

Higher Uric Acid Serum Levels Are Associated With Sarcopenia In West China: Results From The WCHAT Study

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Abstract

Background: Sarcopenia is the decline in muscle strength and mass attributed to aging. The pathogenesis of sarcopenia may be triggered by oxidative stress and uric acid (UA) has strong antioxidant properties. The aim of this study was to investigate the relationship between UA and sarcopenia in community-dwelling adults of West China using the baseline data of West China Health and Aging Trend (WCHAT) study.

Methods: 4236 adults aged 50 years or older in communities of west China were enrolled in this study. We applied AWGS 2019 criteria to define sarcopenia. Muscle mass was measured using skeletal muscle index (SMI) based on bioimpedance analysis (BIA). Handgrip strength (HGS) and gait speed (GS) were recorded, respectively. Different variables like anthropometry measures, life styles, chronic disease and blood test were collected.

Results: Participants were grouped according to UA quartiles by gender. After adjusting for potential confounders, a significant association between serum UA levels and sarcopenia was shown both in men and women. And a significant association between serum UA levels and HGS in women was shown as a inverted J shape. Besides, the association between the UA quartiles and SMI was significant, irrespective of gender.

Conclusions: Our results showed that a specific range of serum UA levels might be associated with sarcopenia and better HGS or SMI among Chinese adults aged over 50. Higher UA serum levels might slow down the progression of sarcopenia.

Introduction

Sarcopenia was an age-dependent loss of muscle mass and function which was common among older adults, leading to disability, loss of independence and death¹. The prevalence of sarcopenia varies in different countries according to different diagnostic criteria. In west China, our previous studies showed a high prevalence of sarcopenia which was 19.31% in 4500 participants over 50 years old². According to recent studies, sarcopenia was significantly associated with ethnicity, age, gender, obesity, life styles, chronic disease and so on³. In addition to these risk factors, age-related decreases in hormone concentrations could cause loss of muscle mass and strength, such as growth hormone, testosterone, thyroid hormone, vitamin D, albumin and insulin-like growth factor⁴. Another metabolic factor, uric acid (UA), was studied most recently in the relationship with skeletal muscle mass and/or strength, but the conclusions were varied and ambiguous^{5,6}.

As the final product of purine metabolism, UA is generated in the xanthine/hypoxanthine reactions and other potentially deleterious prooxidant molecules are produced as a by-product of this reaction. As a result of this, UA has been treated as a reliable marker of oxidative stress⁷. UA is a crucial endogenous antioxidant, which can eliminate reactive oxygen species (ROS) and, thus preventing oxidative stress.

Recently, it was found that UA was positively associated with muscle mass and strength in kidney transplant patients⁶. Besides, another cross-sectional study showed that a specific range of serum UA levels may be associated with better hand grip strength among Chinese adults aged over 45⁵. However, in a study of 586 Japanese men aged over 30, it was found that hyperuricemia was associated with reduced muscle strength, and UA levels showed an inverted J-shaped curve with handgrip strength⁸. What's more, in a sample of 7,544 US men and women aged 40 and above, it showed that increased serum UA was significantly related with sarcopenia after adjustment for the cofounders⁹.

In our study, we grouped the participants according to UA quartiles by gender. Then we performed our study to determine the relationship between sarcopenia and UA in a large group of multi-ethnic residents enrolled in the West-China Health and Aging Trend Study (WCHAT). Specifically, we also investigated the relationship between UA and skeletal muscle index (SMI), grip strength (HGS) and gait speed (GS).

Materials And Methods

Study Sample

The current research is a cross-sectional analysis obtaining baseline data of the WCHAT study between July 2018 and October 2018¹⁰. Participants aged ≥ 50 years were selected from 4 provinces including Yunnan, Guizhou, Sichuan, and Xinjiang. Participants were recruited by convenience and asked verbally by the researchers about their willingness to take part in the study. Before investigation, informed consent was signed and obtained by each participant. Initially, we recruited 7536 community-dwelling multi-ethnic residents in total. 4500 participants did the bioelectrical impedance analysis (BIA) which is available for the selection of sarcopenia. Then other small ethnic group participants (n=67), participants without blood uric acid test (n=57), participants with kidney disease (n=87), participants with mental disease (n=5) and participants with tumor (n=24) were excluded. Finally, 4260 participants were included and were grouped according to UA quartiles in our study (Figure 1).

Definitions of Sarcopenia

We defined sarcopenia according to the AWGS 2019^{11,12} which defined sarcopenia according to low skeletal muscle mass, low strength, and/or low physical function. Skeletal muscle mass was estimated by a trained doctor using a bioimpedance analysis (BIA) device (InBody 770, Biospace, Korea). For AWGS 2019, the SMI was using BIA predicted skeletal muscle mass and cutoffs were 7.0 kg/m² in men and 5.7 kg/m² in women. Grip strength was measured using a dynamometer (EH101; Camry, Zhongshan, China) to test the muscle strength. Tests were performed on two independent occasions using the dominant hand and the largest value was recorded. Cutoffs of grip strength was defined as 28kg in men and 18kg in women. The physical function was estimated using gait speed (GS) through a 4-m walking test. The walking time was recorded using a kind of infrared sensor and the acceleration phase was strictly excluded. The participants were asked to perform the test by walking at a normal pace. Subjects stood at the starting point and upon the starting command, walked forward at a normal pace to the 4-meter line.

During the test, subjects wore common shoes, could use mobility aids, but could not be assisted. There were no time limits to the assessments and subjects could stop and rest if necessary. Sitting down was prohibited. The participants performed 2 trials, and the results were averaged to the nearest 0.01 m/s. The cutoff of gait speed was defined as less than 1.0m/s.

Demographic data and blood sample collection

Information regarding age, gender, ethnic groups, education level, smoking history and alcohol consumption history was gathered. Blood samples were drawn from the vein in the morning after a minimum of 8 h of fasting. Blood handling and collection was carried out under strictly standardized conditions. UA level were measured using the same standard.

Assessment of cognition, depression, sleep quality and chronic diseases

Cognitive status was assessed using a 10-item Short Portable Mental Status Questionnaire (SPMSQ)¹³ and the result was based on educational level. Depressive symptoms were assessed using the 15-item Geriatric Depression Scale (GDS-15)¹⁴. Sleeping quality was assessed using the Pittsburgh Sleep Index Scale (PSQI) questionnaire¹⁵. A medical history of chronic disease was self-reported. These disease conditions included hypertension, diabetes mellitus, coronary heart disease (CHD), liver disease, chronic obstructive pulmonary disease (COPD), gastrointestinal disease, stroke and osteoarticular disease.

Statistical Analyses

The data analyses were performed using SPSS version 20.0 (SPSS Inc, Chicago, IL). The categorical data was presented as counts (percentages), and the normal distributed continuous data was presented as mean (standard deviation [SD]). For the normal distribution variables, the difference between the groups is compared by the independent sample T-test and the count data is compared using the χ^2 test. Participants was grouped according to UA quartiles. We also performed UA subgroup analyses according to gender. The relationship between UA and sarcopenia was estimated by deriving odds ratios (ORs) and 95% confidence intervals (CIs) from multivariate logistic regression models. We also performed multivariate logistic regression models to investigated the three components and A value of $P \leq 0.05$ (two-side) was considered to be statistically significant.

Results

Characteristics of Participants

We included 4260 participants (1542 men and 2718 women). Participants was grouped according to quartiles of UA (Q1, <269.825 μ mol/L; Q2, 269.825 ~318.15 μ mol/L; Q3, 318.15 ~378.75 μ mol/L; Q4, \geq 378.75 μ mol/L). Table 1 shows the association of UA tertiles with participants' characteristics in the whole sample. The higher of the UA level, the higher mean age of the participants and the lower percentage of female. Besides, the higher of the UA level, the higher percentage of drinking and smoking.

The GDS score of the participants in the Q4 group was significantly lower than the Q1 group and the percentage of cognitive decline in the Q4 group was significantly lower than the Q1 group. However, the percentage of hypertension, diabetes and CHD was significantly higher in the Q4 group than the Q1 group.

Serum UA level and sarcopenia

Table 2 showed the relationship between UA tertiles and sarcopenia in non-adjusted model and adjusted model in female and male, respectively. We grouped UA levels according to gender. In female, Q1[#] <253.85umol/l, 253.85≤Q2[#]<293.8umol/l, 293.8≤Q3[#]<340.4umol/l, 340.4umol/l≤Q4[#]; In male, Q1^{*} <319.2umol/l, 319.2≤Q2^{*}<372.25umol/l, 372.25≤Q3^{*}<423.525umol/l, 423.525umol/l≤Q4^{*}. In non-adjusted model, sarcopenia was mostly significantly associated with UA in both male and female. In adjusted model which adjusted age, ethnic groups, GDS score, sleeping quality, education level, cognitive function, smoking history, drinking history, ADL score, and chronic disease (hypertension, diabetes, coronary heart disease, chronic obstructive pulmonary disease, osteoarthritis, liver disease, gastrointestinal disease, stroke history), sarcopenia was still significantly associated with Q3^{*} (OR 0.664, 95% CI 0.462-0.955) and Q4^{*} (OR 0.513, 95%CI 0.349-0.753) group in male. Besides, in adjusted model, sarcopenia was significantly associated with UA in female with a dosage effect (Q2[#], OR 0.729, 95% CI 0.542-0.982; Q3[#], OR 0.593, 95% CI 0.436-0.805; Q4[#], OR 0.477, 95% CI 0.348-0.652).

Serum UA level and SMI/GS/HGS

The results of general linear models for the relationship between UA levels and SMI/GS/HGS in male and female were presented in table 3. We found that serum UA level was independently associated with SMI in female with a dosage effect [Q2[#], β 0.201; Q3[#], β 0.248, Q4[#], β 0.370]. UA level was negatively associated with GS in female in the Q4 group [β -0.039, 95% CI -0.070-0.008]. Besides, the serum UA levels showed an inverted J-shaped relationship with HGS in female [Q2[#], β 0.737; Q3[#], β 1.142, Q4[#], β 0.694]. While in male, the UA levels was significantly associated with SMI in Q3 and Q4 group [Q3[#], β 0.237, Q4[#], β 0.359]. And UA levels was only associated with HGS in the Q4 group in male [β 1.406, 95% CI 0.018-2.794].

Discussion

Our study investigated the relationship between UA levels and sarcopenia or its three components in a large sample of community of West China using AWGS 2019 diagnostic algorithm. We showed that serum UA levels shared a significant inverted J-shaped curve relationship with HGS in female and only a positive relationship in male in Q4 group after adjustment for potential confounding factors. This was consistent with previous studies. One study showed that an inverted J-shaped association between serum UA levels and HGS in both genders among Chinese adults aged over 45⁵. Another study in China showed that higher uric acid levels were significantly correlated with higher muscle mass, grip strength in 388 participants aged over 60¹⁶. Besides, study in Japan found an inverted J-shaped association

between the serum UA quartiles and muscle strength in 630 male Japanese employees aged over 30 years old⁸. Moreover, a most recent prospective cohort study reported that a higher baseline UA levels still remained significantly associated with higher follow-up strength measures during a 3-year follow-up period¹⁷. These studies supported that maintaining optimal levels of serum UA may help to maintain the quality and strength of skeletal muscle. The mechanism might be related with the powerful antioxidant capacity of UA which may protect skeletal muscle function from ROS-induced protein oxidative damage¹⁸. Besides, low UA level might be a marker of low nutrient status, which was an important risk factor associated with poor grip strength¹⁹. Moreover, elevated serum UA levels were positively correlated with serum creatinine level which was correlated to the individual's muscle mass²⁰. However, it was well known that an increased UA level was related to high inflammatory cytokines such as IL-6, CRP and TNF- α , which were contributors to poor muscle strength²¹. Besides, the gender difference of the relationship between UA and HGS in our study could be related with hormone difference. Several studies reported that estrogen promotes UA secretion and leads to increases in UA levels in postmenopausal women²², which may partially strengthen the significant association between UA and ASM in the total female population.

In our study, we found that UA level was also significantly associated with SMI, irrespective of gender. This implying that higher UA maybe protective in maintaining muscle mass. Consistently, another study also found that UA was positively associated with ASM in a retrospective cohort²³. Interestingly, this association was only significant in males but not in females²³. Another cross-sectional study in China which included 3,079 middle-aged and older participants indicated a positive association between UA and ASMI which was tested by dual-energy X-ray absorptiometry²⁴. Besides, in men with T2DM, higher serum UA was found to be an independent risk factor of reduced muscle mass²⁵. In hemodialysis (HD) patients, UA was identified as a nutritional marker and was shown to be positively associated with nutritional markers²⁶. The mechanism could also be explained. Firstly, higher UA levels was found to be positively associated with the rate of normalized protein equivalent of nitrogen appearance²⁶, which was shown to be beneficial for skeletal muscle mass. Secondly, extracellular UA has antioxidant effects, acting as a powerful scavenger of free radicals, protecting muscle cell from oxidative damage²⁷. Thirdly, UA was shown to have potential therapeutic effects in suppressing the redox process, promoting both myoblast proliferation and differentiation in muscle aging²⁸.

However, in our study, UA was found significantly associated with gait speed only in female in the highest group. While higher UA was found to be related with lower gait speed. This was also consistent with previous studies. One previous study showed that serum UA were associated with low physical activity (OR 1.10, 95%CI 0.99-1.23) , also associated with low walking speed (OR 1.08, 95%CI 0.95-1.23)²⁹. Conversely, higher UA level was found to have no relationship with physical performance which was assessed using Short Physical Performance Battery (SPPB) scale in another two cross-sectional study^{16,17}. This might be explained by the reason that SPPB is a final sum of multiple parameters that included walking speed over 4 meters, five timed repeated chair rises and standing balance. That is why

SPPB was affected not only by muscle strength but also by balance and coordination. Anyway, the relationship between UA and gait speed need to be further investigated.

Towards the prevalence of sarcopenia, UA was found to be significantly associated sarcopenia both in female and male in our study after adjusted confounding factors and it seemed that higher UA was a protective factor. However, a previous research found that elevations in UA may lead to sarcopenia and they thought that UA could lead to reactive oxygen species formation and inflammation, both of which are associated with sarcopenia⁹. And another research found that sarcopenia might be treated using allopurinol, a medicine which could reduce the serum UA level³⁰. On the contrary, as our previous discussed, serum UA may have a protective role in aging-associated decline in muscle strength as UA has strong anti-oxidant properties³¹. Since our study included most relatively “healthy” participants, the level of UA was not very much high. The antioxidant effect was not overwhelmed by its harmful inflammatory effect and might be related with slowing down the progress of sarcopenia.

Conclusions

In conclusion, our findings showed an independent association of higher UA serum levels with sarcopenia in west China and UA was significantly associated with HGS/SMI, not with GS. Besides, there were not much distinct difference when these relationships were studied in men and women separately. This indicated that maintaining a specific higher concentration of UA could have some important biological advantage. Specifically, UA plays a role in the antioxidant ability on muscle proteins and slows down the progression of sarcopenia among older persons.

Limitations

Some limitations of our study need to be considered. Firstly, people over 50 years old were enrolled in this study and most of them were in the age range of 50-60 years old. The relationship between UA level and sarcopenia could only reflect mostly middle aged participants. Secondly, although we included many important confounders in our study. More adjustment should be made for confounders. For example, gout and medicine intake which might affect the UA level should be adjusted. Besides, we used 4 meter gait speed evaluation instead of 6 meter gait speed and this might exist some bias. Lastly, our study was an observational cross-sectional study which cannot determine the causal relationship between sarcopenia and serum UA level.

Declarations

Availability of Data and Materials

The datasets generated and analyzed during the current study will be available two years later and is also available now from the corresponding author on a reasonable request.

Acknowledgement

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Ethics approval and consent to participate

Subjects (or their guardians) have given their written informed consent. The current research was approved by the Ethical Review Committee of West China Hospital with the committee's reference number 2017(445) and the registration number is ChiCTR 1800018895. All methods were performed in accordance with the relevant guidelines and regulations

Declarations of interest

None.

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Author Contributions

Xiaolei Liu and Xiaoyan Chen design and write the manuscript. Lisha Hou and Xin Xia helped analyzed data. Fengjuan Hu, Shuyue Luo, Gongchang Zhang, Xuelian Sun and Xuchao Peng helped collect data. Jirong Yue and Birong Dong helped revise the manuscript.

Consent for publication

Not applicable

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Tables

Table 1. Baseline characteristics of participants according to the quartiles of UA.

Characteristics	Uric Acid tertiles (umol/L)				P
	Q1(n=1065) <269.825	Q2(n=1065) 269.825~318.15	Q3(n=1065) 318.15~378.75	Q4(n=1065) ≥378.75	
Age (years) ,mean (SD)	61.68(7.90) ^{cd}	61.65(7.94) ^{cd}	62.57(8.16) ^{abd}	63.44(8.72) ^{abc}	∩0.01
Female (%)	953(89.48) ^{bcd}	801(75.21) ^{acd}	621(58.31) ^{abd}	343(32.21) ^{abc}	∩0.01
Ethnic groups (%)					0.018
Han	433(40.66)	465(43.66)	480(45.07)	461(43.29)	
Zang	292(27.42)	283(26.57)	299(28.08)	330(30.99)	
Qiang	286(26.85)	272(25.54)	229(21.5)	222(20.85)	
Yi	54(5.07)	45(4.23)	57(5.35)	52(4.87)	
Education (%)					∩0.01
No formal education	395(39.42) ^{bcd}	301(29.6) ^a	295(29.27) ^a	255(25.05) ^a	
Primary school	314(31.34)	367(36.09)	325(32.24)	360(35.36)	
Middle school and above	293(29.24)	349(34.32)	388(39.49)	403(39.59)	
smoking history ∩%∩					∩0.01
No	936(93.69) ^{bcd}	887(87.82) ^{acd}	793(79.06) ^{abd}	700(68.97) ^{abc}	
Yes	63(6.31)	123(12.18)	210(20.94)	315(31.03)	
drinking history ∩%∩					∩0.01
No	838(83.88) ^{cd}	805(79.7) ^d	743(74.08) ^{ad}	627(61.77) ^{abc}	
Yes	161(16.12)	205(20.3)	260(25.92)	388(38.23)	
ADL score, mean (SD)	99.18(3.51)	99.11(3.50)	99.07(3.82)	99.01(3.36)	0.733
GDS score, mean (SD)	2.85(2.43) ^d	2.68(2.35)	2.57(2.42)	2.49(2.23) ^a	0.005
Cognitive function (%)					∩0.01
No decline	820(82.16) ^{bd}	878(87.02) ^a	851(85.01) ^d	911(89.93) ^{ac}	

Mild decline	126(52)	107(10.6)	113(11.29)	77(7.6)	
Moderate-severe decline	52(5.21)	24(2.38)	37(3.7)	25(2.47)	
Sleep quality (%)					0.672
Good	529(52.53)	539(53.05)	517(51.19)	542(53.88)	
Bad	478(47.47)	477(46.95)	493(48.81)	464(46.12)	
Hypertension (%)					0.01
No	881(82.72) ^{cd}	858(80.56) ^d	814(76.43) ^{ad}	721(67.7) ^{abc}	
Yes	184(17.28)	207(19.44)	251(23.57)	344(32.3)	
Diabetes (%)					0.001
No	1006(94.46) ^d	1000(93.9) ^d	1000(93.9) ^d	102(9.58) ^{abc}	
Yes	59(5.54)	65(6.1)	65(6.1)	963(90.42)	
CHD					0.017
No	1042(97.84) ^d	1039(97.56)	1038(97.46)	1020(95.77) ^a	
Yes	23(2.16)	26(2.44)	27(2.54)	45(4.23)	
Liver disease (%)					0.26
No	1045(98.12)	1040(97.65)	1043(97.07)	1032(96.9)	
Yes	20(1.88)	25(2.35)	22(2.07)	33(3.1)	
Gastrointestinal disease (%)					0.107
No	984(92.39)	1005(94.37)	1005(94.37)	1008(94.65)	
Yes	81(7.61)	60(5.63)	60(5.63)	57(5.35)	
Stoke history (%)					0.213
No	1046(98.22)	1054(98.97)	1051(98.69)	1043(97.93)	
Yes	19(1.78)	11(1.03)	14(1.31)	22(2.07)	
COPD (%)					0.022
No	1059(99.44) ^c	1056(99.15)	1045(98.12) ^a	1054(98.97)	
Yes	6(0.56)	9(0.85)	20(1.88)	11(1.03)	
Osteoarticular disease(%)					0.034

No	960(90.14) ^b	996(93.52) ^a	984(92.39)	976(91.64)
Yes	105(9.86)	69(6.48)	81(7.61)	89(8.36)

Note: Baseline characteristics of participants according to the quartiles of UA. For continuous variables, one-way ANOVA was used to detect differences across groups for the continuous variables, and Fisher's Least Significant Difference (LSD) post hoc analysis was used to determine the difference between every two groups. For the categorical variables, the chi-squared test was used to detect the difference across groups. When significant difference was identified across groups, column proportions tests (z-tests) with Bonferroni correction were performed to determine the difference between every two groups. During most testing, $p < 0.05$ was considered statistically significant, however, p-values were corrected for z-tests with the Bonferroni correction (with the statistical significance set at $p < 0.008$, where $0.008 = 0.05/6$). Q stands for UA: Q1 is the lowest quartile and Q4 is the highest quartile. ^a Significantly different from the Q1 group. ^b Significantly different from the Q2 group. ^c Significantly different from the Q3 group. ^d Significantly different from the Q4 group. CHD, coronary heart disease; COPD, chronic obstructive pulmonary disease.

Table 2. The relationship between UA tertiles and sarcopenia in non-adjusted model and adjusted model.

variable		Non-adjusted Model		Adjusted Model	
		P-value	OR (95% CI)	P-value	OR (95% CI)
Male	Q1*	-	-	-	-
	Q2*	0.248	0.836(0.618-1.133)	0.572	0.903(0.633-1.288)
	Q3*	0.004	0.629(0.459-0.861)	0.027	0.664(0.462-0.955)
	Q4*	0.001	0.442(0.317-0.616)	0.001	0.513(0.349-0.753)
Female	Q1#	-	-	-	-
	Q2#	0.002	0.666(0.514-0.864)	0.037	0.729(0.542-0.982)
	Q3#	0.001	0.653(0.504-0.848)	0.001	0.593(0.436-0.805)
	Q4#	0.001	0.645(0.497-0.837)	0.001	0.477(0.348-0.652)

Note: Adjusted model: adjusted age, ethnic groups, GDS score, sleeping quality, education level, cognitive function, smoking history, drinking history, ADL score, and chronic disease (hypertension, diabetes, coronary heart disease, chronic obstructive pulmonary disease, osteoarthritis, liver disease, gastrointestinal disease, stroke history). In female: Q1# 253.85umol/l, 253.85umol/l ≤ Q2# 293.8umol/l, 293.8umol/l ≤ Q3# 340.4umol/l, 340.4umol/l ≤ Q4#; In male: Q1* 319.2umol/l, 319.2umol/l ≤ Q2* 372.25umol/l, 372.25umol/l ≤ Q3* 423.525umol/l, 423.525umol/l ≤ Q4*.

Table 3. General linear model testing the relationship between UA tertiles and SMI, gait speed, handgrip strength after adjusting for relevant confounders.

variable	β	SE	P-value	95%CI	
In female					
SMI					
Q1 [#] (Ref)	-	-	-	-	-
Q2 [#]	0.201	0.0418	☒0.001	0.119	0.283
Q3 [#]	0.248	0.0415	☒0.001	0.167	0.33
Q4 [#]	0.27	0.0417	☒0.001	0.189	0.352
Gait speed (GS)					
Q1 [#] (Ref)	-	-	-	-	-
Q2 [#]	0.004	0.0156	0.817	-0.027	0.034
Q3 [#]	0.01	0.0155	0.512	-0.02	0.041
Q4 [#]	-0.039	0.0156	0.012	-0.07	-0.008
Handgrip strength (HGS)					
Q1 [#] (Ref)	-	-	-	-	-
Q2 [#]	0.737	0.3212	0.022	0.107	1.366
Q3 [#]	1.142	0.3194	☒0.001	0.516	1.768
Q4 [#]	0.694	0.3207	0.03	0.066	1.323
In male					
SMI					
Q1 [*] (Ref)	-	-	-	-	-
Q2 [*]	0.088	0.0599	0.144	-0.03	0.207
Q3 [*]	0.237	0.0598	☒0.001	0.12	0.354
Q4 [*]	0.359	0.0605	☒0.001	0.241	0.476
Gait speed (GS)					
Q1 [*] (Ref)	-	-	-	-	-
Q2 [*]	0.01	0.0205	0.642	-0.031	0.05
Q3 [*]	0.005	0.0203	0.821	-0.035	0.044

Q4*	0.006	0.0203	0.757	-0.034	0.046
Handgrip strength (HGS)					
Q1*(Ref)	-	-	-	-	-
Q2*	0.233	0.7151	0.745	-1.169	1.635
Q3*	0.482	0.7068	0.495	-0.903	1.867
Q4*	1.406	0.7083	0.047	0.018	2.794

Note: General linear model was adjusted age, ethnic groups, GDS score, sleeping quality, education level, cognitive function, smoking history, drinking history, ADL score, and chronic disease (hypertension, diabetes, coronary heart disease, chronic obstructive pulmonary disease, osteoarthritis, liver disease, gastrointestinal diseases, stroke history). In female: Q1# 253.85umol/l, 253.85umol/l ≤ Q2# 293.8umol/l, 293.8umol/l ≤ Q3# 340.4umol/l, 340.4umol/l ≤ Q4#; In male: Q1* 319.2umol/l, 319.2umol/l ≤ Q2* 372.25umol/l, 372.25umol/l ≤ Q3* 423.525umol/l, 423.525umol/l ≤ Q4*.

Figures

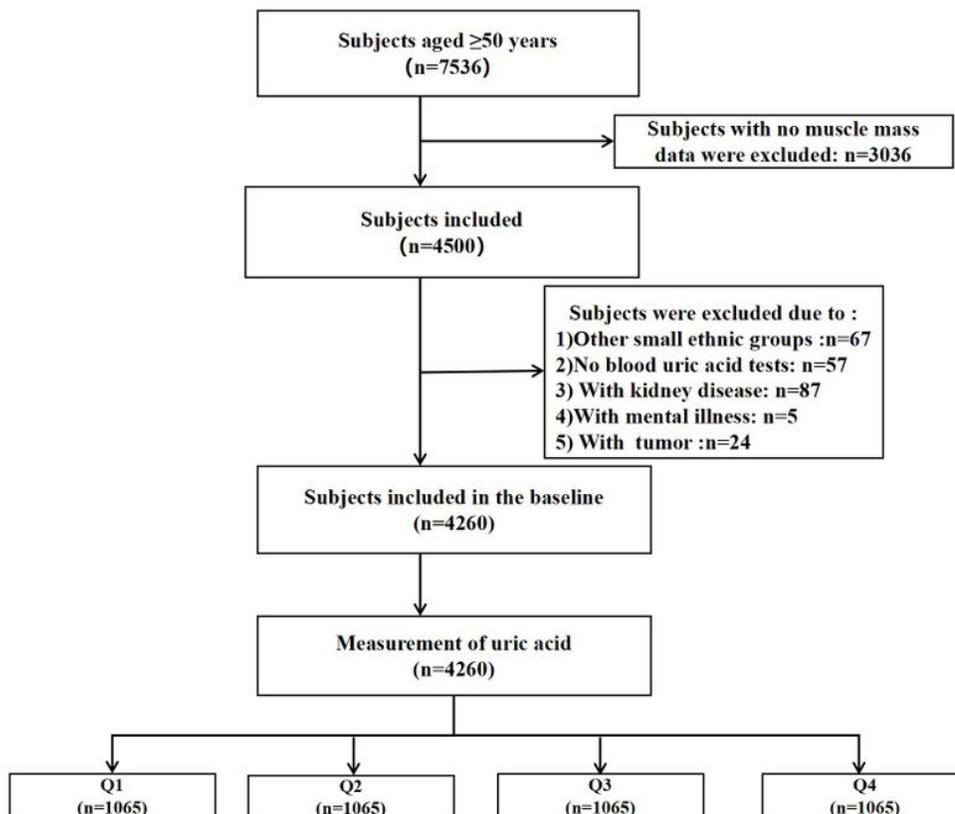


Figure 1

Flow chart of study participants. Initially, we recruited 7536 community-dwelling multi-ethnic residents in total. 4500 participants did the bioelectrical impedance analysis (BIA) which is available for the selection of sarcopenia. Then other small ethnic group participants (n=67), participants without blood uric acid test (n=57), participants with kidney disease (n=87), participants with mental disease (n=5) and participants with tumor (n=24) were excluded. Finally, 4260 participants were included and were grouped according to UA quartiles in our study.