Original Article

A cross-sectional study of impaired awareness of hypoglycemia and its risk factors among people living with type 1 diabetes in western region, Saudi Arabia

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ABSTRACT

Background: One of the most prevalent endocrine metabolic diseases affecting children and adolescents worldwide is type 1 diabetes mellitus (T1DM), it frequently has severe acute and long-term effects. The prevalence of impaired awareness of hypoglycemia (IAH) is notably high among T1D patients in Saudi Arabia. This study aimed to determine the prevalence of IAH and identify the associated risk factors in individuals with Type 1 diabetes.

Methodology: A cross-sectional observational study was conducted through an online survey distributed across the Western region of Saudi Arabia between July and October 2024. The study utilized the Clarke Hypoglycemia Awareness Survey.

Results: Data from 382 T1D patients were analyzed, revealing a prevalence of IAH of 75.1% in the Western region of Saudi Arabia. Younger adults, particularly those aged 25–54, reported more frequent moderate and severe hypoglycemic episodes. Female participants exhibited a higher prevalence of reduced awareness (72.1%). Patients with higher educational attainment demonstrated poorer awareness of hypoglycemic symptoms. However, this finding was not statistically significant ($p \geq 0.05$).

Conclusion: The high prevalence of impaired awareness of hypoglycemia (IAH) among T1D patients in Saudi Arabia's Western region underscores the urgent need for improved patient education and awareness programs on hypoglycemia and effective self-management strategies, especially for newly diagnosed individuals. Addressing key factors, such as the duration of diabetes and the importance of tailored educational interventions, is crucial to reducing the risks associated with IAH.

Keyword: Awareness of hypoglycemia, Hypoglycemia risk, Saudi Arabia, Type 1 diabetes

Introduction

Diabetes mellitus is a chronic condition characterized by abnormalities in insulin secretion, action, or both, leading to prolonged elevated blood glucose levels. Type 1 diabetes (T1D) results from the autoimmune destruction of pancreatic β-cells, leading to an absolute insulin deficiency. In contrast, Type 2 diabetes (T2D) is characterized by insulin resistance and a relative deficiency of insulin [1].

The global prevalence of diabetes is rising steadily, with the disease affecting an estimated 537 million individuals worldwide as of 2021. This figure is projected to increase to 643 million by 2030 and to 783 million by 2045 [2]. With respect to T1D, 530,000 new cases were diagnosed globally in 2022, of which 201,000 cases involved individuals under the age of 20. Saudi Arabia ranks among the top ten countries with the highest number of T1D cases [3].

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Hypoglycemia, defined as a blood glucose level below 70 mg/dL, is a common and significant complication in people with T1D [4,5]. The risk of hypoglycemia in T1D patients is influenced by factors such as avoiding meals, administering insufficient insulin during exercise, or excessive insulin dosing leading to increased glucose utilization [6]. The neuroglycopenic and autonomic symptoms associated with hypoglycemia alert patients to the onset of an episode, prompting them to take corrective actions [7]. However, frequent episodes of hypoglycemia can lead to impaired awareness of hypoglycemia (IAH), a condition in which patients lose the ability to recognize the symptoms of impending hypoglycemia, as these symptoms gradually diminish over time [8]. This lack of awareness significantly increases the risk of severe hypoglycemic episodes, which can lead to dangerous complications such as unconsciousness and seizures [9]. To date, there has been only one study addressing the prevalence of IAH among patients with T1D in Saudi Arabia. Conducted in a single center in the Riyadh region, this study found that 62.8% of T1D patients exhibited impaired awareness of hypoglycemia [10]. However, no data exist for the Western region, which this study aims to assess the prevalence of IAH and identify the risk factors contributing to impaired awareness among T1D patients in the Western region of Saudi Arabia.

Methods

This cross-sectional observational study was carried out from July to October 2024 in Saudi Arabia's western area. The study included patients diagnosed with Type 1 diabetes mellitus (T1D) who were aged 15 years or older. Exclusion criteria included non-diabetic individuals, patients with Type 2 diabetes mellitus (T2D), and individuals younger than 15 years. The minimum required sample size for the study was calculated to be 384 using the Raosoft online sample size calculator. However, due to missing data in the records of two participants, their responses were excluded, leaving a total of 382 questionnaires for analysis. In this computation, a 95% confidence interval and a 5% margin of error were assumed. We received the ethical permission number (HAO-02-T-105) from the Saudi Arabian Taif University Research Ethics Committee. All participants were informed about the purpose and nature of the study, and consent was obtained from them, allowing the use of their data in the analysis. Participants were given an online survey to collect data. The questionnaire was divided into two sections. The first section collected sociodemographic data, including age, gender, education level, and the duration of diabetes diagnosis. The second section utilized the Clarke Hypoglycemia Awareness Questionnaire [11]. We categorized the participants into two groups based on their responses to the first eight questions: the "aware group" (those who demonstrated awareness of hypoglycemia) and the "reduced-awareness group" (those with impaired awareness of hypoglycemia). A subject was classified as having reduced awareness if they provided four or more responses indicating reduced awareness (denoted by "R"). A subject was categorized as aware if they provided two or fewer responses indicating reduced awareness. Additionally, a "U" response indicated hypoglycemia unawareness. The Statistical Package for the Social Sciences (SPSS) version 26 was used to analyze the data. Descriptive statistics were used to gather the information, and integers and percentages were employed to show categorical variables. We used a chi-squared test (χ^2) to assess the association between categorical variables. The standard deviation and mean were used to express quantitative data, and the Mann-Whitney U test was applied to non-parametric data. Statistical significance was defined as a p-value (less than 0.05).

Results

A total of 382 participants with Type 1 diabetes mellitus (T1D) were included in the study. (Table 1) summarizes the demographic details of the participants. Among them, 42.95% were aged between 25 and 54 years, with 71.7% identifying as female. The majority (54.2%) had attained a university-level education. Comorbidities were reported by 35.6% of the participants. The mean ± standard deviation (SD) of diabetes duration was 15.57 ± 10.92 years. (non-tabulated). (Table 2) presents the results of the survey assessing participants' awareness of hypoglycemia. Regarding the recognition of hypoglycemia symptoms, 40% of participants reported feeling symptoms when their blood glucose levels were low, while 53.7% indicated that they had lost the ability to recognize these symptoms over time. Only 21.5% of participants reported no moderate hypoglycemic episodes, and 50.5% experienced no severe hypoglycemic episodes. Notably, 2.1% of participants had experienced severe hypoglycemia (defined as episodes ≥12 times) in the past six months. In terms of symptom frequency, 27.5% of participants reported experiencing hypoglycemic episodes with symptoms once a week during the last month, and 19.6% reported experiencing hypoglycemic episodes without any symptoms. Additionally, 14.7% of participants reported that their blood glucose levels would drop below 40 mg/dL before they felt any symptoms of hypoglycemia. Approximately one-third (33%) of

Table (1): Distribution of studied patients according to their demographic characteristics, chronic diseases and DM type 1 duration (No.: 382).

Variable	N. (%)
Age	
15-19	114 (29.8)
20-24	84 (22)
25-54	164 (42.9)
55-64	20 (5.2)
Gender	
Female	274 (71.7)
Male	108 (28.3)
Educational level	
Primary	15 (3.9)
Intermediate	33 (8.6)
Secondary	127 (33.2)
University	207 (54.2)
Chronic diseases	
No	246 (64.4)
Yes	136 (35.6)

Table 2: Responses of patients to survey items used to categorize being aware or having reduced awareness of hypoglycemia (No.: 382).

	Variable	N. (%)
1	**When your blood sugar is low, do you experience symptoms of hypoglycemia such as (Shaking, sweating, dizziness)**	
	Never (R)	25 (6.5)
	Sometimes (R)	203 (53.1)
	Always (A)	154 (40.3)

2	**Have you stopped experiencing hypoglycemia symptoms when your blood sugar was low?**	
	No (A)	205 (53.7)
	Yes (R)	177 (46.3)
3	**How frequently have you experienced episodes of moderate hypoglycemia in the last six months? (Episodes in which you may feel disoriented, confused, or lethargic and are unable to take care of yourself)**	
	None (A)	82 (21.5)
	Once / month (R)	231 (60.5)
	Once /6 month (R)	69 (18.1)
4	**How frequently have you experienced severe hypoglycemia episodes in the last 12 months? (Episodes where you were unconscious or had a seizure required intravenous glucose)**	
	None (A)	193 (50.5)
	1 time (R)	103 (27)
	2-6 times (R)	56 (14.7)
	7-11 times (R)	22 (5.8)
	12 or more (U)	8 (2.1)
5	**3- In the past month, how many times did you have hypoglycemia with symptoms?**	
	Never (A)	38 (9.9)
	1-3/month (R)	101 (26.4)
	1/week (R)	105 (27.5)
	2-3/week (R)	89 (23.3)
	4-5/week (R)	30 (7.9)
	Almost daily (R)	19 (5)
6	**3- In the past month, how many times did you have hypoglycemia without any symptoms?**	
	Never (A)	99 (25.9)
	1-3/month (R)	89 (23.3)

	1/week (R)	75 (19.6)
	2-3/week (R)	86 (22.5)
	4-5/week (R)	21 (5.5)
	Almost daily (U)	12 (3.1)
7	**What was the lowest blood sugar level before feeling the symptoms of hypoglycemia?**	
	<40 (R)	56 (14.7)
	40-49 (R)	83 (21.7)
	50-59 (A)	98 (25.7)
	60-69 (A)	93 (24.3)
	>70 (A)	52 (13.6)
8	**How often did you experience symptoms of hypoglycemia when your blood glucose level was low?**	
	Never (R)	17 (4.5)
	Rarely (R)	21 (5.5)
	Sometimes (R)	111 (29.1)
	Often (A)	107 (28)
	Always (A)	126 (33)
Reduced awareness is indicated by four or more R replies, while awareness is indicated by two or fewer.		

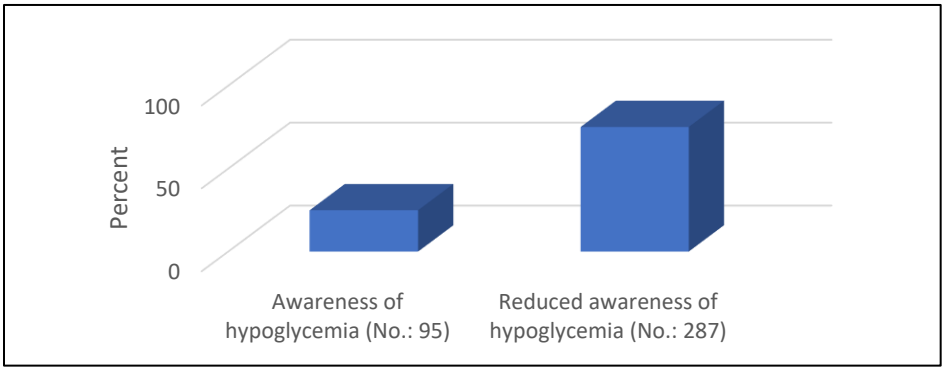

Figure 1. Prevalence of reduced awareness of hypoglycemia among studied diabetic patients.

Table 3: Relationship between awareness of hypoglycemia and patients' demographics, chronic diseases and DM type 1 duration (No.: 382).

Variable	Awareness of hypoglycemia		$\chi 2$	p-value
	Awareness N. (%)	Reduced awareness N. (%)		
Age			5.54	0.136
15-19	37 (38.9)	77 (26.8)		
20-24	16 (16.8)	68 (23.7)		
25-54	38 (40)	126 (43.9)		
55-64	4 (4.2)	16 (5.6)		
Gender			0.09	0.764
Female	67 (70.5)	207 (72.1)		
Male	28 (29.5)	80 (27.9)		
Educational level			2.62	0.453
Primary	6 (6.3)	9 (3.1)		
Intermediate	10 (10.5)	23 (8)		
Secondary	30 (31.6)	97 (33.8)		
University	49 (51.6)	158 (55.1)		
Chronic diseases			0.61	0.432
No	58 (61.1)	188 (65.5)		
Yes	37 (38.9)	99 (34.5)		
DM duration (years)			7.08	0.131
1-15	50 (52.6)	181 (63.1)		
16-30	32 (33.7)	85 (29.6)		
31-45	9 (9.5)	15 (5.2)		
46-60	3 (3.2)	6 (2.1)		
>60	1 (1.1)	0 (0.0)		

participants indicated that they always experience symptoms when their blood glucose levels are low. As shown in (Figure 1), a significant proportion of the study population (75.1%) demonstrated reduced awareness of hypoglycemia. (Table 3) explores the potential associations between demographic factors and the prevalence of reduced hypoglycemia awareness. Although the prevalence of reduced awareness was higher among participants aged 25-54 years, female participants, those with a university education, and those with a shorter duration of diabetes, none of these associations reached statistical significance ($p \geq 0.05$). Additionally, the mean ± standard deviation (SD) of diabetes duration (years) among participants with reduced awareness was 14.88 ± 10.38, with a p-value of 0.108. (non-tabulated).

Discussion

This study aimed to assess the prevalence of impaired awareness of hypoglycemia (IAH) and its risk factors among individuals with Type 1 diabetes (T1D) in the Western region of Saudi Arabia. Our findings revealed a high prevalence of IAH, with 75.1% of participants exhibiting reduced awareness of hypoglycemia. This result is consistent with a previous study in Riyadh, which reported a prevalence of 62.8% [10]. However, the prevalence in our study was notably higher compared to a study conducted in Madinah, where only 25.2% of insulin-treated diabetic patients exhibited IAH [12]. This discrepancy may be attributed to regional differences, as we conduct our study in multiple cities, which emphasizes the need to understand local factors affecting diabetes management in this area [13]. Female participants in our study were more likely to experience reduced awareness of hypoglycemia compared to males, with a prevalence rate of 72.1% among females. This finding aligns with some previous studies, such as one conducted in Jeddah, which reported a 53.3% prevalence of IAH among female patients with both Type 1 and Type 2 diabetes [15]. The higher prevalence of IAH among females in our study may suggest the need for gender-specific educational interventions to improve hypoglycemia recognition and management [16]. Interestingly, our study also found that younger adults, particularly those aged 25-54 years, and individuals with a university education had a higher prevalence of IAH. This contrasts with earlier research, which indicated that IAH is more common in older adults, particularly those over the age of 65, and among individuals with lower educational levels [14]. The increased prevalence in younger, more educated individuals in our cohort may be attributable to the lifestyle factors associated with this age group, such as career demands and family responsibilities, which may interfere with regular blood glucose monitoring and the recognition of hypoglycemic symptoms [15]. Moreover, despite their higher educational attainment, these individuals may not have received adequate education on the critical aspects of hypoglycemia management, leading to a false sense of security [16]. Another finding from our study was the higher prevalence of IAH among individuals with a shorter duration of diabetes, this finding aligns with a previous study conducted in Norway, which reported that a shorter duration of diabetes was associated with an increased prevalence of IAH [17]. However, most prior research indicates that longer diabetes duration is typically associated with increased IAH [10, 12, 14]. One possible explanation is that newly diagnosed patients may lack the experience and knowledge required to recognize the symptoms of hypoglycemia, thus exhibiting reduced awareness. These patients might still be adjusting to their diagnosis and have not yet developed the necessary skills for effective self-management [18]. In contrast, longer-term diabetes patients are likely to experience repeated hypoglycemic episodes, which can lead to a diminished physiological response to low blood glucose levels over time, further contributing to the development of IAH [19]. This highlights the importance of early and ongoing education for both newly diagnosed and long-term diabetes patients, ensuring they are equipped with the knowledge and tools to manage their condition effectively [20].

Limitations: In our study, while we observed notable relationships between age, gender, educational level, and diabetes duration with impaired awareness of hypoglycemia (IAH), these findings were not statistically significant. This may reflect the demographic characteristics of our sample, indicating a need for further research with a larger and more diverse population to explore these potential risk factors in greater depth. Additionally, recall bias may have affected participants' responses regarding hypoglycemic episodes, as they were required to rely on memory for events from the past 12 months; online recruitment may have excluded older or digitally inactive individuals, affecting representativeness. The study's focus on a single region also limits the generalizability of the results to the broader Saudi population. Despite these limitations, the findings underscore the necessity for enhanced patient

education and awareness programs to address the risks associated with IAH in Type 1 Diabetes (T1D) patients.

Conclusion

This study reveals a high prevalence (75%) of impaired awareness of hypoglycemia (IAH) among Type 1 Diabetes (T1D) patients in Western Saudi Arabia, increasing the risk of severe events and highlighting the need for better education and self-management. Newly diagnosed patients, especially with shorter diabetes duration, require early, targeted education on symptom recognition and management. While our findings suggest a potential link between shorter diabetes duration and reduced awareness of hypoglycemia, further research is needed to confirm and better understand this relationship. Future studies should examine IAH changes over time, the impact of diabetes duration and lifestyle, and the effectiveness of educational interventions should be implemented to improve hypoglycemia awareness, particularly among newly diagnosed patients and reduce risks.

Conflict of Interest

None

Funding

None

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