Assessing Student Pharmacists' Confidence and Knowledge of Basic Diabetes Self-Management Skills.

ABSTRACT

Introduction: The significance of diabetes self-management and recent advances in diabetes medications call for healthcare professionals' preparedness in educating patients. This study assessed correlations between student pharmacists' confidence and knowledge of diabetes self-management skills.

Methods: An online questionnaire was administered to third-year student pharmacists at one United States college of pharmacy. Students indicated their level of agreement (strongly disagree, disagree, agree, strongly agree) with nine confidence items and identified the correct multiple-choice response for nine knowledge items. Correlations between confidence and knowledge scores were assessed using simple linear regression, logistic regression, and Spearman rank (Rho) test.

Results: Forty-five students completed the questionnaire. Majority agreed/strongly agreed that they were confident in their knowledge for eight of the nine confidence items. Majority correctly answered six of the nine knowledge items. No associations were identified between confidence and knowledge scores in the linear regression (beta scaled = 0.25) or Spearman's correlation test (r = 0.294). In the logistic regression model, confidence and knowledge scores were associated positively for three domains: Glucose meter use (odds ratio [OR] = 4.88), glucagon-like peptide-1 receptor agonist use (OR = 4.23) and hyperglycemia treatment (OR = 3.33) and associated negatively with one domain: Insulin syringe administration (OR = 0.41).

Conclusion: This study found no overall association between confidence and knowledge scores in third-year student pharmacists' basic diabetes self-management skills, although there were significant associations with four specific domains. Student pharmacists may therefore require additional training to improve their diabetes self-management skills.

Keywords: Diabetes; Student pharmacists; Self-management; Confidence; Knowledge.

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Disclosures: None.

INTRODUCTION

Diabetes mellitus (DM) is a significant global health risk with 463 million individuals affected worldwide in 2019 and a 51% projected increase by 2045.[1] In the United States (US), approximately 10.5% of adults had diabetes in 2018, resulting in a large number of emergency department visits and hospitalizations, $327 billion in estimated care costs in 2017, and an emotional burden on patients and their families.[2]

Despite the large number of medications approved for diabetes management and significant enhancements in diabetes technology, fifty percent of patients with diabetes do not achieve a glycated hemoglobin A1c (Hb_{A1c}) level of <7%.[2-3] This statistic indicates there is an opportunity to improve care for patients with diabetes to improve health outcomes. Diabetes self-management is one of the essential aspects of diabetes care and includes, but is not limited to, blood glucose self-monitoring and managing, problem solving, and using medications correctly.[4]

Pharmacists have an important role in educating and empowering patients in diabetes self-care.[5] For instance, a literature review concluded that community pharmacy-led diabetes interventions enhanced health outcomes.[6] Pharmacists are continually ranked as one of the most trusted professionals, are extremely accessible, and practice in a large variety of patient care settings. Pharmacists have many roles including educators, health care team members, and may have prescribing authority under collaborative practice agreements and/or as certified diabetes educators.[6-9]

Various studies have found that student or resident physicians and student pharmacists may not have the knowledge and skills to educate or assist patients in basic aspects of diabetes care and have suggested the need for additional trainings.[10-17] Furthermore, overconfidence and underconfidence that have been seen in student pharmacists can adversely affect the quality of their clinical decisions and patient education.[18-19] It is important that student pharmacists and pharmacists have the knowledge and appropriately correlated confidence to effectively educate patients with diabetes on basic self-care skills

Previous studies have only assessed students' pre- and post-intervention attitude, knowledge, and/or confidence in diabetes self-management education without assessing the correlation between confidence and knowledge. Furthermore, studies have not assessed newer technology such as continuous glucose monitors (CGMs).[11-13,17,20] There is a need to better understand how the pre-advanced pharmacy practice experience (APPE) student pharmacists' knowledge is associated with their confidence. The purpose of this study, therefore, was to assess third-year student pharmacists' confidence, knowledge, and their correlation, for specific aspects of basic diabetes self-management skills. In particular, this study assessed confidence and knowledge related to newer DM technologies and injectable administration devices.

METHODS

Study Design: This was a descriptive, observational, cross-sectional study that obtained data from a questionnaire. The University of Arizona Human Subjects Protection Program reviewed and approved this study (#2021-002-PHPR; January 19, 2021).

Study Cohort and Eligibility: Participants were third-year student pharmacists (class of 2022) attending a single College of Pharmacy in the US. This cohort was chosen because they were pre-clinical rotations and had completed their didactic coursework on diabetes, which consists of medication management of diabetes and an introduction to diabetes technology (insulin pumps and CGMs) and devices in Pharmacotherapeutics and Advanced Patient Care courses. Participation of the subjects in diabetes related extracurricular trainings was not assessed.

Questionnaire: A 23-item electronic questionnaire was created using REDCap, version 10.6.0 (Research Electronic Data Capture). The content validity of this questionnaire was assessed by two academic pharmacists who are specialized in diabetes care, one is a Certified Diabetes Care and Education Specialist (CDCES) and one is Board Certified in Advanced Diabetes Management (BC-ADM®).

The areas assessed in the survey were taken from the Diabetes Self-Management Education and Support (DSMES) curriculum with the focus on what is related to pharmacy practice.[4] The first section consisted of nine items that assessed students' confidence in their diabetes knowledge using a four-point agreement scale (response options included: strongly disagree, disagree, agree, strongly agree). The next section consisted of nine items that assessed students' knowledge of diabetes by selection of the best response from four possible options. The final section consisted of five demographic/descriptive items (experience working with diabetes patients; settings worked with diabetes patients; length of time worked with diabetes patients; average weekly number of diabetes patients seen; nature of experience working with diabetes patients (Supplement 1).

Data collection: An email inviting eligible students to participate in the study was sent in February 2021. The email contained a summary of the study purpose and a website link to the online questionnaire. Participants were reminded of their privacy rights and advised their participation was voluntary. Participants were asked to view and acknowledge the consent document on the first page of the questionnaire before they proceeded further. A second email was sent two weeks after the initial email, and data collection finished two weeks later (March 2021).

Data analysis: Data for analysis were exported from REDCap to Microsoft Excel, version 16.46 (Microsoft) and R Core Team, version 4.0.1 (R Foundation for Statistical Computing). Demographic/descriptive, confidence, and knowledge data were summarized as frequencies with percentages. For knowledge questions, the number of correct answers were summed for each student to create knowledge scores, for a maximum score of 9. Confidence questions were scored between 0 and 3 for each item (strongly disagree=0, disagree=1, agree=2, strongly agree=3), for a maximum score of 27. Then for both knowledge scores and confidence scores, a mean (with standard deviation [SD]) and median (with interquartile range [IQR]) were used to present the spread of the data.

To test for an association between the independent variable (confidence scores) and the dependent variable (knowledge scores), a simple linear regression model was used. Scaling was applied for an easier interpretation of the coefficient. In scaling, the variable's mean was divided by the variable's standard deviation. The transformed value had a mean of 0 and a standard deviation of 1. The interpretation of the scaled β is that for each 1 standard deviation increase in the confidence score, there was a X (value) increase in the standard deviation of the knowledge score. Significance was set a priori at $p<0.05$. The R^2 value (which can range from 0 to 100% where a higher value is desirable) is a metric used to assess how much the independent variable (confidence score) explains the variance seen in the dependent variable (knowledge score).

For correlation testing, we used the Spearman's rank test. Two assumptions were made: 1) confidence scores are ordinal data and 2) the relationship between confidence scores and knowledge scores is monotonic. The r value, which ranges from -1 to +1, explains the strength of the correlation. The 95% confidence interval (CI) for Spearman's rank test was calculated using the jackknife Euclidean likelihood-based inference method.[21-22]

For each confidence domain there was a corresponding knowledge domain. A univariable logistic regression model was built to determine the relationship between each confidence and knowledge domain. The independent variable was the confidence score in the specific domain and the dependent variable was the knowledge score in the same domain (correct=1, incorrect=0). This was to test overconfidence or underconfidence in specific domains. The logistic regression model results are reported as odds ratios (OR) with 95% confidence intervals (CI). An OR>1 meant as confidence increased, there were higher odds of correctly answering the question in that domain, whereas an OR<1 can be interpreted as lower odds of correctly answering the question as confidence increased. Lastly, for significant domains ($p<0.05$), the probability of answering a correct question when confidence was at its highest (score of 3) was estimated and visualized using the ggplot2 package in R, version 4.0.1 (R Foundation for Statistical Computing).[23-24]

RESULTS

A total of 45 third-year student pharmacists (33.8% response rate) completed the questionnaire. Majority of participants had experience working with diabetes patients (77.8%), worked with diabetes patients in community pharmacy settings (64.4%), had less than five years of work experience with diabetes patients (84.4%), and saw less than 10 diabetes patients weekly (66.6%). Students most commonly saw diabetes patients for self-management/problem (low/high blood sugar) solving education (37.8%) (Table 1). Majority of students agreed/strongly agreed that they were confident in their knowledge for eight of the nine confidence items (ranging from 52% in agreement to 95% in agreement). The one item where the majority (64%) indicated that they disagreed/strongly disagreed that they were confident in their knowledge was how to administer glucagon-like peptide-1 receptor agonists (GLP-1 RA) (Figure 1). The mean±SD confidence score was 17.7±4.7, and the median (IQR) score was 18.0 (14.8-20.3). Majority of students correctly answered six of the nine knowledge items correctly (Table 2). The three knowledge items that were answered incorrectly by majority of the students were: lancing device use, FreeStyle Libre continuous glucose monitoring (CGM) use, and administration of Lantus® Solostar insulin pen. The mean±SD number of correct answers was 5.2±1.6 and the median (IQR) score was 5.0 (4.0-6.0).

There was no significant association between confidence score and knowledge score in the simple linear regression model with β scaled (95% CI) =0.25 (-0.04, 0.54, p=0.095) and R^2=0.043 (or 4.3%) (Figure 2). Spearman's correlation test revealed no significant correlation with r value=0.294 (95% CI=-0.009, 0.597). There were three domains in which confidence scores were associated positively with knowledge scores (i.e., had a higher probability of answering the question correctly as confidence increased). These domains were: Glucose meter use (OR=4.88 [95% CI=1.41, 16.88], p=0.012), GLP-1 RA use (OR=4.23 [95% CI=1.29, 13.90], p=0.017) and hyperglycemia treatment (OR=3.33 [95% CI=1.08, 10.27], p=0.037). In one domain (insulin syringe administration), confidence scores were negatively associated with knowledge scores (i.e., had a lower probability of answering the question appropriately as confidences increased; OR=0.41 [95% CI=0.17, 0.95, p=0.038) (Table 3 and Supplement 2).

DISCUSSION

This study was designed to address the need for information regarding student pharmacists' knowledge of basic diabetes self-management skills, especially, with regards to the newer DM technologies and injectable medication administration. We found that majority (88.9%) of the students lacked the knowledge of FreeStyle Libre CGM use, which suggests the anticipated need for additional training for the newer DM technologies. Lack of knowledge of insulin pen (i.e., Lantus® Solostar) administration was seen in >70% of the students and >50% answered the question regarding the use of lancing devices incorrectly. A majority (~70%) of the students had knowledge regarding administration of the GLP- RA in question, despite it being a newer DM injectable (Table 2). However, this does not rule out the lack of knowledge in administering other GLP-1 RAs. Overall, our results suggest the need in additional training in area of newer DM technologies, glucometer use, and administration of injectable diabetes medications.

Furthermore, this study aimed to address the lack of data regarding the correlation between the student pharmacists' confidence and knowledge with regards to basic diabetes self-management skills. We found that most third-year student pharmacists had experience working in diabetes clinics, which may have increased their confidence in answering the diabetes survey questions. There were a few outliers in the data where students had high confidence but low knowledge scores, and vice versa. There was also a cluster of students who had an average confidence score but low knowledge score. Only two students had high confidence and high knowledge scores (Figure 2). Overconfidence in knowledge when measured via surveys is a known phenomenon,[25] which may explain this finding.

This study found no overall association between confidence and knowledge scores. However, when the data were analyzed by domain, a positive association was found between confidence and knowledge scores in the following categories: glucose meter use, GLP-1 RA administration, and hyperglycemia treatment. A negative association was found for insulin syringe use. A mis-calibration (underconfidence and over confidence) was seen in the logistic regression model (Supplementary Figure 1) in which students with low confidence scored higher and students with high confidence scored lower.[26] Confidence is a psychometric concept that can be defined as "A form of metacognition or self-monitoring that reflects a person's perception of their accuracy on a given task".[27] Confidence has real world implications in the decision-making process and in the workplace. Highly confident individuals can be regarded as decisive whereas underconfident individuals can be seen as hesitant in their decision process. Moreover, confidence is an important predictor of the accuracy of scoring tests correctly in the literature with correlation ranges between 0.4 to 0.6.[27] There are two approaches that may explain the miscalibration between confidence and scoring accuracy of the test: 1) ecological approach, which suggests the source of miscalibration is outside the individual and maybe related to the difficulty of the test; and 2) heuristics and biases (or error model), which suggests miscalibration may result from the little experience of the individual with the test questions.[28-30]

These results can be helpful to educators in various ways. In particular, these findings help focusing their attention on the domains where an association was not found, for example by providing more experiential training to enhance students' self-awareness in the areas of over- or underconfidence. In addition, in the domains where there was a miscalibration (e.g., insulin syringe administration), the source of the problem can be investigated through focus groups and addressed.[31] Additional analyses could then be conducted after these interventions to assess if the confidence and knowledge were increased.

The findings of our study provide an understanding of the student pharmacists' additional diabetes self-management related training needs. Studies have shown that diabetes self-management and diabetes care education programs have benefited student pharmacists. Morello et al.[11] found that the student pharmacists who completed a diabetes self-care education program perceived that their knowledge and ability increased and majority of them were able to assist patients with diabetes. The authors suggested that pharmacy schools should consider adding an advanced elective course in diabetes in second year to supplement diabetes education program. In another study by Wongwiwatthananukit et al.,[12] a hands-on training program on diabetes care was offered to second-year and third-year student pharmacists. This study found that the student pharmacists' confidence and competence in diabetes care increased after completion of the training. We believe that our results would allow for a more focused training approach by providing information on areas of low confidence and/or knowledge and areas that there is no or negative correlation between those.

There were some limitations in this study. One of the main limitations was the small sample size of third-year student pharmacists from one US school of pharmacy, thus, the findings may not be representative or generalizable to other student pharmacists. The sample size may be too small to find an association between knowledge and confidence scores, thus only simple univariable regression was conducted without adjustment for other characteristics that maybe associated with confidence or knowledge scores. In addition, the response rate of 33.8% may indicate response bias. The nature of the survey design assumed students were able to understand the questions and respond to them accurately. This assumption of internal validity is a limitation of our study and limits our ability to assess the source of miscalibration. Future research is warranted to establish the validity of the data collection instrument. Future research could also collect data from student pharmacists at other colleges of pharmacy which would increase the sample size and help improve the external validity of the findings. Furthermore, additional studies are warranted to evaluate potential interventions resulted from this study.

CONCLUSIONS

In this study, there was no overall association between confidence and knowledge scores in the third-year student pharmacists' basic diabetes self-management skills at one US school of pharmacy. However, there was a significant association in three specific domains that had a positive association (glucose meter use, GLP-1 RA administration, and hyperglycemia treatment) and one domain with a negative association (insulin syringe administration). Lack of knowledge in areas of newer DM technology, glucometer use, and administration of diabetes injectables are seen and suggest there may be a need for additional training in those areas for some students at this institution. Future research is needed with additional cohorts of student pharmacists to increase the sample size and enhance the reliability and validity of these results.

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Figure 1. Confidence with diabetes knowledge among third-year student pharmacists included in the study (N=45). SBMG: Self blood glucose monitoring. CGM: Continuous glucose monitoring. GLP1 RA: Glucagon-like peptide-1 receptor agonist.

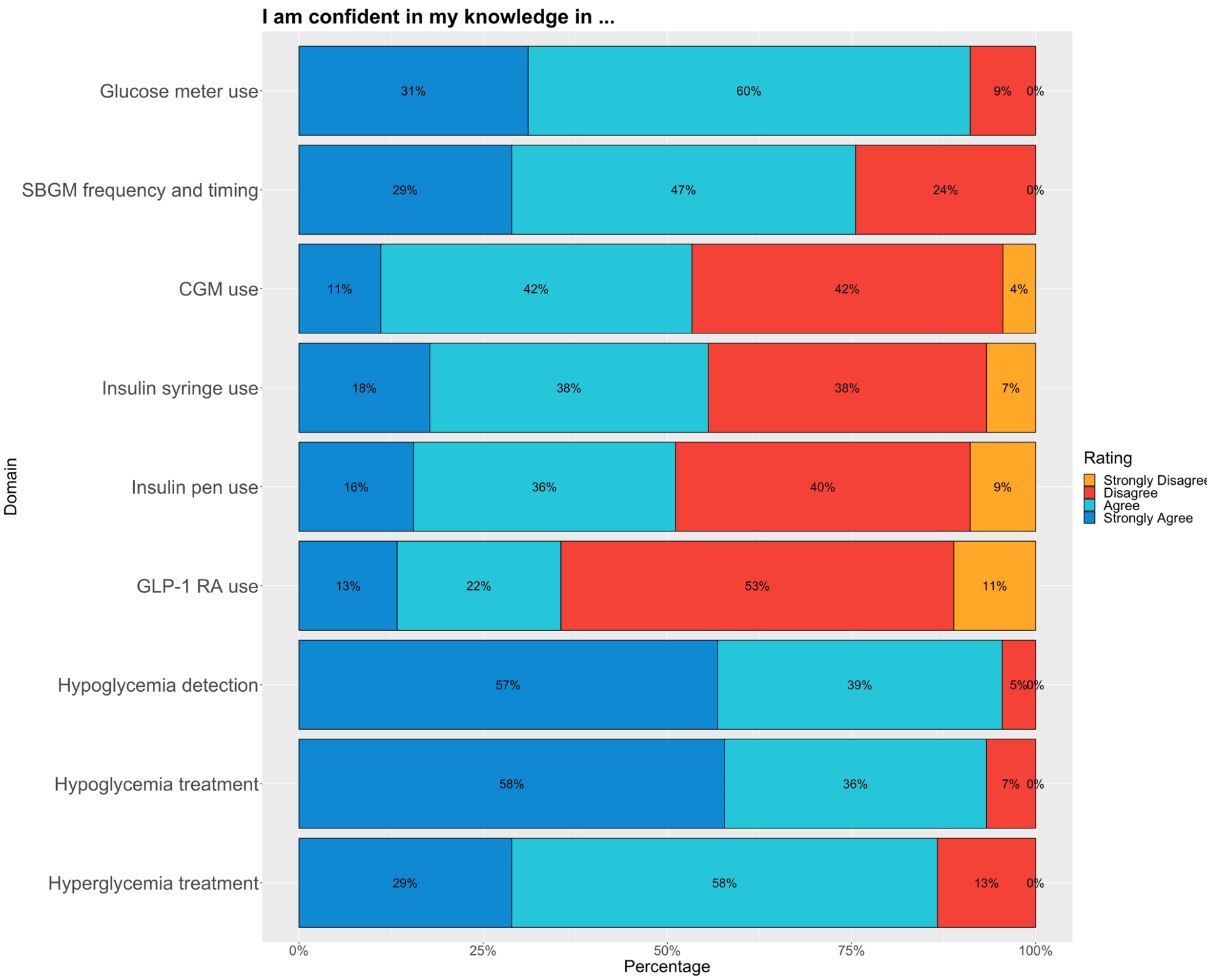

Figure 2. Visual representation of the findings from the linear regression model of confidence score versus knowledge score

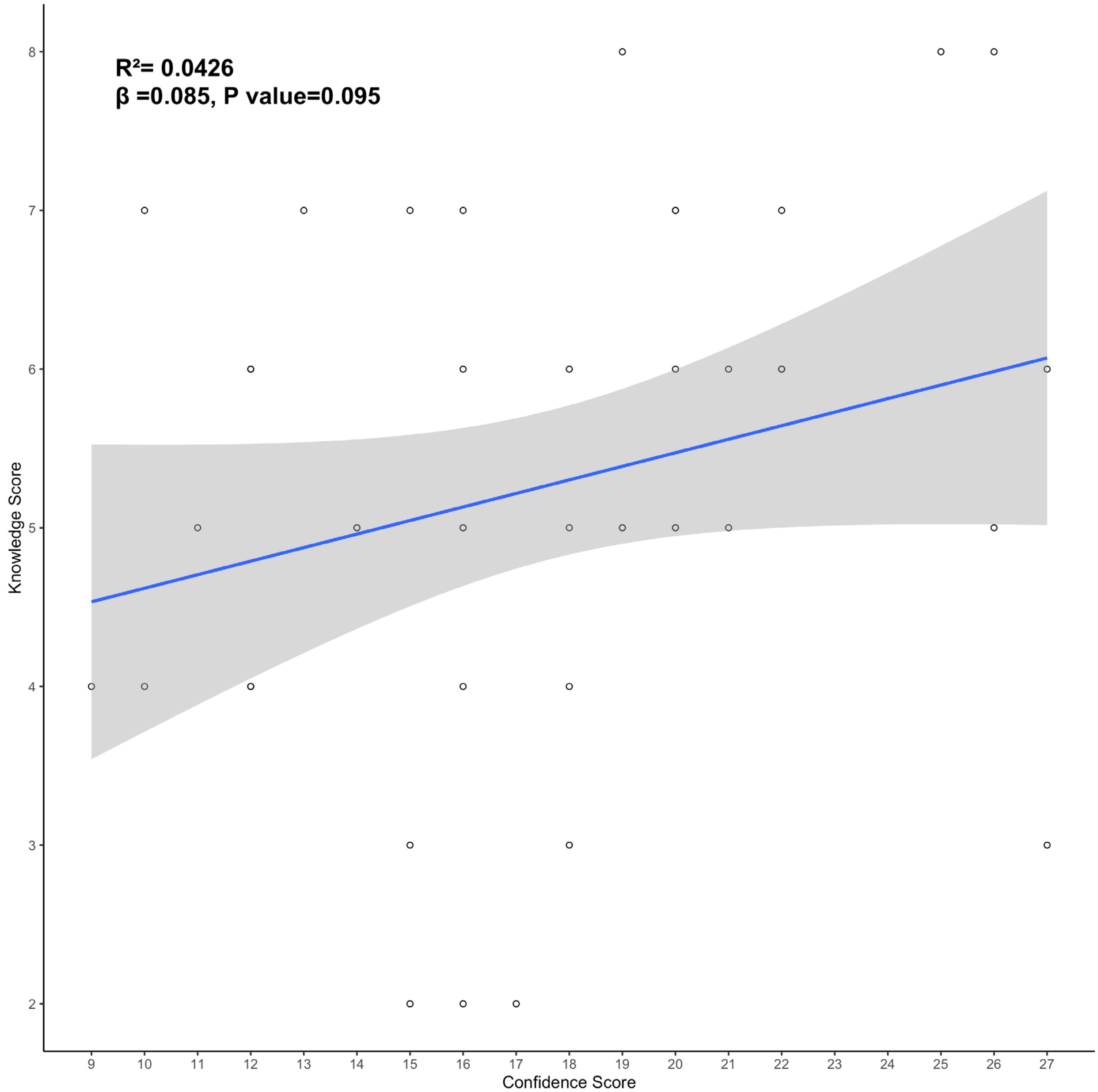

Table 1. Descriptive characteristics of third-year student pharmacists included in the study (N=45)

Descriptive Variable	N (%)
Experience working with patients with diabetes	
Yes	35 (77.8)
No	10 (22.2)
Setting worked with patients with diabetes	
Community pharmacy	29 (64.4)
Office-based clinic	3 (6.7)
Hospital inpatient	1 (2.2)
Hospital outpatient	1 (2.2)
Nursing home	0 (0)
Health fairs	3 (6.7)
Other	8 (17.8)
Length of time in setting working with patients with diabetes	
< 1 year	18 (40.0)
1-5 years	20 (44.4)
>5-10 years	5 (11.1)
>10-15 years	2 (4.4)
Patients with diabetes seen in average week	
0-5	20 (44.4)
6-10	10 (22.2)
11-15	5 (11.1)
>15	10 (22.2)
Nature of experience working with patients with diabetes	
Educating patients on administration of their diabetes injectable medications	11 (24.4)
Educating patients on blood sugar self-monitoring	10 (22.2)
Educating patients on self-managing/problem solving low or high blood sugar	17 (37.8)
Other	7 (15.6)

Table 2. Knowledge of diabetes among third-year student pharmacists included in the study (N=45)

Knowledge Items	Correct N (%)	Incorrect N (%)
Which ONE of the following options is correct in regard to changing the depth of puncture made by lancets?	21 (46.7)	24 (53.3)
Which ONE of the following options is the most appropriate glucose self-monitoring plan for a patient on glargine at bedtime and lispro three times daily with meals?	26 (57.8)	19 (42.2)
Which ONE of the following options is true about the FreeStyle Libre continuous glucose monitoring system?	5 (11.1)	40 (88.9)
Which ONE of the following options outlines the most appropriate steps for injecting 10 units of NPH U-100 insulin vial?	31 (68.9)	14 (31.1)
Which ONE of the following options is the correct instruction to provide to a patient who is on Lantus® SoloStar pen 50 units daily?	11 (24.4)	34 (75.6)
Which ONE of the following options is correct in regard to administering Ozempic® (semaglutide)?	32 (71.1)	13 (28.9)
Which ONE of the following options is correct in regard to hypoglycemia?	44 (97.8)	1 (2.2)
Which ONE of the following options is the MOST APPROPRIATE instruction for a patient with diabetes, who is conscious, to treat a blood sugar of 58 mg/dL?	35 (77.8)	10 (22.2)
Which ONE of the following options is the MOST APPROPRIATE instruction for an ill patient who has blood sugar in 300s.	29 (64.4)	16 (35.6)

Table 3. Confidence by domain category and the probability of answering the knowledge question correctly

Domain	Beta (95% CI)	Odds (95% CI, p value)	Predicted % probability of answering question correctly when confidence score is at 3[1].
Glucose meter use	1.59 (0.35–2.83)	4.88 (1.41–16.88, 0.012)	0.74
SMBG	-0.56 (-1.40 – 0.29)	0.57 (0.25 –1.33, 0.197)	-
CGM	1.31 (-0.11 – 2.73)	3.70 (0.89 –15.35, 0.071)	-
Insulin syringe administration	-0.90 (-1.75–0.05)	0.41 (0.17 – 0.95, 0.038)	0.42
Insulin pen administration	-0.22 (-1.03 – 0.58)	0.80 (0.36–1.79, 0.584)	-
GLP-1 RA	1.44 (0.25 –2.63)	4.23 (1.29–13.90, 0.017)	0.97
Hypoglycemia recognition	1.32 (-1.7 – 14.35)	3.73 (0.18 –77.11, 0.394)	-
Hypoglycemia treatment	-0.73 (-2.07 – 0.61)	0.48 (0.13 –1.83, 0.283)	-
Hyperglycemia treatment	1.20 (0.07–2.33)	3.33 (1.08 –10.27, 0.037)	0.84

SMBG: Self-monitoring blood glucose
CGM: Continuous glucose monitor
GLP-1 RA: Glucagon-like peptide receptor agonist
[1] Predicted probability was calculated for significant results only.