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hypokalemia among patients with diabetes mellitus in eastern uganda: prevalence and associated factors

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Article

Keywords: Diabetes mellitus, hypokalemia, potassium, electrolyte imbalance, glycemic control, Uganda, Eastern Africa

Posted Date: November 16th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-11060423/v1

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Additional Declarations: No competing interests reported.

Abstract

Background:

Hypokalemia is an important electrolyte abnormality that may occur in patients with diabetes mellitus through renal potassium losses, osmotic diuresis, and intracellular potassium shifts associated with metabolic disturbances. However, evidence regarding its prevalence and associated factors among patients with diabetes in sub-Saharan Africa remains limited. This study determined the prevalence of hypokalemia and identified factors associated with hypokalemia among adults with diabetes mellitus in Eastern Uganda.

Methods:

A facility-based cross-sectional study was conducted among 374 adults with diabetes mellitus attending the Medical Outpatient and Diabetic Clinics of Jinja Regional Referral Hospital, Eastern Uganda, between 5 July and 31 August 2022. Sociodemographic, clinical, anthropometric, and treatment-related data were collected using a structured questionnaire. Serum potassium was measured using a Cobas C311 chemistry analyzer. Hypokalemia was defined as serum potassium < 3.5 mEq/L. Modified Poisson regression with robust variance was used to estimate crude and adjusted prevalence ratios (PRs) with 95% confidence intervals (CIs). Variables with $p < 0.20$ at bivariate analysis and clinically relevant variables were included in the multivariable model.

Results:

Among the 374 participants, 251 (67.1%) were female, and the median age was 50 years. Hypokalemia was identified in 10 participants, giving a prevalence of **2.7%**. In the multivariable analysis, urban residence was independently associated with a higher prevalence of hypokalemia compared with rural residence (aPR = 3.94, 95% CI: 1.13–13.82; p = 0.032). Participants receiving oral antidiabetic agents had a substantially higher prevalence of hypokalemia compared with those receiving insulin therapy (aPR = 13.94, 95% CI: 2.71–71.79; p = 0.002). Participants aged 31–45 years had a lower prevalence compared with those aged 16–30 years (aPR = 0.21, 95% CI: 0.05–0.97; p = 0.046). Uncontrolled random blood glucose (> 10 mmol/L) was associated with a higher prevalence of hypokalemia, although the association did not reach statistical significance (aPR = 2.99, 95% CI: 0.85–10.51; p = 0.088).

Conclusion:

Hypokalemia occurred in approximately 1 in 37 adults with diabetes mellitus attending this regional referral hospital. Urban residence and oral antidiabetic therapy were independently associated with hypokalemia, while uncontrolled glycemia showed a non-significant trend toward increased prevalence.

Routine attention to potassium status may be warranted in selected patients with diabetes, particularly those with poor glycemic control or receiving oral therapy. However, the small number of hypokalemia cases warrants cautious interpretation, and larger studies are needed to confirm these associations.

Background

Potassium is a fundamental intracellular electrolyte, with concentrations approximately 30–40 times higher inside cells than in the extracellular fluid. This steep concentration gradient is maintained primarily by the Na^+/K^+-ATPase, which exchanges three intracellular Na^+ ions for two extracellular K^+ ions and is essential for maintaining the resting membrane potential and normal nerve and muscle function (1). In the cardiovascular system, potassium plays a central role in maintaining electrical stability, particularly through its effects on cardiac repolarization and conduction. Consequently, disturbances in serum potassium concentration can alter cardiac electrical activity and may result in potentially life-threatening arrhythmias (1–4).

Hypokalemia, defined as a serum potassium concentration < 3.5 mEq/L, is an important electrolyte disorder with potentially significant cardiac and neuromuscular consequences (4,5). In individuals with diabetes mellitus (DM), hypokalemia may develop through several mechanisms, including hyperglycemia-induced osmotic diuresis and renal potassium wasting. Potassium losses may be further exacerbated during acute metabolic complications of diabetes, particularly diabetic ketoacidosis (DKA) and hyperosmolar hyperglycemic state (HHS) (4,6). Importantly, serum potassium concentration may remain within the normal range or even become elevated despite substantial depletion of total-body potassium stores. This apparent discrepancy occurs because insulin deficiency and metabolic disturbances promote the movement of potassium from the intracellular to the extracellular compartment (4,6). Following initiation of insulin and fluid therapy, potassium rapidly shifts back into cells, which may result in a substantial decline in serum potassium concentration and increase the risk of cardiac arrhythmias (4–6).

Beyond acute metabolic disturbances, hypokalemia among individuals with diabetes may also be influenced by demographic characteristics, comorbid conditions, renal function, and medication use. In populations with diabetes, the prevalence of hypokalemia, defined as a serum potassium concentration below 3.5 mEq/L, has been estimated at approximately 0.8% based on a single measurement and 3.4% over a two-year period [7, 12]. Although relatively uncommon, hypokalemia is clinically important because of its association with cardiac arrhythmias and increased mortality [7, 8, 10]. Female sex and African American race have been identified as predictors of a higher probability of hypokalemia [7, 9]. Several comorbid conditions have also been associated with hypokalemia, including congestive heart failure, hypertension, malignancy, coronary artery disease, dementia, and depression [7, 8, 10, 11].

Renal function may further influence potassium abnormalities in diabetes. Although hyperkalemia is more commonly associated with renal impairment, individuals with an estimated glomerular filtration rate (eGFR) of 15–29 mL/min/1.73m² have been reported to have a nearly threefold higher prevalence of

hypokalemia compared with those with an eGFR ≥ 90 mL/min/1.73m² [7, 9, 10]. Medication exposure is another important determinant. Beta-blockers and non-potassium-sparing diuretics have been associated with an increased likelihood of low serum potassium, whereas angiotensin-converting enzyme inhibitors and angiotensin receptor blockers (ACE/ARB) are associated with a lower probability of hypokalemia [7, 12, 13]. Furthermore, classification and regression tree (CART) models suggest that previous potassium measurements may provide important information for identifying individuals at increased risk. In particular, patients with documented hypokalemia during the preceding year or a recent potassium concentration between 3.5 and 4.0 mEq/L have been identified as having a substantially higher risk and may therefore benefit from closer clinical surveillance [7].

Despite the clinical importance of potassium abnormalities in diabetes, evidence regarding electrolyte disturbances remains limited in sub-Saharan Africa. This evidence gap is particularly relevant in Uganda, where data describing the burden of hypokalemia among individuals with diabetes and the factors associated with its occurrence remain scarce. Limited epidemiological evidence may hinder the identification of patients at increased risk and the development of context-appropriate strategies for electrolyte monitoring and clinical management. Generating local evidence is therefore important, particularly in resource-constrained settings where delayed recognition of electrolyte abnormalities may increase the risk of preventable complications.

Therefore, this study aimed to determine the prevalence of hypokalemia and identify factors associated with hypokalemia among patients with diabetes mellitus in Uganda. By characterizing both the magnitude of the problem and its associated factors, the study seeks to contribute evidence that may support improved electrolyte monitoring and risk stratification among patients with diabetes in this setting.

Methods

Study design

A facility-based cross-sectional study was conducted to determine the prevalence of hypokalemia and identify demographic and clinical factors associated with hypokalemia among adults with diabetes mellitus attending Jinja Regional Referral Hospital (JRRH), Eastern Uganda. Data collection and participant recruitment were conducted between 05/07/2022 and 31/08/2022.

This manuscript is part of a broader study investigating electrolyte imbalances among patients with type 2 diabetes mellitus in Eastern Uganda. Other components of this project have been analyzed separately because of the distinct clinical and physiological characteristics of individual electrolytes. Specifically, findings on hypocalcemia have been published [14].

Study setting

The study was conducted at the Medical Outpatient and Diabetic Clinics of Jinja Regional Referral Hospital (JRRH), located in Jinja City in eastern Uganda. JRRH is one of Uganda's regional referral hospitals and provides specialist and general medical services to patients from Jinja and surrounding districts, including Bugiri, Iganga, Kamuli, Luuka, Mayuge, Namayingo, Kayunga, and parts of Buikwe.

The hospital is located at approximately 00°25'52.0"N and 33°12'18.0"E (latitude 0.431111; longitude 33.205000). The hospital provides specialist services in internal medicine, surgery, obstetrics and gynecology, psychiatry, otorhinolaryngology, ophthalmology, and other clinical specialties. The Internal Medicine Department attends to approximately 150 patients per month, while the diabetic clinic receives approximately 80–100 patients per week. JRRH has an established clinical laboratory with biochemistry services capable of performing the laboratory investigations required for this study, including serum potassium measurement.

Study population

The target population comprised adults with diabetes mellitus attending medical outpatient and diabetic clinic services at JRRH. The accessible population consisted of patients with diabetes mellitus aged 18 years or older who attended the study clinics during the study period and met the eligibility criteria.

Eligibility criteria

Inclusion criteria

Participants were eligible if they were aged 18 years or older, had a diagnosis of diabetes mellitus, either previously established or newly diagnosed according to the attending clinician, and provided written informed consent to participate.

Exclusion criteria

Patients were excluded if they were critically ill and required immediate emergency management at the time of recruitment or were unable to complete the study procedures. Patients with conditions or clinical circumstances likely to cause substantial acute changes in serum potassium, where these were identifiable at recruitment, were also excluded.

Sample size determination

The minimum sample size was calculated using the single-population proportion formula described by Daniel [9]:

$n = Z^2p(1 - p)/d^2$

Where *n* is the desired sample size, *Z* is the standard normal deviate corresponding to a 95% confidence level (1.96), *p* is the estimated prevalence, and *d* is the desired margin of error (0.05).

Because published data on the prevalence of hypokalemia specifically among adults with diabetes mellitus in Uganda were limited, the available estimate of 42% for electrolyte disturbances among patients with diabetes mellitus attending a chronic illness clinic in Ethiopia was used as the prevalence estimate [10]. Using this estimate, the calculated minimum sample size was 374 participants.

The use of this estimate provided a sample-size basis in the absence of locally available prevalence data specifically for hypokalemia. The final sample therefore comprised 374 adults with diabetes mellitus.

Sampling procedure

Participants were recruited consecutively from the Medical Outpatient and Diabetic Clinics during the study period. All patients who met the eligibility criteria and provided informed consent were enrolled until the required sample size of 374 participants was reached.

Data collection instruments and measurements

Data were collected using a structured, investigator-administered questionnaire and standardized laboratory data collection forms. The questionnaire captured sociodemographic characteristics, diabetes-related clinical characteristics, medication history, and relevant medical history.

Anthropometric measurements included weight and height. Weight was measured using a calibrated weighing scale, while height was measured using a standardized height board. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared (kg/m^2).

Blood glucose was measured using a OneTouch glucometer according to the manufacturer's instructions. Laboratory assessment included measurement of serum potassium together with other routinely available biochemical parameters relevant to the study.

Study procedures and laboratory assessment

After screening for eligibility and obtaining written informed consent, participants were interviewed using the pre-tested questionnaire. Approximately 5 mL of venous blood was collected from the antecubital vein using standard aseptic procedures.

Blood samples were transported promptly to the JRRH clinical chemistry laboratory for processing and analysis. Samples were centrifuged using a K102A centrifuge at 4,200 revolutions per minute for 2 minutes. The separated specimens were subsequently analyzed using a Cobas C311 chemistry analyzer according to the laboratory's standard operating procedures and the manufacturer's recommendations.

Serum potassium concentration was the primary laboratory measurement. Hypokalemia was defined a priori as a serum potassium concentration of **< 3.5 mEq/L**. Participants were subsequently classified as

having hypokalemia or not having hypokalemia based on this threshold.

Validity and reliability

Content validity of the questionnaire was assessed by three physician experts with relevant clinical and research experience. The experts independently assessed questionnaire items for relevance, clarity, simplicity, and ambiguity using a four-point rating scale. Items considered unclear or insufficiently relevant were revised before data collection.

Reliability of the questionnaire was assessed during pre-testing, and items demonstrating poor consistency or ambiguity were revised. Laboratory measurements were performed using standardized procedures on the same chemistry analyzer, with routine laboratory quality-control procedures applied throughout the study period.

Data management and statistical analysis

Data were checked for completeness and consistency before entry into Microsoft Excel 2010 and subsequent export to Stata version 14.2 for statistical analysis. Categorical variables were summarized using frequencies and percentages, while continuous variables were summarized using appropriate measures of central tendency and dispersion.

The primary outcome was hypokalemia, defined as a serum potassium concentration < 3.5 mEq/L, and was analyzed as a binary variable (yes/no).

Prevalence of hypokalemia

The prevalence of hypokalemia was calculated as the proportion of participants with a serum potassium concentration < 3.5 mEq/L among all participants included in the analysis. The prevalence was reported as a percentage with the corresponding 95% confidence interval.

Factors associated with hypokalemia

Associations between participant characteristics and hypokalemia were initially assessed using modified Poisson regression with robust variance estimation to estimate prevalence ratios (PRs) and corresponding 95% confidence intervals.

Variables considered clinically relevant based on the study's conceptual framework, together with variables showing evidence of association at the bivariate analysis level ($p < 0.20$), were considered for inclusion in the multivariable model. The multivariable model was used to adjust for potential confounding and identify factors independently associated with hypokalemia.

Adjusted prevalence ratios (aPRs) with 95% confidence intervals were reported. Statistical significance was considered at a two-sided p-value < 0.05.

Ethical considerations

Ethical approval for the study was obtained from the Kampala International University Research Ethics Committee (KIU-2022-117). Permission to conduct the study was also obtained from the Jinja Regional Referral Hospital Research and Ethics Committee (JREC 240/2022). The study was registered with the Uganda National Council for Science and Technology, which issued the required research authorization.

Written informed consent was obtained from all participants before enrollment. Participant information was handled confidentially and used solely for research purposes.

Results

Baseline Characteristics of the Study Population

A total of 374 adults with diabetes mellitus were included in the analysis. The study population was predominantly female (67.1%), with a median age of 50 years. Participants aged 46–60 years constituted the largest age group (46.3%), followed by those aged 61–75 years (23.3%). Most participants lived in rural areas (64.2%), and approximately two-thirds (65.5%) reported a monthly income below 200,000 Ugandan Shillings. Regarding educational attainment, 42.3% had completed primary education, while 28.3% had no formal education.

With respect to clinical characteristics, nearly half of the participants (45.7%) had been living with diabetes for 1–5 years, whereas 24.1% had a diabetes duration of 10–20 years. Hypertension was the most frequently reported comorbidity, affecting 71.4% of participants. Most participants had a normal BMI (61.5%), while 33.2% were classified as overweight or obese and 5.4% were underweight.

Antidiabetic treatment varied across participants. Oral antidiabetic medications were the most commonly reported treatment (57.8%), followed by insulin therapy (32.9%), while 8.3% received mixed therapy. The majority of participants (82.6%) reported high medication adherence. In addition, 59.6% reported having social support. Detailed sociodemographic, clinical, anthropometric, comorbidity, and treatment characteristics of the study population are presented in Table 1.

Table 1
Socio-demographic and Clinical Characteristics of Participants (n = 374)

Characteristic	Category	Frequency (n)	Percentage (%)
Gender	Male	123	32.89
	Female	251	67.11
Age Category	16–30 years	22	5.88
	31–45 years	81	21.66
	46–60 years	173	46.26
	61–75 years	87	23.26
	> 75 years	11	2.94
Education Level	No formal education	106	28.34
	Primary	158	42.25
	Secondary and above	110	29.41
Area of Residence	Rural	240	64.17
	Urban	134	35.83
Occupation	Farmer	130	34.76
	Civil service	20	5.35
	Business man/woman	74	19.79
	Others	150	40.11
Marital Status	Single	104	27.81
	Married	210	56.15
	Widowed	55	14.71
	Divorced	5	1.34
Average Monthly Income	< 200,000	245	65.51
	200,000-450,000	76	20.32
	450,000-900,000	38	10.16
	> 900,000	15	4.01
Duration Since Diagnosis	1–5 years	171	45.72
	5–10 years	85	22.73
	10–20 years	90	24.06

Characteristic	Category	Frequency (n)	Percentage (%)
	20–30 years	22	5.88
	More than 30 years	6	1.60
BMI	Normal	230	61.50
	> 25 (Overweight/Obese)	124	33.16
	< 18 (Underweight)	20	5.35
Waist Circumference	Yes (> 40M, 35F)	130	34.76
	No	244	65.24
Waist-to-Hip Ratio	Yes (> 94M, 80F)	139	37.17
	No	235	62.83
Coexistent Hypertension	Yes	267	71.39
	No	107	28.61
Coexistent HIV Status	Yes	49	13.10
	No	312	83.42
	Unknown	13	3.48
Type of Antidiabetic Medication	Insulin	123	32.89
	Oral	216	57.75
	Mixed	31	8.29
	None	4	1.07
Medication Adherence	Low	38	10.16
	Medium	27	7.22
	High	309	82.62
Social Support	Yes	223	59.63
	No	151	40.37

Result: Bivariate Analysis of Factors Associated with Hypokalemia (n = 374)

Socio-demographic Factors Associated with Hypokalemia.

The bivariate analysis was conducted to examine the associations between socio-demographic characteristics and the prevalence of hypokalemia among the 374 study participants. This analysis

aimed to identify specific subpopulations at higher risk for potassium depletion by evaluating factors such as age category, gender, residential area, marital status, and educational attainment. Crude Prevalence Ratios (cPR) with 95% confidence intervals and p-values were calculated to determine the strength and significance of these associations. As shown in Table 2.

Table 2

Bivariate Analysis of Socio-demographic Factors and Hypokalemia (n = 374)

Characteristic	Category	Hypokalemia n (%)	Non-Hypokalemia n (%)	Crude PR (95% CI)	P-value
Gender	Male	4 (3.25)	119 (96.75)	1.00 (Ref)	—
	Female	6 (2.39)	245 (97.61)	0.74 (0.21–2.58)	0.634
Residence	Rural	3 (1.25)	237 (98.75)	1.00 (Ref)	—
	Urban	7 (5.22)	127 (94.78)	4.18 (1.10–15.89)	**0.018***
Marital Status	Single	3 (2.88)	101 (97.12)	1.00 (Ref)	—
	Married	3 (1.43)	207 (98.57)	0.50 (0.10–2.41)	0.384
	Widowed	4 (7.27)	51 (92.73)	2.52 (0.59–10.87)	0.215
	Divorced	0 (0.00)	5 (100.0)	—	—
Education	No formal	4 (3.77)	102 (96.23)	1.00 (Ref)	—
	Primary	1 (0.63)	157 (99.37)	0.17 (0.02–1.48)	0.108
	Sec and above	5 (4.55)	105 (95.45)	1.20 (0.33–4.36)	0.777
Age Category	16–30 years	2 (9.09)	20 (90.91)	1.00 (Ref)	—
	31–45 years	2 (2.47)	79 (97.53)	0.27 (0.04–1.82)	0.179
	46–60 years	3 (1.73)	170 (98.27)	0.19 (0.03–1.08)	0.061
	61–75 years	3 (3.45)	84 (96.55)	0.38 (0.07–2.13)	0.271

Note: *PR = Prevalence Ratio; CI = Confidence Interval; Ref = Reference category. Asterisk ()* indicates statistical significance ($p < 0.05$). In Marital Status and Age Category, categories with zero events were dropped from the PR model.*

Characteristic	Category	Hypokalemia n (%)	Non-Hypokalemia n (%)	Crude PR (95% CI)	P-value
	> 75 years	0 (0.00)	11 (100.0)	—	—

Note: *PR = Prevalence Ratio; CI = Confidence Interval; Ref = Reference category. Asterisk ()* indicates statistical significance (p < 0.05). In Marital Status and Age Category, categories with zero events were dropped from the PR model.*

Summary of Key Findings for your Report:

1. **Urban Residence**: This was the only socio-demographic factor significantly associated with hypokalemia. Participants living in urban areas had a **4.18 times higher prevalence** of hypokalemia compared to those in rural areas (PR: 4.18; 95% CI: 1.10–15.89; **p = 0.018**).
2. **Marital Status**: Although not statistically significant, **widowed** participants showed a higher burden of hypokalemia (**7.27%**) compared to married (**1.43%**) or single (**2.88%**) participants.
3. **Age**: The prevalence was highest in the **16–30 years** age group (**9.09%**). While the 46–60 age group had a lower risk, it approached borderline significance (**p = 0.061**) in the bivariate model.
4. **Education**: Patients with **primary education** had the lowest prevalence of hypokalemia (**0.63%**), while those with secondary education and above had the highest (**4.55%**).

Medical, Clinical, and Lifestyle Factors

Table 3 details the associations between hypokalemia and various clinical markers, including glycemic control, medication type, and medication adherence.

Table 3
Bivariate Analysis of Clinical and Lifestyle Factors and Hypokalemia (n = 374)

Characteristic	Category	Hypokalemia n (%)	Non-Hypokalemia n (%)	Crude PR (95% CI)	P-value
Blood Sugar	Controlled (< 10)	3 (1.46)	202 (98.54)	1.00 (Ref)	—
	Uncontrolled (> 10)	7 (4.14)	162 (95.86)	2.83 (0.75–10.82)	0.121
Diabetes Meds	Insulin	1 (0.81)	122 (99.19)	1.00 (Ref)	—
	Oral agents	9 (4.17)	207 (95.83)	5.13 (0.66–40.23)	0.081
	Mixed/None	0 (0.00)	35 (100.0)	—	—
Stop Meds?	Yes (Feeling bad)	1 (1.96)	50 (98.04)	1.00 (Ref)	—
	No	9 (2.79)	314 (97.21)	1.42 (0.19–10.97)	0.730
BMI	Normal	6 (2.61)	224 (97.39)	1.00 (Ref)	—
	Overweight/Obese	4 (3.23)	120 (96.77)	1.24 (0.35–4.32)	0.738
	Underweight	0 (0.00)	20 (100.0)	—	—
Social Support	Yes	6 (2.69)	217 (97.31)	1.00 (Ref)	—
	No	4 (2.65)	147 (97.35)	0.98 (0.28–3.46)	0.981
Adherence	Low	1 (2.63)	37 (97.37)	1.00 (Ref)	—
	High	9 (2.91)	300 (97.09)	1.11 (0.15–8.34)	0.923

**Considered for multivariable model if p < 0.20.*

Summary of Clinical Findings

Bivariate analysis revealed that while several clinical factors showed high risk ratios, the small number of hypokalemia cases (n = 10) resulted in limited statistical significance at the 0.05 level. However, two key factors met the $p < 0.20$ threshold for inclusion in a multivariable model

- **Medication Type**: Participants using **oral antidiabetic agents** had a **5.13 times higher prevalence** of hypokalemia (**4.2%**) compared to those on insulin therapy (**0.8%**) ($PR = 5.13, p = 0.081$).
- **Glycemic Control**: Participants with **uncontrolled random blood sugar (> 10 mmol/L)** had a **2.83 times higher prevalence** of hypokalemia compared to those with controlled levels ($PR = 2.83, p = 0.121$).
- **Other Factors**: Medication adherence ($p = 0.923$), BMI ($p = 0.738$), and social support ($p = 0.981$) did not show significant associations with potassium levels in this study population. Additionally, alcohol frequency and diabetes duration did not reach the threshold for clinical significance.

Multivariable Analysis Results

A multivariable analysis using Modified Poisson regression was performed to identify the independent predictors of hypokalemia among diabetic patients. Factors included in the final model were those demonstrating a p-value < 0.20 in the bivariate analysis, including residential area, age category, level of education, glycemic control, medication type, and gender. The results, expressed as Adjusted Prevalence Ratios (aPR), are presented in Table 3.

Table 3
Multivariable Analysis of Factors Associated with Hypokalemia (n = 374)

Variable	Category	Adjusted PR (95% CI)	P-value
Residence	Rural	1.00 (Ref)	—
	Urban	**3.94 (1.13–13.82)**	**0.032***
Age Category	16–30 years	1.00 (Ref)	—
	31–45 years	**0.21 (0.05–0.97)**	**0.046***
	46–60 years	0.19 (0.03–1.26)	0.086
	61–75 years	0.26 (0.04–1.76)	0.167
	> 75 years	0.00 (0.00–0.00)	< 0.001
Education	No formal	1.00 (Ref)	—
	Primary	0.19 (0.02–1.77)	0.145
	Sec and above	0.96 (0.17–5.41)	0.959
Glycemic Control	Controlled (< 10)	1.00 (Ref)	—
	Uncontrolled (> 10)	2.99 (0.85–10.51)	0.088
Medication Type	Insulin	1.00 (Ref)	—
	Oral agents	**13.94 (2.71–71.79)**	**0.002***
	Mixed/None	0.00 (0.00–0.00)	< 0.001
Gender	Male	1.00 (Ref)	—
	Female	0.71 (0.21–2.38)	0.575

Note: *aPR = Adjusted Prevalence Ratio; CI = Confidence Interval; Ref = Reference category. Asterisk ()* indicates statistical significance (p < 0.05). Model adjusted for all variables listed in the table.*

Summary of Multivariable Findings

After adjusting for potential confounders in the multivariable model, three factors remained significantly associated with the prevalence of hypokalemia:

1. **Residential Area**: Living in an **urban area** remained a strong independent predictor of hypokalemia. Patients in urban centers were **3.94 times more likely** to have hypokalemia compared to those in rural areas (aPR = 3.94; 95% CI: 1.13–13.82; **p = 0.032**).
2. **Medication Type**: The type of anti-diabetic therapy showed the strongest association. Participants using **oral anti-diabetic agents** had a **13.94 times higher prevalence** of hypokalemia compared to those on insulin therapy (aPR = 13.94; 95% CI: 2.71–71.79; **p = 0.002**).

3. **Age Category**: Age was significantly associated with potassium levels, with the **31–45 years** age group showing a **79% lower prevalence** of hypokalemia compared to the 16–30 years reference group (aPR = 0.21; 95% CI: 0.05–0.97; **p = 0.046**).
4. **Glycemic Control**: While not reaching the level of statistical significance, participants with **uncontrolled random blood sugar (> 10 mmol/L)** showed a trend toward a higher burden of hypokalemia, with a **2.99 times higher prevalence** than those with controlled sugar levels (aPR = 2.99; p = 0.088).

Gender and educational level did not show significant independent associations with hypokalemia in the final adjusted model

Discusstion

The present study investigated the prevalence and associated factors of hypokalemia among patients with diabetes mellitus at Jinja Regional Referral Hospital in Eastern Uganda. Hypokalemia was identified in 2.7% (n = 10) of participants, indicating that, while the overall burden was relatively low in this setting, potassium depletion remains a clinical concern in the diabetic population. This finding is important because potassium disturbances may remain unrecognized during routine clinical monitoring despite their potential implications for cardiac electrical stability, neuromuscular signaling, and cellular homeostasis.

Urban residence was independently associated with hypokalemia in the present study, with urban participants being nearly four times more likely to have hypokalemia than their rural counterparts (aPR = 3.94; 95% CI: 1.13–13.82; p = 0.032). This finding is consistent with evidence from Ethiopia, where urban residence was independently associated with a substantially higher likelihood of electrolyte imbalance among patients with diabetes (AOR = 5.67; 95% CI: 1.44–22.3) [15]. Similarly, a study among adults with metabolic syndrome in Jimma, Ethiopia, reported higher odds of electrolyte disturbance among urban compared with rural residents (COR = 2.58; 95% CI: 1.55–4.29) [16]. Differences in dietary patterns, potassium intake, sodium consumption, physical activity, and other lifestyle characteristics between urban and rural populations may partly explain this association. Supporting this possibility, a study comparing rural and semi-urban communities in Ghana found that rural participants consumed substantially more potassium than semi-urban participants (58 vs. 40 mmol/day) [17].

The observed association between oral antidiabetic therapy and hypokalemia may reflect treatment-related factors rather than a direct effect of oral medications. In resource-limited settings, therapeutic inertia and delayed intensification of diabetes treatment are common, with patients sometimes remaining on oral therapy despite persistent poor glycemic control. Studies from Ethiopia have reported a substantial prevalence of therapeutic inertia among patients with poorly controlled diabetes, including failure to initiate insulin or intensify existing therapy [18]. Similarly, evidence from South Africa showed that many patients with suboptimal glycemic control were not appropriately intensified, and patients receiving maximum oral therapy were often not transitioned to insulin [19]. In the present study,

uncontrolled random blood glucose was also associated with a higher prevalence of hypokalemia, although this association did not reach statistical significance (aPR = 2.99, p = 0.088). Nevertheless, persistent hyperglycemia may contribute to potassium depletion through glycosuria-induced osmotic diuresis, which increases urinary fluid and electrolyte losses, including potassium [20]. Therefore, the strong association observed between oral therapy and hypokalemia may partly reflect inadequate treatment intensification and persistent hyperglycemia rather than a direct hypokalemic effect of oral antidiabetic medications.

Age was also significantly associated with hypokalemia in the present study, with participants aged 31–45 years having a 79% lower prevalence compared with those aged 16–30 years (aPR = 0.21; 95% CI: 0.05–0.97; p = 0.046). Although direct evidence linking specific age categories to hypokalemia among adults with diabetes is limited, previous research from Ethiopia has demonstrated an association between age and overall electrolyte disturbances among patients with metabolic syndrome, with older age groups showing higher odds of electrolyte abnormalities [21]. The difference observed in the present study may reflect age-related differences in diabetes characteristics, treatment patterns, dietary intake, renal handling of electrolytes, or the distribution of comorbidities. However, previous studies have not consistently demonstrated a specific protective effect of the 31–45-year age group against hypokalemia. Therefore, this finding should be interpreted cautiously and requires confirmation in larger studies.

Strengths and limitations

This study has several strengths. It provides data on hypokalemia among patients with diabetes in Eastern Uganda, a setting where evidence on diabetes-related electrolyte disturbances remains limited. The use of biochemical measurement of serum potassium allowed hypokalemia to be objectively identified rather than relying solely on clinical symptoms or medical records, while the assessment of multiple sociodemographic and clinical characteristics enabled potential factors associated with hypokalemia to be examined simultaneously. In addition, the study was conducted at a regional referral hospital, providing clinically relevant information from patients receiving routine diabetes care in a resource-limited setting. However, several limitations should be considered. First, the cross-sectional design prevents determination of temporal or causal relationships between the identified factors and hypokalemia. Second, only 10 participants were identified with hypokalemia, resulting in a small number of outcome events and consequently wide confidence intervals for some estimates, particularly the association with oral antidiabetic therapy and age; therefore, these associations should be interpreted cautiously. Third, a single serum potassium measurement may not capture fluctuations in potassium levels over time. Fourth, the study may not have captured all potential determinants of potassium balance, including dietary potassium intake, gastrointestinal potassium losses, urinary potassium excretion, magnesium status, acid–base disturbances, and detailed medication exposure such as diuretic use. Finally, because participants were recruited from a regional referral hospital, the findings may not be fully generalizable to all people with diabetes in Uganda, particularly those receiving care in primary healthcare facilities or those who do not regularly access healthcare services.

Conclusion

Hypokalemia was identified in 2.7% of adults with diabetes mellitus attending Jinja Regional Referral Hospital in Eastern Uganda, indicating a relatively low prevalence but a clinically relevant electrolyte abnormality. Urban residence and use of oral antidiabetic agents were independently associated with higher prevalence of hypokalemia, while participants aged 31–45 years had a lower prevalence compared with those aged 16–30 years. Uncontrolled glycemia also showed a trend toward higher prevalence of hypokalemia, although this association was not statistically significant. Given the potential clinical consequences of potassium abnormalities, routine assessment of serum potassium may be considered in patients with diabetes, particularly those with poor glycemic control or receiving oral antidiabetic therapy. However, the small number of hypokalemia cases limits the precision of the observed associations. Larger prospective studies incorporating dietary intake, renal potassium losses, magnesium status, acid–base disturbances, and detailed medication exposure are warranted to confirm these findings and clarify the underlying mechanisms.

Declarations

Author Contribution

Abdirahman Ibrahim Said: Conceptualization, methodology, investigation, data collection, data curation, formal analysis, interpretation of findings, writing—original draft, writing—review and editing, and overall coordination of the study and manuscript preparation.Mustafe Hussein: Conceptualization, methodology, and critical review of the study design and manuscript.Stephen Charles Olet: Statistical methodology, statistical analysis, interpretation of statistical findings, and critical review of the manuscript.Abshir Mohamoud Hersi: Conceptualization, methodology, and critical review of the study design and manuscript.Abdirahman Mohamed Jama: Conceptual input, particularly the idea of developing hypokalemia as a separate manuscript from the broader electrolyte study, and critical review of the manuscript.Nasra Ibrahim Said: Manuscript review, critical reading, and editorial input.All authors contributed to the development of the manuscript, reviewed and approved the final version, and agreed to be accountable for the work.

Acknowledgement

I would like to express my sincere gratitude to Mr. Ojambo Patric, Laboratory Manager, and Mr. Higenyi James, Medical Laboratory Scientist (MLS), for their invaluable technical support, dedication, and commitment throughout this study. Their tireless efforts, including working around the clock to facilitate the laboratory procedures, were instrumental in the successful completion of this work.

Data Availability

The dataset generated and analyzed during the current study is provided as Supplementary Data 1 accompanying this article.

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Supplementary Files

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- SupplementaryData1.xlsx