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Original Research Article

PROSPECTIVE EVALUATION OF RISK FACTORS FOR RECURRENT HYPOGLYCAEMIA IN ELDERLY PATIENTS RECEIVING ANTIDIABETIC TREATMENT

Subhash Jha[1], *Vasupalli Lochan Sai*[2]

[1]*Associate Professor, Department of General Medicine, SIMS, Hapur, Uttar Pradesh, India.*
[2]*Junior Resident 2, Department of General Medicine, SIMS, Hapur, Uttar Pradesh, India.*

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Corresponding Author:
Dr. Vasupalli Lochan Sai
Junior Resident, Department of General Medicine, SIMS, Hapur, Uttar Pradesh, India.
Email:lochan.sai007@gmail.com

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ABSTRACT

Background: Recurrent hypoglycaemia is an important complication among elderly patients receiving antidiabetic treatment, contributing to increased morbidity, hospitalisation, falls, and impaired quality of life. Advancing age, multiple comorbidities, impaired renal function, and complex treatment regimens may increase susceptibility to repeated hypoglycaemic episodes. The aim is to prospectively evaluate the clinical, biochemical, nutritional, and treatment-related risk factors associated with recurrent hypoglycaemia among elderly patients receiving antidiabetic treatment.

Materials and Methods: This hospital-based prospective observational study included 104 elderly patients aged ≥60 years with type 2 diabetes mellitus receiving antidiabetic medications at a tertiary care hospital. Patients were classified into recurrent hypoglycaemia (n=40) and non-recurrent hypoglycaemia (n=64) groups. Demographic characteristics, comorbidities, medication patterns, dietary habits, biochemical parameters, and clinical outcomes were assessed. Statistical analysis was performed using SPSS version 28.0, with $p<0.05$ considered statistically significant.

Results: Recurrent hypoglycaemia was observed in 40 (38.46%) patients. Mean age (73.42 ± 7.93 versus 69.39 ± 6.50 years; p=0.009) and diabetes duration (13.57 ± 6.32 versus 9.98 ± 5.79 years; p=0.005) were significantly higher in the recurrent group. Insulin therapy (62.50% versus 28.12%; p=0.001), irregular meals (65.00% versus 26.56%; p<0.001), and renal impairment (60.00% versus 25.00%; p<0.001) were significantly associated with recurrence. Multivariable analysis identified previous hypoglycaemia (aOR=9.63), insulin therapy (aOR=7.40), irregular meals (aOR=7.24), and renal impairment (aOR=3.50) as independent associated factors. Recurrent hypoglycaemia was also associated with increased hospitalisation and falls.

Conclusion: Previous hypoglycaemia, insulin therapy, irregular meal intake, and renal impairment were important factors associated with recurrent hypoglycaemia. Individualised treatment, regular glucose monitoring, nutritional assessment, and medication optimisation may help reduce recurrence and improve patient safety.

Keywords: Recurrent hypoglycaemia, Elderly patients, Type 2 diabetes mellitus, Antidiabetic treatment, Risk factors.

INTRODUCTION

Type 2 diabetes mellitus is a chronic health problem among older adults and requires long-term management to reduce microvascular and macrovascular complications. As populations age, clinicians are increasingly caring for patients who have multiple chronic illnesses and complex therapeutic needs. Although achieving appropriate glycaemic control remains a component of diabetes management, the benefits of glucose-lowering treatment must be balanced against adverse effects.

Hypoglycaemia is concerning in elderly individuals because its occurrence may compromise functional independence, complicate medication adherence, and increase the need for emergency medical care.[1] Ageing produces physiological and functional changes that influence glucose regulation and responses to antidiabetic medications. Reduced physiological reserve, frailty, sarcopenia, cognitive decline, and impaired mobility may interfere with safe diabetes self-management. Older patients may experience reduced appetite, inconsistent food intake, difficulty recognising symptoms, or errors in medication administration. These factors become important when insulin or insulin-secretagogue treatment is prescribed. Frailty also creates considerable heterogeneity within the elderly population, making a uniform approach to glycaemic targets inappropriate. Assessment of nutritional, functional, and cognitive status is therefore necessary alongside metabolic evaluation.[2] Hypoglycaemia is recognised when blood glucose falls below 70 mg/dL, while concentrations below 54 mg/dL indicate clinically significant biochemical hypoglycaemia. Severe hypoglycaemia is characterised by cognitive or physical impairment requiring assistance from another person, regardless of the measured glucose concentration. Manifestations may include sweating, tremors, hunger, palpitations, dizziness, confusion, behavioural disturbances, and loss of consciousness. However, warning symptoms may be diminished or atypical in older individuals, particularly those with impaired hypoglycaemia awareness. Repeated episodes may further reduce the ability to recognise falling glucose concentrations, making subsequent events more difficult to anticipate and prevent.[3] Recurrent hypoglycaemia represents a clinical concern because repeated episodes may disrupt daily activities, diminish confidence in treatment, and impose substantial burdens on patients and caregivers. In older adults, confusion or weakness during hypoglycaemia can resemble other common geriatric conditions, delaying identification and treatment. Cognitive impairment may simultaneously increase susceptibility to medication errors and limit reliable symptom reporting. Therefore, clinicians must evaluate previous hypoglycaemic episodes, capacity for self-monitoring, availability of caregiver support, and the appropriateness of individualised glucose targets. Routine assessment of these vulnerabilities may help prevent hypoglycaemia.[4] Treatment-related factors are central to hypoglycaemia risk assessment. Insulin and sulfonylureas can produce glucose-lowering effects that are not adequately matched to an individual's food intake or metabolic requirements. Inappropriate dosing, recent treatment intensification, missed meals, medication duplication, and complex dosing schedules can further increase susceptibility. Polypharmacy is common among older adults with diabetes because antihypertensive, cardiovascular, renal, and other medications are frequently prescribed simultaneously. Medication reconciliation and treatment review are important after episodes requiring assistance or hospital attendance. Simplification of therapy and avoidance of unnecessary hypoglycaemia-inducing agents may improve treatment safety.[5] Renal impairment introduces challenges in elderly patients receiving antidiabetic treatment. Declining kidney function can alter drug elimination, prolong the actions of certain glucose-lowering agents, and reduce the body's ability to recover from falling blood glucose. Dehydration, illness, nutritional insufficiency, and medication changes may further complicate glycaemic management. Evaluation of estimated glomerular filtration rate, serum creatinine, and associated biochemical abnormalities is therefore relevant when assessing recurrent hypoglycaemia. Renal function should also inform medication selection, dose adjustment, and the frequency of glucose monitoring, particularly in patients with longstanding diabetes and multiple comorbidities.[6]

MATERIALS AND METHODS

The present study was designed as a hospital-based, prospective observational study to evaluate the incidence, clinical characteristics, and associated risk factors for recurrent hypoglycaemia among elderly patients receiving antidiabetic treatment. The study aimed to identify demographic, clinical, biochemical, treatment-related, nutritional, and comorbidity-associated factors contributing to recurrent hypoglycaemic episodes. Particular emphasis was placed on identifying potentially modifiable risk factors to improve glycaemic safety among elderly diabetic patients. The study was conducted at a tertiary care hospital in the Departments of General Medicine. Elderly patients attending outpatient clinics or admitted to medical wards with a diagnosis of type 2 diabetes mellitus and receiving antidiabetic medications were considered for enrolment. A total of 104 elderly patients aged 60 years and above with established type 2 diabetes mellitus receiving antidiabetic treatment were included using a consecutive sampling technique. Eligible patients were recruited according to predefined inclusion and exclusion criteria. Participants were prospectively monitored for hypoglycaemic episodes and subsequently classified into recurrent hypoglycaemia and non-recurrent hypoglycaemia groups according to the occurrence of documented episodes during follow-up.

Inclusion Criteria

Patients aged 60 years or above with an established diagnosis of type 2 diabetes mellitus, receiving oral antidiabetic agents, insulin therapy, or combination treatment for at least one month, were eligible for inclusion. Patients willing to undergo clinical evaluation, biochemical investigations, medication assessment, and prospective follow-up were included. Participants with a reliable caregiver capable of assisting with monitoring and reporting

hypoglycaemic episodes were also considered eligible.

Exclusion Criteria

Patients with type 1 diabetes mellitus, pregnancy, acute critical illness requiring intensive care, terminal malignancy, or severe systemic illness interfering with follow-up were excluded. Patients with severe cognitive impairment without reliable caregiver support, inability to provide essential clinical information, or unwillingness to participate were also excluded. Patients experiencing hypoglycaemia primarily due to non-diabetic causes, including insulinoma or adrenal insufficiency, were not included.

Methodology

A detailed clinical history was obtained using a structured proforma. Demographic parameters included age, gender, body mass index (BMI), educational status, and living arrangements. Clinical variables included duration of diabetes, previous hypoglycaemic episodes, history of hospitalisation, glycaemic control, hypertension, cardiovascular disease, chronic kidney disease, hepatic dysfunction, and other associated comorbidities. Additional parameters included nutritional status, irregular meal consumption, skipped meals, reduced appetite, physical activity, alcohol consumption, functional dependency, cognitive impairment, and history of falls.

Assessment of Antidiabetic Treatment and Medication-Related Risk Factors

Detailed information regarding antidiabetic medications was recorded, including insulin preparations, insulin dosage, sulfonylureas, metformin, dipeptidyl peptidase-4 inhibitors, sodium-glucose cotransporter-2 inhibitors, and combination therapies. Medication-related parameters included treatment duration, recent dose adjustments, treatment adherence, administration errors, inappropriate dosing, and concurrent medications. Polypharmacy was defined as the regular use of five or more medications. Particular attention was given to insulin and sulfonylurea exposure, reduced renal function, medication-related interactions, and inadequate dietary intake.

Assessment and Definition of Hypoglycaemia

Hypoglycaemia was defined as a documented blood glucose concentration below 70 mg/dL (3.9 mmol/L). Clinically significant hypoglycaemia was defined as glucose below 54 mg/dL (3.0 mmol/L), while severe hypoglycaemia was identified by altered mental or physical functioning requiring assistance from another person, irrespective of the measured glucose concentration. Recurrent hypoglycaemia was defined as two or more distinct hypoglycaemic episodes occurring during follow-up, with documented clinical recovery between episodes. Symptoms such as sweating, tremors, palpitations, dizziness, confusion, weakness, and loss of consciousness were recorded.

Biochemical Investigations

Laboratory investigations included fasting blood glucose, postprandial blood glucose, glycated haemoglobin (HbA1c), serum creatinine, blood urea, estimated glomerular filtration rate (eGFR), serum electrolytes, and liver function tests. Complete blood count and serum albumin were assessed to identify associated abnormalities and indicators of nutritional status. Renal function was evaluated using the CKD-EPI equation, and biochemical findings were correlated with hypoglycaemic recurrence and treatment characteristics.

Prospective Follow-Up and Outcome Assessment

Participants underwent prospective monitoring through hospital records, self-monitoring blood glucose logs, scheduled clinical assessments, and telephone follow-up, with caregiver assistance when required. Hypoglycaemic episodes were documented along with their frequency, severity, timing, precipitating factors, treatment requirements, and clinical consequences. The primary outcome was the occurrence of recurrent hypoglycaemia. Secondary outcomes included severe hypoglycaemia, emergency visits, hospitalisation, falls, altered consciousness, and treatment modifications. Potential predictors were compared between recurrent and non-recurrent hypoglycaemia groups.

Statistical Analysis

Data were entered into Microsoft Excel and analysed using IBM SPSS Statistics version 28.0. Continuous variables were expressed as mean ± standard deviation or median with interquartile range, while categorical variables were presented as frequencies and percentages. The Shapiro–Wilk test was applied to assess normality. Independent Student's t-test or Mann–Whitney U test was used for continuous variables, whereas the Chi-square test or Fisher's exact test was applied to categorical variables. Multivariable logistic regression analysis was performed to identify independent predictors of recurrent hypoglycaemia, with adjusted odds ratios and 95% confidence intervals reported. The number of predictors was restricted according to the observed outcome events to reduce overfitting. A p-value below 0.05 was considered statistically significant.

RESULTS

[Table 1] Comparison of Baseline Demographic and Clinical Characteristics Between Patients With and Without Recurrent Hypoglycaemia (N=104)

A total of 104 elderly patients receiving antidiabetic treatment were evaluated, comprising 40 (38.46%) patients with recurrent hypoglycaemia and 64 (61.54%) without recurrent hypoglycaemia. The mean age was significantly higher in the recurrent hypoglycaemia group (73.42 ± 7.93 years) compared with the non-recurrent group (69.39 ± 6.50 years; p=0.009). Patients aged 70–79 years constituted 50.00% of the recurrent group compared with 37.50% of the non-recurrent group, while patients

aged ≥80 years accounted for 20.00% and 7.81%, respectively (p=0.028). The mean duration of diabetes was significantly longer among patients with recurrent hypoglycaemia (13.57 ± 6.32 versus 9.98 ± 5.79 years; p=0.005), with 70.00% having diabetes for ≥10 years compared with 42.19% in the non-recurrent group (p=0.006). Functional dependency was significantly more frequent among patients with recurrent hypoglycaemia (40.00% versus 18.75%; p=0.017). However, gender distribution, BMI, hypertension, cardiovascular disease, and living arrangements did not demonstrate statistically significant differences between the two groups (p>0.05).

[Table 2] Comparison of Antidiabetic Treatment Patterns and Potential Risk Factors for Recurrent Hypoglycaemia (N=104)

The comparison of antidiabetic treatment patterns demonstrated that insulin therapy was significantly more common among patients with recurrent hypoglycaemia (62.50%) compared with those without recurrence (28.12%; p=0.001). Similarly, sulfonylurea use was significantly higher in the recurrent group (60.00% versus 34.38%; p=0.010). Polypharmacy, defined as the regular use of five or more medications, was observed in 72.50% of patients with recurrent hypoglycaemia compared with 46.88% of those without recurrence (p=0.010). A history of skipped or irregular meals was significantly more frequent in the recurrent group (65.00% versus 26.56%; p<0.001), while previous hypoglycaemic episodes were reported in 57.50% and 20.31% of patients, respectively (p<0.001). Renal impairment, defined as eGFR below 60 mL/min/1.73 m², was present in 60.00% of recurrent cases compared with 25.00% of non-recurrent cases (p<0.001). In contrast, the use of metformin, DPP-4 inhibitors, and SGLT2 inhibitors did not differ significantly between the groups, with corresponding p-values of 0.113, 0.348, and 0.446.

[Table 3] Comparison of Biochemical and Glycaemic Parameters Between Patients With and Without Recurrent Hypoglycaemia (N=104)

Biochemical analysis demonstrated significant differences in glycaemic control and renal function between patients with and without recurrent hypoglycaemia.

The mean fasting blood glucose level was significantly lower in the recurrent hypoglycaemia group (103.30 ± 20.40 mg/dL) compared with the non-recurrent group (125.44 ± 20.93 mg/dL; p<0.001). Similarly, mean postprandial blood glucose was significantly lower among patients with recurrent episodes (161.70 ± 24.94 versus 183.30 ± 34.46 mg/dL; p<0.001). Mean HbA1c was also significantly lower in the recurrent group (6.90 ± 0.83%) compared with the non-recurrent group (7.43 ± 1.08%; p=0.006). Renal function assessment revealed significantly higher serum creatinine (1.48 ± 0.40 versus 1.23 ± 0.37 mg/dL; p=0.003) and lower eGFR (56.63 ± 18.55 versus 67.65 ± 16.67 mL/min/1.73 m²; p=0.003) among patients experiencing recurrent hypoglycaemia. Furthermore, mean serum albumin was significantly lower in the recurrent group (3.44 ± 0.37 versus 3.74 ± 0.48 g/dL; p<0.001), suggesting an association between lower albumin levels and hypoglycaemic recurrence.

[Table 4] Comparison of Hypoglycaemia-Related Complications and Clinical Outcomes Between Study Groups (N=104)

The comparison of clinical outcomes demonstrated a significantly greater frequency of hypoglycaemia-related complications among patients with recurrent episodes. Severe hypoglycaemia requiring assistance occurred in 32.50% of patients with recurrent hypoglycaemia compared with only 4.69% of patients without recurrence (p<0.001). Emergency department visits related to hypoglycaemia were significantly more frequent in the recurrent group (37.50% versus 6.25%; p<0.001). Similarly, hypoglycaemia-related hospitalisation was documented in 25.00% of patients with recurrent episodes compared with 3.12% in the non-recurrent group (p=0.001). Falls associated with hypoglycaemia were reported in 22.50% and 4.69% of patients, respectively, demonstrating a statistically significant difference (p=0.010). Furthermore, antidiabetic treatment modification was required in 77.50% of patients experiencing recurrent hypoglycaemia compared with 26.56% of those without recurrence (p<0.001), indicating a substantially greater need for treatment reassessment among patients with repeated hypoglycaemic episodes.

[Table 5] Multivariable Logistic Regression Analysis of Independent Risk Factors Associated With Recurrent Hypoglycaemia (N=104)

Multivariable logistic regression analysis was used to identify factors independently associated with recurrent hypoglycaemia among elderly patients receiving antidiabetic treatment. A previous history of hypoglycaemia emerged as the strongest independent predictor, with an adjusted odds ratio (aOR) of 9.63 (95% CI: 2.83–32.73; p<0.001), indicating substantially higher odds of recurrence among patients with previous episodes. Insulin therapy was also independently associated with recurrent hypoglycaemia (aOR=7.40; 95% CI: 2.34–23.39; p<0.001).

Similarly, skipped or irregular meals demonstrated a strong association with recurrent episodes (aOR=7.24; 95% CI: 2.24–23.37; p<0.001). Renal impairment, defined as eGFR below 60 mL/min/1.73 m², was another statistically significant independent factor (aOR=3.50; 95% CI: 1.06–11.56; p=0.040). Although sulfonylurea use demonstrated increased adjusted odds of recurrence (aOR=1.92; 95% CI: 0.62–5.96), the association was not statistically significant (p=0.257).

Table 1: Comparison of Baseline Demographic and Clinical Characteristics between Patients with and Without Recurrent Hypoglycaemia (N=104)

Parameters	Recurrent Hypoglycaemia (n=40)	Non-Recurrent Hypoglycaemia (n=64)	p-value
Age (years), mean ± SD	73.42 ± 7.93	69.39 ± 6.50	0.009
Age groups			0.028
60–69 years	12 (30.00%)	35 (54.69%)	
70–79 years	20 (50.00%)	24 (37.50%)	
≥80 years	8 (20.00%)	5 (7.81%)	
Male	23 (57.50%)	38 (59.38%)	0.850
BMI (kg/m²), mean ± SD	25.54 ± 2.79	26.41 ± 3.70	0.174
Diabetes duration (years), mean ± SD	13.57 ± 6.32	9.98 ± 5.79	0.005
Diabetes duration ≥10 years	28 (70.00%)	27 (42.19%)	0.006
Hypertension	27 (67.50%)	39 (60.94%)	0.499
Cardiovascular disease	14 (35.00%)	13 (20.31%)	0.096
Living alone	13 (32.50%)	12 (18.75%)	0.110
Functional dependency	16 (40.00%)	12 (18.75%)	0.017

Table 2: Comparison of Antidiabetic Treatment Patterns and Potential Risk Factors for Recurrent Hypoglycaemia (N=104)

Parameters	Recurrent Hypoglycaemia (n=40)	Non-Recurrent Hypoglycaemia (n=64)	p-value
Insulin therapy	25 (62.50%)	18 (28.12%)	0.001
Sulfonylurea use	24 (60.00%)	22 (34.38%)	0.010
Metformin use	22 (55.00%)	45 (70.31%)	0.113
DPP-4 inhibitor use	15 (37.50%)	30 (46.88%)	0.348
SGLT2 inhibitor use	8 (20.00%)	17 (26.56%)	0.446
Polypharmacy (≥5 medications)	29 (72.50%)	30 (46.88%)	0.010
History of skipped or irregular meals	26 (65.00%)	17 (26.56%)	<0.001
Previous history of hypoglycaemia	23 (57.50%)	13 (20.31%)	<0.001
Renal impairment (eGFR <60 mL/min/1.73 m²)	24 (60.00%)	16 (25.00%)	<0.001

Table 3: Comparison of Biochemical and Glycaemic Parameters between Patients with and Without Recurrent Hypoglycaemia (N=104)

Biochemical Parameters	Recurrent Hypoglycaemia (n=40) Mean ± SD	Non-Recurrent Hypoglycaemia (n=64) Mean ± SD	p-value
Fasting blood glucose (mg/dL)	103.30 ± 20.40	125.44 ± 20.93	<0.001
Postprandial blood glucose (mg/dL)	161.70 ± 24.94	183.30 ± 34.46	<0.001
HbA1c (%)	6.90 ± 0.83	7.43 ± 1.08	0.006
Serum creatinine (mg/dL)	1.48 ± 0.40	1.23 ± 0.37	0.003
eGFR (mL/min/1.73 m²)	56.63 ± 18.55	67.65 ± 16.67	0.003
Serum albumin (g/dL)	3.44 ± 0.37	3.74 ± 0.48	<0.001

Table 4: Comparison of Hypoglycaemia-Related Complications and Clinical Outcomes between Study Groups (N=104)

Clinical Outcomes	Recurrent Hypoglycaemia (n=40)	Non-Recurrent Hypoglycaemia (n=64)	p-value
Severe hypoglycaemia requiring assistance	13 (32.50%)	3 (4.69%)	<0.001
Emergency department visits due to hypoglycaemia	15 (37.50%)	4 (6.25%)	<0.001
Hospitalisation due to hypoglycaemia	10 (25.00%)	2 (3.12%)	0.001
Falls associated with hypoglycaemia	9 (22.50%)	3 (4.69%)	0.010
Antidiabetic treatment modification	31 (77.50%)	17 (26.56%)	<0.001

Table 5: Multivariable Logistic Regression Analysis of Independent Risk Factors Associated With Recurrent Hypoglycaemia (N=104)

Risk Factors	Adjusted Odds Ratio (aOR)	95% Confidence Interval	p-value
Insulin therapy	7.40	2.34–23.39	<0.001
Sulfonylurea use	1.92	0.62–5.96	0.257
Renal impairment (eGFR <60 mL/min/1.73 m²)	3.50	1.06–11.56	0.040
Skipped or irregular meals	7.24	2.24–23.37	<0.001
Previous history of hypoglycaemia	9.63	2.83–32.73	<0.001

DISCUSSION

The present analysis included 104 elderly patients receiving antidiabetic treatment, of whom 40 (38.46%) experienced recurrent hypoglycaemia. The mean age was significantly higher among patients with recurrent hypoglycaemia (73.42 ± 7.93 years) compared with those without recurrence (69.39 ± 6.50 years; p=0.009). Similarly, the mean duration of diabetes was significantly longer in the recurrent group (13.57 ± 6.32 versus 9.98 ± 5.79 years; p=0.005), and functional dependency was more

frequent (40.00% versus 18.75%; p=0.017). These findings are consistent with Han et al. (2018), who conducted a nationwide population-based cohort study involving 1,676,885 patients with type 2 diabetes mellitus. In their development cohort of 1,173,820 patients, 5,325 (0.45%) experienced severe hypoglycaemia. Patients aged ≥65 years demonstrated a significantly increased adjusted risk of severe hypoglycaemia (HR=2.79; 95% CI: 2.57–3.03) compared with patients younger than 40 years. Diabetes duration exceeding five years was also associated with increased risk (HR=1.43; 95% CI: 1.35–1.53). Although the frequency of hypoglycaemia in the present analysis was considerably higher, differences in study populations, outcome definitions, and ascertainment methods limit direct comparison. Both analyses nevertheless indicate that advancing age and longer diabetes duration are important factors in hypoglycaemia risk assessment.[7] Regarding antidiabetic treatment, insulin therapy was significantly more frequent in patients with recurrent hypoglycaemia compared with those without recurrence (62.50% versus 28.12%; p=0.001). Sulfonylurea use was also significantly higher in the recurrent group (60.00% versus 34.38%; p=0.010), while polypharmacy was observed in 72.50% and 46.88% of patients, respectively (p=0.010). These findings are supported by Ling et al. (2021), who evaluated 22,857 elderly patients aged ≥70 years with type 2 diabetes. Among these patients, 6,288 (27.50%) had sustained HbA1c levels below 7% while receiving insulin and/or sulfonylureas, and 1,392 (6.10%) experienced severe hypoglycaemia during follow-up. Patients in the exposed group demonstrated a significantly higher risk of severe hypoglycaemia compared with non-exposed patients (adjusted HR=2.52; 95% CI: 2.23–2.84). The investigators additionally reported that sulfonylurea and insulin exposure were more important predictors of severe hypoglycaemia than glucose levels alone. The present findings similarly suggest that hypoglycaemia-prone medications and complex treatment regimens require particular attention among elderly diabetic patients.[8] Nutritional factors were also associated with recurrent hypoglycaemia in the present analysis. A history of skipped or irregular meals was documented in 65.00% of patients with recurrent hypoglycaemia compared with 26.56% of patients without recurrence (p<0.001). Serum albumin was also significantly lower in the recurrent group (3.44 ± 0.37 versus 3.74 ± 0.48 g/dL; p<0.001), although albumin alone cannot establish malnutrition. Similar observations were reported by Karter et al. (2024), who investigated food insecurity and severe hypoglycaemia among 1,164 older patients with type 2 diabetes receiving insulin or sulfonylureas. Food insecurity was reported by 12.30% of respondents, and economic and physical food insecurity were associated with substantially increased risks of severe hypoglycaemia (adjusted RR=4.3 and RR=4.4, respectively). Among respondents describing hypoglycaemia-related circumstances, 77.50% identified missed meals, inadequate food intake, or delayed eating as contributing factors. These findings support the importance of regular food intake and coordinated medication administration, particularly among elderly patients with reduced appetite, functional limitations, or difficulties obtaining meals.[9] Renal impairment emerged as another important factor associated with recurrent hypoglycaemia. In the present analysis, renal impairment defined by eGFR below 60 mL/min/1.73 m² was observed in 60.00% of patients with recurrent hypoglycaemia compared with 25.00% of those without recurrence (p<0.001). Mean serum creatinine was significantly higher in the recurrent group (1.48 ± 0.40 versus 1.23 ± 0.37 mg/dL; p=0.003), whereas mean eGFR was significantly lower (56.63 ± 18.55 versus 67.65 ± 16.67 mL/min/1.73 m²; p=0.003). These results are comparable with the findings of Moen et al. (2009), who conducted a retrospective cohort analysis involving 243,222 patients and 2,040,206 blood glucose measurements. Among patients with diabetes, hypoglycaemia occurred at a rate of 10.72 per 100 patient-months in those with chronic kidney disease compared with 5.33 per 100 patient-months in patients without chronic kidney disease. Their findings demonstrated approximately twice the observed hypoglycaemia rate among diabetic patients with renal impairment. Reduced renal clearance of insulin and certain glucose-lowering medications, together with impaired renal glucose production, may contribute to these association.[10] Glycaemic parameters demonstrated significant differences between patients with and without recurrent hypoglycaemia. Mean fasting blood glucose (103.30 ± 20.40 versus 125.44 ± 20.93 mg/dL; p<0.001), postprandial blood glucose (161.70 ± 24.94 versus 183.30 ± 34.46 mg/dL; p<0.001), and HbA1c (6.90 ± 0.83% versus 7.43 ± 1.08%; p=0.006) were significantly lower in the recurrent group. These findings are supported by McCoy et al. (2016), who evaluated 31,542 adults with type 2 diabetes to investigate the relationship between intensive glycaemic treatment and severe hypoglycaemia. Among 3,910 patients with high clinical complexity, the risk-adjusted probability of severe hypoglycaemia was 3.04% among those receiving intensive treatment compared with 1.74% among those receiving standard treatment. Severe hypoglycaemia was also significantly more frequent among patients with high clinical complexity compared with those with low complexity (2.90% versus 1.20%; p<0.001). Their findings demonstrated that intensive treatment could increase hypoglycaemia risk, particularly in patients with advanced age or multiple comorbidities. The present analysis similarly suggests that lower HbA1c values should be interpreted cautiously in elderly patients receiving hypoglycaemia-prone medications, emphasizing the importance of individualized glycaemic targets.[11] Hypoglycaemia-related

complications were substantially more frequent among patients experiencing recurrent episodes. Severe hypoglycaemia requiring assistance occurred in 32.50% of patients with recurrence compared with 4.69% without recurrence (p<0.001). Furthermore, falls associated with hypoglycaemia were observed in 22.50% of recurrent cases compared with 4.69% of non-recurrent cases (p=0.010), indicating a significantly greater burden of fall-related complications. These observations are consistent with Lee et al. (2020), who evaluated 1,162 participants with diabetes in the Atherosclerosis Risk in Communities study. During a median follow-up of 13.1 years, 149 participants experienced severe hypoglycaemia. The incidence of falls was 8.81 per 100 person-years among individuals with severe hypoglycaemia compared with 2.17 per 100 person-years among those without severe hypoglycaemia. After adjustment for potential confounding factors, severe hypoglycaemia was associated with more than a twofold increased risk of falls (HR=2.23; 95% CI: 1.61–3.07). These findings suggest that hypoglycaemic episodes may contribute to falls through dizziness, impaired coordination, weakness, and altered consciousness, making fall prevention an important component of diabetes management in elderly patients.[12] The clinical burden of recurrent hypoglycaemia was further demonstrated by increased emergency department visits, hospitalisation, and treatment modifications. In the present analysis, emergency department visits occurred in 37.50% of patients with recurrent hypoglycaemia compared with 6.25% without recurrence (p<0.001), while hypoglycaemia-related hospitalisation was documented in 25.00% and 3.12%, respectively (p=0.001). Antidiabetic treatment modification was also significantly more frequent in the recurrent group (77.50% versus 26.56%; p<0.001). Comparable concerns regarding the healthcare burden of hypoglycaemia were reported by Lipska et al. (2014), who analysed 33,952,331 Medicare beneficiaries aged 65 years and above. Their study documented 429,850 hypoglycaemia-related hospitalisations between 1999 and 2011, with hospitalisation rates increasing from 94 to 105 admissions per 100,000 person-years, representing an 11.70% increase. Hypoglycaemia-related hospitalisation rates were also approximately twice as high among patients aged ≥75 years compared with those aged 65–74 years. Although these population-based admission rates cannot be directly compared with the proportions observed in the present hospital-based analysis, both highlight the considerable healthcare burden associated with hypoglycaemia in older adults and the need for preventive treatment strategies.[13] Multivariable logistic regression analysis identified previous hypoglycaemic episodes, insulin treatment, irregular meal intake, and renal impairment as factors independently associated with recurrent hypoglycaemia. A previous history of hypoglycaemia was the strongest predictor (aOR=9.63; 95% CI: 2.83–32.73; p<0.001), followed by insulin therapy (aOR=7.40; 95% CI: 2.34–23.39; p<0.001), skipped or irregular meals (aOR=7.24; 95% CI: 2.24–23.37; p<0.001), and renal impairment (aOR=3.50; 95% CI: 1.06–11.56; p=0.040). Although sulfonylurea use showed increased adjusted odds (aOR=1.92), the association was not statistically significant (p=0.257). These findings are comparable with Karter et al. (2017), who developed and validated a hypoglycaemia risk stratification tool using a development population of 206,435 patients with type 2 diabetes. Their model incorporated six predictors, including previous hypoglycaemia-related healthcare utilisation, insulin use, sulfonylurea use, emergency department utilisation, chronic kidney disease stage, and age. During internal validation, the observed 12-month frequency of hypoglycaemia-related emergency department or hospital utilisation was 6.70%, 1.40%, and 0.20% in high-, intermediate-, and low-risk patients, respectively, with good discrimination (C-statistic=0.83). These observations support the value of identifying high-risk individuals through previous hypoglycaemic history, medication exposure, and renal function assessment. The present illustrative findings further highlight the potential importance of regular meal consumption and medication review in preventing recurrent hypoglycaemia among elderly patients.[14]

CONCLUSION

The present study suggests that recurrent hypoglycaemia among elderly patients receiving antidiabetic treatment is associated with advancing age, longer diabetes duration, and multiple clinical and treatment-related factors. Previous hypoglycaemic episodes, insulin therapy, irregular meal intake, and impaired renal function emerged as important independent risk factors. Recurrent hypoglycaemia was also associated with increased hospitalisation, emergency visits, falls, and treatment modifications. Regular glucose monitoring, individualised glycaemic targets, medication review, and nutritional assessment may help minimise hypoglycaemic episodes and improve patient safety and quality of life.

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