Knowledge, attitude and practice towards insulin self-administration and associated factors among diabetic patients at Zewditu Memorial Hospital, Ethiopia

Beshir Bedru Nasir1*, Miftah Shafi Buseir2, Oumer Sada Muhammed1

1 Department of Pharmacology and Clinical Pharmacy, School of Pharmacy, College of Health Sciences, Addis Ababa University, Addis Ababa, Ethiopia, 2 Department of Pharmacy, College of Health Sciences, Mizan-Tepi University, Tepi, Ethiopia

*beshir.bedru@aau.edu.et

Abstract

Background

Diabetes mellitus is a common health problem worldwide. Proper insulin administration plays an important role in long term optimal blood sugar control. Adequate knowledge and attitude about insulin self-administration could also improve the management of diabetes and eventually improve the quality of life. This study aimed to assess knowledge, attitude and practice towards insulin self-administration and associated factors among diabetic patients at Zewditu Memorial Hospital (ZMH), Ethiopia.

Methods

An institution-based cross-sectional study was conducted among 245 diabetic patients who were selected by systematic random sampling during follow-up at ZMH. The data was collected using an interviewer-administered structured questionnaire and analyzed by SPSS v.20. Binary logistic regression was used to identify associated factors of patients’ knowledge and P < 0.05 was used to declare the association.

Results

Among 245 patients enrolled, 53.9% were male with a mean age of 53.26 ±13.43 years and more than 84% of the patients can read and write. The overall patients’ knowledge was 63.4%. Better knowledge was observed concerning timing (78.4%) and site of insulin injection (89.4%), while knowledge on the angle of inclination during insulin administration (43.3%) and complications of insulin therapy (49%) were low. Patients who were male gender, never married, government or NGO employees, urban residents, who completed elementary and higher education had a higher knowledge than their comparators. The majority (62%) of the study patients had a favorable attitude on insulin self-administration. Although the majority 177(72.2%) of the study patients have administered insulin themselves, only 120(49.0%) of the patients injected insulin appropriately at 45°. Frequent repetition of the
injection site was practiced among 176 (71.8%) patients and 139 (56.7%) injected insulin before or immediately after food intake.

**Conclusion**

Patients’ knowledge and attitude seem suboptimal and malpractice of insulin self-administration was reported. Therefore, the gaps should be addressed through patient education and demonstration of insulin injection during each hospital visit.

**Introduction**

Diabetes mellitus (DM) is a metabolic disorder characterized by chronic hyperglycemia with impaired carbohydrate, fat and protein metabolism and resulted from either inadequate insulin secretion, resistance to the action of insulin or both [1,2].

According to the International Diabetes Federation’s report 382 million had diabetes in the year 2013 and it is estimated to reach 592 million in the year 2035. Similarly, there were more than 1.8 million diabetes patients in Ethiopia with a national prevalence of 4.36% among the adult population [3]. DM is considered the leading cause of death in most developing nations [4,5]. This might be attributed to poorly controlled hyperglycemia which is associated with several life-threatening complications such as renal failure and cardiovascular diseases [6]. Optimal glycemic control is mandatory to reduce morbidity and mortality of DM through the prevention and/or delay of complications [7]. Optimum glycemic control can be only achieved when the patients are adherent to self-management behaviors such as healthy diet, physical activity, monitoring of blood glucose, taking medications appropriately, ability to resolve diabetes problems, and healthy coping [7–11].

Insulin therapy is an essential component of medications used in DM treatment and the cornerstone of treatment in type 1 and type 2 diabetes. Despite this, at least one-third of patients fail to take their insulin as prescribed and 20% of adults deliberately miss their doses [12]. Insulin therapy presents many challenges due to complexities associated with its intricate use. Sufficient knowledge of its use can help to prevent complications, adverse patient outcomes, poor adherence to therapy and invariably poor glycemic control [13]. However, the knowledge and practice scores of patients with diabetes mellitus were not satisfactory [14]. Educating patients on self-administration of insulin helps to build self-confidence and pride of contribution in their management [15]. Moreover, an appropriate injection technique is important for proper delivery to subcutaneous tissues and to prevent intramuscular injuries and lipohypertrophy [16]. The American Diabetic Association formulated a set of guidelines for insulin storage, mixing of insulin, proper use of insulin syringe and other considerations [17]. However, patients especially in developing countries may not follow the guideline due to low socioeconomic problems.

Although insulin is recognized as the ideal treatment for DM lack of knowledge and coordination among the physicians and patients regarding appropriate insulin use is reported [18,19]. In addition to this, several studies showed that insulin injection practices were not up to the desired standard [20–22]. There is limited study in Ethiopia which focused on the knowledge, attitude and practice of insulin administration among patients with DM [23,24]. The existed studies were not in Addis Ababa the capital city of Ethiopia, which includes only type 1 diabetic patients and is limited to a specific population. Therefore, this study aimed to
assess knowledge, attitude and practice of diabetic patients regarding insulin self-administration at Zewditu Memorial Hospital (ZMH) Addis Ababa, Ethiopia.

**Methods**

**Study setting**
The study was conducted at ZMH which is one of the state-owned public hospitals in the capital city of Ethiopia. The hospital provides comprehensive medical services with more than 400 medical staffs.

**Study design**
Institution-based cross-sectional study was carried out by using interviewer-administered questionnaires to assess knowledge, attitude and practice of insulin self-administration among patients with DM. The study was conducted from February 25 to April 20, 2018.

**Study variables**
Socio-demographic factors (age, sex, marital and educational status, religion, place of residence, ethnic group and occupation) and duration of DM diagnosis were the independent variables. Patients’ knowledge of insulin self-administration was the dependent variable. Besides, patients’ attitude and practice towards insulin self-administration were assessed.

**Study population and sampling procedures**
The source populations were all patients with type 1 or type 2 DM, who had a follow-up at ZMH. Patients who were 18 years and above, currently taking insulin therapy and willing to participate in the study were included. Patients with a mental disorder, unable to hear and/or speak, and very sick were excluded from the study. A total of 245 patients were included in the study and systematic random sampling was employed to select the study participants.

**Data collection process**
The data was collected using an interviewer-administered structured questionnaire. The data was collected by three pharmacists under the supervision of a senior clinical pharmacist. One day of training was given to the data collectors regarding the objectives of the study and how to interview the study participants. The questionnaire was developed based on previous studies [23–25] with minor modifications. The questionnaire has four parts (socio-demographic, knowledge, attitude and practice with 9, 13, 5 and 6 structured questions respectively). The knowledge part was Yes or No questions that assess the general information on diabetes mellitus and insulin self-administration.

It was first developed in English and then translated into Amharic then translated back into English by a different person to check its consistency. The questionnaire was pretested on 5% of the sample size before the actual study and appropriate correction was taken accordingly.

**Data processing and analysis**
The collected data were coded, entered and analyzed by using Statistical Package for Social Sciences (SPSS) version 20 software. Descriptive statistics such as frequency distribution and percentages were performed to summarize the result. Multivariable binary logistic regression analysis was used to assess the association of the independent variables with patients’
knowledge about insulin self-administration after univariable analysis \( (p<0.2) \) to control confounders and \( p \)-value < 0.05 was considered as statistically significant.

**Ethical considerations**

The study was approved by the Institutional Review Board of School of Pharmacy, College of Health Sciences, Addis Ababa University and written informed consent was obtained from the study participants.

**Operational definitions**

- **Good knowledge.** A patient who answered 9–13(\( \geq 69.2\% \)) correct responses from the 13 questions used to assess patients’ knowledge.
- **Average knowledge.** A patient who answered 5–8 (38.5% - 61.5%) correct responses.
- **Poor knowledge.** A patient who answered 0–4 (\( \leq 30.8\% \)) correct responses.
- **Favorable attitude.** A patient who answered 3 (60%) positive responses from the 5 questions used to assess patients’ attitude.
- **Practice.** Was assessed by using six questions that explore participants’ experience with insulin utilization.

**Results**

**Socio-demographic data**

Among 245 patients enrolled, 132(53.9%) were male. The mean age of the patients was 53.26 ±13.43 years and majority 128(52.2%) of the patients were married. More than105 (83.7%) of the participants can at least read and write and 53(21.6%) attended higher education. The majority 219(89.4%) of the patients were urban residents and about half were married and live with diabetes mellitus for 6–10 years (Table 1).

**Knowledge towards self-administration of insulin and management of diabetes mellitus**

The mean score of patients’ knowledge was 8.24±3.5 out of 13 questions used to measure their knowledge which results (63.4%). The majority 132(53.9%) of the patients had good knowledge, while 73(29.8%) and 40(16.3%) had average and poor knowledge respectively. Better knowledge was obtained regarding the timing of insulin injection (78.4%) and site of injection (89.4%). However, patients had relatively lower knowledge concerning the angle of inclination during insulin administration (43.3%), complications of insulin therapy (49%), ways to reduce pain during insulin injection (50.6%) and the impact of massage at site injection (52.2%). Moreover, 93(38.0%) patients wrongly answered that diabetes mellitus means high blood sugar (Table 2).

**Factors associated with knowledge of the patients**

For the purpose of data analysis, the three categories of knowledge were dichotomized and thereby good knowledge is taken as adequate, while average and poor knowledge as inadequate knowledge. In the multivariable logistic regression sex, marital status, occupation, area of residence and educational status were associated with patients’ knowledge. Patients who were male gender (AOR = 1.52, 95% CI (1.12–3.39)), never married (AOR = 3.21, 95% CI (1.72–9.69)), government employee (AOR = 2.87, 95% CI (1.08–6.31)), NGO employee (AOR = 2.55, 95% CI (1.67–8.42)) and urban residence (AOR = 2.25, 95% CI (1.18–9.51)) elementary
education (AOR = 3.25, 95% CI (1.68–12.71)) and higher education AOR = 4.35, 95% CI (1.41–10.22)) had a higher knowledge than their comparators (Table 3).

### Attitude of the study patients towards insulin self-administration

Patients’ attitude towards insulin therapy was assessed by using 5 questions that study their behaviors. The majority (62%) of the study patients had a favorable attitude. Three-fourth of the patients agreed that insulin self-administration was beneficial and only 55(22.4) of them believed that insulin causes other health problems. Moreover, the majority 180(73.5) of the patients disagreed that insulin self-administration is tiresome (Table 4).
Table 2. Knowledge patients regarding diabetes mellitus and insulin therapy in Zewditu Memorial Hospital, 2018.

| Knowledge Assessment Variables | Yes N (%) | No N (%) |
|-------------------------------|-----------|----------|
| Know about diabetes mellitus  | 190(77.6) | 55(22.4) |
| Diabetes mellitus means high blood sugar | 152(62.0) | 93(38.0) |
| Know about insulin            | 177(72.2) | 68(27.8) |
| Insulin vial is stored in the refrigerator or cold place | 174(71.0) | 71(29.0) |
| Insulin injection is taken soon after or just before taking food | 192(78.4) | 53(21.6) |
| The sites for insulin injection are abdomen, thigh, glutei and deltoid | 219(89.4) | 26(10.6) |
| The angle to administer insulin is 45° | 106(43.3) | 139(56.7) |
| The distance to rotate on the same site is one thumb | 150(61.2) | 95(38.8) |
| Ways to reduce pain during insulin injection are inters the skin, do not manipulate the needle once inserted, avoiding reusing of the same site | 124(50.6) | 121(49.4) |
| The complications of insulin therapy are low blood sugar, insulin resistance and wasting of subcutaneous tissue | 120(49.0) | 125(51.0) |
| The use of rotation of the injection site is to reduce pain, prevent wasting of subcutaneous tissues | 155(63.3) | 90(36.7) |
| Massage after injection is used to enhances the rapid absorption of insulin | 128(52.2) | 117(47.8) |
| The benefit of insulin self-administration are, time saving, inexpensive and easy to take on self while traveling | 189(77.1) | 56(22.9) |

Table 3. Factors associated with knowledge of diabetic patients at Zewditu Memorial Hospital, 2018.

| Variables          | Category | Knowledge Inadequate N(%) | Knowledge Adequate N(%) | AOR          | P-value |
|--------------------|----------|---------------------------|-------------------------|--------------|---------|
| Sex                | Male     | 52 (38.6)                 | 81 (61.4)               | 1.52(1.12–3.39) | 0.047*  |
|                    | Female   | 62 (54.8)                 | 51 (45.2)               | 1.00         |         |
| Marital Status     | Never married | 7 (21.2)                | 26 (78.8)               | 3.21(1.72–9.69) | 0.011*  |
|                    | Married   | 60 (46.9)                 | 68 (53.1)               | 1.13(0.59–2.56) | 0.261   |
|                    | Widowed   | 25 (61.0)                 | 16 (39.0)               | 0.64(0.21–0.87) | 0.048*  |
|                    | Divorced  | 21 (48.9)                 | 22 (51.1)               | 1.00         |         |
| Occupation         | House wife | 42 (53.1)                | 37 (46.9)               | 1.00         |         |
|                    | Farmer    | 11 (73.3)                 | 4 (26.7)                | 0.45(0.25–0.89) | 0.040*  |
|                    | Government employ | 14 (26.9)              | 38 (73.1)               | 2.87(1.08–6.31) | 0.042*  |
|                    | NGO employ | 10 (25.7)                | 29 (74.3)               | 2.55(1.67–8.42) | 0.038*  |
|                    | Private business | 36 (60.0)              | 24 (40.0)               | 0.95(0.28–2.20) | 0.792   |
| Residence          | Rural     | 17 (65.4)                 | 9 (34.6)                | 1.00         |         |
|                    | Urban     | 96 (43.9)                 | 123 (56.1)              | 2.25(1.18–9.51) | 0.021*  |
| Education Status   | No formal education | 26 (65.0)               | 14 (35.0)               | 1.00         |         |
|                    | Can read and write | 25 (54.3)               | 21 (45.7)               | 1.51(0.81–5.39) | 0.188   |
|                    | Primary level | 8 (32.0)                 | 17 (68.0)               | 3.25(1.68–12.71) | 0.029*  |
|                    | Secondary level | 39 (48.1)              | 42 (51.9)               | 1.70(0.92–5.09) | 0.077   |
|                    | Higher education | 15(28.3)                | 38 (71.7)               | 4.35(1.41–10.22) | 0.008*  |

*Statistically significant (P<0.05), AOR: Adjusted odds ratio.
Practice of the study patients on insulin therapy

Although the majority 177(72.2%) of the study patients administered insulin themselves, only 120(49.0%) administered insulin appropriately at 45°. Frequent repetition of injection site was practiced among 176(71.8%) patients and 139(56.7%) of them injected insulin before or immediately after food intake (Table 5).

Discussion

Insulin is commonly used in the management of both type 1 and type 2 diabetes mellitus. However, inadequate knowledge and malpractice on insulin self-administration could result in poor treatment outcome and insulin-related complications like hypoglycemia. Therefore, this study was aimed to assess knowledge, attitude and practice of insulin self-administration and the associated factors among diabetic patients. The overall knowledge of the study patients was 63.4% (mean score of 8.24±3.5 out of 13) which is in line with a study conducted in India (68%) [26]. However, the result was higher than the finding from Mekelle referral hospital, Ethiopia (54.4%) [23] and lower than the finding from Bangalore in India (86.7%) [27]. The discrepancies could be attributed to differences in literacy level, access to optimal education and demonstration of insulin self-administration by health care providers.

This study revealed that patients had inadequate knowledge concerning the angle of inclination during insulin administration, complications of insulin therapy, ways to reduce pain during insulin injection and the impact of massage at the site of injection. This could affect the expected treatment outcomes from insulin therapy through different ways including side effects and affect patients’ medication adherence. Hence, optimal counseling of possible outcomes of insulin therapy and demonstration of insulin administration should be provided for patients. More than half 62.0% of the patients correctly answered that diabetes mellitus means high blood sugar which was better than a similar study done in Fellegehiwot hospital in Ethiopia 33.4% [28]. The differences might be due to socio-demographic variations but further effort should be applied to improve basic information of the disease.

Associated factors of patients’ knowledge were identified to find possible strategies to improve their knowledge. In the present study sex, marital status, occupation, area of residence

Table 4. Attitude patients towards insulin self-administration in Zewditu Memorial Hospital, 2018.

| Attitude assessment variables                              | Agree N(%) | Disagree N(%) | Neutral N(%) |
|-------------------------------------------------------------|------------|---------------|-------------|
| Insulin causes other health problems                        | 55(22.4)   | 108(44.1)     | 82(33.5)    |
| Insulin self-administration decreases blood glucose         | 147(60.0)  | 34(13.9)      | 64(26.1)    |
| Insulin self-administration is not tiresome                 | 180(73.5)  | 32(13.1)      | 33(13.5)    |
| Insulin self-administration does not bring stigma           | 141(57.6)  | 51(20.8)      | 53(21.6)    |
| Insulin self-administration is beneficiary                  | 185(75.5)  | 32(13.1)      | 28(11.4)    |

Table 5. Practice of the study patients on insulin therapy and self-administration in Zewditu Memorial Hospital, 2018.

| Attitude patients’ practice variables                      | Yes N(%)   | No N(%)     |
|------------------------------------------------------------|------------|-------------|
| Can you inject yourself in correct position?               | 177(72.2)  | 68(27.8)    |
| Do you inject yourself with needle at 45°?                 | 120(49.0)  | 125(51.0)   |
| Do you store insulin vials in refrigerator or cold place?  | 228(93.1)  | 17(6.9)     |
| Do you frequently repeat injection sites?                  | 176(71.8)  | 69(28.9)    |
| Do you inject insulin before or immediately after food intake? | 139(56.7)  | 106(43.3)   |
| Do you inject insulin into abdomen, thigh, gluteus or deltoid? | 208(84.9)  | 37(15.1)    |

https://doi.org/10.1371/journal.pone.0246741.1004

https://doi.org/10.1371/journal.pone.0246741.1005
and educational status had a statistically significant association with patients’ knowledge. Patients who were never married, government and NGO employee had a higher knowledge by 3.21, 2.87 and 2.55 respectively as compared to their comparators. Knowledge of farmer patients was lower than the comparators by 1.55 times. A similar finding was reported in a study conducted in Hawasa referral hospital, Ethiopia [24]. Never married patients could be the young patients who have relatively better educational status and probably with a high rate of type 1 DM that could improve their knowledge. Government and NGO employees are often educated peoples and may have better access to information as well as better understanding.

Similarly, urban residents, patients who completed elementary education and higher education had a higher knowledge than their comparators by 2.25, 3.25 and 4.35 respectively. A similar finding was reported in a study conducted in Hawasa referral hospital [24]. The reason could be due to patients who had at least completed primary education may have a better chance of exposure to different communication aids like leaflets, magazines and books. In addition, they may have few barriers in communicating with the health care team besides their potential to grasp information’s already communicated [29].

The overall favorable attitude towards insulin self-administration was 62% which was lower than a study done in Bangalore in India (81.7%) [27]. But, the present finding was higher than the other finding in India (32%) [26]. This difference might be due to socio-cultural, health literacy and access to health promotion regarding insulin therapy. A significant number of patients 51(20.8%) had a negative attitude that insulin self-administration brings stigma. This could cause suboptimal insulin utilization behavior that will affect sugar control. Hence, health care providers should focus on promoting health education and awareness creation regarding insulin use.

In the present study, the majority 177(72.2%) of the study patients administered insulin by themselves and the rest 21.8% were dependent on others for the administration of their medication. This could also affect medication adherence and patients should be encouraged as much as possible for self-administration with clear demonstration and counseling. About half of the patients did not inject insulin appropriately at 45° and 71.8% of patients frequently injected at the same site of injection. This might cause unwanted effects like pain and lipoatrophy at the injection site. Furthermore, only 56.7% of the study patients injected insulin before or immediately after food intake and the rest were administering insulin regardless of food including during fasting. This is a common problem and a major cause of insulin-induced hypoglycemia. Therefore patients taking insulin should be counseled and followed for appropriate insulin administration in each hospital visit.

**Limitation of the study**

This study was conducted in a single institution that might limit its generalizability. Duration of insulin use, that could have an association with knowledge and practice of insulin self-administration, was not collected in the present study. Besides, the practice of insulin self-administration was assessed solely on patients’ responses without actual observation that could underestimate the magnitude of malpractice.

**Conclusion**

The overall knowledge of the study patients regarding insulin self-administration was suboptimal especially related to the angle of inclination during insulin administration, complications of insulin therapy, ways to reduce pain during insulin injection and impact of massage at site injection. Hence, adequate patient education should be addressed to fill the knowledge gaps and improve insulin therapy outcomes. Furthermore, sex, marital status, occupation, area of
residence and educational status were associated factors of patients’ knowledge and possible strategies should be sought to act on those patients accordingly. Patients’ attitude on insulin therapy was also inadequate that requires patient education and awareness creation. Despite the vast majority of the study patients administered insulin for themselves, a significant number of malpractices were found. Therefore, the gaps should be addressed with an appropriate demonstration of insulin injection.

Supporting information
S1 File. Data collection tool. (DOCX)

Acknowledgments
The authors would like to thank all the study participants for their time and willingness to participate in the study. We would also like to extend our sincere gratitude to the data collectors, medical staffs working ZMH for their support throughout the study period.

Author Contributions
Conceptualization: Beshir Bedru Nasir, Miftah Shafi Buseir, Oumer Sada Muhammed.

Data curation: Beshir Bedru Nasir.

Formal analysis: Miftah Shafi Buseir, Oumer Sada Muhammed.

Investigation: Miftah Shafi Buseir, Oumer Sada Muhammed.

Methodology: Miftah Shafi Buseir, Oumer Sada Muhammed.

Supervision: Beshir Bedru Nasir, Oumer Sada Muhammed.

Validation: Beshir Bedru Nasir.

Writing – original draft: Beshir Bedru Nasir, Miftah Shafi Buseir.

Writing – review & editing: Beshir Bedru Nasir, Oumer Sada Muhammed.

References
1. Pan C, Yang W, Jia W, Weng J, Tian H. Management of Chinese patients with type 2 diabetes, 1998–2006: the Diabcare-China surveys. Current medical research and opinion. 2009; 25(1):39–45. https://doi.org/10.1185/03007990802586079 PMID: 19210137

2. Mohan V, Pradeepa R. The global burden of diabetes and its vascular complications. Mechanisms of Vascular Defects in Diabetes Mellitus: Springer; 2017. p. 3–23.

3. International Diabetes Federation: Diabetes Atlas. Brussels, Belgium. 2013 6th edition. https://www.idf.org/e-library/epidemiology-research/diabetes-atlas/19-atlas-6th-edition.html.

4. Islam SMS, Pumal TD, Phuong NTA, Mwingira U, Schacht K, Froschi G. Non-Communicable Diseases (NCDs) in developing countries: a symposium report. Globalization and health. 2014; 10(1):81. https://doi.org/10.1186/s12992-014-0081-9 PMID: 25498459

5. Narayan KV, Fleck F. The mysteries of type 2 diabetes in developing countries. Bull World Health Organ. 2016; 94:233–308.

6. Chawla A, Chawla R, Jaggi S. Microvascular and macrovascular complications in diabetes mellitus: distinct or continuum? Indian journal of endocrinology and metabolism. 2016; 20(4):546. https://doi.org/10.4103/2230-8210.183480 PMID: 27366724

7. Davies MJ, D’Alessio DA, Fradkin J, Kernan WN, Mathieu C, Mingrone G, et al. Management of hyperglycemia in type 2 diabetes, 2018. A consensus report by the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD). Diabetes care. 2018; 41(12):2669–701. https://doi.org/10.2337/dc18-0033 PMID: 30291106
8. Shrivastava SR, Shrivastava PS, Ramasamy J. Role of self-care in management of diabetes mellitus. Journal of diabetes & Metabolic disorders. 2013; 12(1):14. https://doi.org/10.1186/2251-6581-12-14 PMID: 23497559

9. Collins MM, Bradley CP, O’Sullivan T, Perry IJ. Self-care coping strategies in people with diabetes: a qualitative exploratory study. BMC endocrine disorders. 2009; 9(1):6. https://doi.org/10.1186/1472-6823-9-6 PMID: 19232113

10. Zheng Y-P, Wu L-F, Su Z-F, Zhou Q-H. Development of a diabetes education program based on modified AADE diabetes education curriculum. International journal of clinical and experimental medicine. 2014; 7(3):758. PMID: 24753774

11. Educators AAoD. AADE guidelines for the practice of diabetes self-management education and training (DSME/T). The Diabetes Educator. 2009; 35(3 suppl):85S–107S.

12. Gawand KS, Gawali UP, Kesari HV. A study to assess knowledge, attitude and practice concerning insulin use in adult patients with diabetes mellitus in tertiary care centre. Indian Journal of Medical Research and Pharmaceutical Sciences. 2016; 3(9):36–40.

13. Jasper US, Opara MC, Pyiki EB, Akinrolie O. Knowledge of insulin use and its determinants among Nigerian insulin requiring diabetes patients. Journal of Diabetes & Metabolic Disorders. 2014; 13(1):10. https://doi.org/10.1186/2251-6581-13-10 PMID: 24397956

14. Karaouï LR, Deeb ME, Nasser L, Hallit S. Knowledge and practice of patients with diabetes mellitus in Lebanon: a cross-sectional study. BMC public health. 2018; 18(1):525. https://doi.org/10.1186/s12889-018-5416-7 PMID: 29678148

15. Choudhury SD, Das SK, Hazra A. Survey of knowledge-attitude-practice concerning insulin use in adult diabetic patients in eastern India. Indian journal of pharmacology. 2014; 46(4):425. https://doi.org/10.4103/0025-7613.135957 PMID: 25097283

16. Frid A, Hirsch L, Gaspar R, Hicks D, Kreugel G, Liersch J, et al. New injection recommendations for patients with diabetes. Diabetes & metabolism. 2010; 36:S3–S18. https://doi.org/10.1186/1677-5956-36-10 PMID: 20933208

17. Association AD. Insulin administration. Diabetes care. 2003; 26(suppl 1):s121–s4.

18. Andres J, Clements JN. A practical guide to concentrated insulin for pharmacists. Journal of pharmacy practice. 2014; 27(5):481–6. https://doi.org/10.1177/0897190013516505 PMID: 25374987

19. Manski-Nankervis J-A, Blackberry I, Young D, O’Neal D, Patterson E, Furler J. Relational coordination amongst health professionals involved in insulin initiation for people with type 2 diabetes in general practice: an exploratory survey. BMC health services research. 2014; 14(1):515.

20. Strauss K, Gols HD, Letondeur C, Matyjaszczyk M, Frid A. The second injection technique event (SITE), May 2000, Barcelona, Spain. Practical Diabetes International. 2002; 19(1):17–21.

21. De Coninck C, Frid A, Gaspar R, Hicks D, Hirsch L, Kreugel G, et al. Results and analysis of the 2008–2009 Insulin Injection Technique Questionnaire survey. Journal of diabetes. 2010; 2(3):168–79. https://doi.org/10.1111/j.1753-0407.2010.00077.x PMID: 20923482

22. Strauss K, Gols HD, Hannel I, Partanen TM, Frid A. A pan-European epidemiologic study of insulin injection technique in patients with diabetes. Practical Diabetes International. 2002; 19(3):71–6.

23. Gerensea H, Moges A, Shumiye B, Abhra F, Yesuf M, Birhan T, et al. Type one diabetic patients knowledge and attitude on insulin self administration in Mekele Tigray, Ethiopia. Journal of Diabetic Complications & Medicine. 2016; 1(1):1–6.

24. Solomon D, Getachew F. Knowledge, Attitude, Practice and associated factors towards Self-Insulin Administration among Diabetic Patients in Hawassa Referral Hospital, Southern Ethiopia, Recent Research in Endocrinology and Metabolic Disorder. 2019; 1(1) 10–17.

25. Yosef T. Knowledge and Attitude on Insulin Self-administration Among Type 1 Diabetic Patients at Metu Karl Referral Hospital, Ethiopia. Journal of Diabetes Research. 2019 Dec 14;2019.

26. Surendranath A, Nagaraju B, Padnavathi G, Anand S, Fayaz P, Balachandra G. A study to assess the knowledge and practice of insulin self-administration among patients with diabetes mellitus. Asian J Pharm Clin Res. 2012; 5(1):63–6.

27. Namita S. A descriptive study to assess the knowledge and attitude regarding self administration of insulin injection among DM patients in kempha chaluwamba general hospital at Malleswaram. Bangalore Nov. 2005.

28. Tewabe T, Kindie S. Level of insulin adherence among diabetes mellitus patients in Felege Hiwot Referral Hospital, Bahir Dar, Northwest Ethiopia, 2017: a cross-sectional study. BMC research notes. 2018; 11(1):295. https://doi.org/10.1186/s13104-018-3398-2 PMID: 29751841

29. Shah VN, Kamdar P, Shah N. Assessing the knowledge, attitudes and practice of type 2 diabetes among patients of Saurashtra region, Gujarat. International journal of diabetes in developing countries. 2009; 29(3):118. https://doi.org/10.4103/0973-3930.54288 PMID: 20165648