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Assessment of knowledge, attitude, practice on self-administration of insulin via insulin pen in diabetic patients

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Abstract

Insulin is a vital treatment for individuals with Type 1 diabetes mellitus (T1DM) and uncontrolled Type 2 diabetes mellitus (T2DM). However, the effective use of insulin presents several challenges, which can impact treatment adherence. This was a cross-sectional and educational interventional study involving 312 participants with the primary objective to assess Knowledge, Attitude and Practice regarding self-administration of insulin using insulin pen among diabetic patients attending the outpatient unit of the General Medicine Department. Additionally, to assess medication adherence among diabetic patients and also raising awareness about the benefits of using insulin pen as a delivery method. By facilitating the proper use of insulin pens, we seek to enhance patient adherence to the therapy. Data was collected using a validated sociodemographic data collection form and KAP questionnaire, and the Modified Morisky Medication Adherence Scale-8 (MMAS-8). The collected data was statistical analysed using SPSS software Version 2. The results indicated a significant improvement in KAP compared to pre-interventional assessment with a notable improvement in adherence during the use of insulin pens. These findings highlight a marked enhancement when compared to pre-study data. This study demonstrated that providing comprehensive education to patients can significantly enhance their KAP related to insulin pen use. Improved understanding and skills in using insulin pens are associated with increased medication adherence. Consequently, highlighting the critical role of patient education in improving diabetes management and reducing adverse reactions associated with insulin pen use by healthcare providers can foster better health outcomes and support more effective diabetes care.

Keywords: ADR, QOL, insulin, diabetes mellitus, adherence

Introduction

Diabetes Mellitus (DM) is a metabolic disorder characterized by chronic hyperglycaemia due to insulin production defects, insulin resistance, or both. It disrupts carbohydrate, fat, and protein metabolism. DM is classified into four main types: Type 1 Diabetes Mellitus (T1DM), Type 2 Diabetes Mellitus (T2DM), Gestational Diabetes Mellitus (GDM), and monogenic diabetes linked to specific genetic conditions [1]. T1DM, an autoimmune disorder, results from T-cell-mediated destruction of pancreatic β -cells, leading to insulin deficiency. Idiopathic diabetes (type 1B) involves β -cell dysfunction without autoimmunity, mainly affecting Asian and African-Caribbean populations. T2DM, comprising 90-95% of cases, arises from insulin resistance and β -cell dysfunction, often associated with obesity and lifestyle factors. GDM occurs during pregnancy and usually resolves postpartum but increases the risk of T2DM later in life. Monogenic diabetes, including Maturity-Onset Diabetes of the Young (MODY) and Neonatal Diabetes Mellitus (NDM), stems from single-gene mutations affecting insulin secretion [2, 3]. In India, diabetes prevalence is 9.3%, with 24.5% having impaired fasting glucose (IFG). Among diabetics, only 45.8% were aware, 36.1% received treatment, and 15.7% had it under control, mostly from allopathic practitioners. Older adults and those with high blood pressure or cholesterol showed greater awareness and treatment [4]. A nationwide survey reported 1.3% self-reported type 2 diabetes, higher in men.

In Western Maharashtra, 20-35.7% recognized the importance of check-ups, while 12% without check-ups showed metabolic disorders, stressing improved awareness [5]. Maintaining effective glycemic control is essential for preventing or mitigating the long-term complications of diabetes. For type 1 diabetes, optimal control is typically managed through lifestyle modifications. In contrast, type 2 diabetes management often starts with lifestyle changes, such as dietary adjustments, but may advance to include a combination of oral medications, non-insulin injectables, and/or insulin therapy alongside lifestyle modifications. Given the significant impact of type 2 diabetes, there is a need to understand real-world adherence to and persistence with insulin therapy [6]. Insulin, secreted by pancreatic β cells, lowers blood sugar by promoting glucose uptake, glycogen storage, protein synthesis, and lipogenesis, while balancing glucagon's catabolic effects to regulate energy, weight, and nutrient homeostasis [7]. Insulin preparations vary in onset and duration to meet individual needs. Short-acting insulin, like regular insulin, is injected 30 minutes before meals, while rapid-acting analogs (lispro, aspart, glulisine) act faster, improving post-meal glucose control and reducing hypoglycemia. Inhaled insulin (Afrezza) provides rapid absorption but is unsuitable for respiratory patients. Intermediate-acting NPH insulin offers 2-16 hours of coverage. Long-acting options include glargine (24-hour stable release), detemir (16-24 hours, albumin-bound), and degludec (42+ hours, ultra-long action). Each plays a vital role in diabetes management. The ADA recommends individualized glycemic targets, balancing safety and control ($\text{HbA1c} < 7-8\%$) [6,8].

The American College of Endocrinology (ACE) and American Association of Clinical Endocrinologists (AACE) recommend lifestyle management at all stages of type 2 diabetes, with treatment intensification at higher HbA1c levels. Oral medications are suggested when HbA1c is 6-7%, while insulin therapy is initiated above 8%, starting with basal and adding bolus if needed. However, adherence remains poor, with insulin persistence ranging from 26-52% for basal and 19-42% for bolus insulin. Studies indicate insulin pens improve adherence, reduce healthcare costs, and provide accurate, simplified dosing compared to vials and syringes [6].

The global insulin market is largely dominated by Eli Lilly, Novo Nordisk, and Sanofi, controlling 99% of market value and 96% of market volume. A significant shift toward expensive insulin analogs has replaced cheaper human and animal insulins, driving up costs and affecting affordability for patients and healthcare systems worldwide [9].

Efforts to improve insulin accessibility include initiatives like rBIO, which uses genetically engineered microbes to produce insulin more efficiently and at lower costs. By offering insulin at wholesale prices, rBIO aims to reduce patient expenses and create competitive pressure on major pharmaceutical companies to lower their prices [10].

Several organizations and brands also contribute to improving access. The Access to Medicine Foundation evaluates how companies such as Eli Lilly, Novo Nordisk, and Sanofi address global insulin accessibility. Beyond these major players, other insulin brands include Lantus, Januvia, Wockhardt, Levemir, Humalog, and Novolog [11]. According to the PURE study, insulin availability was 94% in high-income countries, 40% in upper middle-income, 29% in lower middle-income, and only 10% in low-income

countries (excluding India). In India, availability was higher at 76%, yet affordability remains a challenge, with 51% of households unable to afford insulin-part of a global issue where 37% of diabetic households face this barrier [9].

Challenges in insulin administration can cause serious health consequences. Errors in dosing, timing, or product selection may result in hypo- or hyperglycemia, wide glucose fluctuations, and diabetic ketoacidosis (DKA). About 31% of people with diabetes use insulin, with 15.4% relying solely on it and 13.6% combining it with oral agents. Insulin is essential in type 1 and many type 2 cases, yet risks of acute complications remain. Long-term studies show severe hypoglycemia occurs regardless of A1C, while DKA is more common when A1C exceeds 10%, emphasizing the importance of continuous glucose monitoring and timely insulin adjustment [12].

Materials and Methods

Study Site and Setting

The study was conducted in the Outpatient Department of General Medicine, ESIC Medical College, PGIMS, and Model Hospital, Rajajinagar, Bengaluru, India.

Study Design and Duration

This was a cross-sectional, educational interventional study conducted over six months. The protocol was reviewed and approved by the Institutional Ethics Committee (IEC), and written informed consent was obtained from all participants.

Sample Size Estimation

Sample size was determined based on a pilot study carried out in the same setting. At a 95% confidence level and an absolute allowable error of 5%, the required sample size was calculated to be 309. During the study period, data were collected from 312 eligible participants.

Study Population

Inclusion criteria

- Age ≥ 18 years.
- Diagnosed with type 1 or type 2 diabetes mellitus.
- On insulin pen therapy for at least six months.
- Willing to participate and provide informed consent.

Exclusion criteria

- Known psychiatric illness.
- Pregnant or lactating women.
- Newly diagnosed cases of diabetes mellitus.

Data Collection and Study Instruments

Data were obtained through one-to-one interviews using a validated patient profile form to capture sociodemographic and clinical details. Knowledge, attitude, and practice (KAP) regarding diabetes were assessed using a validated KAP questionnaire, while treatment adherence was measured with the Modified Morisky Medication Adherence Scale-8 (MMAS-8). Baseline and post-intervention responses were collected and recorded in Microsoft Excel for analysis.

Study Procedure

Eligible participants were identified during outpatient visits and recruited based on inclusion and exclusion criteria. After obtaining informed consent, demographic and clinical details were recorded, followed by administration of the

KAP and MMAS-8 tools to establish baseline scores. Structured educational interventions on diabetes self-management and insulin pen usage were then delivered. Post-intervention, the same instruments were re-administered to evaluate changes in knowledge, attitude, practice, and adherence.

Statistical Analysis

All analyses were performed using SPSS Statistics. Continuous variables were summarized as mean±standard Deviation (SD) or median (interquartile range, IQR), depending on distribution, while categorical variables were expressed as frequencies and percentages. The Shapiro-Wilk test was used to assess data normality. For inferential statistics, the Wilcoxon signed-rank test compared pre- and post-intervention scores, the Mann-Whitney U test examined differences across independent groups, and Spearman's rank correlation coefficient (ρ) assessed associations between adherence and KAP outcomes. Data were visually represented using bar and pie charts for categorical variables and box plots for continuous distributions. A two-tailed p-value < 0.05 was considered statistically significant.

Results

A total of 312 samples were collected, all meeting the inclusion and exclusion criteria. Among these, the majority of patients were female (N=169) and remaining were male patients (N=143), among injection site-related complications (38.1%, n=118), pain was the most frequently observed (17.6%), followed by swelling (5.4%), allergic reactions (5.1%), and bleeding (4.5%). Less common adverse effects included pigmentation (3.5%), redness (1.3%), and muscle loss (0.3%). These findings underscore the importance of proper injection techniques and vigilant post-administration monitoring to minimize adverse effects. Hypertension was the most common comorbidity, affecting 184 patients, while fewer patients had cancer or cataracts, as shown in Table 1. Also majority of patients (54.8%, N=171) reported using Humalog, while only 0.3% (N=1) used Basa log or Human R insulin among different brands of insulin.

The analysis of medication adherence scores revealed majority of patients had low adherence scores, with 142 patients scoring less than 6, prior to counselling. In contrast, 75 patients had a score of 8 or higher. After counselling, a notable improvement was observed, with 126 patients scoring 8 or higher. Meanwhile, only 87 patients had a score of less than 6 post-counselling, as shown in figure 4.

The study observed only 33.6% patients exhibiting good knowledge (scoring 9-13) before intervention, while there was a significant enhancement in knowledge with 66.2% patients achieving good knowledge (scoring 9-13) post intervention as shown in figure 5. The study showed a significant positive improvement in patients' attitude due to the intervention. Before intervention 76.6% of patients exhibited a favourable attitude, while 84.3% of patients exhibited favourable attitude after the intervention as shown in figure 6.

The study showed 76.9% of participants washed their hands prior to injection, 86.9% mixed the insulin, 62.5% primed the pen, 54.2% made a skin fold, and 66.0% changed the site of injection. However, 57.7% did not clean the site before injection, 51.6% did not keep the needle of inside

after injecting, and 82.1% did not massage the injection site before the intervention.

Table 1: Sociodemographic Data

S. No	Parameters	Number of Patients (n)
1	Age (yrs)	
	Less than 30	9
	30-50	87
	51-70	176
	Greater than 70	38
2	Sex	
	Male	143
	Female	169
3	Diet	
	Vegetarian	49
	Non Vegetarian	263
4	Social Habits	
	Smoking	256
	Alcohol	56

Table 2: Distribution based in problems at injection site

Problem Observed	N	%
Pain at site	55	17.6
Pigmentation	11	3.5
Allergy	16	5.1
Swelling	17	5.4
Muscle loss	1	0.3
Bleeding	14	4.5
Redness	4	1.3
Total	118	100

Table 3: Patient distribution by disease and affected system with case counts

System	Disease	N	N (Total)
CVS	HTN	184	268
	Dyslipidaemia	56	
	Heart problem	27	
	Stroke	1	
Endocrine	Thyroid	25	25
GIT	Liver problem	4	24
	Kidney Problem	16	
	Pancreatitis	2	
	Acute cholelithiasis	1	
	Hernia	1	
Others	TB	3	13
	UTI	1	
	Asthma	3	
	Paralysis	1	
	Juvenile myoclonus epilepsy	1	
	Cancer	3	
	Cataract	1	

Table 4: Distribution based on brands of insulin used

Insulin Type	N	%
Don't Know	18	5.8
Humalog	171	54.8
Novomix	95	30.4
Human R Insulin	1	0.3
Lanctus	4	1.3
Levemir	5	1.6
Treshiba	11	3.5
Wosulin	4	1.3
Mixtard	2	0.6
Basalog	1	0.3
Total	312	100

Table 5: Distribution of patients based on insulin administration

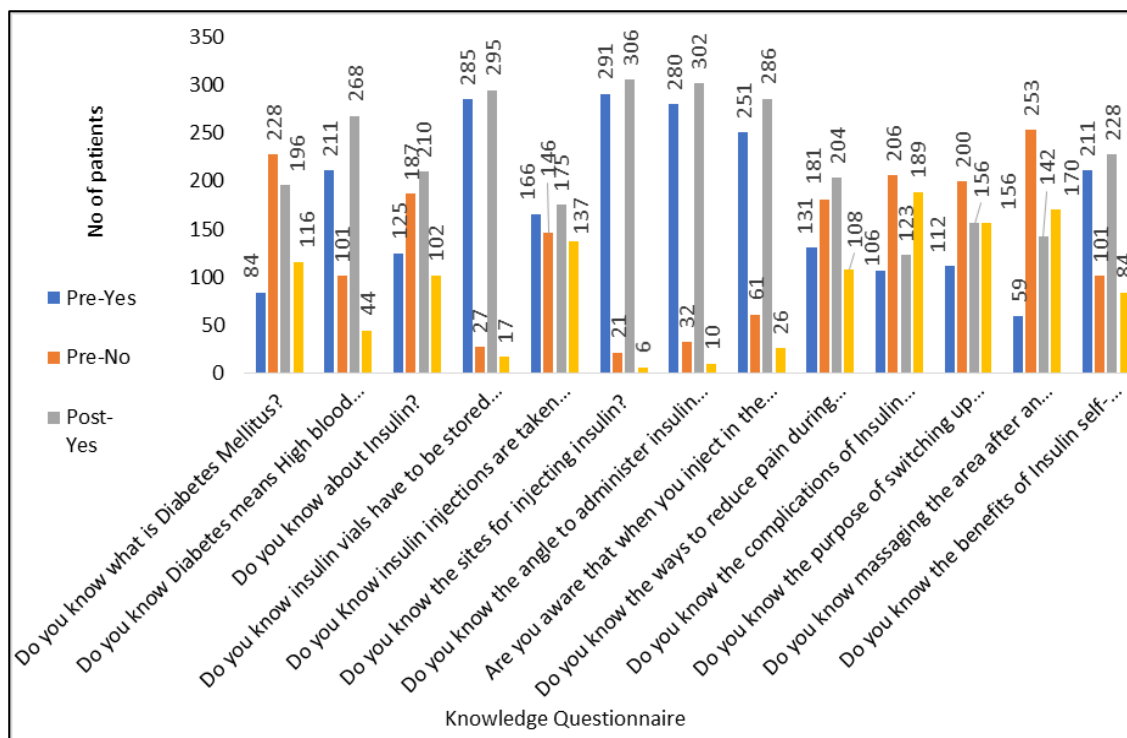
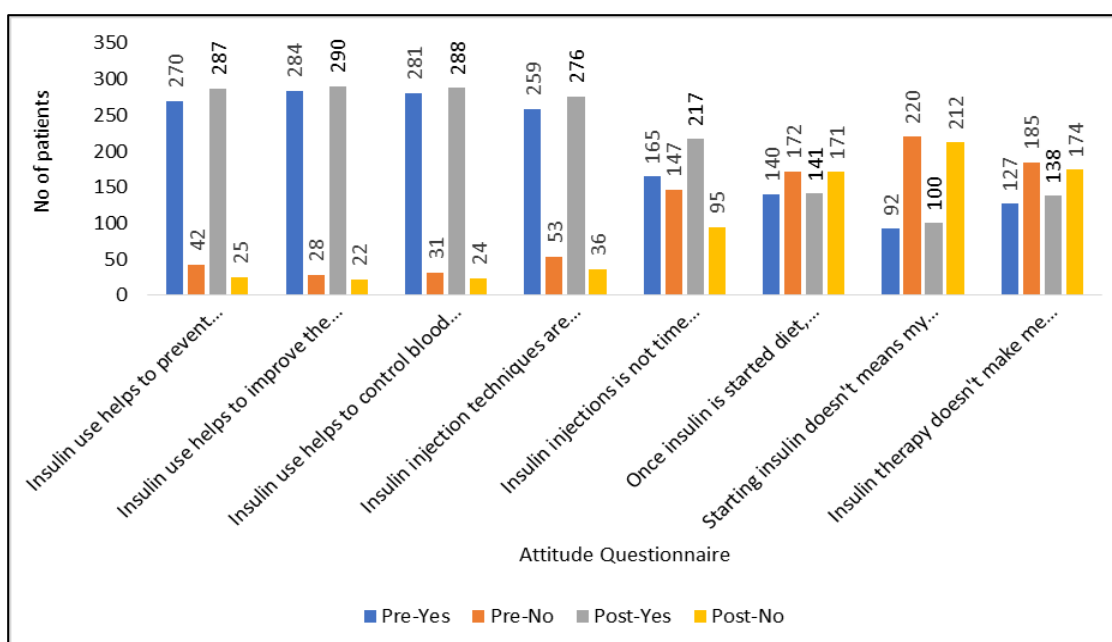
Response	Refrigerator	Mud pot	Bottle	Room Temperature	Total
n (Pre)	285	13	1	13	312
N Post	289	10	3	10	312

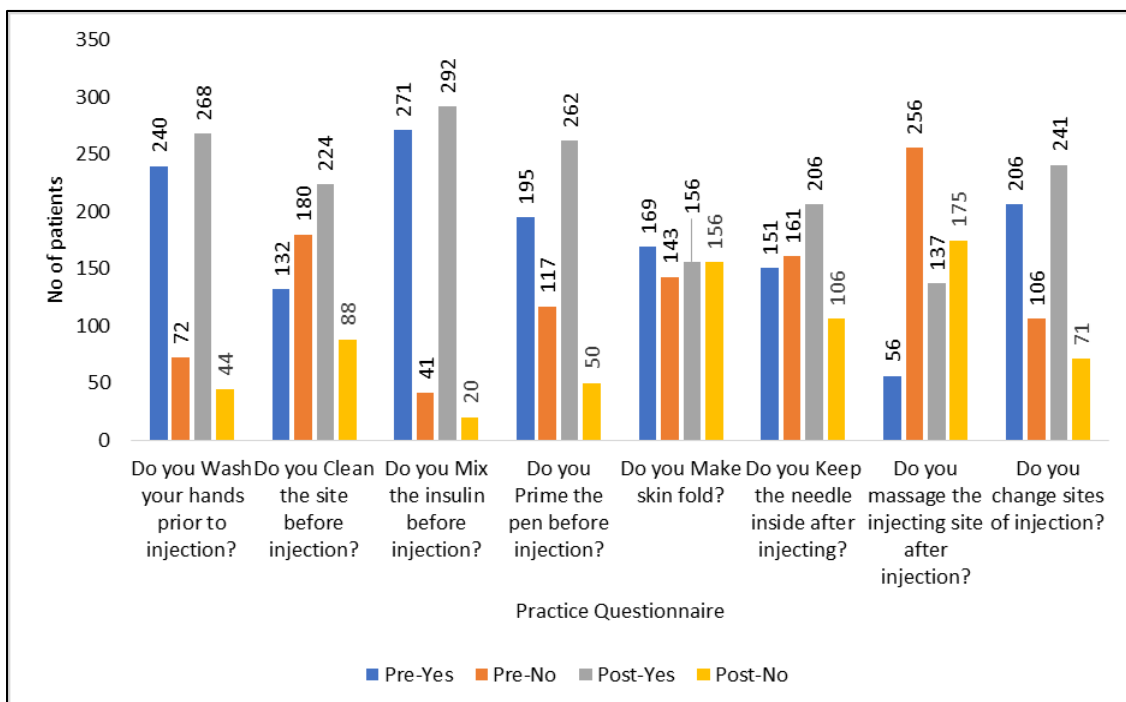
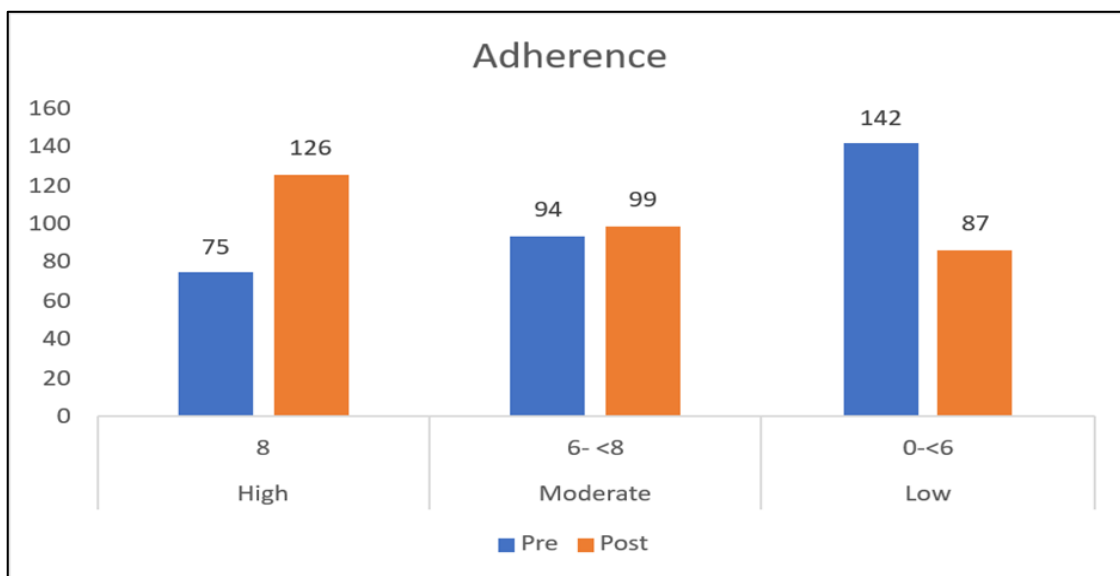
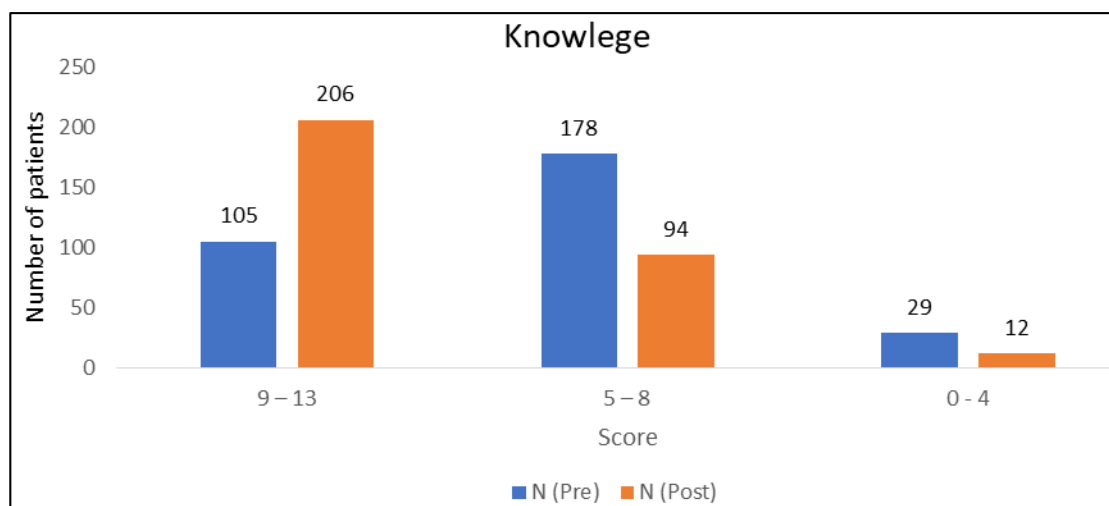
Table 6: Distribution based on the time gap

Response	15-30 min	31-60 min	> 1 hour	Total
N Pre	306	5	1	312
N Post	307	4	1	312

Table 7: Distribution based on materials used

Response	Cotton	Water	Spirit	Doesn't clean	Total
N Pre	46	63	23	180	312
N Post	54	135	34	89	312

**Fig 1:** Knowledge Questionnaire Pre and**Fig 2:** Attitude Questionnaire Pre and Post

**Fig 3:** Practice questionnaire Pre and Post**Fig 4:** Adherence Pre and Post**Fig 5:** Knowledge Pre and Post

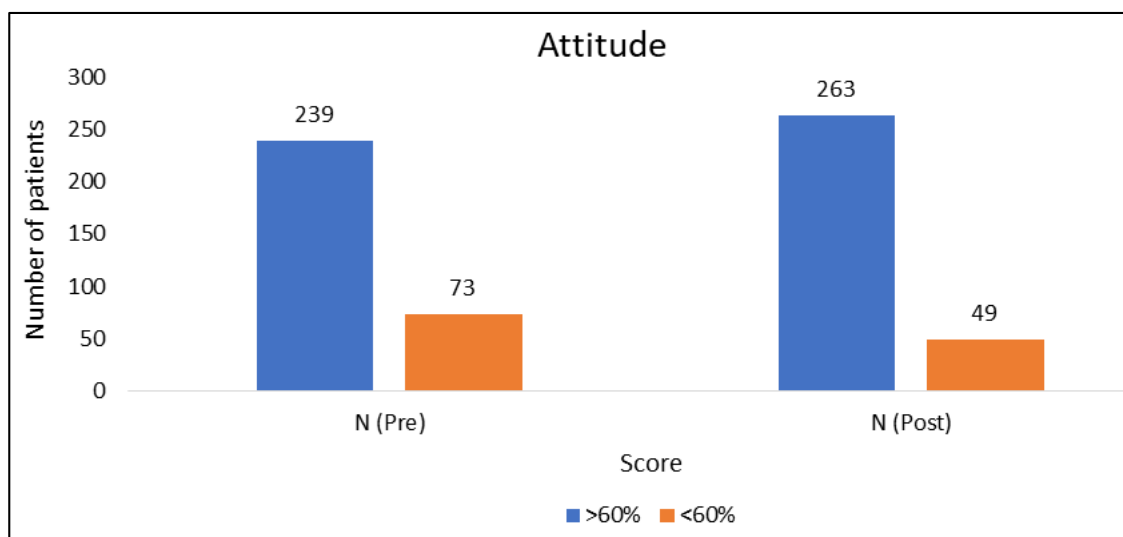


Fig 6: Attitude Pre and Post

Whereas improvements were observed, with 85.9% washing their hands, 71.8% cleaning the site, 93.6% mixing the insulin, 84.0% priming the pen, and 77.2% changing the injection site. While 56.1% still did not massage the injection site, 66.0% kept the needle inside after injection after the intervention as shown in the table 4, 5, 6. The comparison between adherence pre and post score (p less than 0.01), knowledge pre and post scores (p -value less than 0.01), attitude pre and post score (p -value less than 0.01), practice pre and post score (p -value less than 0.01). This suggests that counselling had a significant Impact in the Pre and Post scores in the Diabetic patients using insulin pen. The association between gender and attitude score (pre) (p value=0.001), diet and attitude score (post) (p value=0.001), diet and GRBS score (pre) (p value=0.001). This suggests that there is a significant association between the mentioned factors. Analysis revealed that there is a positive correlation between Knowledge (pre) and attitude (pre) score ($r=0.429$, $P<0.001$), attitude (pre) and practice (pre) score ($r=0.194$, $P<0.001$), practice (post) and attitude (post) score ($r=0.257$, $P<0.001$) and further negative correlation between GRBS (post) and knowledge (post) score ($r=-0.136$, $P=0.016$), GRBS (post) and practice (post) score ($r=-0.163$, $P=0.004$).

Discussion

A cross-sectional observational study was conducted in the Outpatient department of General Medicine ESIC-PGIMSR and Model Hospital, Rajajinagar, a multispecialty tertiary care teaching hospital in Bengaluru. As per the inclusion and exclusion criteria, 312 patients were included in the study.

The patients were assessed for their Knowledge, Attitude, and Practice towards the self-administration of Insulin via insulin pen followed by an evaluation of the quality of life in the patients having Diabetes Mellitus either Type 1 or Type 2.

In this study, the majority of patients (56.4%) were between 51 and 70 years old, with a higher proportion of males (54.1%). Most patients (89.42%) lived in urban areas, and the majority (84.29%) followed a mixed diet. Additionally, 82.05% consumed alcohol, and 12.82% were smokers. Nearly all patients (94.87%) were diagnosed with Type 2 Diabetes Mellitus. Out of 312 patients, 87.18% have lived

with the condition for more than 5 years. Furthermore, 68.91% of the patients had started using an insulin pen rather than an insulin vial and syringe for their treatment.

The study revealed significant improvements in patients' knowledge about insulin administration following an educational intervention. The mean knowledge score increased from 7.42 ± 2.23 pre-intervention to 9.27 ± 3.99 post-intervention, based on 13 knowledge-assessment questions. In the pre-interventional assessment, 57.05% of patients had average knowledge, 33.65% showed good knowledge, and 9.3% had poor knowledge. In the post-interventional study, 66.02% exhibited good knowledge, 30.13% maintained average knowledge, and only 3.85% remained in the poor knowledge category. Initially, patients demonstrated higher awareness regarding insulin storage (91.3%), injection sites (93.2%), and the proper injection angle (89.7%), but lower knowledge on the effects of massage at the injection site (18.9%), insulin therapy complications (33.9%), the importance of rotating injection sites (35.9%), and the meaning of diabetes mellitus (26.9%). Post-intervention, knowledge improved significantly in these areas, with 45.5% understanding the effect of massage, 39.4% recognizing complications of insulin therapy, 50% understanding the need to switch injection sites, and 62.8% grasping the concept of diabetes mellitus. In contrast, another study conducted in Ethiopia at Zewditu Memorial Hospital by Nasir BB *et al.*, found that patients had a mean score of 8.24 ± 3.5 . The majority had good knowledge (53.9%), while 29.8% displayed average knowledge, and 16.3% showed poor knowledge. Notably, patients in the Ethiopian study had higher knowledge regarding insulin injection timing (78.4%) and the injection site (89.4%), but gaps existed in understanding the angle of inclination for insulin administration (43.3%), complications from insulin therapy (49%), pain reduction methods for injection (50.6%), and the effect of massage at the injection site (52.2%). Additionally, 38.0% of patients mistakenly believed that diabetes mellitus solely referred to high blood sugar levels.

The patients' attitude toward insulin therapy was evaluated through eight behaviour-related questions. In the pre-interventional study, 76.6% of patients exhibited a favourable attitude toward insulin therapy, while 23.4% had an unfavourable attitude. In the post-interventional study,

the percentage of patients with a favourable attitude increased to 84.3%, and those with an unfavourable attitude decreased to 15.7%. In the pre-interventional study, 91% of patients believed insulin improves health, 90% thought it better controls blood glucose, 86.5% felt it helps prevent diabetes complications, and 83% found insulin injection techniques easy. However, only 40.7% believed insulin therapy doesn't make patients dependent on physicians, and 70.6% viewed the initiation of insulin as a sign of worsening diabetes. In the post-interventional study, patients' attitudes improved, with 92.9% believing insulin improves health, 92.3% believing it better controls blood glucose, 91.9% recognizing its role in preventing complications, and 88.4% finding injection techniques easy. Additionally, 44.2% no longer felt that insulin therapy makes them dependent on physicians, although 68% still associated insulin initiation with a worsening diabetic condition. In another study, Nasir BB *et al.* assessed patients' attitudes using five behaviour-focused questions, where 62% of patients had a positive attitude, with three-quarters agreeing that insulin self-administration was beneficial. Only 22.4% believed insulin led to other health issues, while 73.5% disagreed that insulin self-administration was burdensome.

The patients' practices related to insulin therapy were assessed through 14 questionnaires. In the pre-interventional study, 98% of patients injected insulin within 15-30 minutes of their meal, irrespective of the insulin type. Most patients (91.3%) stored their insulin in a refrigerator. While 86.8% of patients mixed their insulin before injection, only 8% did so correctly by rolling it between their palms, leading to altered insulin concentration and increased consumption. Additionally, 62.5% of patients followed the crucial step of priming the insulin pen to ensure proper needle function and eliminate air bubbles. In terms of technique, 54.1% of patients folded their skin before injecting, 57.6% skipped cleaning the injection site, 82% did not massage the injection site afterward, 92.6% reused their needles, and 66% rotated the injection site to prevent complications. In the post-interventional study, significant improvements were observed. The proportion of patients injecting insulin within 15-30 minutes increased to 98.4%, and 92.6% continue storing insulin in a refrigerator. The percentage of patients mixing their insulin rose to 93.6%, with 31.4% now properly rolling it between their palms. Pen priming also increased, with 83.9% of patients adopting this practice. While 50% still folded the skin before injection, 28.2% neglected to clean the site, and 56.1% refrained from massaging the injection site afterward. Needle reuse remained high at 86.5%, but site rotation improved, with 77.2% of patients now rotating injection sites to minimize complications. Contrary to our study, the study conducted in Nepal among Diabetic patients in a Tertiary care hospital, Mehta *et al.*, 85% of the patients in this study injected insulin within 15-30 minutes of their meal. Additionally, only 38.3% of patients properly mixed their insulin before injection. In the pre-interventional study, 65% of patients primed their insulin. The majority of patients (88.3%) injected insulin into the abdomen, consistent with other studies reporting the abdomen and thigh as common injection sites. Moreover, 76.7% of patients created a skin fold before injection. An ITQ survey revealed that 39.7% of insulin pen users and 44% of syringe users reused needles an average of 3-5 times. In this study, 90% of patients rotated their injection sites to avoid complications, yet

improper needle reuse remained prevalent, underscoring the need for improved patient education on insulin administration practices.

The QOLID analysis revealed notable improvements from the pre-interventional study to the post-interventional study. Treatment satisfaction rose from 26% pre-study to 27.6% post-study, while satisfaction with exercise increased from 19% to 21.2%. Although general health ratings dropped from 17% to 7.1%, concentration improved from 23% to 33%, and symptoms like excessive thirst and frequent urination decreased from 29% to 20.8% and from 24% to 19.6%, respectively. Financial concerns were low, with the perception of diabetes management being affordable increasing from 84% to 86.5%, and no impact on leisure spending was reported by 90.4% post-study, up from 88% pre-study. Emotional well-being showed improvement, with self-satisfaction rising from 78.2% to 81.4% and satisfaction with personal relationships increasing from 75% to 78.8%. Those never discouraged by health issues improved from 66% to 71.5%. Physical endurance also saw gains, with participants reporting no limitations on vigorous activities rising from 33% to 38.8%, walking for 1-2 hours improving from 32% to 40.1%, and moderate activities increasing from 35% to 42%. Role limitations due to diabetes decreased, with no impact on work efficiency improving from 45% to 58%, and those reporting no social limitations rose from 64% to 76%. Travel restrictions diminished, with 86.5% post-study compared to 79% pre-study, while social activity limitations dropped from 88% to 92%.

The analysis of insulin pen adherence revealed notable improvements in both pre-interventional and post-interventional studies. Pre-intervention, 34.6% of patients reported occasionally forgetting their medication, which dropped to 17.6% post-intervention. Those who missed medication in the past two weeks decreased from 25% to 14.1%. The percentage of patients stopping medication without consulting a doctor fell from 22.7% to 15.1%. Forgetting to carry medication while traveling declined from 40% to 32%, while daily adherence improved from 82% to 90.4%. Patients stopping medication when sugar levels were under control reduced from 32% to 18.9%. Difficulties adhering to anti-diabetic medication decreased from 29.8% to 18.3%, and those never or rarely having difficulty remembering their medication increased from 58.6% to 67.6%. Overall, the intervention significantly enhanced medication adherence among insulin pen users. The study was conducted in a tertiary care teaching hospital, focusing only on the patients visiting out-patient department of general medicine. Insulin therapy remains a cornerstone of diabetes management, essential for achieving optimal glycaemic control and preventing complications. The aim of the study was to assess the knowledge, attitude and practice in patients self-administering insulin via insulin pen. In conclusion, this study has illuminated the critical interplay between knowledge, attitudes, and practices regarding insulin use among individuals with diabetes.

The findings reveal that while awareness of insulin's importance is generally high, misconceptions and gaps in knowledge persist, impacting treatment adherence and self-management. Furthermore, positive attitudes towards insulin are often hindered by societal stigma and fear, which can adversely affect patients' willingness to initiate or maintain insulin therapy. It also demonstrates a notable association between the knowledge, attitudes, and practices (KAP)

surrounding insulin pen usage and the incidence of injection site reactions.

The results of the current study indicate that quality of life of patients with diabetes who are currently on insulin therapy have improved with better practices after the implementation of targeted educational interventions that address these knowledge gaps and reshape attitudes toward insulin. Ultimately, promoting a comprehensive understanding of insulin therapy not only improves adherence but also contributes to better overall health outcomes for individuals living with diabetes. Future research should continue to explore these dynamics, focusing on tailored approaches that consider cultural and individual differences in patient populations.

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Author contributions

Concept-SR, VP; Design YMR-Supervision-VP; Resources-C; Materials-PM; Data Collection and/or Processing-AD, PT, YMR, SR; Analysis and/or Interpretation-AD, PT, YMR, SR, VP, AA; Literature Search-AD, PT, YMR, SR; Writing-AD, PT, YMR, SR; Critical Reviews-VP.

Conflict of interest

The authors declared no conflict of interest in the manuscript.

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