Insulin Injection Technique Education: A survey on knowledge and practice of insulin injection technique education among physicians in Indonesia

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Submitted to: JMIR Diabetes
on: August 15, 2024

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Abstract

Background: Insulin therapy is crucial for diabetes management, and its effectiveness is well-established. With better access to health services, adherence to guidelines, and the availability of insulin, its usage in Indonesia may rise. However, prescribing insulin poses challenges such as storage issues, patient preparation, and proper injection techniques, all of which can impact insulin's effectiveness.

Patient education is vital for successful diabetes management, especially for those on insulin. Indonesia has guidelines for insulin injection techniques, adapted from the Forum for Injection Technique and Therapy Experts (FITTER), but proper insulin use remains insufficient. A preliminary study at a Jakarta hospital revealed that only 6.1% of diabetes patients received education during outpatient treatment.

Objective: This study seeks to investigate physicians' knowledge and practice in providing education on insulin use to diabetes patients in Indonesia, as no previous research has addressed this issue.

Methods: This study recruited potential participants (all physicians in Indonesia) through the internet using convenience sampling method. Participants gave their informed consent before completing the questionnaire. The online questionnaire was created by the research team and pretested on 30 individuals before distributed to participants. The survey lasted from February to March 2021.

Results: A total of 823 participants were included in the analysis. More than 80% of the participants had given insulin education to patients at least once during the last 30 days. However, only 58.20% used specific guidelines in their practice, with only 34.02% aware of the Indonesian guideline. Almost all (99.03%) participants agreed that insulin injection techniques would affect clinical results. The median score of knowledge about insulin injection techniques were 7 (IQR 2) among the study participants.

Conclusions: Most physicians in this study had given education to their patients. However, there was still a gap between the guideline and practice of insulin education, as shown by the lack of awareness and the fair level of knowledge about the Indonesian guideline.

(JMIR Preprints 15/08/2024:65359)
DOI: https://doi.org/10.2196/preprints.65359

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Introduction

According to the International Diabetes Federation, Indonesia was ranked as the 7th country with the largest number of adults with diabetes in 2019.[1] Among those 10.7 million individuals with diabetes, only 0.7-53% managed to achieve their treatment targets (depending on the parameters used – either HbA1c or fasting plasma glucose.[2-6] Meanwhile, glycemic stability is needed to reduce the morbidity and mortality of diabetes.[7] Insulin therapy is part of diabetes management plan and has long been proven to be effective for patients whose blood glucose targets cannot be achieved with oral medications.[8,9] Unfortunately, only 1 out of 8 people who need insulin therapy in Indonesia actually received it. This is due to the relatively quicker growth of the prevalence of diabetes than that of the insulin market as well as general practitioners (GPs) having to depend on specialists to prescribe insulin.[6] With the growing availability and affordability of insulin as well as improved access to healthcare services overall in the country, the use of insulin is expected increase in the coming years.[10] However, prescribing insulin to patients with diabetes mellitus is not without its challenges. Several factors that may affect the effectiveness of insulin are storage conditions, patient preparation, and injection techniques.[11,12]

It is widely known that patients' awareness and self-management are keys to successful diabetes care, especially for those receiving insulin. Thus, patient education and empowerment are critical tasks of healthcare professionals.[13,14] Indonesia has adapted guideline from the Forum for Injection Technique and Therapy Experts (FITTER) for insulin injection techniques, titled *Pedoman Teknik Menyuntik Insulin Indonesia (PTMII) 2017*.[15,16] However, insulin usage is still not optimal due to a number of issues, such as the low level of diabetes knowledge and insulin education practice among healthcare professionals.[6,17,18] In a preliminary study conducted at one of the tertiary hospitals in Jakarta, only 6.1% of patients with diabetes mellitus received education while receiving outpatient

treatment. Similar findings are found in other countries, such as Iran and the United States.[19,20] Moreover, there is still a significant gap between insulin injection practice and current guideline.[21] In order to improve the outcomes of diabetes education, it is vital to examine these issues. To our best knowledge, previous studies in Indonesia mostly focused on patients' knowledge about diabetes and its impact on their self-management of diabetes. There is still a paucity of studies that looked at physicians in general. Thus, this study aims to investigate the practice of insulin education as well as the knowledge of insulin injection techniques among physicians working in Indonesia.

Methods

Study design and recruitment

This is a cross-sectional online survey in which data collection lasted for two weeks from February 28th to March 14th, 2021. The authors recruited potential participants (target population was all physicians in Indonesia) by sending invitations to instant messaging (WhatsApp) groups for seminars/workshops/trainings, university alumni, hospitals, study/work societies, etc., using convenience sampling method. Anyone with the link could have access to the online survey. Potential participants could then read detailed explanation about the study on the first page of the survey, i.e. study objectives, time needed to complete the questionnaire, and data anonymity, before they consented and proceeded to the questionnaire.

Study questionnaire

The questionnaire was created by the research team at the Fatmawati Central General Hospital Integrated Diabetes Service Center, comprising 2 endocrinologists, 2 internists, and an epidemiologist. The questionnaire had 32 questions divided into 4 sections. The first section consisted of 9 questions regarding demographic information. Section 2 included 7 questions about

the practice of insulin education. Section 3 consisted of 6 questions pertaining to the Indonesian adaptation of insulin injection technique guideline. The final section consisted of 10 questions about the knowledge of insulin injection technique. The questionnaire was assessed for usability, technical functionality, and realibility before its final version distributed to the study participants.

Statistical analysis

Data analysis was performed using SPSS (Statistical Package for the Social Sciences) version 25. The authors did not conduct data imputation or missing data analysis in this study. Numerical data was presented as mean (standard deviation) or median (inter-quartile range or minimum and maximum) while categorical data was presented as frequency tables or bar graphs. Distribution of numerical data was examined using skewness, kurtosis, and tests of normality Kolmogorov-Smirnov. Bivariate analyses were done using Kruskal-Wallis tests.

Ethics statement

The ethical review for this study was approved by the ethics committee at Fatmawati Central General Hospital on February 26, 2021 numbered 10/KEP/II/2021.

Results

Study participants

The questionnaire was pretested on 30 individuals not included in the main study (10 general practitioners, 8 internal medicine residents, 8 internists, and 4 endocrinologists) which yielded a KR-20 realibility coefficient of 0.70. The final version of the questionnaire was then distributed among groups and a total of 929 physicians participated in the survey. During the preliminary analysis, the authors decided to exclude 100 participants with incomplete answers and 6 participants because of

data inconsistency, i.e. claiming to prescribe insulin in one question while there were no patients with diabetes under care during the last 30 days. Thus, 823 participants were included in the final analysis. Table 1 below shows study participants' characteristics.

Table 1. Demographic characteristics of study participants (N=823)

Demographic characteristics	Percentage (N)
Age (years old)	
< 30	15.92% (131)
30 – 40	43.99% (362)
40 – 50	18.71% (154)
50 – 60	14.46% (119)
> 60	6.93% (57)
Profession	
General practitioner	25.03% (206)
Internal medicine resident	25.52% (210)
Internist	36.45% (300)
Other specialists	1.82% (15)
Consultant in endocrinology, metabolism & diabetes	8.75% (72)
Other consultants	1.82% (15)
Others	0.61% (5)
Location in Indonesia (island)	
Java	44.47% (366)
Sumatra	15.55% (128)
Kalimantan	5.59% (46)
Sulawesi	25.27% (208)
Bali, NTB, NTT	6.56% (54)
Papua	2.55% (21)
Individuals with diabetes nearby	
Oneself	3.52% (29)
Friend	16.04% (132)
Family	58.56% (482)
None	21.87% (180)
Years of working experience	
1 – 5	36.3% (299)
6 – 10	34.6% (285)
11 – 15	13.2% (109)
16 – 20	6% (49)
> 20	9.8% (81)

Almost half of study participants belonged to 30-40 years age group (43.99%) while more than a third of them were internists (36.45%). A small proportion (3.52%) of the participants had diabetes while more than half (58.56%) of them had one or more family members with diabetes. Almost half

(44.47%) of the participants worked in the Island of Java. Around 70% of the participants have worked less than 10 years in the field.

Table 2. Characteristics of study participants' work (N=823)

Work characteristics	Percentage (n)
Practice setting	
Private primary clinic	3.52% (29)
Private specialist clinic	1.34% (11)
Private practice	4.74% (39)
Primary healthcare centre	6.80% (56)
Primary care hospital	4.25% (35)
Secondary care hospital (limited specialties)	23.69% (195)
Secondary care hospital (limited subspecialties)	20.41% (168)
Tertiary care hospital (top referral hospital)	35.24% (290)
Availability of diabetes education service	
Yes	54.92% (452)
No	45.08% (371)
Number of patients with diabetes treated in the last 30 days	
None	2.67% (22)
1 – 10	28.55% (235)
10 – 50	47.02% (387)
50 – 100	12.39% (102)
> 100	9.36% (77)
Number of insulin prescription in the last 30 days	
None	12.15% (100)
1 – 10	43.62% (359)
10 – 50	30.98% (255)
> 50	13.24% (109)

From Table 2, it is shown that around 80% of the participants worked at hospitals, in which mostly worked at tertiary care hospitals (35.24%). More than half (54.92%) of the hospitals participants worked at had diabetes education services. Almost half (47.02%) of the participants treated 10-50 patients with diabetes during the last 30 days and gave 1-10 insulin prescriptions to their patients.

Table 3. Insulin education practice (N=823)

The practice of insulin education	Percentage (n)
Have you ever given insulin education to patients	
Never	17.38% (143)
Ever	82.62% (680)
Frequency of insulin education in the last 30 days	
None	18.10% (149)
1 – 10	57.84% (476)
10 – 50	20.66% (170)
> 50	3.40% (28)
Use of specific guideline	
Yes	58.20% (479)
No	41.80% (344)
Recommended area for injection	
Abdomen	83.96% (691)
Upper arm	12.27% (101)
Thigh	3.04% (25)
All	0.61% (5)
Others	0.12% (1)
Which healthcare professional should be responsible for educating patients	
Pharmacists	3.65% (30)
Doctors	62.45% (514)
Diabetes educators	27.83% (229)
Nurses	5.59% (46)
Other professionals	0.49% (4)
Insulin injection technique would affect clinical results	
Agree	99.03% (815)
Disagree	0.97% (8)

Table 3 shows the practice of insulin education among study participants. More than 80% of the participants claimed that they had ever given insulin education to patients, with more than half (57.84%) of them had given education 1-10 times during the last 30 days. More than half (62.45%) said that physicians are responsible for educating patients. Only less than 1% said that the responsibility should be given to other professionals. Almost all (99.03%) participants agreed that insulin injection techniques would affect clinical results with the majority (83.96%) recommended abdomen as the area for insulin injection. Less than half (41.80%) of the participants did not use specific guidelines to educate their patients.

A total of 280 participants (34.02%) were aware of the Indonesian guideline for insulin injection

techniques. From this number, almost 90% of them (n=247) used the guideline in their practices. Awareness of the guideline mostly came from societies, such as study society for diabetes, society of diabetes educators, and society of endocrinologists (n=169), as well as seminars or symposia (n=109). Two of the participants learned about the guideline during their residency.

Table 4. Important aspects of insulin pen injection (N=823)

The most important aspect of insulin pen injection	Percentage (n)
Needle length	9.23% (76)
Choosing area of injection	55.16% (454)
Use of disposable needle	14.95% (123)
Method of skinfold pinching	14.46% (119)
Size of needle gauge	6.20% (51)

Table 4 above shows what participants thought was the most important aspect of insulin pen injection. More than half (55.16%) of the participants regarded area of injection as most important compared to only 6.2% of them who thought size of needle gauge as the most vital aspect of insulin injection.

Table 5. Awareness of important aspects of insulin pen injection across professions (N=823)

Profession	Needle length (col %)	Area of injection (col %)	Disposable needle (col %)	Skinfold pinching (col %)	Size of needle gauge (col %)	Subtotal (col %)
General practitioner	14 (18.4%)	106 (23.3%)	38 (30.9%)	36 (30.3%)	12 (23.5%)	206 (25%)
Internal medicine resident	16 (21.1%)	121 (26.7%)	28 (22.8%)	32 (26.9%)	13 (25.5%)	210 (25.5%)
Internist	29 (38.2%)	166 (36.6%)	45 (36.6%)	42 (35.3%)	18 (35.3%)	300 (36.5%)
Other specialists	3 (3.9%)	6 (1.3%)	2 (1.6%)	3 (2.5%)	1 (2%)	15 (1.8%)
Consultant in endocrinology. metabolism & diabetes	7 (9.2%)	46 (10.1%)	9 (7.3%)	5 (4.2%)	5 (9.8%)	72 (8.7%)
Other consultants	5 (6.6%)	7 (1.5%)	1 (0.8%)	1 (0.8%)	1 (2%)	15 (1.8%)

Others	2 (2.6%)	2 (0.4%)	0 (0%)	0 (0%)	1 (2%)	5 (0.6%)
Subtotal (row %)	76 (9.23%)	454 (55.16%)	123 (14.95%)	119 (14.46%)	51 (6.2%)	823 (100%)

col % = column percentages; row % = row percentages

From Table 5, it is shown that relatively more internists and consultants chose needle length and area of injection as the most important aspects of insulin injection while relatively more GPs regarded use of disposable needle and method of skinfold pinching were the most important aspects.

Table 6. Lists of questions regarding knowledge about insulin injection techniques (N=823)

Questions	Correct answer percentage
Insulin absorption is influenced by the correct choice of injection area - True	89.55% (737)
The rate of insulin absorption is constant regardless of injection area - False	77.76% (640)
Injection time of rapid acting insulin analogs (Aspart, Glulisin, Lispro) is the same as that of short acting human insulin (Actrapid, Humulin-R) - False	72.17% (594)
Injecting insulin on intramuscular tissue may relieve the pain better than subcutaneous tissue - False	70.11% (577)
Injecting rapid acting insulin analogs (Aspart, Glulisin, Lispro) on thigh areas is good for blood glucose control - False	57.72% (475)
Removing needle within less than 10 seconds after injecting insulin can reduce the amount of insulin injected - True	81.65% (672)
The fastest-absorbing location for insulin injection is abdominal area - False	30.62% (252)
The best location for insulin injection is areas with lipohypertrophy - False	73.51% (605)
The angle of insulin injection is usually perpendicular to the area of injection - True	89.55% (737)
Prior to injecting insulin at home. patients must always disinfect with alcohol - False	29.65% (244)

Table 6 above lists the true-false questions on knowledge about insulin injection techniques. Questions in which the majority (89.55%) of participants answered correctly were “Insulin absorption is influenced by the correct choice of injection area” and “The angle of insulin injection is usually perpendicular to the area of injection”. Meanwhile, questions with the most incorrect answers were “Prior to injecting insulin at home, patients must always disinfect with alcohol” (29.65%) and

“The fastest-absorbing location for insulin injection is abdominal area” (30.62%).

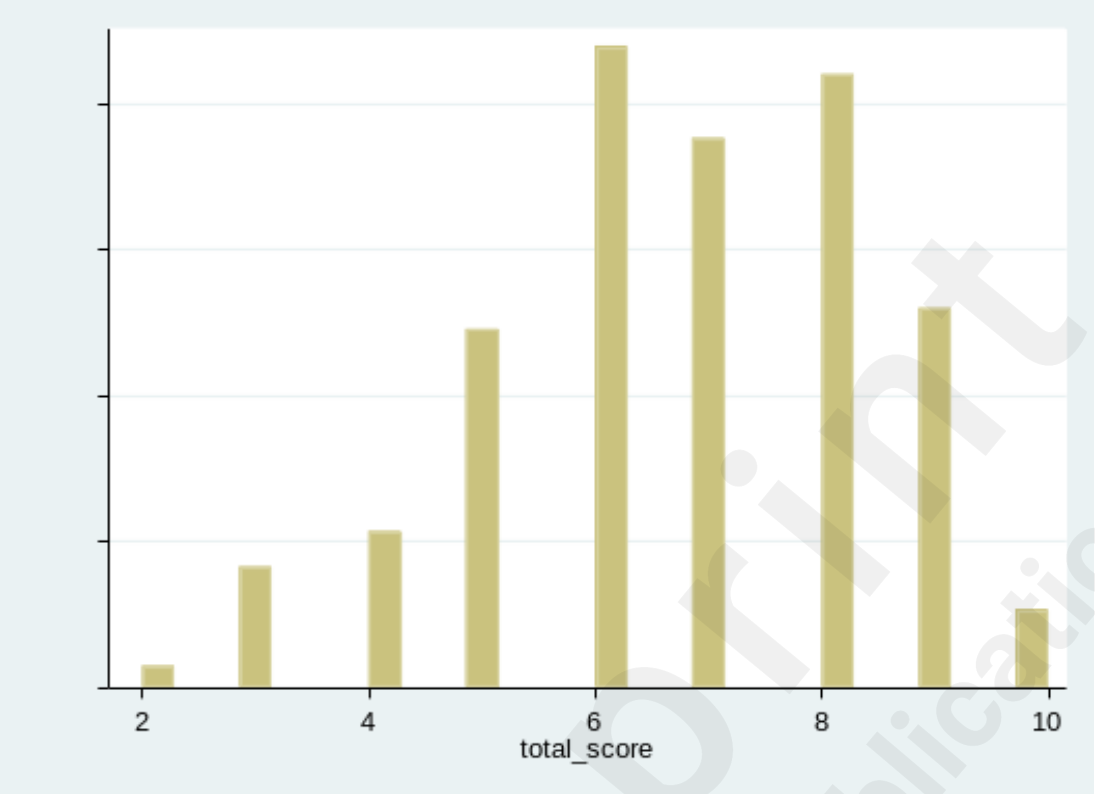

Figure 1. Distribution of total scores among participants

Figure 1 shows participants’ scores of the knowledge about insulin injection techniques. Many participants obtained a total score of 6 and 8, i.e. 21.99% and 21.02% respectively. The lowest score achieved by 6 participants (0.73%) was 2 while 22 participants (2.67%) earned a perfect score of 10. The median score was 7 (IQR 2).

Table 7. Knowledge scores across demographic characteristics (N=823)

Demographic characteristics	Median score (min-max)	*P* value
Age (years old)		
< 30	6 (3 – 9)	
30 – 40	7 (2 – 10)	
40 – 50	7 (2 – 10)	0.05
50 – 60	7 (2 – 10)	
> 60	7 (2 – 10)	

Profession		
General practitioner	6 (2 – 10)	<0.001
Internal medicine resident	7 (3 – 10)	
Internist	7 (2 – 10)	
Other specialists	5 (3 – 8)	
Consultant in endocrinology, metabolism & diabetes	8 (5 – 10)	
Other consultants	6 (5 – 8)	
Others	6 (5 – 7)	
Location in Indonesia (island)		
Java	7 (2 – 10)	0.12
Sumatra	7 (2 – 9)	
Kalimantan	7 (3 – 10)	
Sulawesi	7 (3 – 10)	
Bali, NTB, NTT	7 (3 – 10)	
Papua	6 (3 – 10)	
Individuals with diabetes nearby		
Oneself	7 (4 – 9)	0.94
Friend	7 (2 – 10)	
Family	7 (2 – 10)	
None	7 (3 – 10)	
Years of working experience		
1 – 5	7 (2 – 10)	0.28
6 – 10	7 (3 – 10)	
11 – 15	7 (2 – 10)	
16 – 20	6 (3 – 10)	
> 20	6 (2 – 10)	

Table 7 shows the median score of knowledge about insulin across demographic characteristics. Profession was the only statistically significant variable associated with knowledge scores, with the highest median score held by consultants in endocrinology, metabolism & diabetes and the lowest by other specialists.

Discussion

This study examined the practice of insulin education as well as knowledge about insulin injection techniques among physicians working in Indonesia. To the authors' best knowledge, there has been no similar studies during the last decade in the country; the last study was conducted by one

pharmaceutical company in 2012.[6] With the numerous challenges surrounding diabetes management in the country, this study aimed to address the research gap and build on the evidence to improve outcomes for diabetes care.

This study used convenience sampling method to recruit potential participants from all over the country as it was not possible to obtain the list of all physicians in Indonesia and use the random sampling methods. Although this method has weaknesses, the authors tried to minimize selection bias by preventing direct contact with potential participants. This was achieved by sending out invitations (with link to the online questionnaire attached) to social media groups and participants were not required to disclose their personal identities. It was not necessary for the research team to contact the study participants either and vice versa. However, due to these protocols, the authors had to exclude participants if they had incomplete answers to the questionnaire. A total of 929 participants had participated in the survey, but 100 participants did not fill in the province where they worked and 6 participants gave inconsistent answers that would be questionable upon further analysis, and thus there remained 823 participants in the final analysis. This meant that there was 10.76% missing data and the authors did not conduct data imputation or missing data analysis.

Principal results

More than half of the participants were aged 40 and below. This was supported by the fact that the majority of them were GPs, internal medicine residents, or internists. Looking at the geographical spread of the participants, the distribution followed that of the general population in Indonesia, with many of them concentrated in the Island of Java.[21] Thus, it can be assumed that the participants in this study were representative of the population of physicians in Indonesia.

It seemed that participants in this study regarded insulin education as important because more than 80% of them had given insulin education to patients in the last 30 days of practice. This was

supported by another finding that 99% of them agreed that insulin injection technique would affect clinical results and more than 80% of the participants thought that the responsibility to educate patients goes to physicians and diabetes educators. However, more than 40% of the participants did not use specific guidelines in their insulin education practices. This may be due to the finding that 66.98% of the participants were not aware of the Indonesian guideline for insulin injection techniques PTMII. Participants who were aware of the guideline mainly received the information through study or professional societies and seminars/ symposia. This finding underscores the importance of further training/education and networking through societies in the updates of diabetes knowledge and practice. Participants who were not aware of the guideline further stated that they would appreciate if the study/professional societies could provide webinars or sessions to disseminate the guideline. The distribution of guideline through social media, such as Whatsapp groups, was also encouraged by many participants.

While participants in this study were generally aware of the importance of area of insulin injection, awareness of needle length and size of needle gauge still had to be improved since only a small proportion of the participants (< 10%) regarded them as the most important aspects of insulin injection. Although needle length does not directly affect glycemic control, it is important for correct insulin deposition (subcutaneous vs intramuscular) as there is a greater risk of intramuscular injections the longer the needle is.[22] Moreover, longer and larger needles would cause more pain and therefore making patients uncomfortable during injection.[23] The use of disposable needle must also be encouraged to reduce local complications, such as lipohypertrophy.[24]

Comparison with prior work

The results of this study also showed that the majority of the participants had a fair knowledge of insulin injection techniques from the Indonesian guideline PTMII, as evidenced by a median score of

7. This finding was similar to the findings among physicians in Iran (correct answer 66.29%), better than the results in Egypt (57% lacked knowledge), but worse than those in Singapore (median score 8).[25-27] However, these findings are not entirely comparable as there were differences in the contents of knowledge tested, measurements or the cut-off points for score categories (poor, fair, good), and the medical curriculum between countries. Nonetheless, there is a need to improve Indonesian physicians' knowledge about the differences between areas of injection and disinfection procedures as those questions were answered incorrectly by most of the study participants.

One finding that was consistent to other studies was that consultants tended to score better than junior doctors.[25,26,28,29] This might not be surprising as consultants in general do gain deeper knowledge through further formal trainings. However, it also indicates that physicians in Indonesia, especially general practitioners, still need to participate in more continuing medical education (CME) programs in order to increase their knowledge about diabetes care, particularly regarding insulin injection techniques.

Age, working location, personal or family history of diabetes, and years of working experience were not associated with knowledge scores in this study. These were interesting findings as they were quite different from other studies. Age was found to be associated with knowledge among physicians in Iran and Egypt; however, this may be caused by the categorization of age into two groups only, with a cut-off age of 40 and 32, respectively.[25,26] Meanwhile in this study, there was no strong association between age and knowledge when age was categorized into five groups. Another interesting finding in this study was that only physicians aged below 30 had different ranges of scores, i.e. they had lower median scores, better minimum scores, and lower maximum scores. This could be due to physicians aged below 30 are generally not yet in the fellowship (consultant) stage of training and thus lack the knowledge needed to score well. This finding could also explain why there would be an association between age and knowledge when the cut-off point is set around that number.

Working location was not associated with knowledge in this study. This result is different from those in Iran and Egypt but this may be due to the different operational definitions used in each study. Working location was defined as the main islands physicians worked at in this study while it was categorized as rural vs urban in the Egypt study (Abdelsalam et al, 2022) and whether it was teaching hospital in Iran (Niroomand et al, 2017).[25,26] Looking at the results in this study only, it is rather commending that there was no significant difference in knowledge between physicians working in Java and outside Java, considering the common assumption that most of the country's development and growth are concentrated in Java.

Personal and family history of diabetes were found to be not associated with knowledge in this study, which were in contrast to the studies done in Iran and Egypt. [25,26] However, this may be due to the fact that those factors were combined into a single variable in this study, whereas they were made into two different variables in the other studies. Working experience was also not associated with knowledge and this finding is similar to the study in Egypt, in which years of experience were found to affect physicians' attitude in practice, but not knowledge.[26]

Limitations

The strength of this study came from the fact that it is one of the very few studies that investigated the knowledge and practice of insulin education among physicians in Indonesia. Thus, the results of this study could provide as the basis for future research on similar topics. However, due to its limitation in the amount of missing data, the study results must be interpreted accordingly.

Conclusions

In contrast to the previous finding that only a few patients said that they received education during their outpatient visits, the majority of physicians in this study stated that they had given education to their patients during the last 30 days of practice. This means that future research should be done to explore the barriers and facilitators to diabetes/insulin education from the perspectives of both patients and physicians. Moreover, there was still a gap between the guideline and practice of insulin education, as shown by the lack of awareness and the fair level of knowledge about the Indonesian insulin injection techniques guideline. In response to the demands from participants, it would be helpful if the study and professional societies in Indonesia could increase the promotion and dissemination of the guideline by delivering webinars and/or sharing the guideline through social media. Seminars should focus on educating aspects of insulin injection techniques in which Indonesian physicians found difficult, such as areas of injection and sterilization procedures, as well as aspects that physicians were least aware of, i.e. needle length and size of needle gauge. Last but not least, physicians in Indonesia, especially general practitioners, would benefit from participating in more CME programs related to diabetes care and insulin injection techniques in order to improve patient outcomes.

Acknowledgements

The authors would like to thank all physicians in Indonesia who have participated in the study, the research team and people at Fatmawati Central General Hospital who have helped in various stages of this study.

Conflicts of Interest

The authors have no conflicts of interest to disclose.

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