operational Definitions

We have divided the participants' knowledge into three categories:[39]

### Good Knowledge

A patient who answered 12–17 (≥70%) correct responses from the 17 questions used to assess patients' knowledge.

### Average Knowledge

A patient who answered 6–11 (30% - 70%) correct responses.

### Poor Knowledge

A patient who answered 0–5 (≤30%) correct responses.

### Utilization Practice

It was assessed using Eight questions that explored participants' experience with insulin utilization.

### Disposal Practice of Used Needles

It was assessed using Five questions that explored participants' experience with the disposal practice of used needles.

Combining utilization and disposal practice questionnaire responses except question 8 of utilization practice ie based on 12 responses from each participant, the participant's practice behaviour is divided into three categories:

### Good Practice

A patient who answered ≥70% correct responses from the 12 questions.

### Average Practice

A patient who answered 30% - 70% correct responses.

### Poor Practice

A patient who answered ≤30% correct responses.

## Statistical Analysis

The data analysis was performed utilizing Jamovi software (https://www.jamovi.org/), with results presented in numerical form and corresponding frequencies. To assess the association between the knowledge of patients regarding diabetes mellitus and insulin therapy and demographic characteristics, the Chi-square test was employed. A significance threshold of $p < 0.05$ was applied to determine statistical significance.

# Results

The descriptive statistics of the sociodemographic patient data are displayed in Table 1. A total of 355 participants were taking part. Of the 355, 101 (28.5%) are men and 254 (71.5%) are women. Of the participants, 183 (51.5%) are younger than 30, 90 (25.4%) are older than 55, and 82 (23.1%) are in the 30- to 55-year-old range. 179 people (50.4%) had a higher educational level. 255 people (71.8%) in the occupation did not have a job.

Regarding marital status, 161 people (45.4%) were married. In terms of the duration of illness, 181 participants (51.0%) reported having diabetes for more than ten years. A total of 263 participants (74.1%) indicated that they used an

**Table 1** Descriptives of Socio-Demographic Data of Patients

| **Variables** | **Counts (% of Total) for N=355** |
|---|---|
| Sex | |
| Male | 101 (28.5%) |
| Female | 254 (71.5%) |
| Age | |
| Below 30 years | 183 (51.5%) |
| 30–55 years | 82 (23.1%) |
| Above 55 years | 90 (25.4%) |
| Education | |
| Can read and write | 67 (18.9%) |
| Primary level | 44 (12.4%) |
| Secondary level | 65 (18.3%) |
| Higher education | 179 (50.4%) |
| Occupation | |
| I do not have work | 255 (71.8%) |
| Non-Governmental Organization | 26 (7.3%) |
| Private business | 29 (8.2%) |
| Governmental work | 45 (12.7%) |
| Marital status | |
| Single | 160 (45.1%) |
| Married | 161 (45.4%) |
| Divorced | 12 (3.4%) |
| Widowed | 22 (6.2%) |
| Duration of Diabetes Mellitus | |
| <5 years | 79 (22.3%) |
| 6–10 Years | 95 (26.8%) |
| >10 Years | 181 (51.0%) |
| Types of insulin injection devices used? | |
| Insulin pen | 263 (74.1%) |
| Insulin syringe | 59 (16.6%) |
| Needle with a separate syringe | 33 (9.3%) |

(*Continued*)


https://doi.org/10.2147/IJGM.S478240

**Table 1** (Continued).

| Variables | Counts (% of Total) for N=355 |
|---|---|
| Number of insulin injections per day this month? | |
| 1 | 94 (26.5%) |
| 2 | 105 (29.6%) |
| 3 or more | 156 (43.9%) |
| Who instructs you about insulin injection practices? | |
| Nurse | 32 (9.0%) |
| Physician | 276 (77.7%) |
| Others | 47 (13.2%) |
| Who instructs you about disposal? | |
| Nurse | 67 (18.9%) |
| Physician | 175 (49.3%) |
| Others/ none | 113 (31.8%) |

insulin pen as one of the devices for insulin administration. Additionally, 156 participants (43.9%) reported receiving three or more insulin injections per day during this month. Regarding instruction on insulin administration, 276 participants (77.7%) stated that they were taught by a doctor. Furthermore, 175 participants (49.3%) indicated that instructions on insulin disposal were provided by a physician. The descriptives of Knowledge assessment variables are presented in Table 2. As per operational definitions, In Table 3 responses of "Poor" and "Average" level are combined into the "Inadequate" category of knowledge. Conversely, the "Good" category indicates "Adequate" knowledge. An association between knowledge level and other variables is determined using a chi-square test. Chi-square tests of independence with a 5% significance level revealed no significant associations between knowledge and sex, age,

**Table 2** Descriptives of Knowledge of Patients Regarding Insulin Therapy

| Knowledge Assessment Variables | Yes Count (%) | No Count (%) |
|---|---|---|
| Diabetes mellitus means high blood sugar. | 286 (80.6%) | 69 (19.4%) |
| Insulin vial is stored in the refrigerator or cold place. | 339 (95.5%) | 16 (4.5%) |
| Insulin injection is taken soon after or just before taking food. | 276 (77.7%) | 79 (22.3%) |
| The sites for insulin injection are abdomen, thigh, glutei and deltoid. | 340 (95.8%) | 15 (4.2%) |
| The angle to administer insulin is 45 to 90 degree. | 243 (68.5%) | 112 (31.5%) |
| The distance to rotate on the same site is one thumb. | 200 (56.3%) | 155 (43.7%) |
| Ways to reduce pain during insulin injection are interring the skin, do not manipulate the needle once inserted, avoiding re using of the same site. | 302 (85.1%) | 53 (14.9%) |
| The complications of insulin therapy are low blood sugar, insulin resistance and wasting of subcutaneous tissue. | 264 (74.4%) | 91 (25.6%) |

(*Continued*)

**Table 2** (Continued).

| Knowledge Assessment Variables | Yes Count (%) | No Count (%) |
|---|---|---|
| The use of rotation of the injection site is to reduce pain, prevent wasting of subcutaneous tissues. | 236 (66.5%) | 119 (33.5%) |
| Massage after injection is used to enhances the rapid absorption of insulin. | 232 (65.4%) | 123 (34.6%) |
| The benefit of insulin self-administration are, time-saving, inexpensive and easy to take on self while travelling. | 319 (89.9%) | 36 (10.1%) |
| The sharp waste produced at home is infectious. | 179 (50.4%) | 176 (49.6%) |
| Needle should be recapped after use and before throwing away in the bin. | 336 (94.6%) | 19 (5.4%) |
| Needle should be broken away from syringe and collected in puncture-proof bottles. | 214 (60.3%) | 141 (39.7%) |
| Lancets should not be recapped after use and before throwing in waste bin. | 180 (50.7%) | 175 (49.3%) |
| Sharps like needles and lancets can cause injury if disposed of in public places like parks, streets, etc. | 332 (93.5%) | 23 (6.5%) |
| Used needles and syringes can be misused by rag pickers. | 247 (69.6%) | 108 (30.4%) |

**Table 3** Association Between Knowledge of Patients Regarding Diabetes Mellitus and Insulin Therapy and Demographic Characteristics

| Variables | Category | Knowledge Level | | $\chi^2$ | P-value |
|---|---|---|---|---|---|
| | | Adequate | Inadequate | | |
| Sex | Male | 67 (66.3%) | 34 (33.7%) | 0.156 | 0.693 |
| | Female | 174 (68.5%) | 80 (31.5%) | | |
| Age | Below 30 years | 115 (62.8%) | 68 (37.2%) | 5.33 | 0.070 |
| | 30–55 years | 63 (76.8%) | 19 (23.2%) | | |
| | Above 55 years | 63 (70%) | 27 (30%) | | |
| Occupation | Farmer | 3 (75%) | 1 (25%) | 1.97 | 0.741 |
| | Governmental work | 33 (73.3%) | 12 (26.7%) | | |
| | Private business | 19 (65.5%) | 10 (34.5%) | | |
| | NGO employ | 17 (77.3%) | 5 (22.7%) | | |
| | I do not work | 169 (66.3%) | 86 (33.7%) | | |
| Marital status | Single | 102 (63.7%) | 58 (36.3%) | 2.43 | 0.489 |
| | Married | 115 (71.4%) | 46 (28.6%) | | |
| | Divorced | 8 (66.7%) | 4 (33.3%) | | |
| | Widowed | 16 (72.7%) | 6 (27.3%) | | |
| Duration of Diabetes mellitus | <5 years | 44 (55.7%) | 35 (44.3%) | 6.93 | 0.031* |
| | 6–10 Years | 68 (71.6%) | 27 (28.4%) | | |
| | >10 Years | 129 (71.3%) | 52 (28.7%) | | |

(*Continued*)


https://doi.org/10.2147/IJGM.S478240

**Table 3** (Continued).

| Variables | Category | Knowledge Level | | $\chi^2$ | P-value |
|---|---|---|---|---|---|
| | | Adequate | Inadequate | | |
| Types of insulin injection device used | Needle with separate syringe | 17 (51.5%) | 16 (48.5%) | 4.58 | 0.101 |
| | Insulin pen | 184 (70%) | 79 (30%) | | |
| | Insulin syringe | 40 (67.8%) | 19 (32.2%) | | |
| Number of insulin injections per day this month | 1 | 66 (70.2 5) | 28 (29.8%) | 0.810 | 0.667 |
| | 2 | 73 (69.5%) | 32 (30.5%) | | |
| | 3 or more | 102 (65.4%) | 54 (34.6%) | | |
| Who instructs you about insulin injection practices | Nurse | 18 (56.3%) | 14 (43.8%) | 8.52 | 0.014* |
| | Physician | 198 (71.7%) | 78 (28.3%) | | |
| | Others | 25 (53.2%) | 22 (46.8%) | | |
| Who instructs you about disposal | Nurse | 50 (74.6%) | 17 (25.4%) | 5.93 | 0.051 |
| | Physician | 124 (70.9%) | 51 (29.1%) | | |
| | Others | 67 (59.3%) | 46 (40.7%) | | |

**Notes**: N=355, Statistically significant (P<0.05).

occupation, marital status, type of insulin injection device used, number of daily insulin injections this month, or the source of waste disposal instructions.

However, a significant association was found between knowledge and both the duration of diabetes mellitus and the source of insulin injection training. As the duration of diabetes increases, the percentage of individuals with adequate knowledge also rises. Notably, patients instructed by physicians demonstrate the highest level of adequate knowledge.

The source of instruction on waste disposal also influenced participants' knowledge levels, nearly reaching the significance level with a p-value of 0.051. Additionally, patients with adequate knowledge are more likely to have received physician-directed training.

Table 4 summarizes the participants' self-reported frequencies and percentages of various insulin injection practices. Notably, 92.1% (n = 327) reported injecting insulin in the correct locations, which is a positive finding. Similarly, 95.5% (n = 339) acknowledged storing their insulin in a refrigerator, another important practice for maintaining its efficacy.

**Table 4** Insulin Injection Practices of the Participants

| Practice Assessment Variables | Yes Count (%) | No Count (%) |
|---|---|---|
| Can you inject yourself in the correct position? | 327 (92.1%) | 28 (7.9%) |
| Do you inject yourself with the needle at 45°- 90? | 286 (80.6%) | 69 (19.4%) |
| Do you store insulin vials in a refrigerator or cold place? | 339 (95.5%) | 16 (4.5%) |
| Do you frequently repeat injection sites? | 126 (35.5%) | 229 (64.5%) |
| Do you inject insulin into the abdomen, thigh, gluteus or deltoid? | 337 (94.9%) | 18 (5.1%) |
| Do you inject insulin before or immediately after food intake? | 304 (85.6%) | 51 (14.4%) |

(*Continued*)

**Table 4** (Continued).

| Practice Assessment Variables | Yes Count (%) | No Count (%) |
|---|---|---|
| Do you ever reuse the needle? | 124 (34.9%) | 231 (65.1%) |
| Number of needles thrown away in one week | **Count (%)** | |
| 1–7 | 146 (41.1%) | |
| Do not use syringes | 82 (23.1%) | |
| More than 7 syringes | 127 (35.8%) | |

However, certain areas requiring improvement were also identified. Only 35.5% (n = 126) of participants reported consistently rotating their injection sites, even though regular rotation is vital to prevent lipohypertrophy and promote optimal absorption. While 94.9% (n = 337) mentioned incorporating some form of rotation within or across injection areas, further clarification is needed to ascertain the extent and effectiveness of their practices.

Another concern is the timing of insulin administration. 14.4% (n = 51) admitted injecting before or immediately after food intake, which may not align with their specific insulin type and recommended timing for optimal control.

Furthermore, concerning practices include needle reuse (34.9%, n = 124) and potentially excessive needle waste. 35.8% (n = 127) reported disposing of more than 7 syringes per week, suggesting a potential for unnecessary injection frequency or needle reuse exceeding recommended safe limits.

These findings highlight the need for targeted educational interventions to address knowledge gaps and encourage adherence to optimal insulin injection practices among this population. Table 5 summarizes the participants' self-reported disposal practices of medical insulin injection waste. Analyzing the data reveals a range of approaches, with varying levels of adherence to recommended guidelines.

The dominant practice, employed by 78.3% (n = 278) of participants, involves combining insulin injection waste with other household waste and depositing it in standard public waste collection vehicles. While this approach is acceptable for certain types of medical waste, specific guidance recommends separate disposal for sharps-related materials due to safety concerns.

A considerable proportion of participants, 53.2% (n = 189), reported occasionally employing a more optimal practice. They collect used needles and syringes in a designated container before transferring them to a public waste disposal vehicle. This method improves safety by minimizing risks associated with accidental punctures or exposure to biohazardous materials.

However, a concerning finding is the reported disposal of injection waste in toilets by 7% (n = 25) of participants. This practice is strictly discouraged due to the potential for clogging plumbing systems and posing public health risks.

**Table 5** Waste Disposal Practices of Patients

| Participants' Disposal Practices of Insulin Needles /Other Kits | Yes Count (%) | No Count (%) |
|---|---|---|
| Collect with other waste and transfer to public waste disposal vehicle. | 278 (78.3%) | 77 (21.7%) |
| Collect in a separate container and transfer to a public waste disposal vehicle. | 189 (53.2%) | 166 (46.8%) |
| Collect in a box and keep in the refrigerator | 156 (43.9%) | 199 (56.1%) |
| Thrown in toilet | 25 (7%) | 330 (93%) |
| Burn it | 42 (11.8%) | 313 (88.2%) |

**Table 6** Insulin Injection Practices/ Behaviour of Participants

| Injection Practice | Counts | % of Total |
|---|---|---|
| Good (≥70%) | 235 | 66.2% |
| Average (30–70) | 117 | 33.0% |
| Poor (≤30) | 3 | 0.8% |

**Table 7** Medical Waste Disposal Practices/ Behaviour of Participants

| Disposal Practice | Counts | % of Total |
|---|---|---|
| Good (≥70%) | 106 | 29.9% |
| Average (30–70) | 228 | 64.2% |
| Poor (≤30) | 21 | 5.9% |

Overall, the data highlights the need for educational interventions to promote safer and more responsible disposal practices for medical waste, particularly among the remaining 21.7% of participants who did not report the recommended methods.

Table 6 categorizes participants' insulin injection practices, revealing that 66.2% (n = 235) demonstrate good or safe practices. However, further attention is warranted for the 33.0% (n = 117) exhibiting average or potentially needing improvement practices. Notably, a minority of only 0.8% (n = 3) displayed poor injection practices, suggesting the minimal prevalence of highly concerning behaviours.

Table 7 presents a mixed picture of medical waste disposal practices among the participants. While nearly 30% (n = 106) exhibited good or safe practices, indicating their adherence to recommended guidelines, a considerably larger group, over 64% (n = 228), acknowledged practices that could benefit from refinement or closer attention. This suggests potential knowledge gaps or inconsistencies in safe disposal protocols within this segment.

Most concerningly, nearly 6% (n = 21) of participants reported employing poor disposal practices, posing significant safety hazards and highlighting the urgent need for targeted interventions. These interventions should aim to educate and address these potentially risky behaviours.

Analysis of the correlation matrix revealed a statistically significant, positive correlation between participants' knowledge and practice ($r = 0.221$, $p < 0.001$). This finding indicates that higher levels of knowledge regarding diabetes and insulin therapy showed a linear relationship with recommended injection practices and safe waste disposal protocols.

## Discussion

This study adopted a cross-sectional design, employing a self-administered instrument to investigate insulin needle disposal practices among individuals diagnosed with diabetes, while also examining factors correlated with the adoption of safe sharps disposal practices.

The study revealed a mixed picture of diabetes management among participants. In the present study knowledge about the disease and insulin therapy was generally adequate, nevertheless knowledge gaps existed regarding injection site rotation and timing. The study's findings indicated that injection practices were generally safe, although improvements are needed in areas such as consistent site rotation, optimal timing, and avoiding needle reuse.

Research has indicated that effective education provided by healthcare professionals (HCPs) has enhanced self-management behaviors among individuals with diabetes.[40–42] Regardless of their origin, medical sharps are universally acknowledged as highly hazardous clinical waste, necessitating appropriate collection, disposal, and thorough destruction to mitigate the potential risks of injury or infection to individuals who may come into contact with them.[12]

Regarding knowledge of the patient about safe insulin injection and safe waste medical disposal, the present study showed no significant association of knowledge with sex, age, occupation, marital status, types of insulin injection devices used, number of insulin injections per day this month, and who instructs the patients about waste disposal. However, there is a significant association between knowledge of the duration of diabetes mellitus in patients and who instructs them about insulin injection practices. As the duration of having diabetes mellitus increases, the percentage of adequate knowledge also increases. A discrepancy in statistical significance in our study can be attributed to patients' inattention to doctor and health team directives regarding medical waste. It is also possible that the statistical significance may be influenced by the fact that middle-aged patients are more concerned with the disease itself or its treatment than how medical waste is disposed off.

Notably, this study found that a longer duration of the disease and physician-led instruction were linked to improved knowledge. Additionally, waste disposal practices were problematic, with a significant number of participants engaging in unsafe habits.

A study carried out in India found that patients with diabetes who got advice from their doctors about how to dispose of sharps showed a lower propensity to throw sharps into regular garbage as opposed to those who did not.[43]

A different investigation in Malaysia revealed that patients with diabetes who had been counselled on sharp disposal were six times more inclined to deliver their used sharps to healthcare facilities for appropriate disposal than those who had not received prior advice.[44] Interestingly, these findings diverged from those of Quiwa and Jimeno, whose study found that previous guidance or education regarding sharp disposal did not impact sharp disposal practices.[23] It was hypothesized that the guidance provided to patients with diabetes in the Malaysian study might have been inadequate or not adequately followed by the patients, as HCPs themselves were reportedly unaware of safe sharp disposal options within their community. Furthermore, despite being instructed on proper sharps disposal methods, patients may not consistently adhere to the advice, resulting in a notably low proportion of patients practicing safe sharps disposal techniques.

In spite of being instructed on proper sharps disposal methods, patients may not consistently follow the advice, resulting in a low rate of safe sharps disposal. In other words, while greater knowledge and proper counseling are generally associated with better disposal practices, their effectiveness will depend on the local circumstances and the quality of the implementation.

The instructions given to patients typically include using designated sharps containers, avoiding needle reuse, and returning used sharps to healthcare facilities for safe disposal. However, the lack of adherence suggests that additional measures or reinforcement of these instructions may be necessary to improve compliance.

Waste disposal habits of patients who were good or safe were twice as low or even lower than those whose insulin injection habits were good or safe. There is a possibility that this result was affected by a lack of knowledge about medical waste disposal.

Only 29.9% of respondents in the current study had good or safe waste disposal habits, compared to 66.2% of respondents with good or safe insulin injection practices. These findings disagreed with research conducted in Putrajaya, Malaysia, on the Safe Management of Waste from Healthcare Activities. 67.3% of participants disposed of their insulin needles securely, indicating a good prevalence of safe sharps disposal practices following the insulin needle security guidelines prepared by the WHO.[12]

In Brazil, the responsibility for managing healthcare waste lies with the health facility that generates it, as stipulated by legal regulations.[45] Medical waste generated from home healthcare services must be appropriately stored and collected by service personnel or individuals trained.[46] A study[47] observed instances of chemical and biological waste being disposed of alongside regular household waste in Brazil. A study[16] highlighted in their research that the absence of a specific management plan for home care contributes to inconsistencies and noncompliance, particularly regarding waste management. This situation arises from a lack of clarity regarding the roles and responsibilities of individuals involved in home healthcare services.

Hasan et al study in 2019[44] revealed a notable correlation between knowledge level and the practice of sharp disposal. Specifically, individuals with higher knowledge scores were more inclined to return their used sharps to healthcare facilities for proper disposal. This observation aligns with research conducted in Pakistan, which similarly found that

awareness of the risks associated with blood-borne disease transmission following needle stick injuries was linked to the adoption of safe sharp disposal practices among patients with diabetes.[43,44]

In the present study, one of the established risk variables for diabetic self-care behaviours is the length of diabetes. This study found a strong correlation between the length of diabetes and sharp returns at medical facilities. Concerning the practice of combining medical insulin injection waste with general waste and subsequently transferring it to public waste disposal vehicles, 78.3% of participants reported engaging in this behaviour.

Approximately half of the participants (53.2%) indicated that they occasionally collect such waste in a separate container before transferring it to a public waste disposal vehicle.

These findings highlight the importance of educational interventions to address knowledge gaps and encourage adherence to optimal insulin injection practices among this population. Table 6 shows that the majority of participants adhere to essential injection techniques. In the Silva et al (2022) study,[16] it was noted that non-sharp medical waste and regular household waste were often discarded together and stored in unlabeled plastic bags or containers. Additionally, sharp waste generated from daily procedures such as insulin self-administration and blood glucose monitoring was frequently disposed of alongside ordinary household waste. While regulations governing the disposal of medical waste were effectively enforced in healthcare settings nationwide, proper protocols for managing sharps generated in household settings were not yet adequately implemented.[48] Contrastingly, in the Philippines and Africa, a mere 2.0% of patients with diabetes were reported to dispose of sharps at healthcare facilities.[23,24] Conversely, in developed nations like Turkey, approximately 24.0% of patients were observed to appropriately collect sharps in FDA-cleared or designated household containers before disposing of them at healthcare facilities or centralised collection areas.[49]

The correlation matrix between participants' knowledge and practice in the current study indicates a positive association between participant knowledge and practice, with a value of 0.221.

## Conclusion

This study demonstrated the necessity of advancing ways to enhance home care services and waste disposal. This study revealed a mixed picture of diabetes management among participants. While knowledge about the disease and insulin therapy was generally adequate, knowledge gaps existed regarding injection site rotation and timing. Notably, longer disease duration and physician-led instruction were associated with better knowledge. Injection practices were largely safe, though areas like consistent site rotation, optimal timing, and avoiding needle reuse require improvement. Waste disposal practices were concerning, with a significant portion with unsafe habits. Targeted interventions are crucial to address these specific knowledge gaps and improve adherence to guidelines, particularly in injection timing, needle reuse, and waste disposal, ultimately promoting safer and more effective diabetes management.

## Acknowledgment

The authors are thankful to the King Faisal University, King Fahd Hofuf Hospital, and Study participants for their contribution to the research conducted. The authors are also thankful to the Editor and reviewers for their comments and suggestions for the improvement of the manuscript.

## Funding

This work was supported by the Deanship of Scientific Research, Vice Presidency for Graduate Studies and Scientific Research, King Faisal University, Saudi Arabia [Grant No. KFU251154].

## Disclosure

The authors declare that they have no competing interests in this work.

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