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Evaluating and Improving Insulin Injection Technique An Insight from a Cross-Sectional Survey in a Diabetes Tertiary Centre in Najaf, IRAQ

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Research Article

Keywords: Insulin injection technique, Diabetes mellitus, Glycemic control, Lipohypertrophy, Diabetes education

Posted Date: July 25th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-10362024/v1

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Additional Declarations: The authors declare no competing interests.

Abstract

1.1 Background and Aims:

Correct insulin injection technique is one of the most important elements in managing diabetes in patients using insulin vials and traditional needles. Many patients using these needles are unaware of the correct insulin injection techniques, leading to poor blood glucose control. Over time, this can result in numerous complications. The aim of this study was to assess insulin injection knowledge and practices among insulin-treated patients attending a tertiary diabetes center in Najaf, Iraq, identify common injection technique errors, and evaluate areas requiring targeted educational interventions to improve insulin administration and diabetes care. At the same time structured education about correct injection method were implemented.

1.2 Methods:

A cross-sectional study conducted at the Diabetes and Endocrinology Centre in Najaf, Iraq, from July 2025 to September 2025. The study included 140 insulin-dependent patients with type 1 and type 2 diabetes over 18 years of age who used insulin vials and syringes. Patients' knowledge of insulin injection practice was assessed through structured questionnaires after obtaining verbal consent. Chi-square test used for data analysis and significant results are at p-value < 0.05.

1.3 Conclusion:

Research shows most patients lack knowledge of insulin injection techniques, leading to poor glycemic control and potential complications. Structured, ongoing diabetes education programs are needed.

2. Introduction

2.1 Background / Context:

Insulin is a hormone that helps the body lower blood glucose levels. The endocrine glands of the pancreas secrete it. Along with several other hormones, insulin forms a unit that regulates blood glucose levels in the body (1). When the pancreas is unable to secrete it, as in type 1 diabetes, or when a patient with type 2 diabetes and oral treatments are insufficient or ineffective to lower blood glucose levels, Insulin is given to patients as a lifelong treatment (2), in several ways, including subcutaneous insulin injections, which is the most common method (3). Diabetics are often diagnosed and prescribed insulin injections correctly, but despite this, some patients still suffer from symptoms of hyperglycemia or hypoglycemia, which is also shown by the HbA1C blood glucose test, which will lead to serious complications such as strokes, retinopathy, diabetic foot and even death (4). This brings us to the attention of the factors causing poor glycemic control. It has been found that incorrect practices in using

insulin injections by patients, such as using the same needle more than once, incorrect injection angle, taking the insulin at the wrong time, not rotating the injection site, and other problems.

2.2 Study Aim

To assess the degree of patients' adherence to correct insulin injection techniques and evaluate how these practices influence their glycemic control and overall health outcomes.

1. *2.3 Study Objectives*
2. 1. Evaluate the extent of patients' adherence to the correct injection Techniques.
3. 2. Evaluate the Relative knowledge level assessment of patients using the correct injection Techniques.
4. 3. Identify the most important factors causing injection errors.
5. 4. Proposing possible solutions to increase patient awareness.

2.4 Rationale

It is necessary to master the appropriate injection Techniques to achieve effective control of blood glucose levels, reduce the occurrence of complications, and reduce incorrect injection Techniques.

3. Methods

3.1 Study design and participants:

This is a cross-sectional survey study of patients with type 1 and type 2 diabetes who are insulin-dependent users who visited the Diabetes and Endocrinology Centre in Najaf from July 2025 to September 2025. The number of participants reached (140) [75 (53.57%) were females, and 65 (46.43%) were males]. As for the number of participants according to the type of diabetes, 55 (39.29%) participants were of type 1 and 85 (60.71%) were of type 2. The questionnaire was completed through a face-to-face interview with the participants, and the questionnaire questions were asked with each person's informed consent obtained verbally beforehand. The questionnaire included several questions about demographic data as well as insulin assessment knowledge to evaluate the correct methods for using insulin needles and to know the potential complications of incorrect use of insulin needles and the angle of injection, with the availability of several ways to answer the questions, such as written answers or multiple choices. Some questions were developed based on reliable sources (5), and others were developed in accordance with the patients' habits and community culture.

Tab Table 1. Questionnaire	
Part	Patient Information Questionnaire
Demographic data	Name
	Age
	sex
	Address
	Level of education
	Type of Diabetes Mellitus (DM)
	Duration of DM
	Duration of Insulin Use
Insulin	How do you store insulin?
Assessment Knowledge	Have you ever paid attention to the expiration date?
	If yes, how often?
	Who instructed you on how to inject insulin?
	Who injects your insulin?
	Which sites do you commonly use for injection?
	Do you rotate your injection site?
	If yes, how often?
	What is the usual angle of your injection?
	What type of insulin do you use?
	Did you check your blood glucose level before injecting insulin?
	Do you shake it before use (for NPH/Mixtard)?
	Do you adhere to the prescribed dosage?
	Have you experienced lumps or hard areas at injection sites (lipohypertrophy)?
	If yes, did you inject in the same area?
	Have you experienced bruising?
	Do you reuse insulin needles?
	Do you experience hypoglycemia frequently?
	If yes, how many attacks per week?

Tab Table 1. Questionnaire	
	What was your last HbA1c result?
	What time to take an insulin injection?

The types of insulin available at the centre (NPH, Mixtard, and Regular) were presented according to institutional guidelines. They were either displayed electronically on a tablet or described by their conventional names and colour codes. The angle and anatomical sites of injection, as well as the appearance of lipohypertrophic areas, were also illustrated using the same methods. Finally, each question was reviewed with the patient to ensure standardized understanding, followed by an explanation of the correct insulin injection and storage techniques based on international guidelines (6).

3.2 Measurements

A special score was designed for some questions that could measure the level of knowledge of patients. Different marks were assigned to some questions based on the extent to which the practice impacted the patient's health. 16 of them were related to the patient's health and measured his knowledge. Different weights were assigned to individual items according to the extent to which each practice influenced the patient's health status. Sixteen questions were directly related to clinical outcomes and were used to evaluate patients' knowledge levels.

The total possible score was 28 points, categorised as follows: Poor (0–17), Borderline (18–19), Acceptable (20–22), Good (23–25), and Excellent (26–28).

This scoring approach was adapted, with minor modifications, from a previous study conducted in Baghdad, Iraq, in 2021 (7). In addition, an alternative scoring approach was employed, using HbA1c categories derived from a large population-based cohort study.(8) was employed to classify glycemic control according to HbA1c values: Good control (< 7%), Moderate control [suboptimal] (7%–8%), and Poor control (> 8%).

3.3 Inclusion Criteria

Participants were eligible for inclusion if they met the following criteria:

1. 1. Diagnosed with type 1 or type 2 diabetes mellitus and dependent on insulin therapy.
2. 2. Using insulin vials with syringes for administration.
3. 3. Aged 18 years or older.
4. 4. Receiving insulin therapy for at least three months prior to participation.

3.4 Exclusion Criteria

Participants were excluded if they met any of the following criteria:

1. 1. Dependent on insulin pens rather than vials or syringes.
2. 2. Younger than 18 years of age.
3. 3. Diagnosed with gestational or secondary diabetes.
4. 4. Residing outside Najaf city.
5. 5. Receiving insulin therapy for less than three months.

3.5 Statistical Analysis

Statistical analysis was conducted using Microsoft Excel 2019 under Windows 11. The Chi-square test was applied to evaluate associations between categorical variables, and statistical significance was defined at $p < 0.05$.

The writing process of this manuscript included the application of artificial intelligence for language improvement and data organization, ensuring statistic clarity and technical precision.

Importantly, every part associated by AI-aided was checked manually by authors to guarantee total adherence to rigorous academic standards.

4. Results

The study population comprised 140 participants, with ages spanning from 18 to 76 years (a range of 58 years). Data analysis revealed the mean ages of 47.5 ± 15.8 years and median of 46 years, while the most recurring ages recorded were 50 to 55 years.

Table 2
Demographic and Clinical Characteristics of the Study Participants (n = 140)

Variable		%	Frequency (n.)
Sex	Female	53.57%	75
	Male	46.43%	65
	Total	**100%**	**140**
Age in years	18–29	20.71%	29
	30–39	8.57%	12
	40–49	20%	28
	50–59	25.71%	36
	60–69	18.57%	26
	>=70	6.43%	9
	Total	**100%**	**140**
Type of Diabetes Mellitus (DM)	Type 1	39.29%	55
	Type 2	60.71%	85
	Total	**100%**	**140**
Duration of Diabetes Mellitus (DM) in years	< 5	12.14%	17
	5–10	30%	42
	11–15	22.86%	32
	> 15	35%	49
	Total	**100%**	**140**
Duration of Insulin Use (in years)	< 5	40%	56
	5–10	32.14%	45
	11–15	17.86%	25
	> 15	10%	14
	Total	**100%**	**140**

Table 3
Distribution of Participants According to the Type of Insulin Used

What type of insulin do you use?	%	Frequency (n.)
NPH (cloudy, green) + Regular (Actrapid, yellow) +Mixtard (brown)	0.71%	1
NPH (cloudy, green) + Mixtard (brown)	1.43%	2
NPH (cloudy, green) + Regular (Actrapid, yellow)	33.57%	47
Regular (Actrapid, yellow) + Mixtard (brown)	10.71%	15
Mixtard (brown)	34.29%	48
NPH (cloudy, green)	12.86%	18
Regular (Actrapid, yellow)	5.71%	8
Unknown	0.71%	1
Total	**100%**	**140**

Figure (1): Distribution of Participants According

to Knowledge Assessment Score

Table 4
Distribution of Participants According to Knowledge Assessment Score

Knowledge Assessment Score	Frequency (n.)
Poor	43
Borderline	40
Acceptable	39
Good	16
Excellent	2
Grand Total	**140**

The distribution of knowledge score is presented in Table 4 and Fig. 1. Among the participants 31% had poor knowledge, while 29% were the borderline category another 28% showed acceptable level fewer participants reached higher level, with 11% classified as good and only 1% as excellent. Overall, most participants fill within the lower range of knowledge in fact, 88% were between poor and acceptable level. Only a small group about 12 demonstrate good or excellent understanding **(**Table 4, **Fig. 1)**.

Table 5
Distribution of Performance Levels According to Educational Attainment

Knowledge assessment	Illiterate		Elementary School		Secondary School		University		Total %	Total N.
	%	N.	%	N.	%	N.	%	N.		
Poor	29.17%	7	34.04%	16	32.61%	15	21.74%	5	30.71%	43
Borderline	41.67%	10	23.40%	11	19.57%	9	43.48%	10	28.57%	40
Acceptable	16.67%	4	27.66%	13	32.61%	15	30.43%	7	27.86%	39
Good	8.33%	2	12.77%	6	15.22%	7	4.35%	1	11.43%	16
Excellent	4.17%	1	2.13%	1	0.00%	0	0.00%	0	1.43%	2
Totally	100%	24	100%	46	100%	47	100%	24	100%	140

The distribution of performance level across educational attainment is shown in Table 5 and Fig. 2.

The Chi-square test indicated no significant association between the two variables ($\chi^2 = 11.59$, df = 12, p = 0.479).

Although not statistically significant, participants with higher education levels (Secondary School and University) tended to show better performance outcomes compared to those with lower education levels (Illiterate and Elementary School) **(**Table 5, Fig. 2**).**

Table 6
Distribution of HbA1c Categories Among Participants

HbA1c Categories	%	Frequency (n.)
Good control	10.71%	15
Medium control	22.14%	31
Poor control	41.43%	58
Unknown	25.71%	36
Total	**100%**	**140**

Distribution of HbA1c Categories Among Participants is presented in Table 6 and Fig. 3.

Among the participants, 41.4% had poor glycemic control, 22.1% had medium control, 10.7% achieved good control, and 25.7% were classified as unknown (Those who have old HbA1c tests or who do not remember their last test).

Table 7
Distribution of Participants' Responses to Insulin Injection Practices (Yes/No Questions)

NO/YES Questions	No		Yes	
	Frequency (n.)	%	Frequency (n.)	%
Have You Ever Paid Attention to The Expiration Date?	31	22.14%	109	77.86%
Do You Store Insulin Properly?	1	0.71%	139	99.29%
Do You Rotate Your Injection Site?	42	30%	98	70%
Did You Check Your Blood Glucose Level Before Injecting Insulin?	38	27.14%	102	72.86%
Do You Shake It Before Use (For Nph/Mixtard)?	14	10%	126	90%
Do You Adhere to The Prescribed Dosage?	11	7.86%	129	92.14%
Have You Experienced Lumps or Hard Areas at Injection Sites (Lipohypertrophy)?	56	40%	84	60%
If Yes, Did You Inject in The Same Area?	123	87.86%	17	12.14%
Are You Aware of Lipohypertrophy and How To Avoid It .?	119	85%	21	15%
Have You Experienced Bruising?	62	44.29%	78	55.71%
Do You Reuse Insulin Needles?	33	23.57%	107	76.43%
Do You Experience Hypoglycemia Frequently?	30	21.43%	110	78.57%

Table 8
Distribution of Participants' Responses to Insulin Injection Practices

Questions	Answer	%	Frequency (n.)
What is the usual angle of your injection?	45°	26.43%	37
	90°	58.57%	82
	Wrong angle	15%	21
	Total	**100%**	**140**
Which sites do you commonly Use for injection?	Abdomen	16.43%	23
	Arm	56.43%	79
	Buttocks	0.71%	1
	Thigh	23.57%	33
	Other sites	2.86%	4
	Total	**100%**	**140**
Who instructed you on how to inject insulin?	Doctor	26.43%	37
	Nurse	20.71%	29
	Pharmacist	0.71%	1
	Self-taught	3.57%	5
	Other	48.57%	68
	Total	**100%**	**140**
Who injects your insulin?	My family	17.86%	25
	My self	79.29%	111
	My self & My family	2.86%	4
What is the time of insulin injections	Before meals	75.71%	106
	after meals	15.71%	22
	with meals	0.71%	1
	Before meals & after meals	7.86%	11
	Total	**100%**	**140**
Number of Hypoglycemia attacks per week	None (Null)	21.4%	30
	One	17.1%	24

Questions	Answer	%	Frequency (n.)
	Two	17.9%	25
	Three	9.3%	13
	More than three	15.7%	22
	One per month	18.6%	26
	Total	**100%**	**140**

5. Discussion

5.1 Demographic profile:

The mean age of participants in this study was 47.75 ± 15.8 years. This reflects that insulin injection therapy is most commonly used among middle-aged individuals, with 60.71% of participants having type 2 diabetes and 39.29% having type 1 diabetes. In comparison, studies from Turkey and Iran (9, 10) reported a higher average age of diabetes patients, while a Saudi study (11) reported a lower mean age than present findings; this variation may reflect differences in healthcare access, early diagnosis and diabetes management practices across different healthcare systems.

5.2 Type and duration of diabetes:

In the current study, approximately 60.7% of participants had type 2 diabetes, and 57.9% had been living with the disease for more than 11 years. This aligns with the findings from Jordan (12), where type 2 diabetes was prevalent among insulin users. In contrast, the majority of participants the in Saudi Arabia had type 1 diabetes (11). This difference may be related to genetic and environmental factors, as well as variations in lifestyles.

5.3 Duration and type of insulin use:

Regarding insulin use, the largest proportion of participants (40%) reported using insulin for five years or less (Table 2), similar to a study in Basra, Iraq (13), with the prevalence of human insulin formulations such as Mixtard (34.29%) and NPH + Regular (30.71%). This pattern mirrors a study in Ethiopia (14), suggesting that insulin therapy in Najaf primarily follows traditional regimens due to the limited availability of insulin analogues, cost considerations, and prescribing practices inherent in public health system protocols. This reliance on human insulin also reflects clinical practice in many Middle Eastern healthcare systems, where treatment guidelines prioritise affordability over individualised therapy. However, this long-term use of conventional insulin may increase the likelihood of suboptimal glycemic control if not accompanied by education and regular follow-up.

5.4 Knowledge level:

Knowledge of insulin injection technique was generally low, with 60% of participants demonstrating weak to borderline knowledge (Table 4), similar to findings from a study conducted in Islamabad, Pakistan (15). The study showed that (75.4%) of the participants had inadequate knowledge about insulin injection techniques. This lack of knowledge may be attributed to inadequate patient education, the absence of structured diabetes counselling, and reliance on verbal instructions rather than formal training. In Iraq, patient education is often provided by overburdened doctors or nurses with limited time, rather than certified diabetes educators. Consequently, patients tend to develop misconceptions or rely on their peers for guidance, negatively impacting correct technique and blood glucose levels. In contrast, studies from countries with well-established diabetes education programs, such as Saudi Arabia and Jordan (11, 12), show higher levels of knowledge, highlighting the impact of healthcare infrastructure and enhanced education.

In Table 5, participants with higher educational levels (secondary and university) showed relatively better performance results compared to those with lower educational levels (illiterate and primary school). However, the difference was not statistically significant ($\chi^2 = 11.59$, df = 12, $p = 0.479$), suggesting that educational attainment was not significantly associated with injection performance in this sample.

5.5 HbA1c control:

Regarding the results of this study, 41.43% had poor glycemic control, while only 10.71% had good glycemic control.

It became clear that the majority of patients (48.57%) lacked the ability to control their blood glucose levels despite using insulin. This may be attributed to a lack of awareness, incorrect insulin administration technique, including angle of injection (26.43% used 45° injection angle and other using wrong angle 15%), improper injection sites, not rotating the injection sites (30%), and incorrect timing of insulin doses (15.71%), taking insulin after meals.

In comparison with other studies, the Bangladesh study found HbA1c levels ≥ 7% in 84.17% of patients and < 7% in 5.3% **[16]** which is similar to this research. Similarly, the Jordan study found HbA1c levels > 7% in 83.9% (in type 1 DM) and 85.4% (in type 2 DM), and ≤ 7% in 15.4% (in type 1 DM) and 14.5% (in type 2 DM) (12), which is also similar to this research.

5.6 Injection site rotation:

In this research, the majority of participants rotating the injection site was 70%. This percentage is very close to what was shown in a Jordanian study (12). In comparison with the study in Saudi Arabia (11), the rate was reported to be 87%, which is higher than in the present study. Regarding participants not rotating the injection site, the lowest percentage was 30%. Compared to other studies, such as those in Jordan and Saudi Arabia, they also have a lower percentage, and this is consistent with this research.

5.7 Blood glucose monitoring:

Our findings showed that 72.86% of patients checked their blood glucose levels before injection, while a study in Bangladesh showed that the majority of participants did not undergo blood glucose testing before injections (16).

5.8 Adherence to prescribed dose:

The results of this research show the majority of people 92.14% adhere to the prescribed insulin dosages, while the others 7.86% reported non-adherence.

This high level of adherence may be associated with patient's awareness of their condition and concerns about fluctuations in blood glucose levels. In addition, 21.4% of participants reported not experiencing hypoglycemia, which may have positively influenced their adherence behavior. Furthermore, adherence to doctor's instructions (26.43%) and regular follow-up at diabetes care centers may also contribute to improved compliance with insulin therapy.

5.9 Lipohypertrophy experience and awareness:

Regarding the research findings related to patients who experienced lipohypertrophy while using insulin, the percentage was found to be 60%. This percentage is similar to the 57% found in the Jordanian study. However, it differs from the 38% found in Saudi Arabia (11). This higher percentage in this study may be due to the reuse of insulin needles, which the results showed was 76.43%. Alternatively, it may be due to a lack of awareness about this issue, as 85% of the individuals in this study were unaware of how to avoid lipohypertrophy. This may partly explain the high percentage in the present study. As for those who did not experience lipohypertrophy, their percentage in this study was 40%. This lower percentage can be attributed to changing the injection site, as 70% of the individuals in this study changed their injection site, which reduces the incidence of lipohypertrophy.

5.10 Needle reuse:

The current findings indicate that 76.43% of patients reused needles, and 23.6% did not reuse needles. This does not directly affect insulin injection technique, but there is a risk of infection and poor absorption. Similar to an article in Yazd, Iran, a 71.8% needle reuse rate was shown (17). In comparison, a Saudi study reported that 65% not reuse needles and 35% reuse needles (11).

5.11 Hypoglycemia:

The majority of participants in this study reported episodes of hypoglycemia. Specifically, 78.57% experienced at least one hypoglycemic episode, whereas 21.4% reported no such events. The high frequency of hypoglycemia may be attributed to gaps in self-management practices. For instance, more than a quarter of participants (27.14%) did not routinely check their blood glucose levels before insulin injection, increasing the likelihood of administering an inappropriate dose. In addition, factors affecting insulin absorption appear to play an important role. Lipohypertrophy, which was observed in a considerable proportion of participants, as well as the failure to rotate injection sites, can lead to irregular and unpredictable insulin absorption. Furthermore, needle reuse was highly prevalent (76%) and

is known to negatively affect insulin delivery. Together, these factors may contribute to inconsistent insulin action and help explain the high rate of hypoglycemic episodes observed in this population.

5.12 Injection angle:

The injection site is crucial for insulin users and plays a significant role in absorption. An incorrect angle may contribute to lipohypertrophy (LHT) and hypoglycemia. In this research, 58.57% of people used a 90-degree injection angle, 26.43% used a 45-degree angle, and the smallest percentage (15%) used other injection angles. The predominance of the 90-degree injection angle may reflect a tendency toward ease of use and its prevalence in our society. This does not mean that the 45-degree angle is incorrect; it is preferred in specific cases, such as for thin individuals and children. The angle is also determined by the length of the needle used by the patient.

5.13 Injection site preference:

Insulin absorption is affected by location, depth, volume, and skin temperature. The fastest absorption site is the abdomen, followed by the arms, with the least absorption occurring in the thighs and buttocks. In this study, 56.4% of patients injected insulin into the arms, 23.6% into the thighs, 16.6% into the abdomen, and 0.7% into the buttocks. In contrast to the Jordanian study, where the abdomen was the most common injection site (12). The Saudi study showed similar results, with the arms and thighs being the most common injection sites (11).

5.14 Source of instruction:

The source of instruction plays an important role in ensuring proper insulin administration and adherence to treatment.

In this study, the largest proportion of participants 48.57% reported receiving instructions from non-professional sources, such as other patients or the Internet. This may reflect the lack of structured diabetes education programs, leading patients to rely on the experiences of relatives or peers. Educational level may also influence the ability to seek and understand reliable medical information. In contrast, only 3.57% of participants learned independently while 26.43% reported receiving instructions from doctors. Compared to other studies, a study in Bangladesh found that 63.40% of patients received instruction from doctors (16). Conversely, a study in Basra reported pharmacists as the primary source of instruction (71.4%) (13), while a Saudi Arabia study showed that the majority of patients received instructions from diabetes educators (30.5%) (11). These two studies showed results contrary to this research.

5.15 Timing of insulin injection:

Insulin has a clear effect over time, especially rapid-acting, short-acting, and mixed insulins. Injecting insulin too early (before a meal) may lead to a drop in blood glucose, while injecting it too late (after a meal) may lead to a rise in blood glucose. Therefore, it is preferable to take insulin a few minutes before meals, according to the specific timing for each type of insulin. The current finding revealed that we

found that 75.7% of people take insulin before meals, the same article in Saudi Arabia has a high percentage before meals (11).

6. Limitation

The study was limited by collecting samples from only one center and by a moderate sample size. Which may affect the generalizability of the findings. Moreover, socioeconomic status of the patients was not addressed. Time constraints related to the research submission deadline also limited the study.

7. Conclusions

This research revealed that the majority of patients have a poor to borderline level of knowledge regarding insulin injection techniques, indicating a clear lack of awareness. Most patients demonstrated poor to borderline knowledge of insulin injection techniques. These findings suggest deficiencies in structured health education rather than patient-related non-adherence. This may compromise insulin efficacy. Improper injection techniques, including inadequate site rotation, incorrect injection angle, and suboptimal dose timing, were associated with elevated HbA1c and poor glycemic control. Lipohypertrophy and hypoglycemic episodes were associated with incorrect practices and repeated needle use, which may contribute to variability in insulin absorption related complications. Patient's reliance on non-medical sources Indicates the need for structured and ongoing diabetes education programs supervised by healthcare professionals.

Declarations

The study was reviewed and approved by Najaf Health Directorate/ Training and Human Development Center , Najaf, Iraq, under approval/reference number [4281], dated [1 Feb 2026]. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Informed consent was obtained from all participants before participation in the study.

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Figures

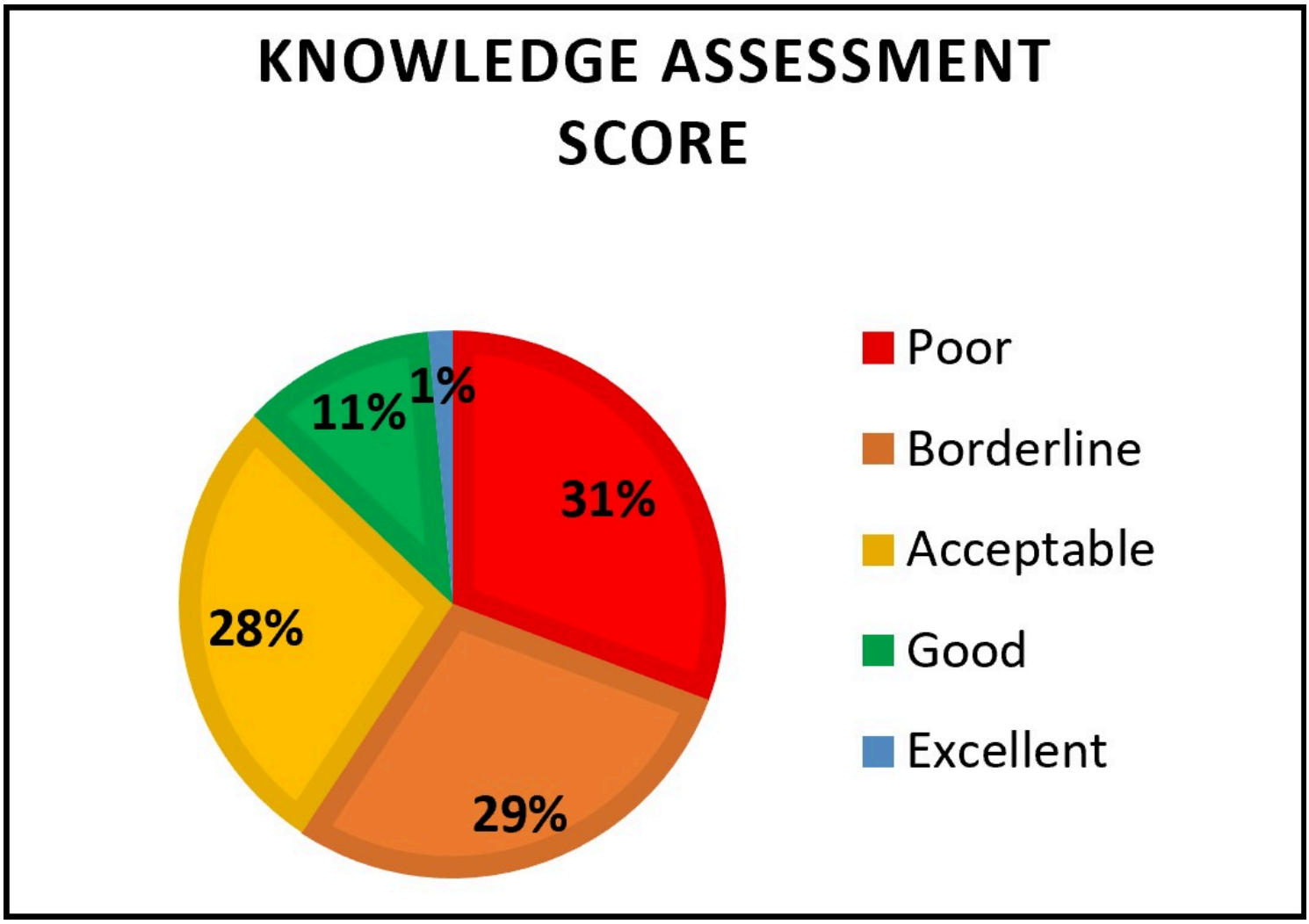


Figure 1

Distribution of Participants According to Knowledge Assessment Score

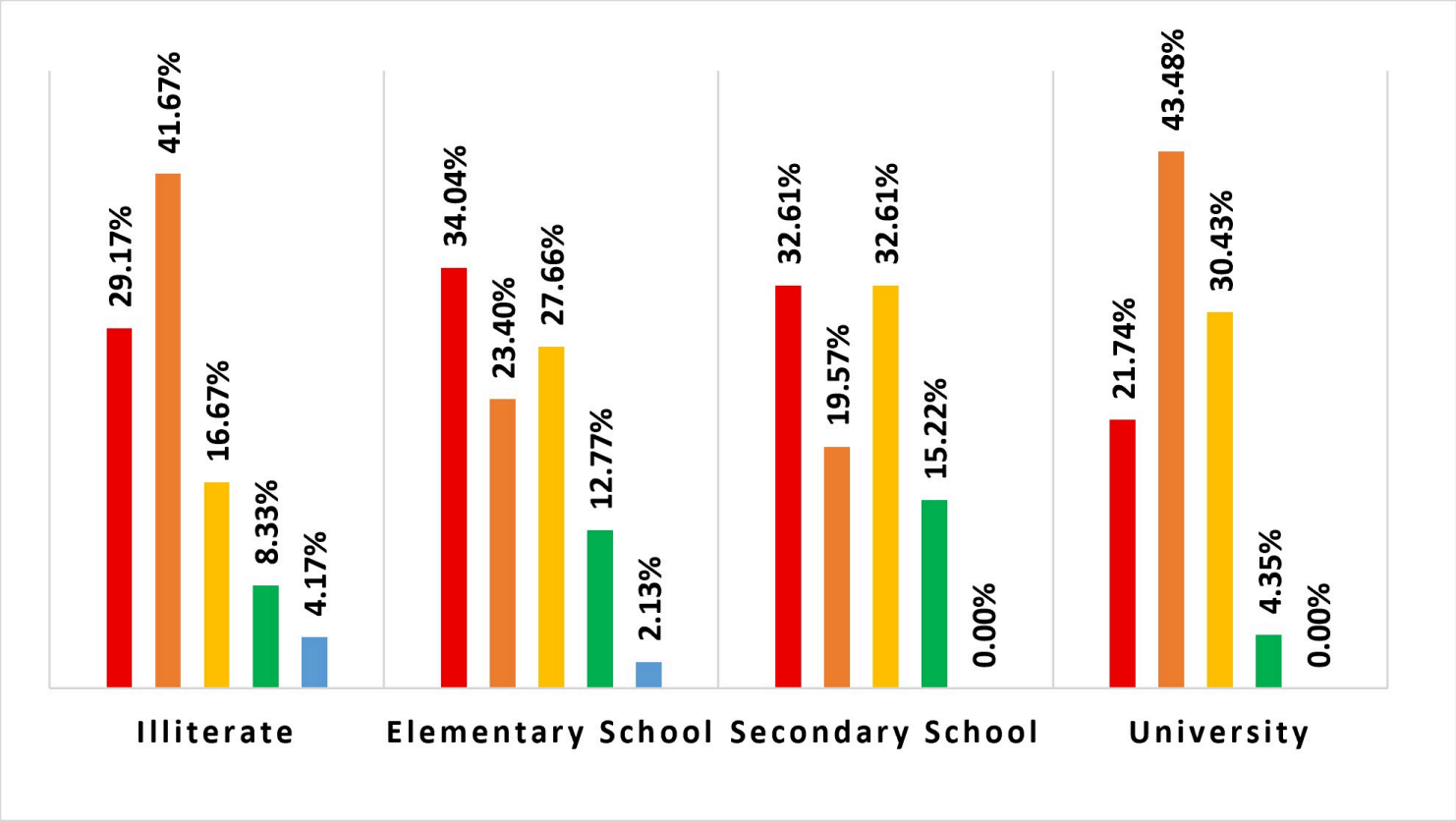


Figure 2

Percentage Distribution of Performance Levels by Educational Attainment

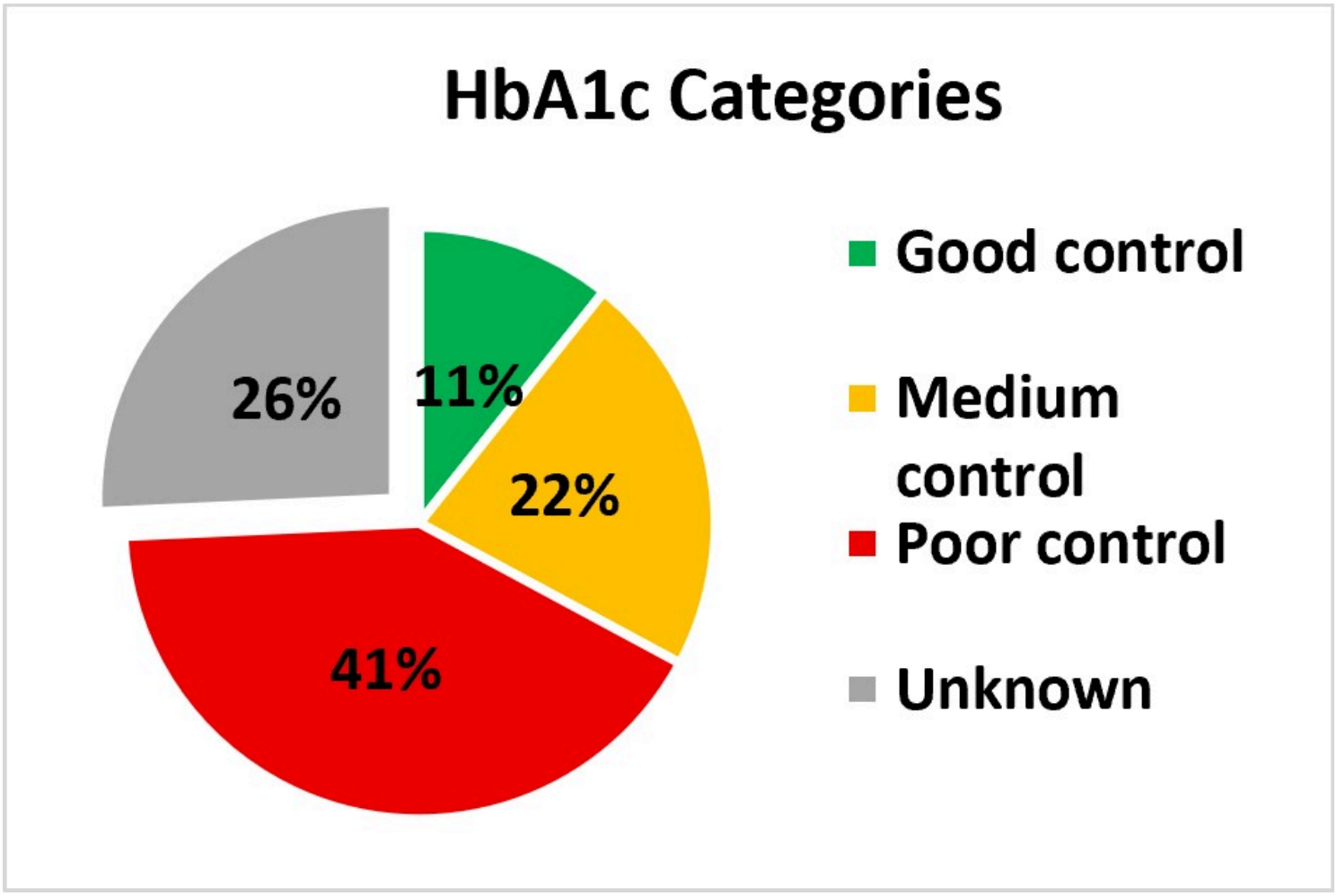


Figure 3

Distribution of HbA1c Categories Among Participants