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## Knowledge about the symptoms of hypoglycemia and its risk among primary school teachers in Riyadh, Saudi Arabia

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### Abstract

**Background:** Hypoglycemia is one of the most common acute complications of the treatment of type 1 diabetes. As children spent major part of their daytime at school, the role of school personnel in recognizing and managing diabetic emergencies such as hypoglycemia is very critical for children safety at school.

**Objective:** To assess the level of knowledge about hypoglycemia and its management among teachers of boys' primary schools in Riyadh. Additionally, evaluate the experience with hypoglycemia recognition and management among them.

**Methods:** Observational cross-sectional study was conducted between January and December 2020 among primary school teachers. Approximately 20 teachers were conveniently recruited from each school. The schools were randomly selected to represent the five geographic regions of Riyadh. Administrative and other auxiliary school employees were excluded. The data were collected using a structured study questionnaire. This included data on socio-demographic characteristics of teachers, knowledge questions about hypoglycemia, previous experience with hypoglycemia, and related health education and training received.

**Results:** A total 404 teachers were included in this analysis. All teachers were Saudi males and the majority (68.1%) of teachers were above the age of 30 years. The majority (64.4%) of teachers had more than 10 years of working experience. The mean knowledge score about hypoglycemia among the study teachers was 77.2%. The majority of teachers were aware that low blood sugar is dangerous (99.0%), need immediate care (99.8%), may be caused by increased dose of treatment (89.1%), and can lead to serious complications including death (77.2%). Only 21.0% of teachers were aware of the first aid measures for low blood sugar. More than half (54.2%) of the teachers have seen a colleague who suffered from low blood sugar. Only 22.6% the teachers who have seen a colleague who suffered from low blood sugar were able to help; by calling emergency (52.6%) or giving him candy (43.9%). Approximately 71% of the teachers have been provided with health education about low blood sugar. However, the majority (89.1%) of teachers believed they need training to deal with low blood sugar conditions. The preferred methods of such training included workshops (48.6%), lectures (36.7%), brochures (12.8%), and mobile messages (1.9%). There was significantly higher knowledge score among teachers who have been provided with health education about low blood sugar. There were no significant associations between knowledge score and socio-demographic characteristics of teachers.

**Conclusions:** We are reporting fair knowledge about hypoglycemia but limited knowledge and skills to manage it among primary school teachers. There is urgent need for diabetes related educational programs targeting teachers working in primary schools to improve their knowledge and confidence in dealing with diabetic emergencies such as hypoglycemia.

**Keywords:** Diabetes mellitus, hypoglycemia, school health, diabetes mellitus, schoolteachers

### Introduction

The burden of type 1 diabetes (T1D) is rapidly increasing worldwide, especially in younger age groups in the Middle East <sup>[1]</sup>. Hypoglycemia is one of the most common acute complications of the treatment of T1D <sup>[2, 3]</sup>. The risk of hypoglycemia in children can prevent optimal glycemic control <sup>[2]</sup>. Additionally, it can significantly add to the psychosocial burden of their disease <sup>[2]</sup>. Common causes of hypoglycemia include excessive insulin dosing, missed meals, exercise, sleep, and alcohol ingestion in case of adolescents <sup>[4]</sup>. Risk factors of hypoglycemia include young age, previous severe hypoglycemic events and reduced

hypoglycemia awareness [4]. Successful management of T1D requires daily balancing of insulin administration, blood glucose monitoring, dietary tracking, and exercise, with the goal of achieving blood glucose levels as near normal as possible [5].

Both children with T1D and their parents have variable degrees of fear of hypoglycemia and its consequences [6]. Children with T1D usually spend much of their waking time in the school environment [5]. Therefore, successful management of diabetes at school promotes good overall diabetes control [7]. Nevertheless, there are several barriers to management of diabetes at school setting [8-10]. These include lack of full-time school nurses, lack of teacher knowledge of diabetes, lack of freedom to perform diabetes self-care, lack of nutritional information in cafeterias, lack of access to diabetes tools, and lack of communication between parents and school personnel [8]. Knowledge and perception of teachers about the management of diabetes emergencies is critical. Nevertheless, several studies showed that the knowledge level was either suboptimal [11-13] or acceptable but still need improvement [14, 15]. The current study is assessing the level of knowledge and experience with hypoglycemia in primary school teachers. The finding will be critical for planning diabetes-related educational activities at school setting.

### Aim and Objectives

This study has the following aims and objectives:

1. To assess the level of knowledge about hypoglycemia and its management among teachers of boys' primary schools in Riyadh.
2. To evaluate the experience with hypoglycemia recognition and management among the above teachers.
3. To determine the factors influencing the knowledge level in the above teachers.

### Materials and Methods

#### Research question

- What is the level of knowledge about symptoms of hypoglycemia among teachers of boys' primary schools in Riyadh?
- What the general awareness about diabetes mellitus among teachers of boys' primary schools in Riyadh?

#### Design

The study used observational cross-sectional design that has been conducted between January and December 2020.

#### Setting

The study was conducted in boys' primary schools in Riyadh, the capital city of Saudi Arabia. Primary education system in Saudi Arabia is divided into boys and girls sections, with only teacher of the same student gender allowed to teach students. According to Saudi government data, 3.16 million students (1.60 million males and 1.56 million females) were receiving primary education in 2019 and the number of teachers totals 217,555 (107,227 male and 110,328 female) [4, 5]. According to Ministry of education (MOE) statistics for the year 2019, there is 7000 boys' primary schools served by more than 100 thousands teachers all over the Kingdom [4, 5]. This includes approximately 750 boys' primary schools in Riyadh, the capital and the biggest city in Saudi Arabia.

### Inclusion and exclusion criteria

The current study targeted primary school teachers working in boys' primary schools in Riyadh. All teachers who were involved directly with students during their school time were eligible to be included, irrespective of their age, nationality, duration of service, or occupational rank. Administrative and other auxiliary school employees have been excluded from the study. Teachers serving children with special needs were not included as they receive additional education and training for supporting children during health and disease status.

### Sample size estimation

As the data on knowledge of symptoms of hypoglycemia among primary school teachers in Saudi Arabia are limited, we assumed at 50% knowledge level to ensure the most conservative (largest) sample size. So assuming knowledge level of 50% with 5% two-sided confidence limits, 384 teachers would be required, using 80% power level and 95% two-sided significance level.

The equation used was

$$N = \frac{Z_{\alpha/2}^2 * P * (1-p) * D}{E^2}$$

$Z_{\alpha/2}$ : is normal deviate at a level of significance = 1.96

P: is the hypothesized % frequency, which was set at 4% (frequency) and 50% (awareness)

E: is the desired precision (half desired CI width), which was set at 2.5% (frequency) and 7.5% (awareness)

D the design effect, which is usually set to 1 in cross-sectional studies

### Sampling technique

Riyadh has been divided into 5 geographic regions; Central, Eastern, Western, Northern, Southern regions. Four schools were randomly chosen from the list of boys' primary schools in each of the five geographic regions of Riyadh. After obtaining the appropriate local administrative approvals, approximately 20 teachers have been targeted conveniently in each of the 20 chosen schools. Teachers were asked to sign a consent form (Appendix-I) before starting the study questionnaire.

### Data collection and data collection tool

The data were collected using a structured study questionnaire. This included data on socio-demographic characteristics of teachers, knowledge questions about hypoglycemia, previous experience with hypoglycemia, and related health education and training received. The questionnaire was self-completed by the teachers. Variables included were shown below and a copy of the questionnaire was shown in Appendix-II

### Socio-demographic characteristics

- Age
- Nationality
- Marital status
- Educational certificate
- Years of experience
- Academic majors

### Knowledge questions about hypoglycemia

- Do you think low blood sugar is dangerous?

- Does the patients with low blood sugar need to see a doctor?
- Do you know about first aid measures for low blood sugar?
- Do you think increased dose of treatment is one of the causes of low blood sugar?
- Do you think that low blood sugar can lead to serious complications that can cause death?

### Experience with hypoglycemia

- Do you have diabetes?
- Do you have a family member who has diabetes?
- Do you have or did you have a colleague with diabetes?
- Have you ever seen a colleague of yours suffer from low blood sugar?
- Did he lose consciousness?
- Did you help him?
- If you helped a colleague who lost consciousness, what actions have you done?

### Health education and training received

- Did doctors provide you with the necessary health education about low blood sugar?
- Did health education include enough information for people to avoid low blood sugar?
- Do you need training to deal with low blood sugar conditions?
- What does this training look like?

### Validation of the study questionnaire

1. The face (how much questions cover the study objectives) and content (scientific merit of questions) validity of the questionnaire were evaluated by three experts in family medicine research. The questionnaire was slightly modified based on the expert suggestions.
2. The questionnaire was initially designed in English and then translated into Arabic by two professional translators.
3. A pilot study was conducted on a sample of 10 teachers with very positive feedback. This pilot study was used to test the clarity and validity of data collection tool, to test the logistics of data collection, and to estimate the duration of data collection.
4. The questionnaire was re-administered after a week to the same teachers of the pilot study to check test-retest reliability. The correlation coefficient of violence questions from the two administrations was 0.95.

### Ethical considerations

The proposal was approved by the research ethics committee Prince Sultan Military Medical City (PSMMC) before starting data collection. Additionally, administrative approval was obtained from the MOE to conduct the study in the schools. The teachers were requested to sign the consent (Appendix-1) after explaining the objectives of the study and before filling the questionnaire. The cover page of the study questionnaire included information about the study objectives as well as the researcher contact information (email address). Acceptance of participation was clearly stated as voluntarily and signing the consent was considered acceptance of participation. The sensitive information of the teachers as name and contacts were not collected and their identity remained anonymous. No incentives or rewards were given to the teachers. The teachers had the right to

withdraw at any time without any obligation towards the study team and to contact the researcher for any query. The data collected were confidentially kept in a safe place and data were only used for the purposes described in the study objectives.

### Data analysis

The questionnaires was coded and the data collected were entered into excel files. All categorical variables were presented as frequencies and percentage while continuous variables were presented as means and standard deviations. Awareness score was created by summing up the responses to 5 knowledge questions; yes was given "one" while no was given "zero". Higher score indicated higher awareness. The score was then transformed into 100-point scale for easy interpretation. Knowledge score was compared between the groups defining socio-demographic characteristics of teachers, previous experience with hypoglycemia, and related health education and training received. Mann-Whitney were used to examine differences in binary variables while Kruskal Wallis test was used to examine differences in multi-level variables. All *P*-values were two-tailed. *P*-value<0.05 was considered as significant. SPSS software (release 25.0, Armonk, NY: IBM Corp) was used for all statistical analyses.

### Results

A total 404 teachers were included in this analysis. The socio-demographic characteristics of the examined teachers are shown in Table 1. The majority (68.1%) of teachers were above the age of 30 years. All teachers had Saudi nationality. The majority (63.6%) of teachers were married while 33.4% were single and only 3.0% were divorced. The majority (89.1%) of teachers had Bachelor degree, with only 6.7% had Master degree and 3.5% had Diploma. The majority (64.4%) of teachers had more than 10 years of working experience while 29.0% had 5-10 years of experience and 6.7% had <5 years of experience. The teachers' majors were scientific studies in 39.1%, Islamic studies in 39.1%, and Social studies in 9.7%.

Table 2 and Figure 1 show the responses of teachers to knowledge questions about hypoglycemia. Almost all teachers were aware that low blood sugar is dangerous (99.0%) and the fact that patients with low blood sugar need to see a doctor (99.8%). The majority of teachers believed that increased dose of treatment is one of the causes of low blood sugar (89.1%) and that low blood sugar can lead to serious complications including death (77.2%). Only 21.0% of teachers were aware of the first aid measures for low blood sugar. As shown in Figure 2, the mean knowledge score about hypoglycemia among the study teachers was 77.2%.

Table 3 shows the experience of teachers with hypoglycemia. Approximately 27.0% of the teachers had diabetes and 45.3% of teachers had a family member who had diabetes. Approximately 59.7% of the teachers had a colleague with diabetes. More than half (54.2%) of the teachers have seen a colleague who suffered from low blood sugar, with 27.8% of these colleagues lost consciousness. Only 22.6% the teachers who have seen a colleague who suffered from low blood sugar were able to help; by calling emergency (52.6%), giving him candy (43.9%), or giving him water (3.5%).

Table 4 shows the health education and training about

hypoglycemia among the study teachers. Approximately 71% of the teachers have been provided by a doctor with the necessary health education about low blood sugar. In almost half (47.0%) of these cases, health education included enough information for people to avoid low blood sugar. The majority (89.1%) of teachers believed they need training to deal with low blood sugar conditions. The preferred methods of such training included workshops (48.6%), lectures (36.7%), brochures (12.8%), and mobile messages (1.9%).

Table 5 shows the knowledge score by socio-demographic characteristics. As shown in Figure 3, there was slightly higher knowledge score among teachers aged 27-30 years (78.9%±13.3%) compared with other age groups (71.3%±10.2% in those aged 20-26 and 76.9%±14.6% in those aged >30 years). However, the difference did not reach statistical significance ( $p=0.068$ ). Additionally, there were no significant differences in knowledge score by other socio-demographic characteristics of the study teachers.

Table 6 shows the knowledge score by experience with hypoglycemia. There was slightly higher knowledge score among teachers who had diabetes (79.1%±13.7% versus 76.5%±14.3%) and those who had a family member who has diabetes (78.5%±14.7% versus 76.2%±13.6%). However, the differences did not reach statistical significance ( $p=0.099$  and  $p=0.078$ , respectively). Additionally, there were no significant differences in knowledge score by other experience with hypoglycemia among the study teachers

Table 7 shows the knowledge score by health education and training about hypoglycemia. There was significantly higher knowledge score among teachers who have been provided

with the necessary health education about low blood sugar (78.2%±14.1% versus 75.6%±14.2%,  $p=0.039$ , Figure 4). However, there were no significant differences in knowledge score by other health education and training about hypoglycemia among the study teachers.

**Table 1:** Socio-demographic characteristics of the study teachers

Characteristics	Number	Percentage
<b>Age (years)</b>		
20-26	16	4.0%
27-30	113	28.0%
>30	275	68.1%
<b>Nationality</b>		
Saudi	404	100.0%
Non-Saudi	0	0.0%
<b>Marital status</b>		
Married	257	63.6%
Single	135	33.4%
Divorced	12	3.0%
<b>Educational certificate</b>		
Diploma	14	3.5%
Bachelor	360	89.1%
Masters	27	6.7%
Others	3	0.7%
<b>Years of experience</b>		
<5	27	6.7%
5-10	117	29.0%
>10	260	64.4%
<b>Academic major</b>		
Scientific	158	39.1%
Islamic studies	158	39.1%
Social studies	39	9.7%
Others	49	12.1%

**Table 2:** Responses to knowledge questions about hypoglycemia among the study teachers

Questions	Yes	No
Do you think low blood sugar is dangerous?	400 (99.0%)	4 (1.0%)
Does the patients with low blood sugar need to see a doctor?	403 (99.8%)	1 (0.2%)
Do you know about first aid measures for low blood sugar?	85 (21.0%)	319 (79.0%)
Do you think increased dose of treatment is one of the causes of low blood sugar?	360 (89.1%)	44 (10.9%)
Do you think that low blood sugar can lead to serious complications that can cause death?	312 (77.2%)	92 (22.8%)

**Table 3:** Knowledge score by socio-demographic characteristics of the study teachers

Characteristics	Mean	Standard deviation	p-value
<b>Age (years)</b>			
20-26	71.3%	10.2%	0.068
27-30	78.9%	13.3%	
>30	76.9%	14.6%	
<b>Marital status</b>			
Married	77.0%	14.6%	0.698
Single	78.1%	12.7%	
Divorced	73.3%	19.7%	
<b>Educational certificate</b>			
Diploma	77.1%	15.4%	0.174
Bachelor	76.9%	14.1%	
Masters	79.3%	14.1%	
Others	93.3%	11.5%	
<b>Years of experience</b>			
<5	74.8%	11.9%	0.237
5-10	79.0%	12.3%	
>10	76.7%	15.1%	
<b>Academic major</b>			
Scientific	76.7%	15.1%	0.820
Islamic studies	78.0%	12.2%	
Social studies	77.4%	17.9%	
Others	76.3%	13.9%	

**Table 4:** Knowledge score by experience with hypoglycemia among the study teachers

Characteristics	Mean	Standard deviation	p-value
<b>Do you have diabetes?</b>			
No	76.5%	14.3%	0.099
Yes	79.1%	13.7%	
<b>Do you have a family member who has diabetes?</b>			
No	76.2%	13.6%	0.078
Yes	78.5%	14.7%	
<b>Do you have or did you have a colleague with diabetes?</b>			
No	77.7%	13.6%	0.600
Yes	76.9%	14.6%	
<b>Have you ever seen a colleague of yours suffer from low blood sugar?</b>			
No	76.9%	13.7%	0.688
Yes	77.5%	14.6%	
<b>Did he lose consciousness?</b>			
No	76.9%	14.4%	0.489
Yes	78.3%	14.3%	
<b>Did you help him?</b>			
No	77.0%	14.3%	0.532
Yes	78.3%	14.8%	
<b>If you helped a colleague who lost consciousness, what actions have you done?</b>			
Called emergency	80.0%	11.7%	0.297
Gave him candy	75.2%	17.6%	
Gave him water	90.0%	14.1%	

**Table 5:** Knowledge score by health education and training about hypoglycemia among the study teachers

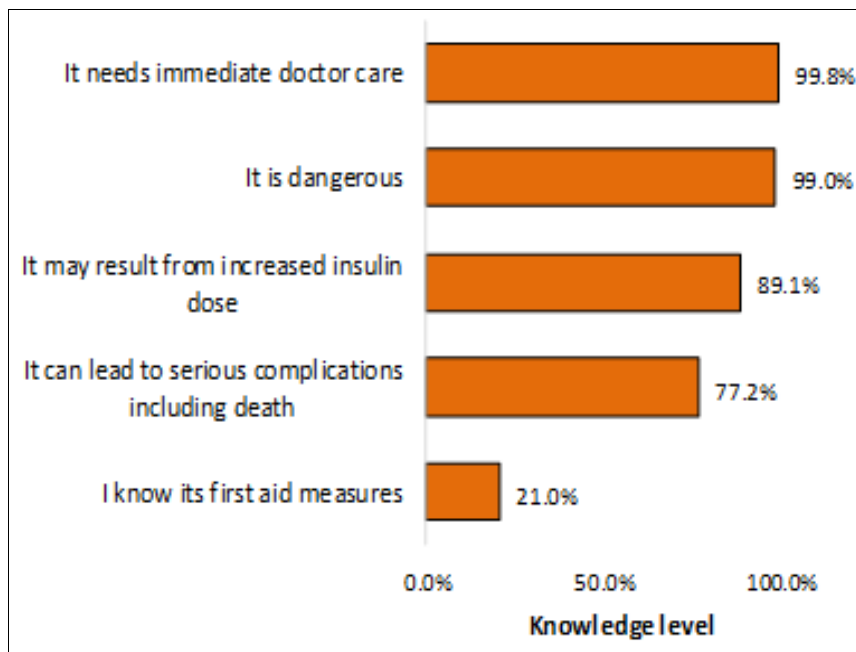
Characteristics	Mean	Standard deviation	p-value
<b>Did doctors provide you with the necessary health education about low blood sugar?</b>			
No	75.6%	14.2%	0.039
Yes	78.2%	14.1%	
<b>Did health education include enough information for people to avoid low blood sugar?</b>			
No	76.5%	14.2%	0.540
Yes	78.5%	14.0%	
<b>Do you need training to deal with low blood sugar conditions?</b>			
No	78.6%	13.2%	0.491
Yes	77.1%	14.3%	
<b>What does this training look like?</b>			
Lectures	75.9%	15.2%	0.498
Workshops	78.2%	13.1%	
Brochures	75.7%	15.7%	
Mobile messages	80.0%	16.3%	

**Table 6:** Knowledge score by experience with hypoglycemia among the study teachers

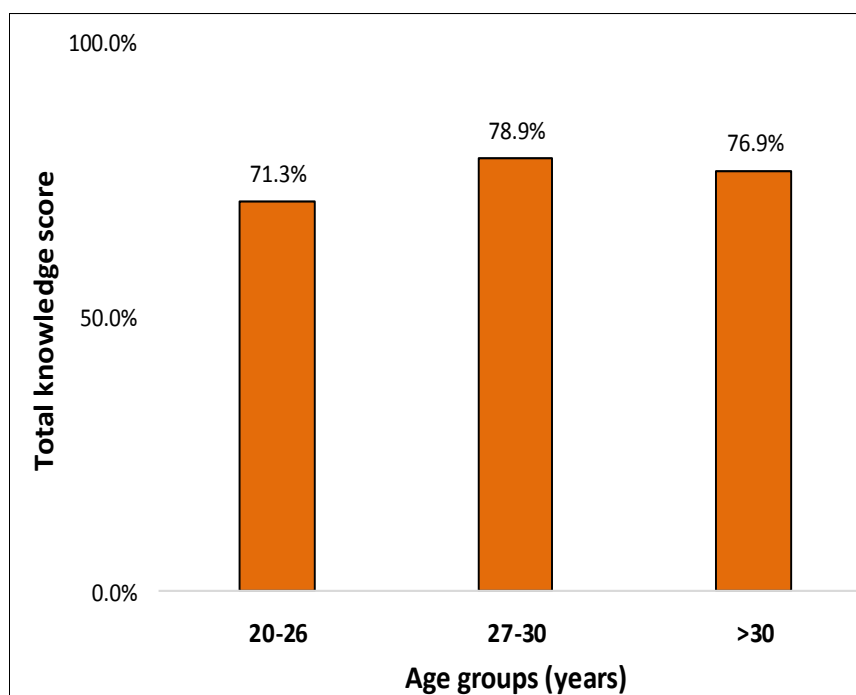
Characteristics	Mean	Standard deviation	p-value
<b>Do you have diabetes?</b>			
No	76.5%	14.3%	0.099
Yes	79.1%	13.7%	
<b>Do you have a family member who has diabetes?</b>			
No	76.2%	13.6%	0.078
Yes	78.5%	14.7%	
<b>Do you have or did you have a colleague with diabetes?</b>			
No	77.7%	13.6%	0.600
Yes	76.9%	14.6%	
<b>Have you ever seen a colleague of yours suffer from low blood sugar?</b>			
No	76.9%	13.7%	0.688
Yes	77.5%	14.6%	
<b>Did he lose consciousness</b>			
No	76.9%	14.4%	0.489
Yes	78.3%	14.3%	
<b>Did you help him?</b>			
No	77.0%	14.3%	0.532
Yes	78.3%	14.8%	
<b>If you helped a colleague who lost consciousness, what actions have you done?</b>			
Called emergency	80.0%	11.7%	0.297
Gave him candy	75.2%	17.6%	
Gave him water	90.0%	14.1%	

**Table 7:** Knowledge score by health education and training about hypoglycemia among the study teachers

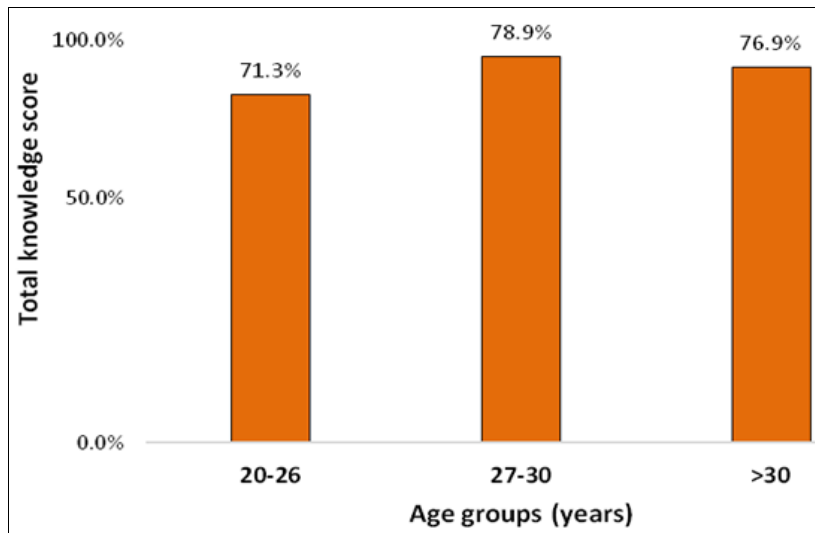
Characteristics	Mean	Standard deviation	p-value
<b>Did doctors provide you with the necessary health education about low blood sugar?</b>			
No	75.6%	14.2%	0.039
Yes	78.2%	14.1%	
<b>Did health education include enough information for people to avoid low blood sugar?</b>			
No	76.5%	14.2%	0.540
Yes	78.5%	14.0%	
<b>Do you need training to deal with low blood sugar conditions?</b>			
No	78.6%	13.2%	0.491
Yes	77.1%	14.3%	
<b>What does this training look like?</b>			
Lectures	75.9%	15.2%	0.498
Workshops	78.2%	13.1%	
Brochures	75.7%	15.7%	
Mobile messages	80.0%	16.3%	



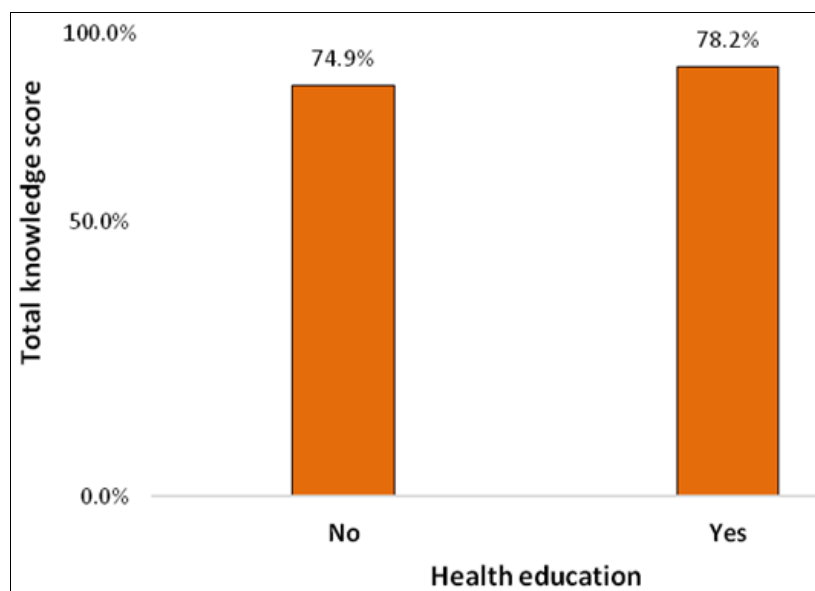
**Fig 1:** Responses to knowledge questions about hypoglycemia among the study teachers



**Fig 2:** Knowledge score among the study teachers by age groups



**Fig 3:** Knowledge score among the study teachers by age groups



**Fig 4:** Knowledge score among the study teachers by the receipt of necessary health education about low blood sugar

**Conclusions**

The current study assessed the level of knowledge of and experience with hypoglycemia among teachers working in boy’s primary schools in Riyadh. All teachers were Saudi males and the majority (68.1%) were above the age of 30 years. The mean knowledge score about hypoglycemia was 77.2%. The majority of teachers were aware that low blood sugar is dangerous (99.0%), need immediate care (99.8%), may be caused by increased dose of treatment (89.1%), and can lead to serious complications including death (77.2%). Only 21.0% of teachers were aware of the first aid measures for low blood sugar. Only 22.6% the teachers who have seen a colleague who suffered from low blood sugar were able to help; by calling emergency (52.6%) or giving candy (43.9%). Approximately 71% of the teachers have been provided with the necessary health education about low blood sugar. Nevertheless, the majority (89.1%) of teachers believed they still need training to deal with low blood sugar conditions. There was significantly higher knowledge score among teachers who have been provided with the necessary health education about low blood sugar. There were no significant associations between knowledge score and socio-demographic characteristics of the teachers.

**Recommendations**

Based on the current study findings, the following recommendations are suggested to improve the knowledge and practice related to care of diabetic emergencies such as hypoglycemia among teachers working in at primary schools in Saudi Arabia:

- There is urgent need for diabetes related educational programs targeting teachers working in primary schools to improve their knowledge and confidence in dealing with diabetic emergencies such as hypoglycemia.
- As almost 90% of the teachers in the current study expressed their need for diabetes-related training to deal with children with hypoglycemia, despite the fact that 70% of them have already received health education about hypoglycemia may indicate poor quality of the currently provided health education. There is urgent need to improve currently provided health education at school to include dedicated teachers, practical training combined with theoretical information, and may be mock training.
- The lower percentage of teachers who helped their colleagues who suffered from low blood sugar may indicate (in addition to limited training) a limited

preparedness of the school environment to manage diabetic emergencies such as hypoglycemia. This calls for more structured program for diabetic care at school which should include presence of full time qualified nurse, health education of teachers, presence of glucometers, presence of glucagon, good communications with parents and healthcare providers, and allowing in-class eating among children with T1D.

- The current findings support the urgent need to create a Saudi T1D school practice guidelines to improve the care and safety of students with T1D at school setting.

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