Submitted: 21 June, 2023 Accepted: 29 August, 2023 Published: 30 September, 2023 DOI:10.22514/jomh.2023.089

ORIGINAL RESEARCH

JOMH Journal of Men's Health

Correlation between muscle mass reduction and serum uric acid and urinary albumin in middle-aged and elderly type 2 diabetes men

Lin Li[1], Xiuli Cao[1], Qihong Yang[1,*]

[1]Department of Geriatrics, People's Hospital of Chongqing Liangjiang New Area, 401121 Chongqing, China

***Correspondence**
yangqihong3062101@163.com
(Qihong Yang)

Abstract

This cross-sectional study correlated the muscle mass reduction with serum uric acid and urinary albumin in middle-aged and elderly men having type 2 diabetes. The study subjects were 288 middle-aged and elderly male patients with type 2 diabetes (T2DM) admitted to our hospital. They were divided into sarcopenia (n = 95) and non-sarcopenia (n = 193) groups based on whether diagnosed with sarcopenia or not. The relevant clinical information of patients was collected. Single factor analysis and multiple factor regression analysis were employed to explore the influencing factors of sarcopenia. A binary logistic regression analysis model was established for the sarcopenia probability in middle-aged and elderly men with T2DM. Hosmer and Lemeshow test evaluated the Goodness of fit of probability model. ROC (Receiver Operating Characteristic) curve was drawn by SPSS and the predictive value of prediction model was evaluated. The univariate analysis depicted that the patients in sarcopenia group compared to those in non-sarcopenia were older with lower BMI (Body Mass Index), lower UA (Uric Acid) and higher CRP (C-reactive Protein). The differences were statistically significant ($p < 0.05$). The binary logistic regression analysis exhibited that the age and UACR (Urine Albumin-to-Creatinine Ratio) were the risk factors, while BMI and UA were the protective factors for sarcopenia in middle-aged and elderly men with T2DM. For middle-aged and elderly male patients with T2DM, age and UACR were the risk factors, and BMI and UA were the protective factors for sarcopenia. The changes in above-stated indicators of patients with T2DM should be clinically monitored, and early and active intervention be given to high-risk groups for minimizing the sarcopenia occurrence.

Keywords

Middle-aged and elderly people; Male; Type 2 diabetes; Reduced muscle mass; Blood uric acid; Urinary albumin; Inflammation

1. Introduction

The clinical studies [1, 2] have indicated that sarcopenia is a progressive and generalized skeletal muscle disorder involving the accelerated loss of muscle mass, muscle force and/or function which are associated with adverse outcomes. People lose the skeletal muscle mass by 3–5% every 10 years from 30 years onwards. The older people have increased adverse outcomes including falls and fractures. Severe negative influence is posed on older patients' later life [3]. The clinical studies [4, 5] reflect that the sarcopenia onset and progression are linked with abnormal lipid metabolism, inflammatory response, oxidative stress response and decreased neuronal stimulation. Pathological process of T2DM patients is similar to these conditions. Sarcopenia and T2DM are thus connected with each other. Clinical statistics show that [5], above 50 million people in the world currently suffer from sarcopenia and expected to reach 500 million in 30 years. According to the International Diabetes Federation, the number of people with diabetes is estimated to increase to 629 million in 2045 from 425 million in 2017. T2DM prevalence will exceed 90% [6]. Studies have found that patients with T2DM have higher sarcopenia risk than healthy people [4–6]. More patients are at sarcopenia risk because of the global increase in T2DM prevalence [5]. The average sarcopenia prevalence in elderly people is ~10%, while it is increased to ~55% in T2DM. Male diabetes patients have higher sarcopenia prevalence [7].

Clinical studies [6, 7] reflect that the blood uric acid can act as an antioxidant to mediate the oxidative stress response. Moreover, the changes in urinary albumin are correlated to insulin resistance, inflammatory response and oxidative stress response. However, there are limited studies on the correlation between sarcopenia, blood uric acid and urinary albumin in the middle-aged and aged patients. Furthermore, the influence of blood uric acid and urinary albumin on sarcopenia is not clear [8, 9].

This is an open access article under the CC BY 4.0 license (https://creativecommons.org/licenses/by/4.0/).

It was a cross-sectional study aimed at investigating the correlation of muscle mass reduction with serum uric acid and urinary albumin. Total of 288 middle-aged and elderly male patients with T2DM admitted to our hospital from December 2020 to December 2021 were selected.

2. Material and methods

2.1 Clinical materials

Total of 288 middle-aged and elderly male patients with T2DM admitted to People's Hospital of Chongqing Liangjiang New Area were selected.

2.1.1 Inclusion criteria

(1) Patients were included based on the clinical diagnostic criteria of T2DM as proposed by WHO (World Health Organization) in 1999; (2) patients above 50 years old were included as per the age structure given by WHO [5]; (3) patients having the two diseases for more than 1 year were included; and (4) all patients were male.

2.1.2 Exclusion criteria

(1) Patients having other severe organic diseases were excluded; (2) patients with cognition disorder were excluded; (3) patients of acute renal dysfunction were excluded; (4) patients without complete clinical information were excluded; (5) patients unable to participate in relevant tests were excluded; and (6) female patients were excluded.

2.2 Methods

Total of 288 middle-aged and elderly male patients with T2DM admitted to our hospital from December 2020 to December 2021 were selected. Patients disease history and clinical information were collected according to the scales designed by hospital which include age, BMI, FBG (fasting blood glucose), HOMA-IR (homeostasis model assessment of insulin resistance), course of diabetes, HbA1c (hemoglobin A1c), UA, eGFR (epidermal growth factor receptor), 25OHD3 (25-hydroxyvitamin D3), CRP, IL-6 (interleukin-6), UACR, smoking history, combined hypertension, education background and others.

2.2.1 Muscle mass detection

The patient was scanned from head to feet for detecting the appendicular skeletal muscle mass (ASM) by a dual energy X-ray absorptiometer (RS 2400, HOLOGIC, Boston, MA, USA). The scanning lasted for 20 min with 60 cm scanning width. The relative skeletal muscle mass index (RSMI) was calculated by the formula, RSMI = ASM/height. Male patients with RSMI <7.0 kg/m^2 were considered having sarcopenia as per the sarcopenia definition published by European Working Group on Sarcopenia in Older People (EWGSOP2) [6].

2.2.2 Lab indexes and detection

Elbow venous blood was collected after the fasting of 8 hours. Midstream urine was collected in the morning. The samples underwent FBG, UA, 25OHD3, CRP, IL-6, UACR and HbA1c clinical analysis. The formula, HOMA-IR = FPG (Fasting Plasma Glucose) $\times$ FINS (Fasting Serum Lisulin)/22.5 was employed. Chronic Kidney Disease Epidemiology Collaborative Study Formula (CKD-EPI) was used to calculate the eGFR.

2.3 Statistics

The data were analyzed by SPSS (Statistical Package for Social Sciences) 27.0 (IBM, Armonk, NY, USA). Normally distributed measurement data were expressed as ($\bar{x} \pm$ s) and tested by t test, while the non-normally distributed expressed by median (upper and lower quartiles) (M (Q1, Q3)) and tested by rank sum test. Count data were expressed by cases and percentage (n (%)), and tested by χ^2. The binary logistic regression model made multiple factors regression analysis. Hosmer and Lemeshow test were adopted to evaluate the goodness of fit of probability model. ROC curve assisted in accessing the predicted value of prediction model. The differences were statistically significant at $p < 0.05$.

3. Results

3.1 Sarcopenia prevalence in middle-aged and older male patients with T2DM

Ninety-five patients had sarcopenia among 288 patients with T2DM. The sarcopenia prevalence was thus 32.99%. They were divided into sarcopenia (n = 95) and non-sarcopenia (n = 193) groups based on their diagnosis for sarcopenia or not.

3.2 Single factor analysis of middle-aged and older male patients having T2DM and sarcopenia

The single factor analysis depicted that patients in sarcopenia group were older with lower BMI and UA, and higher CRP and UACR compared to the ones in non-sarcopenia group. The differences were statistically significant ($p < 0.05$). Further details could be found in Table 1.

3.3 Logistic multi-factor regression analysis of middle-aged and older male patients with T2DM and sarcopenia

The dependent variable was the presence or absence of sarcopenia in middle-aged and older male patients with T2DM. The independent variables were the Age, BMI, UA, CRP and UACR (see Table 2 for the assignment). The binary logistic regression analysis model in SPSS analyzed these variables. Results exhibited that the differences in age, BMI, UA and UACR were significant ($p < 0.05$). The OR (Odds Ratio) values of age and UACR were >1, while of BMI and UA were <1. The age and UACR were thus the risk factors to have sarcopenia in middle-aged and older male patients with T2DM, while BMI and UA were the protective factors. More details could be found in Tables 2 and 3.

TABLE 1. Single factor analysis of middle-aged and older male patients with T2DM and sarcopenia.

Indicators	Non-sarcopenia group (n = 193)	Sarcopenia group (n = 95)	Statistics	*p*
Age	65.36 ± 5.64	69.55 ± 5.45	5.996	<0.001
BMI (kg/m^2)	26.35 ± 1.95	23.11 ± 1.64	−13.908	<0.001
FBG (mmol/L)	9.25 ± 0.95	9.27 ± 0.91	0.126	0.900
HOMA-IR	4.82 ± 0.44	4.86 ± 0.45	0.718	0.474
Diabetes duration (yr)	2.29 ± 0.65	2.31 ± 0.67	0.183	0.855
HbA1c (%)	8.35 ± 0.76	8.37 ± 0.79	0.206	0.837
UA (mmol/L)	345.35 ± 34.26	300.25 ± 29.68	−10.964	<0.001
eGFR (mL/min/m^2)	96.35 ± 0.89	96.41 ± 0.91	0.448	0.654
25OHD3 (pg/mL)	22.35 ± 0.45	22.41 ± 0.38	1.169	0.244
CRP (mg/L)	1.85 ± 0.19	2.47 ± 0.22	24.450	<0.001
IL-6 (pg/mL)	4.03 ± 0.34	4.06 ± 0.36	0.466	0.642
UACR (mg/g)	56.35 ± 5.05	61.26 ± 6.08	6.817	<0.001
Smoking (n, %)				
Yes	136, 70.47	68, 71.58	0.038	0.845
No	57, 29.53	27, 28.42		
Hypertension (n, %)				
Yes	111, 57.51	54, 56.84	0.012	0.914
No	82, 42.49	41, 43.16		
Education background (n, %)				
No more than secondary school	89, 46.11	44, 46.32		
High school and above	66, 34.20	32, 33.68	0.009	0.996
College graduate or above	38, 19.69	19, 20.00		

BMI: body mass index; FBG: fasting blood glucose; HOMA-IR: homeostasis model assessment of insulin resistance; HbA1c: hemoglobin A1c; UA: uric acid; eGFR: epidermal growth factor receptor; 25OHD3: 25-hydroxyvitamin D3; CRP: C-reactive protein; IL-6: interleukin-6; UACR: urine albumin-creatinine ratio.

TABLE 2. Assignment of the variables.

Factors	B	Assignment
T2DM and sarcopenia	Y	Binary variable: Yes, value 1; No, value 0
Age	X_1	Continuous variable
BMI	X_2	Continuous variable
UA	X_3	Continuous variable
UACR	X_4	Continuous variable
CRP	X_5	Continuous variable

T2DM: type 2 diabetes; BMI: body mass index; UA: uric acid; UACR: urine albumin-creatinine ratio; CRP: C-reactive protein.

TABLE 3. Results of the binary logistic multi-factor regression analysis.

Factors	β	Standard error	Wald	*p*	OR value	95% confidence interval of OR value	
						Lower limit	Upper limit
Age	0.144	0.057	6.316	0.012	1.155	1.032	1.293
BMI	−1.137	0.179	40.371	<0.001	0.321	0.226	0.456
UA	−0.061	0.010	34.808	<0.001	0.941	0.922	0.960
UACR	0.148	0.054	7.400	0.007	1.160	1.042	1.290
CRP	0.209	0.193	1.176	0.278	1.233	0.845	1.799
Constant	6.165	18.526	0.111	0.739	475.626		

BMI: body mass index; UA: uric acid; UACR: urine albumin-creatinine ratio; CRP: C-reactive protein; OR: Odds Ratio.

3.4 Prediction model of middle-aged and older male patients with T2DM and sarcopenia

The binary logistic multi-factors regression analysis model as per the 2 risk factors and 2 protective factors in Table 3 was:

$$\text{Logit (P)} = \ln[P/(1-P)] = 6.165 + 0.144X_1 - 1.137X_2 - 0.061X_3 + 0.148X_4$$

The prediction model of male patients with T2DM to have sarcopenia was:

$$P = 1/[1 + \exp(-6.165 - 0.144X_1 + 1.137X_2 + 0.061X_3 - 0.148X_4)]$$

3.5 Goodness of the fit test of prediction model

Hosmer-Lemeshow test was conducted to evaluate the goodness of fit of the prediction model. The results revealed $\chi^2 = 7.270$, and $p = 0.508$, showing that the prediction model fitted well. More details could be found in Table 4.

TABLE 4. Hosmer-Lemeshow test of the prediction model.

χ^2	Degrees of freedom	p
7.270	8	0.508

3.6 Predictive value analysis of prediction model

ROC curve indicated that the prediction model had significant predictive value ($p < 0.05$). AUC (area under the curve) was 0.973. 95% CI (Confidence Interval) was between 0.958 and 0.988. More details could be found in Fig. 1.

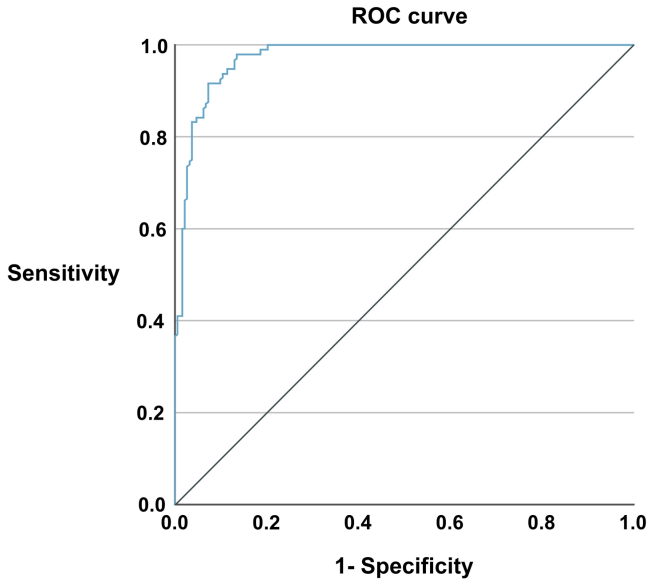

FIGURE 1. ROC curve of the prediction model. ROC: Receiver Operating Characteristic.

4. Discussion

Previous studies [10, 11] had depicted that the onset of one disease increased another disease probability to certain extent. Such a correlation existed between T2DM and sarcopenia. This study exhibited that 95 patients had sarcopenia among 288 patients with T2DM. The sarcopenia prevalence was thus 32.99%. It was consistent with the previous studies which further proved that the sarcopenia prevalence among patients with T2DM was relatively higher. This required attention at the clinical level.

Few clinical studies with varying results were available on the influencing factors of sarcopenia in patients with T2DM [12, 13]. The study herein had shown that age and UACR were the risk factors to have sarcopenia in middle-aged and older male patients with T2DM, while BMI and UA were the protective factors.

Previous clinical studies [14, 15] had proved that muscle mass and muscle relative proportion declined as the patients got older. They lost muscle by 8% to 10% each year, especially in patients older than 70, which resulted in higher sarcopenia prevalence.

Previous studies on relationship between early chronic kidney disease and sarcopenia had found that the decreased glomerular filtration rate increased the sarcopenia prevalence. Other studies had revealed that the patients with high muscle mass in experimental group had higher eGFR than those in the control. These studies had found the relationship between kidney function, UACR and the sarcopenia prevalence in patients with T2DM [16]. This study had confirmed the results of previous studies [17]. Clinical studies had also found that the physio-pathological mechanism of UACR was consistent with that of sarcopenia. The pathogenesis included inflammatory response, oxidative stress response and the insulin resistance. T2DM was associated with inflammatory burden, and sarcopenia with the changes of inflammatory markers in blood [16]. Increasing UACR caused endothelial dysfunction, which further led to the metabolic disorder of skeletal muscles. The combination of endothelial dysfunction and insulin resistance broke the proteins balance in skeletal muscles and speeded up the sarcopenia development. Increasing UACR stimulated the secretions of inflammatory cytokines and thus exacerbated the sarcopenia.

Relative studies [16, 17] in terms of protective factors had found that high uric acid levels in elderly Chinese patients helped in maintaining the normal muscle metabolism, and improving the muscle mass, grip strength and bone density levels. This study through further analysis found that uric acid as an antioxidant had strength to clear the free radicals which improved the muscle protein resistance to oxidative damage. It also protected muscle mass from losing, enhanced the muscle strength stability, and thus prevented the sarcopenia onset. Foreign research [18] had found that BMI was inversely proportional to the sarcopenia prevalence, which was in accordance with this study.

The binary logistic multi-factors regression model was constructed based on the 2 risk factors and 2 protective factors. Hosmer-Lemeshow test was conducted to evaluate the goodness of fit of probabilistic model. ROC curve was employed to

access the predicted value of the model. The results revealed that the prediction model fitted well and had significant predictive value.

This study had some limitations regarding sample size, and patients' source. Moreover, it was a single-core study. The mechanism of protective and risk factors for sarcopenia in male patients with T2DM had not been further explored.

5. Conclusions

This study has found that age and UACR are the risk factors, while BMI and UA are the protective factors to have sarcopenia in middle-aged and older male patients with T2DM. The doctors in clinical cases can monitor these factors in patients with T2DM, and the vulnerable patients can be intervened at earlier stage to reduce the sarcopenia prevalence. In future, more patients can be included for comprehensive conclusions. More research should be conducted towards the mechanism of relative factors to provide the reference and guidance for clinical prevention and control the sarcopenia in male patients with T2DM.

AVAILABILITY OF DATA AND MATERIALS

The authors declare that all data supporting the findings of this study are available within the paper and any raw data can be obtained from the corresponding author upon request.

AUTHOR CONTRIBUTIONS

LL, XLC and QHY—designed the study and carried them out; supervised the data collection, analyzed the data, interpreted the data, prepared the manuscript for publication and reviewed the draft of the manuscript. All authors have read and approved the manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Ethical approval was obtained from the Ethics Committee of People's Hospital of Chongqing Liangjiang New Area (Approval no. 2020022). Written informed consent was obtained from a legally authorized representative for anonymized patient information to be published in this article.

ACKNOWLEDGMENT

Not applicable.

FUNDING

This research received no external funding.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

[1] Anagnostis P, Gkekas NK, Achilla C, Pananastasiou G, Taouxidou P, Mitsiou M, *et al*. Type 2 diabetes mellitus is associated with increased risk of sarcopenia: a systematic review and meta-analysis. Calcified Tissue International. 2020; 107: 453–463.

[2] Feng L, Gao Q, Hu K, Wu M, Wang Z, Chen F, *et al*. Prevalence and risk factors of sarcopenia in patients with diabetes: a meta-analysis. The Journal of Clinical Endocrinology & Metabolism. 2022; 107: 1470–1483.

[3] Aluganti Narasimhulu C, Singla DK. Amelioration of diabetes-induced inflammation mediated pyroptosis, sarcopenia, and adverse muscle remodelling by bone morphogenetic protein-7. Journal of Cachexia, Sarcopenia and Muscle. 2021; 12: 403–420.

[4] Ai Y, Xu R, Liu L. The prevalence and risk factors of sarcopenia in patients with type 2 diabetes mellitus: a systematic review and meta-analysis. Diabetology & Metabolic Syndrome. 2021; 13: 93.

[5] Mu ZJ, Fu JL, Sun LN, Chan P, Xiu SL. Associations between homocysteine, inflammatory cytokines and sarcopenia in Chinese older adults with type 2 diabetes. BMC Geriatrics. 2021; 21: 692.

[6] Chai KC, Chen WM, Chen M, Shia BC, Wu SY. Association between preexisting sarcopenia and stroke in patients with type 2 diabetes mellitus. The Journal of Nutrition, Health & Aging. 2022; 26: 936–944.

[7] Lin TR, Huang XY, Hwu CM. Exercise experiences of older adults with diabetes and sarcopenia: a phenomenological study. Clinical Nursing Research. 2022; 31: 292–300.

[8] Chen LK. The vicious cycle in the development of diabetes mellitus and sarcopenia in older persons. Archives of Gerontology and Geriatrics. 2021; 95: 104437.

[9] Nakamura K, Yoshida D, Honda T, Hata J, Shibata M, Hirakawa Y, *et al*. Midlife and late-life diabetes and sarcopenia in a general older Japanese population: the Hisayama study. Journal of Diabetes Investigation. 2021; 12: 1899–1907.

[10] Remelli F, Maietti E, Abete P, Bellelli G, Bo M, Cherubini A, *et al*. Prevalence of obesity and diabetes in older people with sarcopenia defined according to EWGSOP2 and FNHI criteria. Aging Clinical and Experimental Research. 2022; 34: 113–120.

[11] Wen C, Lien AS, Jiang Y. Sarcopenia in elderly diabetes. Journal of Diabetes Investigation. 2022; 13: 944–946.

[12] Burgos R, García-Almeida JM, Matía-Martín P, Palma S, Sanz-Paris A, Zugasti A, *et al*. Malnutrition management of hospitalized patients with diabetes/hyperglycemia and COVID-19 infection. Reviews in Endocrine and Metabolic Disorders. 2022; 23: 205–213.

[13] Formiga F, Moreno-González R, Corsonello A, Carlsson A, Ärnlöv J, Mattace-Raso F, *et al*. Diabetes, sarcopenia and chronic kidney disease; the screening for CKD among older people across Europe (SCOPE) study. BMC Geriatrics. 2022; 22: 254.

[14] Gao S, Yu L, Yi G, Li T, Chen Z, Ding J. Exercise intervention as a therapy in patients with diabetes mellitus and sarcopenia: a meta-analysis. Diabetes Therapy. 2022; 13: 1311–1325.

[15] Tanabe H, Hirai H, Saito H, Tanaka K, Masuzaki H, Kazama JJ, *et al*. Detecting sarcopenia risk by diabetes clustering: a Japanese prospective cohort study. The Journal of Clinical Endocrinology & Metabolism. 2022; 107: 2729–2736.

[16] Ma XY, Chen FQ. Effects of anti-diabetic drugs on sarcopenia: best treatment options for elderly patients with type 2 diabetes mellitus and sarcopenia. World Journal of Clinical Cases. 2021; 9: 10064–10074.

[17] Tamura Y, Shimoji K, Ishikawa J, Tachibana A, Kodera R, Oba K, *et al*. Associations between sarcopenia and white matter alterations in older adults with diabetes mellitus: a diffusion tensor imaging study. Journal of Diabetes Investigation. 2021; 12: 633–640.

[18] Che S, Meng M, Jiang Y, Ye X, Xie C. Perceptions of exercise and exercise instruction in patients with type 2 diabetes mellitus and sarcopenia: a qualitative study. BMC Geriatrics. 2022; 22: 892.

How to cite this article: Lin Li, Xiuli Cao, Qihong Yang. Correlation between muscle mass reduction and serum uric acid and urinary albumin in middle-aged and elderly type 2 diabetes men. Journal of Men's Health. 2023; 19(9): 99-103. doi: 10.22514/jomh.2023.089.