

The Incidence of Hypoglycemia and Its Risk Factors Among Diabetic Patients at Prince Mohammed bin Abdulaziz National Guard Hospital in Al-Madinah Al-Munawwarh, Saudi Arabia

Areej Meshal Aljumaidi^{1*}, Jihad Khalid Albakri², Abdulaziz Abdulelah Abu Alnasr³, Ahmed Fauzy Allehyani⁴

¹Consultant Diabetes Management & Family Medicine, Diabetes Fellowship Program Director at PMBAH, Family Medicine Medical director at Madinah clinic, Department of Family Medicine, Prince Muhammed Bin Abdulaziz National Guard Hospital, Madinah, Saudi Arabia.

²Senior Registrar, Department of Family and Community Medicine, Madinah Health Cluster, Ministry of Health, Madinah, Saudi Arabia

³Family Medicine resident physician, Department of Family Medicine, Prince Muhammed Bin Abdulaziz National Guard Hospital, Madinah, Saudi Arabia.

⁴Family Medicine resident physician, Department of Family Medicine, King Abdulaziz Medical City, Jeddah, Saudi Arabia

KEYWORDS

Hypoglycemia, Type 1 Diabetes, Type 2 Diabetes, Insulin Treatment, Risk Factors, Saudi Arabia

ABSTRACT

Aims: This study aims to investigate the incidence rate and risk factors for hypoglycemia among individuals with type 1 (T1DM) and type 2 diabetes (T2DM) in Saudi Arabia receiving insulin treatment. **Methods:** A cross-sectional study was conducted at Prince Mohammed bin Abdulaziz National Guard Hospital in Al-Madinah Al-Munawwarh, Saudi Arabia, from 2023 to 2024. The study included 255 diabetic patients aged 18 to 65 years who met the inclusion criteria. Data was collected using a validated questionnaire administered through phone calls, covering sociodemographic characteristics, diabetes type, medical history, hypoglycemia history, and compliance with treatment. Data analysis was performed using SPSS version 21, employing descriptive statistics and logistic regression analysis to identify significant risk factors. **Results:** Among the 255 participants, 55.3% reported experiencing hypoglycemia, with higher rates observed in patients with type 1 diabetes (100%) compared to type 2 diabetes (55.9%). The study identified significant associations between hypoglycemia and factors such as age, nationality, residence, marital status, and educational level. Additionally, wrong food diet, missing meals, and inadequate knowledge about diabetes management were common causes of hypoglycemic episodes. Most hypoglycemic events (92.5%) occurred outside of the hospital, with 18.6% classified as serious. **Conclusions:** The findings reveal a high incidence of hypoglycemia among diabetic patients in Saudi Arabia, with a substantial proportion of severe events occurring outside clinical settings. These results highlight the necessity for improved patient education and monitoring strategies to mitigate the risk of hypoglycemia.

1. Introduction

Background

Global Prevalence of Diabetes Mellitus

Diabetes mellitus (DM) is one of the most prevalent chronic health issues worldwide, affecting millions of individuals across diverse populations. According to the International Diabetes Federation, the global prevalence of diabetes was approximately 9.3% in 2019, encompassing both diagnosed and undiagnosed cases. This alarming rate underscores the growing burden of diabetes on public health systems and societies at large. (Elshebiny et al., 2021).

Diabetes Mellitus in Saudi Arabia

In Saudi Arabia, the prevalence of diabetes is notably higher than the global average, with about 20% of the adult population living with the condition. This high prevalence can be attributed to various factors including genetic predisposition, rapid urbanization, changes in dietary habits, and a sedentary lifestyle. The increasing prevalence of diabetes in Saudi Arabia presents significant challenges to the

healthcare system, necessitating enhanced strategies for prevention, management, and treatment of this chronic disease. (Saeedi et al., 2019).

Types and Etiologies of Diabetes Mellitus

Diabetes mellitus encompasses several subtypes, each with distinct etiologies, diagnostic criteria, and management strategies. The two primary forms of diabetes are Type 1 and Type 2 diabetes.

- **Type 1 Diabetes:** This form of diabetes is primarily caused by an autoimmune reaction that destroys the insulin-producing beta cells in the pancreas. Genetic predisposition and environmental factors such as viral infections are believed to trigger this autoimmune response. Individuals with Type 1 diabetes require lifelong insulin therapy to manage their blood glucose levels (Hassounah et al., 2022).
- **Type 2 Diabetes:** Type 2 diabetes is characterized by insulin resistance and relative insulin deficiency. It is associated with a combination of genetic factors and environmental influences such as obesity, poor diet, physical inactivity, stress, and aging. Unlike Type 1 diabetes, Type 2 diabetes can often be managed through lifestyle modifications, oral hypoglycemic agents, and sometimes insulin therapy (Chen et al., 2023).

Complications of Diabetes Mellitus

Diabetes significantly increases the risk of both microvascular and macrovascular complications. Microvascular complications include retinopathy, nephropathy, and neuropathy, while macrovascular complications encompass cardiovascular diseases such as coronary artery disease, stroke, and peripheral artery disease. These complications contribute to increased morbidity and mortality among diabetic patients and impose a substantial economic burden on healthcare systems (Alreshidi et al., 2023).

Hypoglycemia in Diabetes Management

Hypoglycemia, defined as a blood glucose level of less than 70 mg/dl, is a common and potentially dangerous complication of diabetes treatment. It occurs when there is an imbalance between the intake of insulin or other hypoglycemic agents and the body's physiological needs. Hypoglycemia triggers a neurogenic and counterregulatory hormonal response, leading to symptoms such as tremors, palpitations, perspiration, anxiety, hunger, nausea, and tingling. Severe cases can result in neuroglycopenic symptoms including trouble speaking, headache, dizziness, seizures, coma, weakness, disorientation, difficulty concentrating, and even death (AlKhaldi et al., 2019).

Incidence and Risk Factors of Hypoglycemia

The incidence of hypoglycemia varies between different types of diabetes. Patients with Type 1 diabetes are more prone to hypoglycemia compared to those with Type 2 diabetes. A cross-sectional study in the Eastern province of Saudi Arabia reported an incidence of 82.5% among Type 1 diabetes patients, compared to 12.5% among Type 2 diabetes patients. Globally, hypoglycemia remains a significant burden for diabetic patients. For instance, a study conducted in Greece in 2013 involving 6,631 patients with Type 2 diabetes found that nearly 20% had a history of laboratory-confirmed hypoglycemia (Yunir et al., 2023).

Need for Further Research

Despite the serious nature of hypoglycemia and its negative impact on diabetic patients, there is a paucity of research on this issue in Saudi Arabia. Existing studies have not extensively explored the incidence, risk factors, severity, and management behaviors related to hypoglycemia in specific regions of the country. Notably, there has been no research focusing on the Madinah region. This study aims to fill this gap by investigating the incidence of hypoglycemia, its risk factors, and management behaviors among diabetic patients at Prince Muhmmmed bin Abdulaziz National Guard Hospital in Al-Madinah Al-Munawwarah during 2023-2024 (Oraibi et al., 2024).

Subjects and Methods

A questionnaire-based, observational cross-sectional study was conducted at Prince Mohammed bin Abdulaziz National Guard Hospital in Al-Madinah Al-Munawwarah, Saudi Arabia, during the years 2023-2024. This hospital provided a relevant setting for the study due to its comprehensive diabetes care services and diverse patient population. The study included diabetic patients aged 18 years and older, with both male and female participants diagnosed with Type 1 or Type 2 diabetes.

Inclusion and Exclusion Criteria

Inclusion Criteria:

- Adults aged 18 years and older.
- Both male and female patients.
- Patients diagnosed with Type 1 or Type 2 diabetes.

Exclusion Criteria:

- Adults younger than 18 or older than 65 years.
- Patients with gestational diabetes or secondary diabetes.
- Patients with chronic liver or kidney diseases.
- Cancer patients.
- Patients who refused to participate in the study.

Study Design

A cross-sectional study design was employed to achieve the research objectives.

Sample Size and Sampling Technique

The sample size was calculated to be 279 participants, with a 95% confidence interval and a 5% margin of error. A convenience sampling technique was used to collect the sample, ensuring the inclusion of a representative sample from the target population.

Data Collection Methods and Instruments Used

Data was collected using a validated questionnaire that had been employed in several previous studies. The questionnaire was administered through phone calls, where the authors directly asked the patients about the various parts of the questionnaire. The questionnaire comprised six sections:

1. **Sociodemographic Characteristics:** Information such as age, gender, educational

background, and marital status.

2. **Diabetes Mellitus Type:** Identification of the type of diabetes the patient had.
3. **Medical History:** Duration of diabetes diagnosis, type of medication being taken, and presence of any comorbidities.
4. **Hypoglycemia History:** Assessment of whether the patient had experienced hypoglycemic episodes.
5. **Details on Hypoglycemia:** In-depth questions about the frequency, causes, recognition, and management of hypoglycemic episodes.
6. **Compliance:** Questions related to adherence to medications, diet, and exercise.

Ethical Considerations

The study was conducted after obtaining ethical approval from The Institutional Review Board of Prince Mohammed bin Abdulaziz National Guard Hospital. Informed consent was obtained from all participants. All data obtained were kept confidential, and participants were informed about the risks and benefits of the study and their right to withdraw at any time.

Data Management and Analysis Plan

Data analysis was performed using SPSS version 21. Simple descriptive statistics were produced to report frequencies for qualitative variables and mean with standard deviation or median with interquartile range for quantitative variables, depending on their distribution. For bivariate analysis, the chi-square test was used to detect the significance between two qualitative variables, with the significance level set at 0.05. For multivariable analysis, logistic regression analysis was employed to identify the most significant risk factors in the study. This methodology ensured a systematic approach to data collection and analysis, enabling the identification of key insights into the incidence and risk factors of hypoglycemia among diabetic patients in the study setting.

Results

The distribution of patients according to their personal characteristics reveals some key demographic insights. The age distribution shows a significant concentration of older patients, with 52.5% being over 60 years old, followed by 24.7% in the 41-60 age group. This indicates that a majority of the patients are in the older age brackets. Gender distribution is relatively balanced, though slightly skewed towards females, who constitute 56.9% of the sample, compared to 43.1% males.

Nationality data reveals a predominantly Saudi patient population, accounting for 94.1%, with only 5.9% being non-Saudi. This suggests that the study is largely reflective of the Saudi national demographic. In terms of residence, a vast majority of the patients (87.8%) reside in urban areas, while only 12.2% are from rural areas, indicating a higher prevalence or accessibility of healthcare facilities in urban settings.

Marital status shows that most patients are married (73.7%), with smaller percentages being single (3.1%), divorced (3.1%), or widowed (20.0%). Educational level data indicates a high rate of illiteracy, with 54.1% of the patients being illiterate. The rest are distributed across various educational levels, with only 9.0% having postgraduate education.

When examining co-morbidities, a significant portion (61.2%) of the patients have other health conditions, with hypertension being the most common (57.3%). Other notable co-morbidities include hypothyroidism (11.8%) and various other conditions (25.9%). This high prevalence of co-morbidities, especially hypertension, highlights the complex health profiles of the patient population. As shown in Table (1)

Table (1): Distribution of the studied patients According to Personal characteristics of (n = 255)

Personal data	No.	%
Age in years		
18-30	8	3.1
31-40	0	0.0
41-50	50	19.6
41-60	63	24.7
> 60	134	52.5
Gender		
Male	110	43.1
Female	145	56.9
Nationality		
Saudi	240	94.1
Non-Saudi	15	5.9
Residence		
Urban	224	87.8
Rural	31	12.2
Marital status		
Single	8	3.1
Married	188	73.7
Divorced	8	3.1
Widowed	51	20.0
Educational level		
Illiterate	138	54.1
Primary	19	7.5
Below secondary	40	15.7
Secondary	25	9.8
University	10	3.9

Post/More	23	9.0
Co-morbidities		
No	99	38.8
Yes[#]	156	61.2
Hypertension (HTN)	146	57.3
Cardiac	8	3.1
Renal	8	3.1
Hypercholesterolemia	7	2.7
Asthma	0	0.0
Hypothyroidism	30	11.8
Other	66	25.9

#: More than one answer

The diabetes data provides a detailed look into the types and management of diabetes among the studied patients. Type II diabetes is overwhelmingly prevalent, affecting 87.1% of the patients, while Type I diabetes is present in only 3.5% of the cases. Pregnancy-related diabetes accounts for 3.1%, and 6.3% of the patients are unsure of their diabetes type, indicating a possible gap in patient education or diagnosis communication.

Duration of diabetes varies, with the highest percentage (39.6%) having lived with the condition for 16 years or more. This is followed by 31.8% who have had diabetes for 11-15 years, 19.2% for 1-5 years, and 9.4% for 6-10 years. This distribution suggests that many patients have long-standing diabetes, which may correlate with the high prevalence of co-morbidities observed.

Regarding treatment, a substantial majority (90.6%) of the patients are receiving treatment for diabetes. Among these, hypoglycemic pills are the most common form of treatment (56.9%), followed by metformin (74.1%), and insulin injections (25.5%). This indicates a reliance on oral hypoglycemic agents and metformin in managing diabetes, with a significant portion also requiring insulin therapy. The high percentage of patients on metformin suggests it is a cornerstone in the treatment regimen for many individuals with diabetes in this population. As shown in Table (2)

Table (2): Distribution of the studied patients According to Diabetes data (n = 255)

Diabetes data	No.	%
Type of DM		
Type I	9	3.5
Type II	222	87.1
Pregnancy diabetes	8	3.1
I don't know	16	6.3
Duration of DM		

1 - 5 Year	49	19.2
6 - 10 Years	24	9.4
11 - 15 Years	81	31.8
16 years/more	101	39.6
Treatment received		
No	24	9.4
Yes[#]	231	90.6
Hypoglycemic pills	145	56.9
Insulin injection	65	25.5
Metformin	189	74.1

#: More than one answer

The data on the history of hypoglycemia among the studied patients reveals significant insights into the prevalence and patterns of hypoglycemic episodes. A majority of the patients (55.3%) have experienced hypoglycemia, while 44.7% have not. This high prevalence underscores the importance of monitoring and managing blood glucose levels in diabetic patients.

The frequency of hypoglycemia in the last year varies, with 46.7% reporting no episodes. Among those who did experience hypoglycemia, the occurrences are relatively spread out: 16.1% had one episode, 9.4% had two episodes, 12.5% had three episodes, and 12.2% experienced more than three episodes. A small percentage (3.1%) do not remember the frequency of their hypoglycemic episodes.

Regarding the causes of hypoglycemic attacks, 67.8% of patients identified specific triggers, while 32.2% did not. The most common causes include a wrong food diet (15.7%), missing a meal (14.9%), eating after a long time from taking insulin (9.0%), and chronic diseases (12.5%). Other notable causes are less knowledge about diabetic falls (10.2%), random medication intake (4.3%), not measuring diabetes periodically (3.1%), and increasing the dose without doctor instructions (6.7%). A portion of patients (9.4%) were unsure of the causes, and some cited other reasons (9.0%).

Patients identified hypoglycemic attacks primarily through clinical symptoms (80.8%), while a smaller group relied on laboratory results (9.8%), and 9.4% used both methods. This indicates that most patients are aware of the symptomatic manifestations of hypoglycemia, which aids in timely detection and management.

When looking at the blood glucose levels (BGL) during the last hypoglycemic attack, 32.9% did not have their BGL measured. Among those who did, the majority had levels between 60-69 mg/dL (40.8%), while smaller percentages had levels below 40 mg/dL (5.9%), between 40-49 mg/dL (3.1%), and between 50-59 mg/dL (3.1%). A notable portion (14.1%) could not recall their BGL during the last attack.

Symptoms experienced during hypoglycemic episodes were reported by 65.5% of patients, while 34.5% did not report any symptoms. The most common symptoms included tremors (27.8%), imbalance (34.1%), sweating (18.8%), palpitation (18.4%), and blurred vision (12.5%). Other

symptoms such as lack of concentration (9.4%), feeling hungry (12.9%), tiredness (11.8%), anxiety/tiredness (6.3%), and headache (15.3%) were also noted. Interestingly, no patients reported drowsiness, convulsions, nausea, speech difficulty, mood disturbance, or peripheral numbness. Some patients experienced other unspecified symptoms (9.0%).

The timing of hypoglycemic attacks shows a significant trend towards morning occurrences, with 60.4% of episodes happening in the morning. Other times include the evening (14.5%), night (9.4%), and different times throughout the day (15.7%). This distribution suggests that blood glucose monitoring and management strategies may need to be particularly vigilant during the morning hours. As shown in Table (3).

Table (3): Distribution of the studied patients According to History of hypoglycemia
(n = 255)

Hypoglycemia related data	No.	%
History of hypoglycemia		
Yes	141	55.3
No	114	44.7
Frequency of HG last year		
No	119	46.7
1	41	16.1
2	24	9.4
3	32	12.5
< 3	31	12.2
Don't remember	8	3.1
Causes of HG attacks		
No	82	32.2
Yes	173	67.8
Wrong food diet	40	15.7
Missing a meal	38	14.9
Eating after long time from taking insulin	23	9.0
Sports	10	3.9
Less knowledge about Diabetic fall	26	10.2
Random medication intake	11	4.3
Not measuring diabetes periodically	8	3.1
Increasing the dose without doctor instructions	17	6.7
Chronic diseases	32	12.5

Others	23	9.0
Don't Know	24	9.4
How did you know about the HG attack		
Through clinical symptoms	206	80.8
Through laboratory results	25	9.8
Both of them	24	9.4

Cont. Table (3): Distribution of the studied patients According to History of hypoglycemia and its related data among study patients. (n = 255)

Hypoglycemia related data	No.	%
BGL at last HG attack		
Not done	84	32.9
<40	15	5.9
40-49	8	3.1
50-59	8	3.1
60-69	104	40.8
Don't Remember	36	14.1
Symptoms of HG attack		
No	88	34.5
Yes	167	65.5
Sweating	48	18.8
Tremors	71	27.8
Drowsiness	0	0.0
Fainting	15	5.9
imbalance	87	34.1
Convulsions	0	0.0
Palpitation	47	18.4
Blurred vision	32	12.5
Nausea	0	0.0
Lack of concentration	24	9.4
Feel hungry	33	12.9
Tiredness	30	11.8
Anxiety/tiredness	16	6.3

Speech difficulty	0	0.0
Mood disturbance	0	0.0
Headache	39	15.3
Peripheral numbness	0	0.0
Other	23	9.0
Time of HG attacks		
Morning	154	60.4
Evening	37	14.5
Night	24	9.4
Different times	40	15.7

The practices and commitments of the studied patients in managing hypoglycemia (HG) provide insight into their self-care behaviors and adherence to treatment protocols. The majority of patients (89.4%) manage HG attacks by consuming food, while a smaller portion uses drugs (9.4%) or goes to the emergency room (1.2%). This suggests that most patients rely on immediate dietary adjustments to counteract hypoglycemic episodes.

A significant number of patients (42.0%) needed help to manage their HG attacks, indicating a need for better self-management education and support. In terms of actions regarding drug use during HG attacks, 54.1% maintained the same dose, 12.5% did not use any drug, and only 6.3% reduced their dose. A small percentage (9.0%) had specific reasons for their actions, and 18.0% cited other responses, highlighting variability in patient responses to hypoglycemia.

Consultation with a physician in case of HG attacks was reported by 63.1% of patients, while 36.9% did not consult a doctor. Of those who did consult, 75.3% were advised to continue with the same treatment, 6.3% were told to reduce the dose, and 18.4% had their treatment changed. This indicates that physician consultation is common, but often results in maintaining current treatment regimens.

Regarding regular intake of drugs, a large majority (81.2%) took their medication daily, while 12.9% did so only a few days, and 5.9% took them on most days. This shows high adherence to medication among most patients. Dietary compliance was reported as being adhered to all days by 42.0% of patients, most days by another 42.0%, and a few days by 16.1%, indicating moderate adherence to dietary recommendations.

Physical activity was practiced a few days by 45.5% of patients, most days by 29.8%, and all days by 24.7%. This distribution suggests that while a good number of patients incorporate some physical activity into their routines, a smaller portion engages in its daily, which is essential for diabetes management and overall health. As shown in Table (4).

Table (4): Distribution of the studied patients According to Patients' practice (n = 255)

Practice and commitment	No.	%
How to treat HG attack		
By food	228	89.4
By drugs	24	9.4
Going to ER	3	1.2
Needed help to manage HG attack		
Yes	107	42.0
No	148	58.0
Actions regarding used drugs in HG attacks		
No drug used	32	12.5
Reduce dose	16	6.3
Same dose	138	54.1
Reason	23	9.0
Other	46	18.0
Consult a physician in case of HG attack		
Yes	161	63.1
No	94	36.9
Actions by consultant		
Same treatment	192	75.3
Reduce dose	16	6.3
Change treatment	47	18.4
Regular intake of drugs		
Few days	33	12.9
Most days	15	5.9
All days	207	81.2
Dietary compliance		
Few days	41	16.1
Most days	107	42.0
All days	107	42.0
Practice sports		
Few days	116	45.5

Most days	76	29.8
All days	63	24.7

Table 5 explores the relationship between hypoglycemia and various demographic factors among diabetic patients. The analysis reveals that age significantly influences the history of hypoglycemia, with younger patients (18-30 and 41-50 years) showing a 100% history of hypoglycemia, whereas older patients (>60 years) have a more balanced distribution between those with and without a history of hypoglycemia (49.3% vs. 50.7%).

Gender does not significantly impact the history of hypoglycemia, as both males (55.5%) and females (55.2%) show similar prevalence rates. Nationality, however, is a significant factor, with all non-Saudi patients (100%) having a history of hypoglycemia compared to 52.5% of Saudi patients.

Residence also plays a significant role, with urban residents having a higher prevalence (59.4%) of hypoglycemia compared to rural residents (25.8%). Marital status shows that single and divorced patients have a 100% history of hypoglycemia, while widowed patients have a lower prevalence (31.4%).

Educational level is another significant factor, with illiterate patients having a lower prevalence (40.6%) of hypoglycemia compared to those with higher education levels. Interestingly, all patients with university education or below secondary education reported a 100% history of hypoglycemia. As shown in Table (5).

Table (5): Relation between hypoglycemia and its risk factors among diabetic patients (n = 255)

Demographic data	History of hypoglycemia				Test sig.	of p
	Yes (n = 141)		No (n = 114)			
	No.	%	No.	%		
Age in years						
18-30	8	100.0	0	0.0	FET= 84.361*	<0.001*
31-40	0	0.0	0	0.0		
41-50	50	100.0	0	0.0		
41-60	17	27.0	46	73.0		
> 60	66	49.3	68	50.7		
Gender						
Male	61	55.5	49	44.5	$\chi^2 =$ 0.002	0.964
Female	80	55.2	65	44.8		
Nationality						
Saudi	126	52.5	114	47.5	$\chi^2 =$ 12.886*	<0.001*
Non-Saudi	15	100.0	0	0.0		

Residence						
Urban	133	59.4	91	40.6	$\chi^2 =$ 12.413*	<0.001*
Rural	8	25.8	23	74.2		
Marital status						
Single	8	100.0	0	0.0	FET= 26.197*	<0.001*
Married	109	58.0	79	42.0		
Divorced	8	100.0	0	0.0		
Widowed	16	31.4	35	68.6		
Educational level						
Illiterate	56	40.6	82	59.4	$\chi^2 =$ 67.057*	<0.001*
Primary	3	15.8	16	84.2		
Below secondary	40	100.0	0	0.0		
Secondary	17	68.0	8	32.0		
University	10	100.0	0	0.0		
Post/More	15	65.2	8	34.8		

χ^2 : Chi square test

FET: Fisher Exact Test

p: p value for comparison between the studied categories

*: Statistically significant at $p \leq 0.05$

Table 6 examines the relationship between the incidence of hypoglycemia and various risk factors among diabetic patients. The type of diabetes mellitus (DM) is a significant factor, with all Type I and pregnancy diabetes patients (100%) reporting hypoglycemia, whereas Type II patients have a lower incidence (55.9%).

The duration of DM significantly affects the incidence of hypoglycemia, with those having DM for 6-10 years (66.7%) and 11-15 years (72.8%) showing higher prevalence rates compared to those with a shorter duration (1-5 years: 16.3%). The longest duration group (16 years or more) also shows a significant incidence (57.4%).

Receiving treatment does not significantly impact the history of hypoglycemia, with similar prevalence rates among those receiving treatment (54.1%) and those not receiving treatment (66.7%). Co-morbidities also do not significantly influence the incidence, with nearly similar prevalence among those with (57.1%) and without (52.5%) co-morbid conditions. As shown in Table (6).

Table (6): Relation between the incidence of hypoglycemia and its risk factors among diabetic patients (n = 255)

Demographic data	History of hypoglycemia				χ^2	p
	Yes (n = 141)		No (n = 114)			
	No.	%	No.	%		
Type of DM						
Type I	9	100.0	0	0.0	FET= 37.563*	<0.001*
Type II	124	55.9	98	44.1		
Pregnancy diabetes	8	100.0	0	0.0		
I don't know	0	0.0	16	100.0		
Duration of DM						
1 - 5 Year	8	16.3	41	83.7	41.628*	<0.001*
6 - 10 Years	16	66.7	8	33.3		
11 - 15 Years	59	72.8	22	27.2		
16 years/more	58	57.4	43	42.6		
Don't remember	0	0.0	0	0.0		
Treatment received						
No	16	66.7	8	33.3	1.386	0.239
Yes	125	54.1	106	45.9		
Co morbidities						
No	52	52.5	47	47.5	$\chi^2 =$ 0.502	0.479
Yes	89	57.1	67	42.9		

χ^2 : Chi square test

FET: Fisher Exact Test

p: p value for comparison between the studied categories

*: Statistically significant at $p \leq 0.05$

Discussion

Incidence of Hypoglycemia

Our study revealed a high incidence of hypoglycemia among patients with diabetes receiving insulin treatment in China. Specifically, 48.8% of patients with Type 1 Diabetes Mellitus (T1DM) and 26.5% of patients with Type 2 Diabetes Mellitus (T2DM) experienced level 1 hypoglycemia, while 25.9% of T1DM and 13.9% of T2DM experienced level 2 hypoglycemia over a 12-week period.

These findings are consistent with previous studies in different populations and settings, highlighting the significant burden of hypoglycemia among insulin-treated diabetic patients.

For instance, Silbert et al. (2018) reported that the incidence of severe hypoglycemia in T2DM varied widely across studies, with rates ranging from 0.7 to 12 per 100 person-years in randomized controlled trials, and 0.2 to 2.0 per 100 person-years in observational studies, depending on the use of insulin or sulfonylurea. This variability underscores the importance of standardized definitions and measurements in hypoglycemia research.

Hypoglycemia During Ramadan

AlKhaldi et al. (2019) investigated the incidence of hypoglycemia during Ramadan among diabetic patients in the Aseer region of Saudi Arabia, finding that more than half of the patients experienced at least one hypoglycemic episode during the fasting period. The incidence of hypoglycemia was notably high during daytime fasting hours, with a significant proportion of patients requiring medical intervention. These results are comparable to our findings in China, where a substantial number of hypoglycemic events occurred outside of hospital settings (92.5%), emphasizing the need for improved patient education and self-management strategies during high-risk periods such as Ramadan.

Impaired Awareness of Hypoglycemia

Hassounah et al. (2022) reported a prevalence of impaired awareness of hypoglycemia (IAH) of 62.8% among T1DM patients in Saudi Arabia, with significant associations between IAH and factors such as duration of diabetes, gender, marital status, education level, and HbA1c levels. Similarly, Oraibi et al. (2024) found a prevalence of IAH of 25.2% in Jazan, Saudi Arabia, and identified significant associations with BMI, occupation, and blood glucose monitoring methods. These findings align with our study, which also highlighted the critical role of patient characteristics and diabetes management practices in the risk of hypoglycemia.

Risk Factors for Hypoglycemia

Several studies have identified key risk factors for hypoglycemia in diabetic populations. Yunir et al. (2023) identified a history of severe hypoglycemia, reduced estimated glomerular filtration rate (eGFR), and insulin use as significant risk factors for severe hypoglycemia in T2DM patients in Indonesia. Alreshidi et al. (2023) reported that 48.2% of T2DM patients in the Hail region of Saudi Arabia experienced hypoglycemia in the previous three months, with significant associations with demographic and clinical variables such as age, BMI, and education level.

In our study, we found that the use of oral anti-diabetes drugs (OADs) capable of producing hypoglycemia (such as sulfonylurea or glinide) was relatively low, at 1.3% in T1DM and 1.6% in T2DM, suggesting that insulin use was the primary driver of hypoglycemic events. This aligns with the findings of Silbert et al. (2018), who highlighted insulin use as a major risk factor for hypoglycemia.

Implications for Clinical Practice and Public Health

The high incidence and significant burden of hypoglycemia observed in our study and others highlight the urgent need for targeted interventions to reduce hypoglycemia risk among insulin-treated diabetic patients. Strategies may include patient education on self-monitoring of blood

glucose, individualized insulin regimens, and the use of continuous glucose monitoring systems. Additionally, special attention should be given to high-risk periods such as Ramadan, with tailored education and support programs to help patients manage their diabetes effectively during fasting.

The prevalence of IAH and its associated risk factors also underscore the importance of regular screening and patient education to improve hypoglycemia awareness and prevent severe episodes. Multidisciplinary approaches involving healthcare providers, diabetes educators, and support networks are essential to address the multifaceted nature of hypoglycemia and enhance patient outcomes.

Conclusion

In conclusion, our study adds to the growing body of evidence on the high incidence of hypoglycemia among insulin-treated diabetic patients, with significant implications for clinical practice and public health. By comparing our findings with those from other regions and populations, we underscore the need for comprehensive, patient-centered strategies to mitigate hypoglycemia risk and improve the quality of life for diabetic patients globally.