Original Research Article

Knowledge Assessment and Practice of insulin storage and self-administration techniques among diabetic mellitus patients

ABSTRACT:

Background: Diabetes mellitus (DM) is a long term, progressive metabolic disease marked by high blood sugar levels brought on by aberrant insulin action, production, or both. The procedure by which a person applies insulin to subcutaneous tissue is known as self-administration. Adequate injection procedures are crucial for optimal diabetic management. The most popular method for administering insulin to people is a subcutaneous injection. Only in cases of stress or ketoacidosis are other methods, such as intramuscular (I.M), intravenous (I.V), or infusion, used.

Objective: To evaluate knowledge assessment skills and practice of insulin injection techniques among diabetic mellitus patients.
To re-educate patient for proper insulin injection techniques.

Methodology: We conducted a cross-sectional study for a period of 6 months with the patients who are self-administering insulin injection for diabetic mellitus at Siddaganga hospital. Before conducting the study, the informed consent was obtained from the patients. The data was collected using pre designed data collection form such as patient demographic details, past medical and medication history, blood glucose levels and prepared questionaries. The collected information was assessed for knowledge assessment and practice of insulin storage on self-administration techniques. The descriptive statistics including percentage/proportions, frequencies, mean, median and mode was calculated and represented graphically for the collected data.

Results: A study involving 147 participants revealed that (55.1%) were male and (44.8%) were female. The duration of insulin use varied, with (38.7%) having used it for less than 6 months and (61.2%) for less than a year. Insulin storage practices were inconsistent, with (46%) storing in the fridge door, (46%) inside the fridge, and (16%) at room temperature. Hand hygiene before insulin injection was also a concern, as (54.4%) of participants did not wash their hands before injecting, while (45.5%) washed. In terms of insulin administration, (55.1%) of participants self-administered their injections, while (44.9%) relied on their caregivers.

Conclusion: The study emphasizes the importance of educating diabetic patients on proper insulin storage, handling, and self-administration to improve diabetes management and prevent complications

Keywords: Diabetes mellitus, Insulin injection, self-administration techniques.

ABBREVIATIONS

DM: Diabetes mellitus

BMI: Body Mass Index

IV: Intravenous

IM: Intramuscular

1.INTRODUCTION

Diabetes mellitus (DM) is chronic progressive metabolic disorder characterized by elevated blood glucose level due to abnormal insulin production, insulin action or both.[1] Sufficient knowledge of insulin use can help to prevent complications, adverse patient outcomes, poor adherence to therapy and invariably poor glycaemia control. Increasing self-confidence and pride in their management role is facilitated by self-administration. A higher quality of life and improved diabetes management are linked to proper insulin administration by educating patients[2]

The prevalence of diabetes is increasing rapidly; Diabetes Federation estimates that 463 million people have diabetes globally. By 2030, this figure is predicted to rise to 578 million, and by 2045, predicted to reach 700 million.[3] India facing a significant share of the burden from diabetes from 74.9 million in 2021 to 124.9 million by 2045. Currently, about 101 million people in India, or 11.4% of the population live with diabetes.[4]

The subcutaneous tissue of the upper arm, as well as the anterior and lateral regions of the thigh, buttocks and abdomen, can all receive insulin injections. In order to avoid lipoatrophy or lypohypertrophy, the injection site must rotate. It is advised to rotate within a single area (for example, sequentially rotating injections within the belly) as opposed to moving to a new location for each injection. The US pharmacopeia dispensing information provides the following recommendations for storage of insulin vials; An insulin bottle in use may be kept at room temperature for up to one month. Insulin that has been kept at room temperature longer than one month should be thrown away.[5]

The complications of incorrect self-administration of insulin like improper dose, wrong timings, wrong site selection can result in transient and serious hypoglycaemia and hyperglycaemia, wide glycaemic excursions, and diabetic ketoacidosis.[6]

Proper insulin injection technique is important concept for people with diabetes, though many of them will face a challenge in injecting insulin correctly. Improper injection technique can result in many complications as seen above. To prevent these problems and to achieve the optimal diabetes management it is essential for both patients and health care providers to learn and practice correct injection methods.[7]

This study aims to assess and re-educate patients and care givers on best practices for insulin injection. Key areas include selecting the appropriate needle or syringe, using a lifted skin fold when necessary, rotating injection sites, storing insulin correctly, using needles only once, and adhering to the recommended techniques.[4]

Need for the study:

➢ Diabetes is a growing global health issue, and many patients require insulin therapy to manage their blood glucose levels.

➢ Re-educating patients can help address gaps in their knowledge and improve their skills, thereby enhancing their ability to self-manage diabetes.

➢ This study provide evidence on the current state of patient's knowledge and skills regarding insulin injection.

➢ Research shows that many diabetic patients lack adequate knowledge and skills regarding insulin injection techniques.

➢ Improve glycaemic control and reduce diabetes – related complications.

2.MATERIALS AND METHODS

Study design: A cross-sectional study was carried out in the General Medicine SMCRI, Tumkur District, Karnataka for a period of six months (From 21st of March to 28th of September). After approval has been

obtained from Institutional Ethics Committee of Sree Siddaganga Medical College and Research Institute, this study was conducted (Ref No: SMCRI/ IEC/ 2024-25/ 72).

Sample Size: $n = (Z^2_{(1-\alpha)} \times P(1-P))/d^2$

Where,

n = sample size

$Z1 = Z_{1-\alpha} = 1.97$, associated with 95% CI

d = 7%, absolute precision value

S = 75.4% = 0.754, standard deviation

now, substituting these values in given equation

we get,

$n = ((1.97)^2 \times 0.754(1-0.754)/ (0.07)^2$

$= 146.907$

≈ 147

The sample size is calculated by considering prevalence of patients who had inadequate knowledge score parameter, 75.4% and for margin of error 7% and 95% confidence interval, the minimum number of subjects required for the present study is 147.

Source of Data: Data was collected from patient.

Study criteria: The study was carried out by considering following inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
Patients above 18 years of age	Pregnancy and lactating women.
Patient who are prescribed with insulin.	Any patient who is not willing to give consent form.
	Patients who are admitted in ICU.
	Participants who are not physically and mentally.
	able to respond the interview.

Table 1. Inclusion and exclusion criteria of the study

Sampling Method: Convenient Sampling method.

Materials Used: It involves patient informed consent form, data collection form, participation information sheet, patient case sheet.

Statistical method used: Descriptive Statistical method.

The data was collected, compiled in MS EXCEL worksheet and descriptive statistics like percentage, mean were analysed. Graphical representation such as bar graph, pie charts and tables has been used for visual interpretation of the analysed data

Study Procedure:

This is a cross-sectional study which is conducted over a period of 6 months among the participants above 18 years of age those who are taking a insulin injection for diabetes mellitus and are admitted at Siddaganga hospital. The informed consent forms was obtained from the participants before initiation of the study. Once the consent is obtained, the data was collected using pre-designed data collection form such as demographic details, chief complaints, past history, GRBS value and pre-designed questionnaires. The obtained data are assessed to evaluate the knowledge assessment and practice of insulin storage and self-administration technique among diabetes mellitus patients. Descriptive statistics including, mean, standard deviation, proportions/Percentages, frequencies was calculated and represented graphically for the data which are obtained from the participants.

3.RESULTS

A total of 147 diabetes mellitus subjects were participated in this study with response rate of 100% consisting of 81 (55.10) males and 66 (44.89%) females. Majority of the respondents were found to be at the age category of between 51-60 years which accounts 41(27.89%). The BMI distribution shows that 95 (64.62%) of participants have a normal BMI.

TABLE 2. Demographic data among the studied diabetic patients (n= 147)

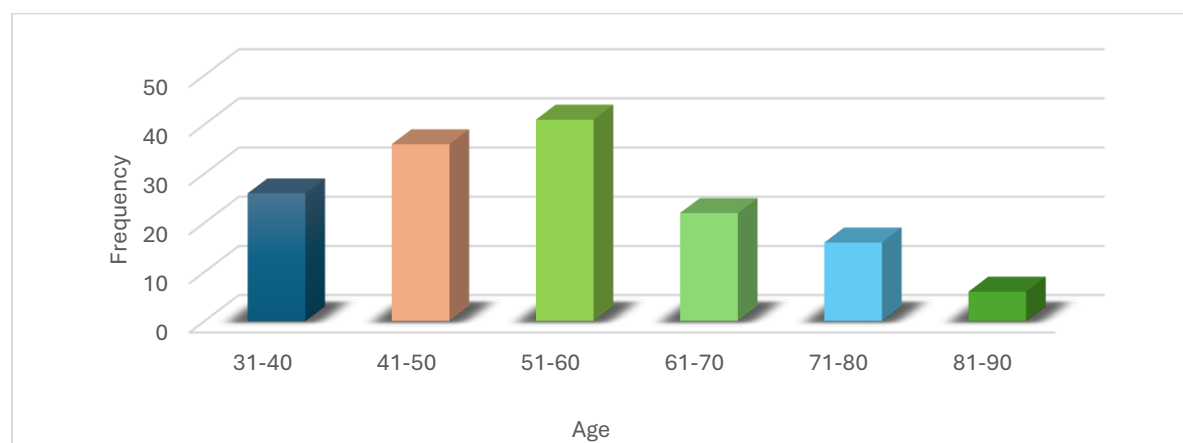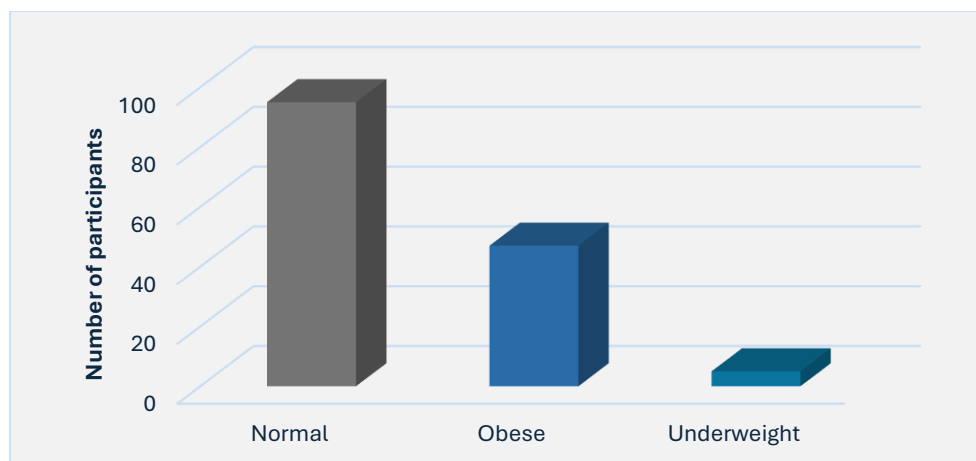| Demographic characters	No. of participants	Percentage (%)
GENDER		
Female	66	44.89
Male	81	55.10
AGE		
31-40	26	17.68
41-50	36	24.48
51-60	41	27.89
61-70	22	14.96
71-80	16	10.88
81-90	6	4.08
Body Mass Index		
Normal	95	64.62
Obese	47	31.97
Underweight	5	3.40

Fig 1. Age distribution

Fig. 2 Body mass index

This study provides information on insulin use among study participants including duration of use, frequency of administration and the individuals responsible for administering insulin, to better understand their experiences and needs in diabetes care. The majority of the diabetic patients in the study use insulin for more than six months 90 (61.22%). The frequency of insulin administration varies, with most patients 68(46.25%) requiring multiple daily injections. More than half of the patients rely on 81 (55.10%) healthcare professionals or caregivers for insulin administration.

Table 3. Insulin use characteristics

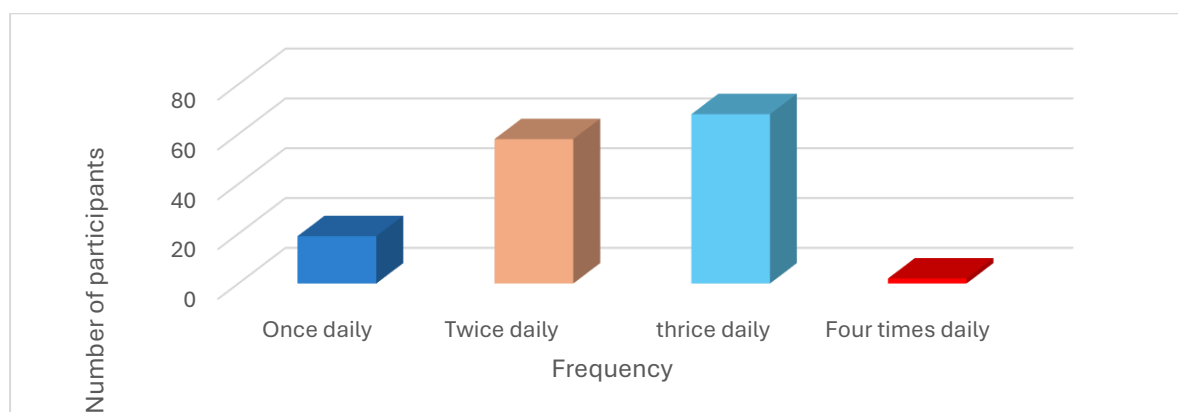| Characteristics	n (%)
Duration of insulin use	
Less than six months	57 (38.77)
More than six months	90 (61.22)
Frequency of insulin administration	
Once daily	19 (12.92)
Twice daily	58 (39.45)
Thrice daily	68 (46.25)
Four times daily	02 (1.36)
Insulin injection administration	
Self-administered	66 (44.89)
Administered by healthcare professional/ caregiver	81 (55.10)

Fig 3 Frequency of insulin administration

The research presents the results of a study assessing knowledge and practice of individuals insulin use practices, such as hand hygiene before injection, injection site, insulin type, recommended dose adherence, complication awareness and self-assessment of injection technique. A significant portion of respondents 80 (54.42%) do not wash their hands before injecting insulin. The most common injection sites are the abdomen 60 (40.81%) calf muscle 40 (27.21%) and buttocks 32 (21.76%). Majority of 108 (73.46%) of respondents check the type of insulin before use and adhere to recommended dose 133 (90.47%). A 62 (42.17%) of respondent's experience complications after using insulin such as pain at the site of injection and hypoglycemia. Most respondents are confident in their injection technique, but a notable percentage are unsure or believe they are not injecting correctly.

Table 4. Knowledge Assessment of Insulin Use

| Knowledge Assessment of Insulin Use		
Question		n (%)
Do you wash your hand before injection?	Yes	67 (45.57)
	No	80 (54.42)
Most common area that you inject?	Abdomen	60 (40.81)
	Calf muscle	40 (27.21)
	Buttocks	32 (21.76)
	Upper arm	15 (10.20)
Do you check the type of insulin that you use?	Yes	108 (73.46)
	No	39 (26.53)
Do you inject the recommended dose?	Yes	133 (90.47)
	No	10 (6.80)
	Sometimes	04 (2.72)
Do you notice any complications after using the insulin?	Yes	62 (42.17)
	No	51 (34.69)
	Sometimes	34 (23.12)
Do you think that you inject insulin correctly?	Yes	88 (59.86)
	No	21 (14.28)
	Not sure	38 (25.85)
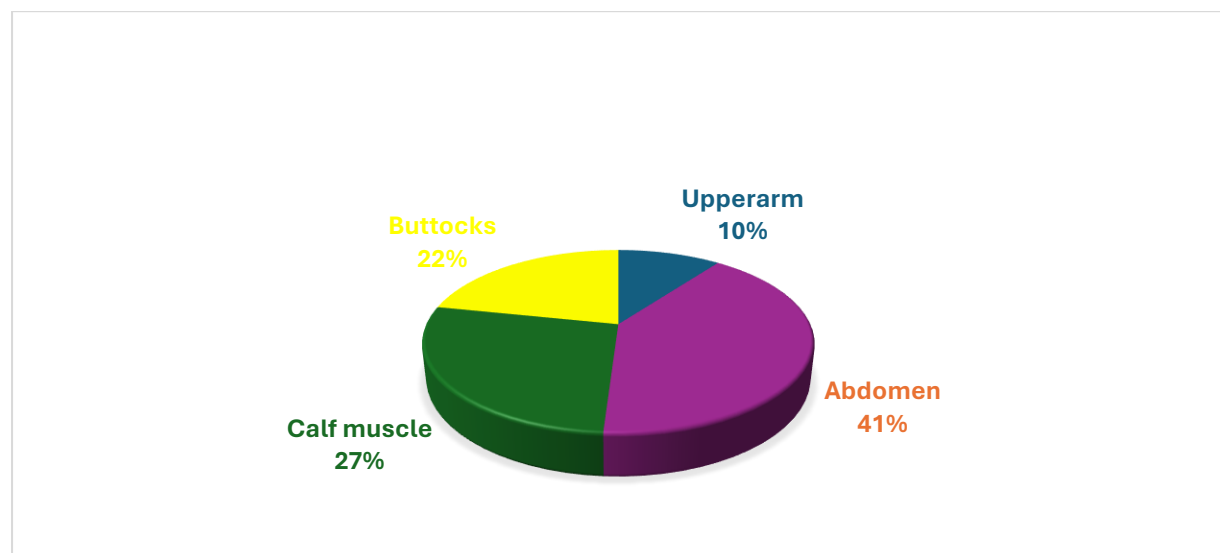
Fig 4. Most common area for injecting insulin

The study presents data on insulin use practices: attitudes and techniques, among participants. The majority of the respondents 124 (84.35%) rotate their injection sites and use water 120 (81.63%) to sterilize the injection site before administration. 61 (41.49%) do not wait for the alcohol to dry before injecting. Most of the respondents use 90º angle 105 (71.42%) and do not leave the needle in their body 100 (68.02%) after injecting. A majority of participants make a skin fold 118 (80.27) when injecting insulin and do not keep the needle 100 (68.02%) in after injecting insulin.

Insulin Use Practices: Attitudes and Techniques		
Question		**n (%)**
Do you change the site of injection every time?	Yes	124 (84.35)
	No	15 (10.20)
	Sometimes	8 (5.44)
What do you use to sterilize the injection site?	Water	120 (81.63)
	Medical swab	27 (18.36)
Do you wait till the site of injection dries from alcohol?	Yes	38 (25.85)
	No	61 (41.49)
	Sometimes	42 (28.57)
What is the angle that you use to inject insulin?	90º	105 (71.42)
	45º	41 (27.89)
	Flat	1 (0.68)
Do you leave the needle in your body after injecting insulin?	Yes	40 (27.21)
	No	100 (68.02)
	I don't know	7 (4.76)
How long do you keep needle?	I don't keep it	100 (68.02)
	5-10 seconds	41 (27.89)
	10-60 seconds	6 (4.08)
Are you making a skin fold?	Yes	118 (80.27)
	No	11 (7.48)
	Sometimes	19 (12.92)

Table 5. Attitudes and Techniques for Insulin Use Practices

The present data on safety and Handling Practices for Insulin Use among study participants. The majority of participants, 68 (46.25%) store their insulin inside the fridge, while 56 (38.09%) store it in the fridge door. Most participants, 90 (61.22%) check the expiry date of their insulin. A significant majority, 127 (86.39%) reuse their needles between one to five times. The majority of participants, 99 (67.34%) dispose their used needle in a bin, a smaller proportion use a special basket for disposal

Safety and Handling Practices for Insulin Use		
Question		**n (%)**
Where do you store insulin?	Inside the fridge	68 (46.25)
	Fridge door	56 (38.09)
	Room temperature	23 (15.64)
Do you check the expiry date?	Yes	90 (61.22)
	No	18 (12.24)
	Sometimes	39 (26.53)
How many times do you reuse the needle?	One to five times	127 (86.39)
	More than five times	20 (13.60)
Where do you throw the needle?	Special basket	22 (14.96)
	Bin	99 (67.34)
	Both	26 (17.68)

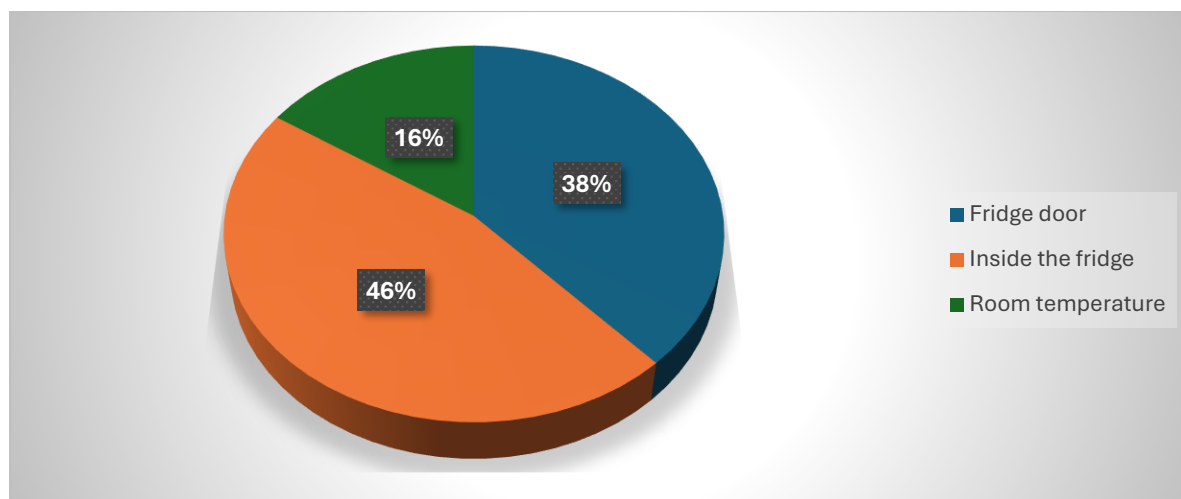Table 6. Safety and Handling Practices for Insulin Use

Fig 5. Storage of Insulin

4.DISCUSSION

Diabetes mellitus (DM) is a long term, progressive metabolic disease marked by high blood sugar levels brought on by aberrant insulin action, production, or both.

According to diabetes federation projections, diabetes prevalence is alarming, with 463million people affected globally and expected to reach 700million by 2045. In India, 101million people (11.4%) currently live with diabetes.

A total of 147 participants in which majority of them are male 88(55.1%) participants compared to female participants 66(44.8%) and most of them are age group between 51-60 years 41(27.89%).

In our study the incidence of male participants (55.1%) and the age group of 51-60 years (27.89%) is high. In contrast to our study Ramkrishna Shabarya A et al., conducted an interventional study in which majority were male (54%) . Ghadeer A Alhazmi et al conducted cross sectional study in which the most prevalence of age group was between 20-60years (69.1%).

In this study most of the participants administering insulin from more than 6 months 90(61.2%) and the administration of insulin frequency is thrice daily 68(46.2%).

In contrast to our study Gerensa H et al., conducted a descriptive cross-sectional study in which the administration of drug is more than 6months is 49(34.7%). Ghadeer A Alhazmi conducted a cross-sectional study in which frequency of administration of insulin exhibited a significant difference in the practice of insulin the patients who administer thrice daily are more prevalence compared to other participants.

In this study the majority of the participants are self-administering 81(55.1%) than given by the care givers 66(44.8%) and the common area of injecting the insulin is abdomen by the participants 60(41.1%)

In our study the incidence of self-administration 81(55.1%) and common area of injecting is abdomen 60(44.1%). In contrast to our study Beshir Bedru Nasir et al., conducted a cross-sectional study the prevalence of self-administration was found to be more 62%. Solomon D et al., conducted descriptive study in which majority of them are injecting the insulin to the abdomen 75(41.7%).

In this study the most of the participants store the insulin in the refrigerator 68(46%) and most of the participants are aware of how much dose need to be drawn for injecting the insulin 133(90%) and majority of the participant's knows the complications caused by insulin like (pain at the injection site and hypoglycaemia) 51(42%).

In our study incidence of insulin storage in refrigerator (46%), recommended dose (90%) and complications (42%) is higher. In contrast to our study Afraha A et al conducted a cross-sectional study in which 37.7% of the participants know the correct way to drawn a recommended dose for injecting the

insulin, majority of the participants stores the insulin in the refrigerator (78.45%) and surprisingly 82.9% of the participants knew the complications of the insulin after administering.

In this study majority of the participants are having a less knowledge and practice of disposal of needles 99(67.3%), washing of hands 80(54.4%), 61(46%) does not allow for drying and 120(81.6%) are using a water for sterilization.

In our study the incidence of knowledge and practice of disposal of needles, cleaning the site before injection and drying the site after sterilization is less. In contrast to our study Patil M et al conducted observational study in which 91% were throwing the needles directly into the garbage and public drainage system. Fego M W et al., conducted a cross-sectional study in which 64% of the participants do not sterilize the injection site and 64% of them inject the insulin before drying. Most of the participants wash their hand before injecting the insulin 80.1%.

CONCLUSION

Self-administration of insulin injection requires diabetic patient to have knowledge and practice according to the study's main outcome. Proper education is a key factor in increasing their knowledge and practice level. Proper insulin injection technique is an important modifiable risk factor for uncontrolled blood glucose level. Improving the use of insulin injection has favorable outcomes in reducing the risk of diabetes mellitus complications. The majority are male participants 81(55.1%) compared to females 66(44.81%) and most of them are age group between 51-60 years 41(27.8%). out of 147 participants most of them are more than 6 months who administer an insulin 90(61.2%).

The majority of participants in our study were given information about self-administrating insulin, but only a few changed their injection site leading to greater chance of lipohypertrophy. Majority of participants kept the insulin inside the fridge 68(46%).

However, it was observed that there was a significant practice gap when it comes to disposing of needles, washing hands and cleaning the injection site before injecting injection. In our study, most of the participants are having less knowledge when comes to washing of hands 80(54.4%), disposal of needles to the bin 99(67.3%) and cleaning the injection site by water 120(81.6%).

6.RECOMMENDATION/ CLARIFICATIONS/ SUGGESTION

A)   Demonstrate proper handling and administration techniques.
B)   Check expiration dates regularly and dispose of expired insulin.
C)   Store insulin in a cool, dry place away from direct sunlight.

7.STRENGTH AND LIMITATIONS

Strength:
➢   Enhances patient safety and treatment effectiveness.
➢   Identifies gaps in patient education.
➢   Supports personalized care.
➢   Prevents health complications and reduces cost.
➢   Guides public health and policy decisions.

Limitations
➢   Self-reporting bias
➢   Limited health literacy.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)
Author(s) hereby declares that NO generative AI technologies such as Large Language Models (ChatGPT, Deep seek, Perplexity) were used during manuscript preparation.

CONSENT AND ETHICAL APPROVAL
The Institutional Ethics Committee (IEC) of Sree Siddaganga Medical College and Research Institute (SMCRI) approved the study protocol and informed consent was obtained from the study participant's.

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COMPETING INTERESTS DISCLAIMER:
Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

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