



Magnitude and correlates of overweight or obesity among adults with diabetes mellitus duration of five or more years in rural Uganda: A cross-sectional study

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ABSTRACT

Background: Overweight and obesity are major risk factors for micro and macrovascular diseases, with diabetes mellitus exacerbating these burdens. We determined the prevalence of overweight or obesity and its associated factors among adults with diabetes mellitus with a duration of ≥ 5 years at Mbarara Regional Referral Hospital in Southwestern Uganda.

Methods: This analytic cross-sectional study was conducted over 5 months, from November 2017 to March 2018. We collected demographic and clinical data and measured body mass index (BMI). The outcome was overweight or obesity, measured as the proportion of individuals with a BMI of 25 kg/m^2 or more. We used binary logistic regression to estimate associations of a priori selected variables with the outcome.

Results: Of 189 participants, 138 (73%) were female, the mean age was 61.5 ± 11.1 years, and the median duration of diabetes mellitus since diagnosis was 10 years (interquartile range, 7–15). Overall, 122 (64.5%) participants were overweight or obese. In the multivariable logistic regression analysis, former cigarette smoking (adjusted odds ratio (AOR) 0.2, 95% confidence interval (CI) 0.1–0.6), every 1-year increase in the duration of diabetes mellitus (AOR 1.1, 95% CI 1.0–1.1), and hypertension (AOR 2.8, 95% CI 1.2–6.5) were independently associated with overweight or obesity.

Conclusion: Overweight/obesity is prevalent among adults with diabetes mellitus duration of 5 years and over, in a rural Ugandan population. Former cigarette smokers have a decreased likelihood of being overweight or obese, while hypertension and every 1-year increase in the duration of diabetes mellitus are associated with a higher likelihood of being overweight or obese.

Background

Diabetes mellitus, a chronic metabolic disorder, has become a major public health concern worldwide, with devastating consequences for individuals, communities, and healthcare systems [1]. Globally, 589 million people were living with diabetes mellitus in 2025, and type-2 diabetes mellitus (T2DM) alone represents more than 90% of the total

global disease burden [2]. In 2024, about 3.4 million died from diabetic associated complications [2]. Africa carries a huge burden of the global numbers of diabetes mellitus, with 25 million adults living with the condition [2]. In Uganda, the burden of diabetes mellitus is increasing, with an estimated population prevalence of 7% as of 2025 [3]. About 2750 Ugandans died from diabetes associated complications in 2024 [2].

Abbreviations: AOR, Adjusted odds ratio; BMI, Body mass index; CI, Confidence interval; HbA1c, Glycated hemoglobin; HIV, Human immunodeficiency virus; LDL, Low-density lipoproteins; MRRH, Mbarara Regional Referral Hospital; MUREC, Mbarara University Research Ethics Committee; SD, Standard deviation; UACR, Urine albumin-to-creatinine ratio.

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Overweight and obesity are well-established risk factors for diabetes mellitus and have increasingly been recognized as critical contributors to the development and progression of diabetes mellitus [2]. Like many African countries, Uganda is undergoing a rapid epidemiological transition characterized by shifting lifestyles, dietary patterns, and increasing urbanization. These changes have led to a rise in the prevalence of overweight and obesity, exacerbating the diabetes mellitus epidemic. Additionally, recent demographic changes in Uganda, characterized by a growing adult population, have led to an increased burden and proportion of people with diabetes mellitus [3]. In Eastern Uganda, a population-based prevalence of overweight and obesity was 20% among rural adults. In contrast, a 2011 national survey reported a prevalence of 11.3% for overweight and obesity in Southwestern Uganda [4,5]. In overweight and obese populations, cardiovascular disease contributed to 41% of deaths and 34% of total disability-adjusted life years [6]. The coexistence of overweight or obesity and diabetes mellitus poses significant challenges for disease management, complications prevention, and overall health outcomes [7]. In the urban tertiary hospital of Uganda, overweight was as high as 36%, whereas obesity was 27% among people with diabetes mellitus [8]. After 5 years of follow-up, 33.3% of obese individuals with diabetes mellitus died, while 45.9% experienced a composite cardiovascular outcome, encompassing major adverse cardiovascular events such as cardiovascular death, myocardial infarction, stroke, or heart-failure-related hospitalization [7]. Additionally, obesity or overweight increases the risks of hypertension, peripheral neuropathies, and poor glycaemic control among people with diabetes mellitus, which further worsens the composite cardiovascular outcome [8].

Despite the growing concern over the rising prevalence of obesity and diabetes mellitus, there is a paucity of data on the prevalence, correlates, and consequences of overweight and obesity among people with diabetes mellitus with a duration of ≥ 5 years in a rural Ugandan population.

In Uganda, previous studies have primarily focused on the risk factors for obesity or underweight without considering the duration of diabetes mellitus, and few studies have focused on rural populations. This study investigated the prevalence and factors associated with overweight or obesity among adults who have had diabetes mellitus for ≥ 5 years in rural Uganda.

Methods and materials

Study design and setting

This was a single-center, analytic cross-sectional study of ambulatory adults with diabetes mellitus conducted at the diabetes mellitus clinic of Mbarara Regional Referral Hospital (MRRH), the largest referral hospital in southwestern Uganda. The hospital, located in Mbarara City, serves six neighboring districts within its catchment area. It provides both inpatient and outpatient medical services across various wards and clinics. The diabetes mellitus clinic, which runs every Thursday, currently serves more than 1500 adults with diabetes mellitus.

Study population and participants' recruitment

We consecutively enrolled adults aged 18 years or older with diabetes mellitus who were taking medications for glycemic control for 5 years or more during routine clinic visits. The data were collected between November 2017 and March 2018.

Sample size calculation

We calculated the sample size using the Kish and Leslie (1965) formula: $n = (Z^2) * P * (1 - P) / d^2$ where n = the required sample size, Z = the Z-score corresponding to the desired confidence level of 1.96 for 95% confidence, P = the expected prevalence was 0.113 (11.3%), the

prevalence of overweight and obesity among population of south-western Uganda in 2011 [4] and d = the margin of error (the level of precision desired) was 0.05. The minimal sample required was 154. However, we increased the calculated sample size to 190 to account for anticipated refusals to participate due to multiple concurrent studies being conducted in the diabetes clinic at that time.

Data collection procedure and study variables

We used a questionnaire to collect quantitative data, including the participants' age, occupational status, educational level, smoking habits, symptoms, human immunodeficiency virus (HIV) status, duration of diabetes mellitus, and history of hypertension. The study team measured weight and height during enrolment. Weight and height were measured using a calibrated weighing scale with a stadiometer (ADE Germany GmbH & Co. KG, Hamburg, Germany). Height was measured to the nearest 0.1 cm (cm) and weight to the nearest kilogram (kg). To ensure accuracy, the anthropometric measurements were set at plausible ranges of 100 to 200 cm for height and 30 to 150 kg for weight. Any value outside of these ranges was considered invalid. We used height and weight to calculate the body mass index (BMI), which is weight in kilograms divided by the square of height in meters.

We categorized BMI per the World Health Organization (WHO) STEPs criteria as follows: underweight ($< 18.5 \text{ kg/m}^2$), normal weight (18.5 to 24.9 kg/m^2), overweight (25 to 29.9 kg/m^2), obesity class I (30 to 34.9 kg/m^2), obesity class II (35 to 39.9 kg/m^2), and obesity class III ($\geq 40 \text{ kg/m}^2$) [9]. This study's BMI $\geq 25 \text{ kg/m}^2$ indicates overweight or obesity. Age and duration of diabetes mellitus were measured on continuous scales in years. Sex was recorded as male or female. Following standardized procedures, the blood pressure was measured using automatic blood pressure monitors (Omron Corporation, Kyoto, Japan). The participant was allowed to sit on a chair and rest for 5 min. Then, three measurements were taken at an interval of 3 min with appropriate cuff sizes for individual participants. The averages of the second and third measurements were used to determine the final blood pressure of each participant [10]. HIV serostatus was defined as positive or negative, measured using the national HIV testing and diagnostic algorithm. Cigarette smoking status was categorized as a current, former, or never smoker based on self-report. Glycated hemoglobin (HbA1c) was measured on a continuous scale in percentage(%) and was grouped as < 7 or $\geq 7\%$ [11]. Low-density lipoprotein (LDL) was measured on a continuous scale and reported in mmol/L. Additionally, LDL was categorized as optimal (< 2.6), near-optimal/above optimal (2.6 – 3.3), borderline high (3.4 – 4.1), high (4.2 – 4.9), and very high (≥ 5) [12]. The urinary albumin-to-creatinine ratio (UACR) was measured on a continuous scale in mg/mol.

Blood samples for laboratory examinations were measured using the Siemens DCA Vantage™ analyzer (Siemens Healthcare Diagnostics Ltd., Frimley, Camberley, UK) for HbA1c and Humastar200™ (Human Diagnostics Worldwide, Wiesbaden, Germany) for LDL and UACR. Laboratory tests were performed at the MRRH laboratory using standardized internal quality control protocols. MRRH laboratory also participates in external quality control programs by the National Health Laboratory Service. For additional clarity, the data collection questionnaire has been included as supplementary material.

Statistical analysis

We summarized continuous variables such as age by means and standard deviations if normally distributed or medians and interquartile ranges when skewed. We used frequencies and percentages to summarize categorical variables such as sex. Comparisons were made between obese ($\geq 30 \text{ kg/m}^2$) and non-obese ($< 30 \text{ kg/m}^2$) individuals. The prevalence of overweight or obesity was defined as individuals with a BMI $\geq 25 \text{ kg/m}^2$, expressed as a percentage. We used binary logistic regression to determine the factors associated with overweight or obesity, adjusted

for important clinical/biologically relevant factors and those known from the literature. The regression model was a priori determined, including age, duration of diabetes mellitus, sex, hypertension, HIV serostatus, smoking status, HbA1c, and LDL [13–17]. All statistical analysis was conducted using Stata version 13 (StataCorp, College Station, Texas, USA).

Ethical approval

This study protocol was reviewed and approved by the Mbarara University of Science and Technology Research Ethics Committee (MUREC 1/7). All consent forms were translated into the local language, “Runnyankole”, and the study methods followed the relevant national research guidelines and regulations. Participants gave a signed informed consent, and for those who were unable to write, a thumbprint in the presence of a witness was provided.

Results

Study profile

A total of 999 individuals with diabetes mellitus were screened for eligibility. Of these, 795 were excluded as their duration of diabetes mellitus was less than five years. Additionally, five participants were excluded due to invalid weight or height measurements, and nine declined to provide informed consent. Furthermore, one participant was excluded during analysis as an outlier, being the only individual with a history of current smoking. Therefore, we analyzed data for 189 participants, with a mean age of 61.4 years (standard deviation or SD, 11.1), and 138 (73%) were female. The median duration for diabetes mellitus was 10 years (interquartile range, IQR, 7–15), and for the HbA1c, the median was 9.1% (IQR 7.7–11). A hundred forty-four (74%) participants had a history of hypertension. The median systolic and diastolic blood pressures were 145 mmHg (IQR 127–157) and 81 mmHg (IQR 75–89), respectively (Table 1).

Prevalence of overweight or obesity among rural Ugandans with diabetes mellitus

The prevalence of overweight or obesity was 64.5% ($n = 122/189$, 95% CI 0.6–0.7). Of the 189 participants, 63 (33.3%) had normal weight, 4 (2.1%) were underweight, 67 (35.4%) were overweight (pre-obese), 40 (21.2%) had obesity class I, 12 (6.4%) had obesity class II, and 3 (1.6%) had obesity class III.

Factors associated with overweight or obesity among rural Ugandans with diabetes mellitus

In the unadjusted analysis, sex, duration of diabetes mellitus, and cigarette smoking history were associated with overweight or obesity among rural Ugandans with diabetes mellitus. We found that being female compared to male and each additional year of duration of diabetes mellitus were associated with increased odds of being overweight or obese.

Also, former cigarette smokers had decreased odds of being overweight or obese compared to never smokers. In the adjusted analysis, sex, duration of diabetes mellitus, hypertension status, and history of cigarette smoking were significantly associated with overweight or obesity. In particular, hypertension and every 1-year increase in the duration of diabetes mellitus were associated with higher odds of overweight or obesity, whereas former cigarette smokers had lower odds of overweight or obesity compared to never smokers (Table 2).

Discussion

Our study investigated the prevalence of overweight or obesity

Table 1

Baseline socio-demographic and clinical characteristics of the study participants by obesity.

Characteristic	Total participants (N = 189)	Obese participants (BMI ≥ 30 kg/m ²)
Age (years) mean (*SD)	61.4 (11.1)	62.6 (10.6)
Sex, n (%):		
Female	138 (73)	52 (94.5)
Male	51 (26.9)	3 (5.5)
Level of education, n (%):		
None	45 (23.8)	16 (29.1)
Primary	89 (47)	25 (45.5)
Secondary	30 (15.8)	7 (12.7)
Tertiary	25 (13.2)	7 (12.7)
Occupation, n (%):		
Peasant farming	105 (55.5)	28 (50.9)
Business	18 (9.5)	8 (14.6)
Employed	30 (15.8)	6 (10.9)
Others	36 (19)	13 (23.6)
Duration of diabetes mellitus in years, median (*IQR)	10 (7–15)	11.5 (8–11)
Self-reported history of hypertension, n (%):		
Hypertension present	140 (74)	46 (83.6)
Hypertension absent	49 (25.9)	9 (16.4)
Cigarette smoking status, n (%):		
Never	155 (82)	50 (90.9)
Former	34 (17.9)	5 (9.1)
Symptoms at enrolment, n (%):		
Paresthesia	123 (65)	38 (69.1)
Blurry vision	122 (64.5)	34 (61.8)
Erectile dysfunction	13 (6.8)	1 (1.8)
Others*	43 (22.7)	12 (21.8)
Blood pressure at enrollment (mmHg), median (IQR)		
Systolic blood pressure	145 (127–157)	149 (27–28)
Diastolic blood pressure	81 (75–89)	83 (10–14)
*HIV status, n (%):		
Positive	14 (7.4)	5 (9.1)
Negative	175 (92.6)	50 (90.9)
Glycated hemoglobin (%), median (IQR)	9.1 (7.7–11)	9.2 (3.3–3.4)
Glycated hemoglobin category in %, n (%):		
Less than 7	25 (13.2)	5 (9.1)
7 and more	164 (86.7)	50 (90.9)
Low-density lipoproteins (mmol/L), median (IQR)	3.02 (2.4–3.9)	124.6 (61.5–62.3)
Low-density lipoproteins categories (mmol/L), n (%):		
Optimal (<2.6)	68 (35.9)	17 (30.9)
Near-optimal/above optimal (2.6–3.3)	38 (20.1)	11 (20.0)
Borderline high (3.4–4.1)	49 (25.9)	14 (25.5)
High (4.2–4.9)	18 (9.5)	7 (12.7)
Very high (≥5)	16 (8.4)	6 (10.9)
Urine albumin creatinine ratio (mg/mol), median (IQR)	266.6 (100–500)	383.3 (400–700)

Note: Others: Dyspnea, lower limbs swelling, or chest pain, SD: Standard deviation, IQR: Interquartile range, HIV: Human Immunodeficiency Virus.

among people with diabetes mellitus with a duration of ≥5 years at a large referral hospital in southwestern Uganda, and we found that slightly more than six in 10 people are either overweight or obese. Additionally, the study showed that a history of cigarette smoking is linked to a lower chance of being overweight and obese. In comparison, hypertension and increasing duration of diabetes mellitus are associated with a higher chance of being overweight and obese. A study conducted in Uganda revealed a 63% prevalence of overweight or obesity among people with diabetes mellitus [18], which is similar to the prevalence of overweight or obesity in the present study.

Comparable to our finding, a prevalence of overweight/obesity was reported at 68% among people living with diabetes mellitus in Kuwait [19]. Also, a systematic review of the African population reported nearly

Table 2

Factors associated with overweight or obesity among rural Ugandans with diabetes mellitus.

Variable	Level	Unadjusted model (OR, 95% CI)	Adjusted model (AOR, 95% CI)
Age	1-unit increase	0.9 (0.9–1.0)	0.9 (0.9–1.0)
Sex	Male	1	1
	Female	2.7 (1.4–5.3)	2.0 (0.9–4.3)
Duration of diabetes mellitus	1-year increase	1.0 (1.0–1.1)	1.1 (1.0–1.1)
History of hypertension	Absent	1	1
	Present	1.7 (0.8–3.2)	2.8 (1.2–6.5)
Cigarette smoking	Never	1	1
	Former	0.3 (0.2–0.7)	0.2 (0.1–0.6)
HIV test	Negative	1	1
	Positive	3.5 (0.8–16.3)	5.3 (0.9–28.5)
Glycated hemoglobin	<7%	1	1
	≥7%	1.8 (0.7–4.3)	2.4 (0.8–7.2)
Low-density lipoprotein category (mmol/L):	Optimal (<2.6)	0.9 (0.4–2.1)	1.3 (0.5–3.4)
	Near Optimal (2.6–3.3)	1.9 (0.9–4.3)	2.2 (0.9–5.6)
	Borderline (3.4–4.1)	2.4 (0.7–8.2)	2.9 (0.8–10.9)
	High (4.2–4.9)	1.1 (0.4–3.6)	0.7 (0.2–2.5)
	Very high (≥5)		
Urine albumin creatinine ratio	1-unit increase	0.9 (0.9–1.0)	1.0 (0.9–1.0)

80% overweight or obesity among individuals with type 2 diabetes mellitus [20], which is higher than the prevalence of overweight or obesity in the current study.

In Asia, the prevalence of overweight/obesity among people with diabetes was 85.8% in Saudi Arabia [21] and 80% in India [22]. Similarly, about 90% and 80% of adults with diabetes were overweight or obese in the United Kingdom [23] and the United States [24], respectively. However, contrary to our finding, Addissae et al. in 2021 found a 36.2% prevalence of overweight or obesity [25], and a population survey showed a prevalence of 11.3% among the general population in the southwestern region of Uganda, which is significantly lower than the prevalence of overweight or obesity in our study. Differences in lifestyle factors, socioeconomic status, and demographics might explain the observed variation in the prevalence of overweight or obesity between the past studies and our study. Although this study found that 64% of participants were overweight or obese, the potential inclusion of individuals with type 5 diabetes mellitus (T5DM) points to a possible dual burden of malnutrition within the community. The findings are likely to predominantly reflect T2DM, which is commonly associated with nutritional transition and excess body weight. Consequently, the study may underrepresent an undernourished subgroup of individuals with T5DM, who may experience comparable yet pathophysiologically distinct metabolic challenges.

We found that hypertension is linked to a higher likelihood of overweight or obesity, similar to past studies [26–28]. In general, a higher BMI raises the risk of hypertension as increased fat levels are assumed to elevate vascular resistance [29]. The consequences of vascular resistance include raised afterload and sympathetic tone, activating the renin-angiotensin system (RAS), and creating a vicious cycle of vascular resistance and activation of RAS. Additionally, hyperinsulinemia and leptin 5 together with other neuropeptides may also increase the potential for overweight, obesity, and hypertension [30].

Studies have also proven that type 2 diabetes mellitus can be brought on by an excessive buildup of body fat, and the chance of developing type 2 diabetes mellitus rises linearly as the body mass index rises [31,32]. Adiposity-induced changes in β -cell function, adipose tissue biology, and multi-organ insulin resistance are among the complex cellular and physiological mechanisms that underlie the association

between obesity and type 2 diabetes mellitus [33,34]. However, in our study, increasing duration of diabetes mellitus is associated with overweight and obesity.

Although overweight and obesity are well-established risk factors for diabetes, the association observed between diabetes duration and overweight in this study should be interpreted with caution. The timing and duration of overweight or obesity relative to the diagnosis of diabetes were not assessed, limiting our ability to determine whether excess weight preceded the onset of diabetes, coexisted with it, or developed as a consequence of the disease or its management. This unique finding necessitates further longitudinal research to understand the causal pathway or mechanism.

This study revealed that a history of cigarette smoking is associated with a lower risk of overweight and obesity. The interpretation of this finding requires caution rather than being viewed as evidence of a protective effect of smoking behavior. Epidemiological evidence shows that while active smoking is often associated with lower BMI—likely due to nicotine's appetite-suppressing and metabolic effects, this does not imply a health benefit, as smoking also increases insulin resistance and central adiposity despite lower BMI in some smokers [35]. Furthermore, smoking cessation is well documented to be followed by weight gain in many individuals, with quitters typically gaining several kilograms during the first years after quitting, which often increases body mass above that of continuing smokers [36]. This dynamic may contribute to complex patterns in cross-sectional data where former smokers appear leaner than non-smokers among people with long-duration diabetes: reverse causation (for instance, individuals experiencing weight gain or worsening metabolic health may be more likely to quit smoking) and residual confounding by lifestyle or health status could bias this association. Additionally, methodological biases such as selection effects or confounding by unmeasured factors (physical activity, diet, duration since quitting) are known to influence associations between smoking status and weight outcomes [37]. Therefore, rather than reflecting a causal “protective” effect of former smoking on overweight or obesity, these results likely reflect a combination of post-cessation weight dynamics, reverse association, and confounding, emphasizing the need for longitudinal data to clarify temporal relationships.

Study strengths and limitations

This study has several strengths. It is among the first to investigate the prevalence of overweight and obesity among individuals with diabetes mellitus of at least five years in duration, providing valuable insights into this understudied subgroup.

By focusing on a rural population, the study highlights the burden of overweight and obesity in settings where healthcare access and lifestyle factors may differ significantly from urban areas.

Additionally, using a well-defined population and standardized BMI classification enhances the reliability of the findings. However, the study has some limitations. Due to constraints in obtaining retrospective study approval, data beyond 2018 to allow for more recent data and a relatively longer study duration were not included. Nevertheless, we do not expect that incorporating more recent data would significantly alter the findings. Another limitation is the study's limited generalizability, as it was conducted in a rural setting and may not fully reflect trends in urban populations where lifestyle, diet, and healthcare access differ. Additionally, certain key variables, such as alcohol consumption and other lifestyle behaviors known to influence overweight and obesity, were not measured, which may impact the interpretation of results. Furthermore, our small sample size may reduce the precision of the estimates and statistical power. The sample size was estimated using the prevalence of overweight/obesity in the general Ugandan population because population-level estimates among people with diabetes were not available prior to 2017. As a result, the study may have been under- or over-powered for the target population, and this should be considered when interpreting the precision and strength of the observed associations.

Conclusion

People with diabetes mellitus in this population are more likely to be overweight or obese, which may greatly increase the burden and negative consequences of diabetes mellitus. Former cigarette smokers have a decreased likelihood of being overweight or obese, while hypertension and every 1-year increase in the duration of diabetes mellitus are associated with a higher likelihood of being overweight or obese.

Availability of data and materials

The datasets used during this study are available from the corresponding authors upon reasonable request.

CRediT authorship contribution statement

Boniface Amanee Elias Lumori: Writing – review & editing, Writing – original draft, Visualization, Validation, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Lodiong Jackson Dumo Lodiong:** Writing – review & editing, Writing – original draft, Validation, Software, Project administration, Investigation, Data curation. **Ucama Ufoymungu Patrick:** Writing – review & editing, Project administration, Methodology, Investigation, Data curation. **Jonathan Izudi:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Formal analysis.

Consent for publication

All co-authors reviewed and approved the manuscript for publication.

Ethics approval and consent to participate

This study protocol was reviewed and approved by the Research and Ethics Committee of Mbarara University of Science and Technology (MUREC 1/7). All consents were translated into the local language and the study methods followed the relevant guidelines and regulations. All individuals gave signed informed consent or provided a thumbprint in the presence of a witness for those unable to write.

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Declaration of competing interest

None.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.gloepi.2026.100254>.

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