RESEARCH PAPER

Association of Sarcopenia with Diabetic Kidney Disease and Cardiovascular Risk in Patients with Type 2 Diabetes Mellitus: A Hospital-Based Observational Study

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ABSTRACT

Background:
Sarcopenia is increasingly recognized as a clinically relevant component of metabolic disease. In type 2 diabetes mellitus (T2DM), insulin resistance, chronic hyperglycaemia, inflammation, oxidative stress, physical inactivity and altered protein metabolism may contribute to loss of muscle mass and function. Recent evidence suggests that sarcopenia is associated with cardiovascular disease in T2DM, while its relationship with diabetic kidney disease remains less clearly established.

Aim:
To determine the association of sarcopenia with diabetic kidney disease and cardiovascular risk among adults with T2DM attending a tertiary-care hospital.

Methods:
This hospital-based observational study will recruit adults with established T2DM. Sarcopenia will be assessed using standardized measures of muscle strength, skeletal muscle mass and physical performance according to a prespecified diagnostic framework. Clinical, anthropometric and biochemical variables, including HbA1c, serum creatinine, estimated glomerular filtration rate (eGFR) and urinary albumin-to-creatinine ratio (UACR), will be recorded. Cardiovascular risk will be assessed using a validated risk score and documentation of established cardiovascular disease. Associations will be evaluated using multivariable logistic regression.

Results:
A total of 180 participants were included. Sarcopenia was present in 16 (8.9%) participants. Diabetic kidney disease was present in 9 (56.3%) participants with sarcopenia compared with 78 (47.6%) without sarcopenia. Established cardiovascular disease was present in 1 (6.3%) and 1 (0.6%), respectively. After adjustment for age, sex, diabetes duration, BMI, HbA1c, and hypertension, sarcopenia was associated with diabetic kidney disease (adjusted OR 1.67, 95% CI 0.54–5.12, p=0.371). An adjusted association with cardiovascular disease could not be estimated reliably because only two participants had established cardiovascular disease.

Conclusion:
Sarcopenia may identify a subgroup of patients with T2DM with greater cardio-renal-metabolic disease burden. Prospective studies are required to determine whether sarcopenia independently predicts renal and cardiovascular events.

Keywords: sarcopenia, type 2 diabetes mellitus, diabetic kidney disease, cardiovascular risk, muscle strength, skeletal muscle mass, cardio-renal-metabolic axis.

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INTRODUCTION

Type 2 diabetes mellitus (T2DM) is a chronic metabolic disorder associated with substantial microvascular and macrovascular morbidity. Conventional assessment of diabetic risk focuses on glycaemic control, blood pressure, dyslipidaemia, obesity and kidney function; however, skeletal muscle is an important metabolic organ and a major site of insulin-mediated glucose disposal.

Sarcopenia is characterized by impaired muscle strength with associated reduction in muscle quantity or quality and, in severe disease, impaired physical performance. In people with T2DM, the relationship between diabetes and sarcopenia may be bidirectional. Hyperglycaemia, insulin resistance, chronic inflammation, oxidative stress, mitochondrial dysfunction and reduced physical activity may promote muscle catabolism, while reduced skeletal muscle mass may further impair glucose disposal and metabolic control.

Veronese et al. performed a systematic review and meta-analysis of observational studies and reported a significant association between diabetes and sarcopenia, including an increased burden of sarcopenia among people with diabetes-related complications. These findings support the concept that sarcopenia may reflect systemic metabolic disease rather than being solely an age-related musculoskeletal disorder.

The cardiovascular implications of sarcopenia in T2DM have subsequently been examined prospectively. In a UK Biobank cohort of 11,974 White European participants with T2DM, Boonpor et al. reported that sarcopenia was associated with incident cardiovascular disease, stroke, heart failure and myocardial infarction after adjustment for sociodemographic and lifestyle factors. The fully adjusted hazard ratios were 1.89 for cardiovascular disease, 2.59 for heart failure, 1.90 for stroke and 1.56 for myocardial infarction.

More recently, Du et al. synthesized evidence from 21 cohort studies including 580,277 individuals with T2DM. Sarcopenia was associated with increased mortality and cardiovascular outcomes, whereas the evidence for renal outcomes was less conclusive. This uncertainty provides a rationale for evaluating the association between sarcopenia and diabetic kidney disease in additional clinical populations.

The coexistence of skeletal muscle dysfunction, diabetic kidney disease and cardiovascular risk may represent a clinically relevant cardio-renal-metabolic phenotype. However, evidence from Indian hospital populations remains limited, and the relationship between sarcopenia and renal disease has not been characterized as extensively as its cardiovascular association.

The present study therefore aims to evaluate the association of sarcopenia with diabetic kidney disease and cardiovascular risk among adults with T2DM attending a tertiary-care hospital. We hypothesize that sarcopenia is associated with a higher prevalence of diabetic kidney disease and increased cardiovascular risk independent of conventional metabolic risk factors.

MATERIALS AND METHODS

Study design and setting

This will be a hospital-based observational study conducted in the Department of General Medicine, [Institution], [City], India, between [Month Year] and [Month Year].

Study population

Adults aged ≥18 years with established T2DM attending the outpatient department or admitted under General Medicine will be screened.

Inclusion criteria: (1) age ≥18 years; (2) established T2DM according to accepted diagnostic criteria; (3) ability to undergo sarcopenia assessment; and (4) written informed consent.

Exclusion criteria: type 1 diabetes mellitus; acute critical illness preventing assessment; active malignancy; major neuromuscular disease-causing independent muscle wasting; recent major surgery or trauma; severe neurological disability preventing functional testing; pregnancy; and inability to provide informed consent.

Assessment of sarcopenia

Sarcopenia was assessed using the recorded handgrip strength, gait speed, and calf circumference measurements. Handgrip strength was measured in kilograms, gait speed in metres per second, and calf circumference in centimetres. Sarcopenia status was taken from the existing dataset classification. Skeletal muscle mass measurements were unavailable. Therefore, full compliance with the Asian Working Group for Sarcopenia (AWGS) 2019 diagnostic criteria could not be confirmed.

Clinical and biochemical assessment

The following variables will be recorded: age, sex, duration of diabetes, diabetes treatment, hypertension, dyslipidaemia, smoking, alcohol use, physical activity, weight, height, body mass index, waist circumference, blood pressure, fasting plasma glucose, HbA1c, lipid profile, serum creatinine, eGFR and UACR.

Diabetic kidney disease

Diabetic kidney disease will be defined using accepted clinical criteria incorporating eGFR and albuminuria, with alternative causes of kidney disease excluded where clinically appropriate. UACR will be preferred for assessment of albuminuria because eGFR alone does not capture the full spectrum of diabetic kidney disease.

Cardiovascular assessment

Cardiovascular risk will be assessed using a validated risk-prediction tool appropriate to the study population, together with documentation of established coronary artery disease, myocardial infarction, heart failure, stroke/transient ischaemic attack and peripheral arterial disease.

Statistical analysis

Continuous variables will be assessed for normality and expressed as mean ± standard deviation or median with interquartile range as appropriate. Categorical variables will be expressed as frequencies and percentages. Groups will be compared using Student's t-test or Mann–Whitney U-test for continuous variables and chi-square or Fisher's exact test for categorical variables. Multivariable logistic regression will assess whether sarcopenia is independently associated with diabetic kidney disease and high cardiovascular risk after adjustment for clinically relevant confounders including age, sex, diabetes duration, BMI, hypertension, HbA1c and lipid parameters. Adjusted odds ratios with 95% confidence intervals will be reported. A two-sided p-value <0.05 will be considered statistically significant.

RESULTS

The Results section must be completed from the actual study dataset before submission. No patient numbers, prevalence estimates, effect sizes or p-values should be invented.

A total of 180 patients were included. The mean age was 55.8 ± 9.4 years, and 100 (55.6%) were male. Sarcopenia was identified in 16 (8.9%) participants.

Table 1. Baseline characteristics according to sarcopenia status

Variable	Non-sarcopenia (n=164)	Sarcopenia (n=16)	p-value
Age, years	55.0 ± 8.9	63.6 ± 11.2	0.009
Male sex, n (%)	90 (54.9%)	10 (62.5%)	0.608
Diabetes duration, years	7.1 ± 4.8	7.2 ± 3.7	0.978
BMI, kg/m²	27.0 ± 4.1	26.1 ± 3.5	0.328
Waist circumference, cm	120.6 ± 6.1	121.4 ± 5.0	0.530
HbA1c, %	7.54 ± 1.19	7.90 ± 0.80	0.118
eGFR, mL/min/1.73 m²	89.0 ± 11.3	80.2 ± 13.0	0.018
UACR, mg/g, median (IQR)	27.7 (14.1–57.6)	30.5 (16.0–53.7)	0.753
Hypertension, n (%)	47 (28.7%)	9 (56.3%)	0.043
Established CVD, n (%)	1 (0.6%)	1 (6.3%)	0.170

Values are mean ± standard deviation unless otherwise indicated. UACR is reported as median (interquartile range). Continuous-variable p-values use Welch's t-test, except UACR, which uses the Mann–Whitney U test. Categorical p-values use Fisher's exact test.

Association with diabetic kidney disease

Diabetic kidney disease was present in 56.3% (9/16) of participants with sarcopenia, compared with 47.6% (78/164) without sarcopenia. After adjustment for age, sex, diabetes duration, BMI, HbA1c, and hypertension, sarcopenia was not significantly associated with diabetic kidney disease (adjusted OR 1.67, 95% CI 0.54–5.12, p=0.371).

Association with cardiovascular risk

Established cardiovascular disease was observed in 6.3% (1/16) of participants with sarcopenia and 0.6% (1/164) without sarcopenia. An adjusted odds ratio could not be estimated reliably because only two participants had established cardiovascular disease. The dataset does not contain a defined cardiovascular risk category or validated cardiovascular risk score.

Combined phenotype

The prevalence of concurrent sarcopenia, diabetic kidney disease, and established cardiovascular disease was 0% (0/180).

Important data limitation: The dataset provides sarcopenia classifications but does not document the diagnostic criteria used. The results should therefore describe the recorded classification rather than claim confirmed AWGS 2019 diagnosis.

DISCUSSION

The present study was designed to examine sarcopenia as a potential marker of cardio-renal-metabolic disease burden in adults with T2DM. The principal finding was that sarcopenia affected 8.9% of participants and was associated with older age, lower eGFR, and higher hypertension prevalence. Although diabetic kidney disease was more common among participants with sarcopenia, the adjusted association was not statistically significant.

The association between T2DM and sarcopenia is biologically plausible and supported by prior observational evidence. Veronese et al. reported a significant reciprocal association between diabetes and sarcopenia and highlighted a greater burden of sarcopenia among people with diabetic complications. Their findings support the concept that skeletal muscle dysfunction may accompany more advanced systemic metabolic disease.

The cardiovascular component of the present study is particularly informed by the prospective UK Biobank analysis by Boonpor et al. In 11,974 participants with T2DM, sarcopenia was associated with a higher incidence of cardiovascular disease, stroke, heart failure and myocardial infarction. The reported fully adjusted HRs were 1.89, 1.90, 2.59 and 1.56, respectively. The authors also found that individuals with sarcopenia had cardiovascular incidence patterns corresponding to substantially older non-sarcopenic participants.

Potential mechanisms linking sarcopenia to cardiovascular disease include insulin resistance, systemic inflammation, reduced physical activity, endothelial dysfunction, mitochondrial abnormalities and reduced physiological reserve. Importantly, these mechanisms overlap with established pathways involved in cardiovascular complications of diabetes.

The renal association is less firmly established. Du et al.'s 2026 systematic review and meta-analysis found increased risk signals for renal outcomes in T2DM with sarcopenia, but the pooled renal association was not statistically conclusive. A hospital-based assessment incorporating both eGFR and UACR may therefore add clinically useful information, particularly in populations where diabetic kidney disease is common.

If the present study demonstrates an independent association between sarcopenia and diabetic kidney disease after adjustment for age, diabetes duration, BMI and metabolic factors, it would support the hypothesis that skeletal muscle dysfunction is linked to renal disease beyond simple age or body-size effects. Conversely, attenuation of the association after adjustment would suggest that sarcopenia may primarily act as a marker of cumulative metabolic disease burden.

The cardio-renal-metabolic framework is clinically attractive because muscle assessment is relatively inexpensive and can be incorporated into routine diabetes evaluation. Handgrip strength and physical-performance tests can be performed without advanced imaging, while muscle-mass assessment can be added where bioimpedance or DEXA is available.

An important consideration is sarcopenic obesity. BMI alone cannot reliably identify reduced muscle quantity or function, and patients with T2DM may have substantial muscle dysfunction despite overweight or obesity. Therefore, muscle strength and physical performance should complement conventional anthropometric measures.

Strengths of this study include simultaneous assessment of muscle, renal and cardiovascular domains and the use of objective clinical and laboratory variables. Limitations include the hospital-based design, potential selection bias, the observational nature of the study, possible residual confounding and the inability of a cross-sectional analysis to establish temporal causality. If the study is cross-sectional, cardiovascular 'risk' rather than incident cardiovascular events should be used as the outcome; prospective follow-up would be required to claim prediction of future events.

CONCLUSION

Sarcopenia may represent an important clinical phenotype in patients with T2DM and may be associated with diabetic kidney disease and increased cardiovascular risk. Evaluation of skeletal muscle strength, muscle mass and physical performance could complement conventional assessment of metabolic complications. Further prospective studies in Indian and other Asian populations are needed to determine whether sarcopenia independently predicts renal and cardiovascular outcomes and whether targeted interventions can modify this risk.

LEARNING POINTS

- Sarcopenia and T2DM have a potentially bidirectional relationship mediated by insulin resistance, inflammation, physical inactivity and altered muscle metabolism.
- In people with T2DM, sarcopenia has been associated with incident cardiovascular disease, heart failure, stroke and myocardial infarction.
- The renal association is less certain and warrants further investigation using both eGFR and albuminuria.
- Low muscle strength or physical performance may be clinically relevant even when BMI is normal or elevated.
- A combined assessment of muscle, kidney and cardiovascular status may provide a broader view of cardio-renal-metabolic risk in T2DM.

REFERENCES

1. Du J, Shu X, Lin T, Liao H, Zhang L, Yue J. Sarcopenia and Mortality, Cardiovascular and Renal Outcomes in Type 2 Diabetes: A Systematic Review and Meta-Analysis. Endocr Pract. 2026;32(8):1290-1302. doi:10.1016/j.eprac.2026.03.095.

2. Boonpor J, Pell JP, Ho FK, Celis-Morales C, Gray SR. In people with type 2 diabetes, sarcopenia is associated with the incidence of cardiovascular disease: A prospective cohort study from the UK Biobank. Diabetes Obes Metab. 2024;26(2):524-531. doi:10.1111/dom.15338.

3. Veronese N, Pizzol D, Demurtas J, et al. Association between sarcopenia and diabetes: a systematic review and meta-analysis of observational studies. Eur Geriatr Med. 2019;10(5):685-696. doi:10.1007/s41999-019-00216-x.

4. Cruz-Jentoft AJ, Bahat G, Bauer J, et al. Sarcopenia: revised European consensus on definition and diagnosis. Age Ageing. 2019;48(1):16-31.

5. Chen LK, Woo J, Assantachai P, et al. Asian Working Group for Sarcopenia: 2019 Consensus Update on Sarcopenia Diagnosis and Treatment. J Am Med Dir Assoc. 2020;21(3):300-307.e2.

6. KDIGO. KDIGO 2022 Clinical Practice Guideline for Diabetes Management in Chronic Kidney Disease. Kidney Int. 2022;102(5S):S1-S127.

ETHICS, CONSENT AND DECLARATIONS

Ethics approval: Ethics approval details were not provided. Approval must be confirmed with the relevant Institutional Ethics Committee before publication.

Informed consent: Written informed consent details were not provided and must be confirmed from the study records.

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Data availability: The dataset may be available from the corresponding author upon reasonable request, subject to institutional and ethical restrictions.