Current Status and Influencing Factors of Impaired Awareness of Hypoglycemia in Patients with Type 2 Diabetes Mellitus: A Postprint

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Abstract

Abstract

Background: Impaired awareness of hypoglycemia (IAH) is a common issue among patients with type 2 diabetes mellitus (T2DM). Recurrent hypoglycemic events can lead to a decline in patients' ability to perceive hypoglycemia, thereby increasing the risk of severe hypoglycemia. However, there are currently few studies on the status and influencing factors of IAH among T2DM patients in community settings.

Objective: To investigate the current status of IAH among community-dwelling T2DM patients and analyze its influencing factors, providing a scientific basis for community health service institutions to enhance the effectiveness of patient health management.

Methods: This cross-sectional study employed a multi-stage stratified random sampling method to select T2DM patients from nine community health service centers (stations) in Fengtai District, Beijing, as research subjects. From May to August 2024, information regarding patients' general data, hypoglycemia experiences, hypoglycemia awareness, and diabetes self-management behaviors was collected through "one-on-one" questionnaire surveys. The GOLD method was used to assess hypoglycemia awareness and determine the occurrence of IAH. A multivariate binary Logistic regression model was used to analyze the influencing factors of IAH.

Results: A total of 487 valid questionnaires were collected, and the self-reported prevalence of IAH among community T2DM patients was 27.1% (132/487). Multivariate binary Logistic regression analysis showed that the risk factors for IAH in T2DM patients were undetected/unclear complications [with no complications as reference, OR (95% CI) = 2.164 (1.215–3.852)] and achieving HbA1c targets [OR (95% CI) = 1.648 (1.033–2.628)]. Protective

factors included a long duration of T2DM [with ≤ 5 years as reference, 11–20 years OR (95% CI) = 0.320 (0.152–0.672), ≥ 20 years OR (95% CI) = 0.459 (0.226–0.955)], oral hypoglycemic agents [OR (95% CI) = 0.052 (0.01–0.274)], insulin use [OR (95% CI) = 0.199 (0.050–0.803)], no use of hypoglycemic agents [OR (95% CI) = 0.029 (0.003–0.245)], multimorbidity [OR (95% CI) = 0.613 (0.348–1.081)], awareness of hypoglycemia diagnostic criteria [OR (95% CI) = 0.498 (0.265–0.935)], certain blood glucose monitoring capabilities [with no capability and no monitoring tools as reference, having tools but monitoring occasionally OR (95% CI) = 0.406 (0.185–0.891), proficient and regular monitoring OR (95% CI) = 0.410 (0.173–0.974)], and good smoking control [with poor smoking control as reference, OR (95% CI) = 0.498 (0.272–0.909)].

Conclusion: Strict glycemic control and a lack of knowledge regarding blood glucose monitoring increase the risk of IAH, while regular blood glucose monitoring, understanding hypoglycemia knowledge, and smoking cessation can reduce the risk. Community healthcare providers should implement comprehensive interventions targeting these factors, optimizing blood glucose monitoring, strengthening health education, and promoting smoking cessation to reduce the incidence of IAH and improve patient disease management and quality of life.

Full Text

Impaired Awareness of Hypoglycemia: Prevalence and Determinants among Community-based Patients with Type 2 Diabetes Mellitus

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Abstract Background: Impaired awareness of hypoglycemia (IAH) is a prevalent issue among patients with Type 2 Diabetes Mellitus (T2DM). Recurrent hypoglycemic events may diminish hypoglycemia perception and elevate the risk of severe hypoglycemia. However, limited research has explored the prevalence and determinants of IAH in community-dwelling T2DM patients. **Objective:** To investigate the prevalence of IAH and its influencing factors among community T2DM patients, providing scientific evidence for community health service institutions to optimize health management strategies. **Methods:** This cross-sectional study adopted a multistage stratified random sampling method to select T2DM patients from 9 community health service centers (stations) in Fengtai District, Beijing. From May to August 2024, data on demographic characteristics, hypoglycemic experiences, hypoglycemia awareness, and diabetes

self-management behaviors were collected via face-to-face questionnaires. The GOLD method was used to assess hypoglycemia awareness and diagnose IAH. Multivariate binary Logistic regression analysis was performed to identify the determinants of IAH. **Results:** Among 487 valid questionnaires, the self-reported prevalence of IAH was 27.1% (132/487). Multivariate binary Logistic regression analysis revealed that the independent risk factors for IAH were undiagnosed or unknown diabetes complications [compared to no complications, OR (95% CI) = 2.164 (1.215–3.852)] and achievement of glycated hemoglobin A1c (HbA1c) targets [OR (95% CI) = 1.648 (1.033–2.628)]. Protective factors included a T2DM duration of 11–20 years [OR (95% CI) = 0.320 (0.152–0.672)] or ≥ 20 years [OR (95% CI) = 0.459 (0.226–0.955)], use of oral hypoglycemic agents [OR (95% CI) = 0.052 (0.01–0.274)], insulin use [OR (95% CI) = 0.199 (0.050–0.803)], no hypoglycemic medication use [OR (95% CI) = 0.029 (0.003–0.245)], multimorbidity [OR (95% CI) = 0.613 (0.348–1.081)], awareness of hypoglycemia diagnostic criteria [OR (95% CI) = 0.498 (0.265–0.935)], having blood glucose monitoring tools with occasional use [OR (95% CI) = 0.406 (0.185–0.891)], proficient and regular blood glucose monitoring [OR (95% CI) = 0.410 (0.173–0.974)], and good tobacco control status [OR (95% CI) = 0.498 (0.272–0.909)]. **Conclusion:** Stringent glycemic control and insufficient blood glucose monitoring knowledge are associated with increased IAH risk, whereas regular glucose monitoring, hypoglycemia awareness, and smoking cessation demonstrated protective effects. Community healthcare providers should implement comprehensive interventions targeting these factors to reduce IAH incidence and improve patients' disease management and quality of life.

[**Key words**] Diabetes mellitus, type 2; Impaired awareness of hypoglycemia; Influencing factors; Community health services; Health management

1 Introduction

In recent years, as research into hypoglycemia in patients with Type 2 Diabetes Mellitus (T2DM) has deepened, the status of impaired awareness of hypoglycemia (IAH) has gained increasing attention [**?**]. Studies have found that recurrent hypoglycemic events can impair a patient' s ability to perceive low blood sugar through mechanisms such as weakened sympathetic nervous system responses, thereby significantly increasing the risk of severe hypoglycemia [**?**]. However, there is currently relatively little research on the prevalence and influencing factors of IAH among community-dwelling T2DM patients [**?**].

Since the community is the primary setting for the residence and treatment of T2DM patients [**?**], understanding the current status of IAH and analyzing its determinants is crucial for developing targeted interventions and improving patients'quality of life and glycemic management. This study aims to investigate the prevalence of IAH in community T2DM patients and analyze its influencing factors to provide a scientific basis for community health service institutions.

2 Methods

2.1 Study Population This cross-sectional study utilized a multistage stratified random sampling method. The survey was conducted in Fengtai District, Beijing, which comprises 26 sub-districts/towns. Nine community health service institutions (4 centers and 5 stations) were randomly selected across nine sub-districts (34.6% of the total). T2DM patients were randomly selected from general outpatient clinics based on their appointment sequence. Inclusion criteria required a definitive diagnosis of T2DM. Exclusion criteria included: (1) presence of other serious comorbidities or mental illness; (2) inability to cooperate with the questionnaire. The study was approved by the Ethics Committee of Fangzhuang Community Health Service Center (Approval No. S20240301), and all participants provided informed consent.

The sample size was estimated based on cross-sectional study requirements and multivariate binary logistic regression models [**?**, **?**]. Using the formula $n = (Z^2_{1-\alpha/2} \times p \times q)/d^2$, with a 95% confidence level ($Z = 1.96$), an expected IAH prevalence (p) of 26.2% [**?**], and an allowable error (d) of 0.1, the base sample size was 75. Accounting for a design effect (DEFF) of 1.5, an 80% response rate, and 10 core independent variables, the final target sample size was set at 360. Samples were distributed based on the service population of each institution, with a minimum of 30 cases per site. Fangzhuang Community Health Service Center, serving over 70,000 residents, contributed approximately 200 cases.

2.2 Data Collection From May to August 2024, trained investigators conducted one-on-one surveys using paper and digital formats. Out of 499 questionnaires collected, 487 were valid (97.6% effective rate). The survey included: 1. **General Data:** Demographics, T2DM duration, family history, complications, medication use, multimorbidity, BMI, recent HbA1c levels, health education, and glucose monitoring ability. 2. **Hypoglycemic Experience:** History of hypoglycemia in the past six months, categorized by ADA standards into severe, symptomatic, asymptomatic, probable symptomatic, and relative hypoglycemia [**?**]. 3. **Hypoglycemia Awareness:** Assessed using the GOLD method, a single-question visual analog scale: "Can you feel when your low blood sugar is starting?" Scores range from 1 (always aware) to 7 (never aware). A score of ≥ 4 indicates IAH [**?**]. 4. **Self-Management Behavior:** Measured via the Summary of Diabetes Self-Care Activities (SDSCA) scale, covering diet, exercise, glucose monitoring, foot care, smoking, and medication adherence [**?**].

2.3 Statistical Analysis Data were analyzed using SPSS 26.0. Categorical data were expressed as frequencies and percentages, with group comparisons performed using χ^2 tests or Fisher' s exact tests. Multivariate binary logistic regression was used to analyze influencing factors for variables showing significance in univariate analysis. Missing HbA1c data (11.5%) were handled via multiple imputation. $P < 0.05$ was considered statistically significant.

3 Results

3.1 Participant Characteristics The majority of the 487 patients were ≥ 60 years old (79.5%) and married (90.8%). T2DM duration was evenly distributed, with 25.5% having a duration ≤ 5 years. Regarding clinical status, 60.4% had no detected complications, 91.4% used oral medications, and 17.9% used insulin. Notably, 52.2% did not meet their HbA1c targets. Sixty-five patients (13.35%) reported 79 hypoglycemic events (see). Self-management scores were generally moderate to good for diet and medication but poor for glucose monitoring (78.6% poor) and foot care (59.0% poor).

3.2 Prevalence of IAH The overall prevalence of IAH was 27.1% (132/487). Significant differences in IAH incidence were observed based on age, T2DM duration, family history, complications, multimorbidity, HbA1c target achievement, knowledge of diagnostic criteria, and glucose monitoring ability ($P < 0.05$). No significant differences were found regarding gender, education, or previous health education (see).

3.3 Multivariate Analysis of Influencing Factors Multivariate logistic regression (see) identified that T2DM duration, complications, medication type, HbA1c achievement, diagnostic knowledge, monitoring ability, and tobacco control were significant predictors of IAH. Specifically, unknown complication status and achieving HbA1c targets were risk factors, while longer disease duration, medication use (oral or insulin), knowledge of hypoglycemia criteria, regular monitoring, and smoking cessation were protective factors.

4 Discussion

IAH is a critical clinical issue in T2DM management [**?**]. Our study found a 27.1% prevalence of IAH in the community, which aligns with global meta-analyses reporting 26.2% [**?**]. Interestingly, while longer duration is often a risk factor, our data suggests that patients with 11–20 years of disease may have developed better symptom recognition through long-term education.

The finding that HbA1c target achievement correlates with higher IAH risk suggests that stringent glycemic control may lead to more frequent hypoglycemic exposure, raising the perception threshold [**?**]. Furthermore, the significant protective effect of knowing diagnostic criteria and having proficient monitoring skills highlights the importance of targeted education. Patients who do not monitor their blood sugar or lack the tools are at much higher risk.

Finally, the association between smoking and IAH risk may be due to nicotine' s impact on the nervous system, potentially raising the threshold for autonomic symptoms [**?**]. Community health providers should therefore integrate smoking cessation and specialized glucose monitoring training into routine T2DM care to mitigate IAH risk and improve patient safety [**?**]. Future research should

incorporate continuous glucose monitoring (CGM) to eliminate the "blind spots" of self-reported data and further refine these interventions [**?**].

Note: Figure translations are in progress. See original paper for figures.