

## Physicians perspective towards impaired awareness of hypoglycaemia in patients with diabetes: A forgotten area

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### RESEARCH

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### ABSTRACT

#### Background

The impaired awareness of hypoglycaemia (IAH) is a critical condition that should be assessed in patient with diabetes. It increases the risk of severe hypoglycaemia and subsequently death.

#### Aims

This study aims to assess knowledge, and practices of primary care physician in Saudi Arabia about IAH.

#### Methods

A cross-sectional study conducted using a newly designed self-administered questionnaire among 292 primary care physicians at three tertiary hospitals and primary care clinics in Riyadh, Saudi Arabia between December 2018 and June 2019.

#### Results

Of the participants, 59.9 per cent of them had acceptable knowledge of IAH while only 40.1 per cent had poor knowledge. Around half (46.2 per cent) of physicians rated

their familiarity with IAH as average or above average, and these had higher mean knowledge scores than participants who reported below average familiarity (mean 5.32 *versus* 4.39) ( $p=0.000$ ). Higher mean knowledge scores were found among physicians who have managed IAH patients than those who have not managed IAH patients (5.58 *versus* 5.01) ( $p=0.019$ ). The differences between physicians' mean knowledge scores and their ages, levels of training, and years in practice were statistically significant.

#### Conclusion

A considerable gap was established in the knowledge, awareness, and practice of IAH among physicians in Saudi Arabia. An effort is needed to implement extensive educational activities about impaired hypoglycaemia awareness to be directed to primary care physicians and further research in this area is warranted.

#### Key Words

Knowledge, practice, primary care physician, impaired hypoglycaemia awareness, diabetic patients, Saudi Arabia

#### What this study adds:

##### 1. What is known about this subject?

Impaired awareness of hypoglycaemia is important risk factor for severe hypoglycaemia and lack of awareness is associated with increased risk of mortality.

##### 2. What new information is offered in this study?

There is a gap in impaired hypoglycaemia awareness among Saudi physicians and Mean knowledge scores were higher in consultants with practice duration >15 years

##### 3. What are the implications for research, policy, or practice?

There is a need to implement strategies and educational activities to increase the level of knowledge among primary care physicians.

## Background

Hypoglycemia is one of the most serious complications in type 2 diabetic patients<sup>1</sup>. The repetitive exposure to hypoglycemic episodes causes an increase in the risk of developing impaired awareness of hypoglycemia (IAH)<sup>2</sup>. In the literature, the prevalence of impaired awareness of hypoglycemia among insulin-treated type 2 diabetic patients was found to be 9.8% and 10%<sup>3,4</sup>. Furthermore, the incidence of severe hypoglycemia was higher in patients with IAH than in those with preserved awareness<sup>3</sup>. Thus, it interferes with the physician's decision to maintain tight glycemic control<sup>1,5</sup>.

IAH is defined as the failure of diabetic patients to develop neurogenic symptoms in response to low level of blood glucose (< 3.9 mmol/l)<sup>6</sup>. Based on the level of hypoglycemia awareness, diabetic individuals are divided into three classes: (1) the first class includes individuals who always recognize hypoglycemic episodes. (2) the second class includes individuals who fail to recognize some episodes and notice a change in the pattern of their symptoms, and (3) the third class involves individual who have completely lost their awareness of these episodes<sup>7</sup>. A number of factors have been identified to increase the risk of IAH. These factors include advanced age and longer period of diabetes mellitus<sup>7,8</sup>, history of frequent hypoglycemia<sup>9</sup>, certain types of treatment that cause hypoglycemia<sup>3</sup>, and near normal glycemic target<sup>10</sup>.

Apparently, severe hypoglycemia is a serious consequence of impaired awareness of hypoglycemia<sup>1</sup>. It is defined as hypoglycemia that involves cognitive impairment and requires external support for recovery<sup>5</sup>. A study done among type 2 diabetic patients found a 79 per cent increment in the odds ratio of developing acute cardiovascular events in patient with histories of severe hypoglycemia compared to patient without hypoglycemia<sup>11-17</sup>. Memory impairment, seizures, behavioral changes, and dementia are recognized neurological complications of severe hypoglycemia<sup>18-21</sup>. In clinical practice, an association has been reported between self-reported severe hypoglycemia and 5-year mortality<sup>22</sup>.

Theoretically, IAH should never happen if hypoglycemia had been avoided since the clinical onset of diabetes<sup>23</sup>. This process could be achieved by preventing hypoglycemia by properly educating patients on insulin dose adjustments, increasing glycemic targets, timing and counting of carbohydrates in snacks, and moderating alcohol intake<sup>1,2</sup>. Physicians play a major role in assisting their patients with respect to detecting, treating, and preventing IAH. This can be achieved by taking full clinical history, assessing previous hypoglycemia attacks, and encouraging their patients to self-monitor their blood glucose (SMBG)<sup>24</sup>. Many

assessment tools, such as the Clarke, and the Pedersen-Bjergaard methods<sup>25-27</sup> have been established to assess hypoglycemia awareness in type 1 diabetic patients. In the literature, some of these methods were used to assess type 2 diabetic patients' IAH<sup>28</sup>. It is critical for physician to understand that if IAH is detected early, interventions may assist in reducing or even stopping hypoglycemia recurrence<sup>29</sup>.

To the best of our knowledge, no previous international or local studies have been done to assess physicians' IAH knowledge or practice. Thus, we believe that reducing this gap by conducting such a study will contribute to the management of IAH.

### Hypothesis and null hypothesis

The level of primary care physicians' knowledge about hypoglycaemia unawareness is around 40 per cent. Around 40% of primary care physicians' evaluation of their type 2 diabetic patients concerns hypoglycaemia unawareness. Average and above 40 per cent knowledge scores are associated with more years of experience.

### Study variables

Independent variables included demographic variables, and dependent variables included knowledge and attitude statements.

## Method

### Study design and setting

This was a cross-sectional study conducted among physicians via a self-administered questionnaire. The study was conducted at three main hospitals and primary care centers in Riyadh, Saudi Arabia.

### Study population and sampling technique

Primary care physicians have an important role in providing care for diabetic patients in a variety of healthcare settings. We approached primary care physicians in Riyadh, Saudi Arabia between December 2018 and June 2019. Within this period, all primary care physicians working at these three main hospital sites and primary care centers were included; a paper copy of an anonymous self-administered questionnaire was distributed by research investigators to the physicians who were willing to participate after clarifying the aim of this survey. A non-probability convenience sampling was used to obtain the required sample size of participants.

### Sample size

The sample size was calculated based on a pilot study using a sample of 25 primary care physicians with different levels of training. Eighty-four percent of participants reported their familiarity with IAH as average or above average. The appropriate sample size was calculated to be 207 participants based on a 5% margin of error, a confidence

interval (CI) of 95 per cent, and 84 per cent average or above average familiarity with IAH. A total of 292 subjects successfully completed the survey.

### Survey instrument

Based on literature review, there has been no previously validated tool for assessing physicians' knowledge and practice about IAH. Thus, after an extensive literature review, a new self-administered questionnaire was initially designed by the researchers. Revision by a panel of three diabetologists experts in research confirmed the content validity of the questionnaire. A pilot study was done to assess the clarity and readability of questions. Several additions and amendments were incorporated to ensure the relevance of the questions. The questionnaire sheet consists of 24 questions that were divided into three parts:

- The first part contains questions about physicians' demographic data, such as age, gender, nationality, level of training, and number of years in practice.
- The second part contains questions about physicians' familiarity with IAH, questions to assess their knowledge about the condition, including its clinical description, prevalence, risk factors, symptoms, management, complications, and questions about their awareness about IAH assessment tools.
- The third section contains questions for assessing physicians' practices when addressing IAH, including how regularly they assess their patients' hypoglycaemic awareness, whether or not they change their management plan accordingly, and their use of IAH assessment tools.

### Statistical tests

Data were entered and analysed using the Statistical Package for the Social Sciences (SPSS) software version 21.0. Descriptive statistics, including frequencies, percentages, and means with standard deviations, were used to measure demographic variables and responses to each question. Familiarity with IAH among physicians was assessed by a 7-point scale in which 1 indicates "not at all familiar" and 7 indicates "extremely familiar." The responses were then classified into "below average" and "average and above" familiarity in which average and above average familiarity was defined for responses of 4–7. For the purpose of analysis, years of practice were categorized as ≤5 years, 6–10 years, 11–15 years, or >15 years. The mean knowledge score was calculated by summing the scores of eleven knowledge questions in which the correct answer to each question was scored as one point. A total score >50% was considered acceptable. The chi-square test was used to assess the relationship between IAH familiarity and physicians' demographics. A logistic regression was used to identify the independent predictors of IAH familiarity. To

test the significance of differences in IAH mean knowledge score between physicians' demographic and familiarity categories, t- and analysis of variance (ANOVA) tests were used. A p-value of ≤0.05 and 95 per cent CIs were used to report the statistical significance and precision of the results.

### Results

This section includes the statistical analysis and results, which were obtained to assess knowledge and practice about impaired awareness of hypoglycaemia in Type 2 diabetic patients among primary care physicians in Riyadh.

Considering a non-response rate of 20 per cent, a total of 365 primary care physicians were approached, and 292 of them completed the survey. A summary of physicians' demographic characteristics is shown in Table 1. Of the 292 physicians, 80.8 per cent were between 24 and 34 years, 15.8 per cent were between 35 and 45 years, and 3.4 per cent were more than 45 years. The study sample consisted of 48.6% males and 51.4 per cent females. Most (89.7 per cent) participants were Saudis. The sample distribution according to the level of training was found to be 77.4 per cent resident, 9.6 per cent registrar, 9.6 per cent consultant, and 3.4 per cent general physician. The mean years of clinical practice were  $4.89 \pm 5.57$ . Almost half of physicians (46.2 per cent) reported their familiarity with IAH as average and above. According to their answers to eleven knowledge questions, the knowledge mean score was  $4.82 \pm 2.06$ .

Table 2 shows the responses to the knowledge questions about IAH. The majority of subjects 90.1 per cent incorrectly defined IAH. The correct statement regarding the prevalence of IAH was chosen by 38.4 per cent of participants. Around two third of subjects (64.4 per cent) recognized old age as a risk factor of IAH, while only 31.2 per cent recognized that repeated exposure of hypoglycaemia leads to an increase in the risk of IAH. Regarding the symptoms that appear first in IAH, 7.5 per cent correctly selected blurred vision. The advisable management choice was selected by 48.3 per cent of subjects. Subjects were given five true or false statements regarding the management of IAH, and 82.5 per cent of physicians agreed that IAH should trigger re-evaluation of the treatment regimen, 63 per cent mistakenly agreed that patients with IAH should check their blood sugar as frequently as others, 66.1 per cent agreed that patients with IAH should treat low sugar levels even if he/she feels okay, 78.1 per cent agreed that IAH is a risk factor of severe hypoglycaemia, and 55.8 per cent agree that hypoglycaemia is a risk factor of IAH.

### Awareness of IAH assessment methods

Physician awareness of various clinical methods to assess hypoglycaemic awareness in diabetic patients was surveyed. According to our literature review, three main assessment methods are used to make assessments: (1) the Clarke method, (2) the Gold method, and the (3) Pedersen-Bjergaard method. Subjects' awareness regarding these methods was 15.4 per cent, 12.3 per cent, and 9.2 per cent, respectively as shown in Table 2.

### Management practices

As demonstrated in Figure 1, assessment of diabetic patients' awareness during hypoglycaemic episodes using the Clarke, Gold, and the Pedersen-Bjergaard methods was performed by 11.3 per cent, 6.2 per cent, and 5.1 per cent, physicians respectively. Around one third (30.5 per cent) of the physicians had previously diagnosed a patient with IAH, and 40.8 per cent of them had managed their IAH patients (Table 2).

Figure 2 shows the distribution of study subjects according to how regularly they assess hypoglycaemia awareness in type 2 diabetic patients who have hypoglycaemia episodes. We noted that 28.4 per cent of physicians reported that they are always assess the hypoglycaemic awareness, 21.4 per cent very often, 25 per cent sometimes, 6.8 per cent rarely, while 17.8 per cent do not assess this awareness.

Table 3 shows the relationship between the familiarity with IAH and personal characteristics of the physicians (age, gender, level of training, years of practice, and overall knowledge of IAH). More than half (59.9 per cent) of the participants presented acceptable knowledge regarding IAH, while only 40.1 per cent had poor knowledge. The results show a statistically significant relationship between the familiarity with IAH and physicians' gender, familiarity with IAH, and overall diabetes/hypoglycaemia knowledge of IAH. Table 4 shows a multivariate regression analysis presenting the predictive factors for familiarity with IAH. After adjustment of all these variables, analysis revealed that gender is the only predictor for familiarity with IAH (odds ratio (OR) =2.4, 95 per cent CI=1.4–3.9; p=0.00). Females were 2.417 times more likely to be familiar with IAH than males.

Physicians with average and above familiarity with IAH had higher mean knowledge scores than those with below average familiarity (mean 5.32 *versus* 4.39; p=0.000). Physicians who managed IAH patients had higher mean knowledge scores compared to those who were/are not managing IAH patients in their care (5.43 *versus* 4.98; p=0.047). Moreover, statistically significant differences between physicians' mean knowledge scores and their ages, levels of training, and years in practice were found. The mean knowledge scores were higher among registrars and

consultants in the age category of older than 45 years and with practice duration >15 years (Table 5).

### Discussion

The knowledge and practice of primary care physicians regarding IAH is not well known. To the best of our knowledge this study is the first study to assess knowledge and practice of primary care physicians regarding IAH. Severe hypoglycemia is an important obstacle in diabetes management as it is associated with increased risk of mortality<sup>30,31</sup>. The severity and recurrence of hypoglycemia attacks exaggerate the fear of future hypoglycemia<sup>31,32</sup> and decrease the quality of life of a patient<sup>33</sup>. As a result, this fear will lead to inadequate glycemic control<sup>34,35</sup>. It was found that IAH increases the risk of severe hypoglycemia in type one and type two diabetes by 6-and 17-fold, respectively<sup>3,26</sup>. In our study, 78.1 per cent of the participants were aware of the increased risk of severe hypoglycemia in patients with IAH.

Although the mean knowledge score was 4.8 out of 11, the majority of physicians failed to define IAH correctly (90.1 per cent). This finding could be explained by difficulty in differentiating between the clinical terms of neurogenic and neuroglycopenic symptoms. Another study reported similar findings of lesser knowledge of hypoglycemia among family practice and internal medicine residents<sup>36</sup>.

The prevention of impaired awareness of hypoglycemia has become a critical part of diabetes mellitus management<sup>1</sup>. The pathophysiology of IAH explains that the impairment is functional rather than structural<sup>1</sup>. Repeated exposure to hypoglycemia can result in diminished autonomic responses, which present a risk factor for hypoglycemia and are also caused in the presence of hypoglycemia<sup>15,37</sup>.

Hence, one of the important interventions for improving IAH is to avoid hypoglycemia, which can be achieved by relaxation of the glycemic target for a short period<sup>38</sup>. In our study, approximately half of the participants agreed with this intervention, while only around a quarter of participants reported that they were able to manage their IAH. Furthermore, the American Diabetic Association (ADA) mentions assessing the awareness of hypoglycemia as one of the components of the comprehensive diabetes medical evaluation<sup>38</sup>. In our study, around one quarter of our physicians rarely or never assessed hypoglycemia awareness in their hypoglycemic patients, which is considered a critical practice gap. Another intervention to improve hypoglycemia awareness among patients with IAH is called the Blood Glucose Awareness Program (BGAT) which is a psycho-educational approach that shows an improvement in patient's self-recognition of hypoglycemia and minimized their fear of hypoglycemia<sup>39,40</sup>. Such

programs can be implemented to support primary care physicians when managing challenging cases of IAH.

We found that older physicians with higher levels of training and more years of practice had better mean knowledge scores than younger and less experienced physicians. These findings explain the fact that more emphasis on discussing this topic is needed to improve the IAH knowledge and practice. More efforts are required to organize educational programs for all primary care physicians and then to assess the result of this effort practically by evaluating their management of patients with IAH. Additionally, further research that seeks to evaluate the knowledge and practice of primary care physicians about IAH is warranted.

This study has limitations. As a cross-sectional study, results show associations but not causal relationships, and this design exhibits a recall bias. Furthermore, test–re-test reliability was not performed while the study tool was designed. More than half the physicians were residents; therefore, results might not be generalizable to all primary care physicians. However, the lack of similar studies renders this result interesting as additional research takes place in other regions.

## Conclusion

A considerable gap was established in IAH knowledge, awareness, and practice among physicians in Riyadh. Physicians with average and above average familiarity with IAH had higher mean knowledge scores; consequently, further efforts are needed to implement extensive educational activities to be directed at all primary care physicians and further research is warranted about this topic.

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## PEER REVIEW

Not commissioned. Externally peer reviewed.

## CONFLICTS OF INTEREST

The authors declare that they have no competing interests.

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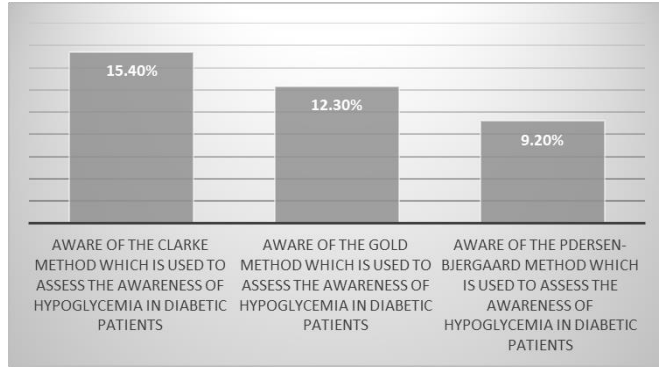
None.

## ETHICS COMMITTEE APPROVAL

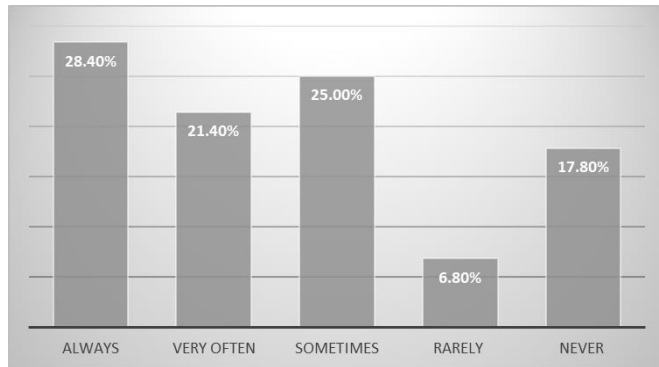
The study protocol received ethical approval from King Fahad Medical City (no. H-01-R-012). Participation in the study was voluntary, the aim of the present study was clearly stated in the questionnaire, and consent was obtained by completing it.

## Figures and Tables

**Figure 1: Summary of physician awareness of the methods that are used to assess the awareness of hypoglycaemia in diabetic patients.**



**Figure 2: Summary of physicians' responses to how frequently they assess hypoglycaemia awareness in type 2 diabetic patients who have hypoglycaemia episodes.**



**Table 1: Physician demographics.**

Characteristics	N (%)
<b>Age</b>	
24-34 years	236 (80.8)
35-45 years	46 (15.8)
>45 years	10 (3.4)
<b>Gender</b>	
Male	142 (48.6)
Female	150 (51.4)
<b>Nationality</b>	
Saudi	262 (89.7)
Non-Saudi	30 (10.3)
<b>Level of training</b>	
General physician	10 (3.4)
Resident	226 (77.4)
Registrar	28 (9.6)
Consultant	28 (9.6)
<b>Years of practice</b>	
Mean (SD)	4.89 (5.57)
<b>Familiarity with IAH</b>	

Below average	157 (53.8)
Average and above	135 (46.2)
<b>Overall knowledge of IAH</b>	
Mean (SD)	4.82 (2.06)

IAH: Impaired awareness of hypoglycemia.

**Table 2: Summary of physicians' responses to questions**

Knowledge	N (%)	
Correctly defined IAH	29 (9.9%)	
Correctly identified the prevalence of IAH	112 (38.4%)	
Correctly identified that old age increases the risk of IAH	188 (64.4%)	
Correctly identified that repeated exposure of hypoglycemia increases the risk of IAH	91 (31.2%)	
Correctly identified the symptom that will appear first in IAH	22 (7.5%)	
Correctly identified the true statement regarding the treatment of IAH	141 (48.3%)	
Agreed that IAH should trigger reevaluation of the treatment regimen	241 (82.5%)	
Agreed that patients with IAH should check their blood sugar as frequently as other patients	108 (37.0%)	
Agreed that patient with IAH should treat low sugar levels, even if he/she feels okay.	193 (66.1%)	
Agreed that IAH is a risk factor of severe hypoglycemia	228 (78.1%)	
Agreed that hypoglycemia is a risk factor of IAH.	163 (55.8%)	
<b>Awareness</b>		
Aware of the Clarke method which is used to assess the awareness of hypoglycemia in diabetic patients	45 (15.4%)	
Aware of the Gold method which is used to assess the awareness of hypoglycemia in diabetic patients	36 (12.3%)	
Aware of the Pedersen-Bjergaard method which is used to assess the awareness of hypoglycemia in diabetic patients	27 (9.2%)	
<b>Practice</b>		
Regularly assess the hypoglycemia awareness in type 2 diabetic patients who have hypoglycemia episodes	Always	83 (28.4%)
	Very often	64 (21.4%)
	Sometimes	73 (25.0%)
	Rarely	20 (6.8%)
	Never	52 (17.8%)
Had diagnosed patient with IAH.	89 (30.5%)	
Had managed patients with IAH.	79 (27.1%)	

Had referred patient with IAH.	49 (16.8%)
Used the Clarke method which is used to assess the awareness of hypoglycemia in diabetic patients	33 (11.3%)
Used the Gold method which is used to assess the awareness of hypoglycemia in diabetic patients	18 (6.2%)
Used the Pedersen-Bjergaard method which is used to assess the awareness of hypoglycemia in diabetic patients	15 (5.1%)

IAH: Impaired awareness of hypoglycemia.

**Table 3: The relationship between IAH familiarity and physicians' demographics.**

Familiarity with IAH**			
Characteristics	Below average	Average and above	P Value*
<b>Age</b>			
24-34 years	129 (44.2%)	107 (36.6%)	0.308
35-45 years	21 (7.2%)	25 (8.6%)	
>45 years	7 (2.4%)	3 (1.0%)	
<b>Gender</b>			
Male	61 (20.9%)	81 (27.7%)	<0.001*
Female	96 (32.9%)	54 (18.5%)	
<b>Level of training</b>			
General physician	7 (2.4%)	3 (1.0%)	0.118
Resident	127 (43.5%)	99 (33.9%)	
Registrar	13 (4.5%)	15 (5.1%)	
Consultant	10 (3.4%)	18 (6.2%)	
<b>Years of practice</b>			
≤5 years	125 (42.8%)	95 (32.5%)	0.267
6-10 years	14 (4.8%)	20 (6.9%)	
11-15 years	11 (3.8%)	14 (4.8%)	
>15 years	7 (2.4%)	6 (2.1%)	
<b>Overall knowledge of IAH***</b>			
Acceptable knowledge	107 (36.6%)	68 (23.3%)	0.002*
Poor knowledge	50 (17.1%)	67 (23.0%)	

Chi-square test: \*Significant at 0.01 IAH: Impaired awareness of hypoglycemia.

\*\*The responses were classified into “below average” and “average and above” familiarity in which average and above average familiarity was defined for responses of ≥4 on the 7-point scale.

\*\*\*The knowledge regarding IAH was considered acceptable if the total score was >50%.

**Table 4: Familiarity with IAH as predicted by physicians' characteristics.**

Adjusted			
Characteristics	OR	P Value	95% CI
<b>Age</b>			
24-34 years *	.	.	.
35-45 years	7.476	0.114	0.616-90.728
>45 years	3.803	0.240	0.409-35.314
<b>Gender</b>			
Male *	.	.	.
Female	2.417	0.000*	1.493-3.915
<b>Level of training</b>			
General physician *	.	.	.
Resident	0.211	0.072	0.038-1.152
Registrar	0.377	0.172	0.093-1.531
Consultant	0.473	0.209	0.147-1.520
<b>Years of practice</b>			
≤5 years *	.	.	.
6-10 years	0.301	0.303	0.031-2.947
11-15 years	0.548	0.558	0.073-4.107
>15 years	0.530	0.526	0.074-3.772

\* Ref: reference (for categorical covariate in logistic regression analysis the first categories are considered as reference category. Then the odds ratio (OR) calculated for each of the other categories with respect to the reference category).

IAH: Impaired awareness of hypoglycemia.

CI: Confidence interval.

**Table 5: Mean knowledge score by physicians' characteristics and IAH familiarity.**

Characteristics	N	Mean Knowledge Score	P Value*
<b>Age</b>			
24-34 years	236	4.62	0.001*
35-45 years	46	5.54	
>45 years	10	6.30	
<b>Gender</b>			
Male	142	4.95	0.300
Female	150	4.70	
<b>Level of training</b>			
General physician	10	5.40	<0.001*
Resident	226	4.55	
Registrar	28	5.68	
Consultant	28	5.96	
<b>Years of practice</b>			
≤5 years	220	4.56	0.001*
6-10 years	34	5.76	
11-15 years	25	5.16	



>15 years	13	6.15	
<b>Familiarity with IAH</b>			
Below average	157	4.39	<0.001*
Average and above	135	5.32	
<b>Manage IAH patients</b>			
Yes	79	5.58	0.019*
No	161	5.01	

Student t- and analysis of variance (ANOVA) tests were used in the analysis. \* Significant at 0.05

IAH: Impaired awareness of hypoglycemia