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SARCOPENIA, OBESITY AND SARCOPENIA OBESITY IN COMPARISON: PREVALENCE, METABOLIC PROFILE, AND KEY DIFFERENCES: RESULTS FROM WCHAT STUDY

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Abstract: *Objective:* To identify the prevalence, lifestyle factors, chronic disease status, and assessing the metabolic profile, comparing key differences in a cohort of subjects with non-sarcopenia/non-obesity (H), sarcopenia/non-obesity (S), non-sarcopenia/obesity (O) and sarcopenia obesity (SO) in a multi-ethnic population in west China. *Design:* A cross-sectional study. *Setting:* The communities in Yunnan, Guizhou, Sichuan, and Xinjiang provinces. *Participants:* We included 4,500 participants aged 50 years or older who did bioelectrical impedance in our analysis from West China Health and Aging Trend (WCHAT) study. *Measurements:* We measured gait speed, handgrip strength and muscle mass by using bioelectrical impedance analysis (BIA) for all participants. We defined sarcopenia using the diagnostic algorithm recommended by the Asian Working Group for Sarcopenia (AWGS). Obesity was defined as the highest sex-specific quintile of the percentage body fat. Different variables like anthropometry measures, life styles, chronic disease and blood test were collected. Analysis of variance and a multinomial logistic regression analysis adjusting for covariates were used to assess the differences of metabolic profiles among different groups. *Results:* Of 4500 participants aged 50 years old or older, the proportions of H, O, S, SO were 63.0%, 17.7%, 16.7% and 2.6%, respectively. And the prevalence of S subjects in men was 18.3% and 15.7% in women, while the prevalence of SO was 3.7% in men and 2.0% in women. Data showed that the prevalence of S and SO has an aging increase pattern which was opposite with O. Both S and SO tends to be older, lower educational level, without spouse, smoking, comorbidity of chronic disease, poor nutrition status, depression and cognitive decline compared to H and S seems to be worse than SO. Compared to H, S cohort showed a decrease in Vitamin D, triglyceride, albumin, fasting glucose, insulin, creatinine, ALT, nutrition scores and increase in HDL. SO cohort were observed for an increase in cholesterol, LDL, total protein and decrease in vitamin D. While O cohort showed an increase in triglyceride, cholesterol, LDL, total protein, glucose, insulin, WBC, uric acid, ALT and nutrition scores, but a decrease in HDL and vitamin D level. *Conclusions:* Among individuals aged 50 years old or older in West China. S, O and SO participants demonstrate distinct differences in the life-styles, chronic disease profile, and metabolic profiles. The prevalence of S and SO has an aging increase pattern contrary to O. Both S and SO tend to be older, lower educational level, without spouse, smoking, comorbidity of chronic disease, poor nutrition status, depression and cognitive decline compared to H and S looks like to be worse than SO. Besides, the S subjects seem to have more metabolic index changes than SO compared to H. While O subjects have some contrary metabolic index to S subjects.

Key words: Sarcopenia, obesity, sarcopenia obesity, prevalence, West China, metabolic profile.

Introduction

Sarcopenia is a condition that is characterized by a progressive and generalized loss of skeletal muscle mass and strength (1). It is associated with physical disability, poor health outcomes, low quality of life and premature death (2). The pathogenesis of sarcopenia involves many aspects, such as lack of exercise, hormonal imbalance, and undernutrition (3).

Obesity was a major health impact on the world and is defined as an excess of body fat. The body mass index (BMI) is the standard measure of overweight and greater or equal to 30 is regarded as obese. However, BMI does not differentiate muscle mass from fat in individuals. A recent study demonstrated that both low BMI and high body fat percentage are independently associated with increased mortality, indicating the importance of using direct measures of adiposity (4). In addition, BMI varies with age and sex. Thus, using BMI to define obesity is particularly problematic in elderly (5).

Sarcopenia obesity is an emerging syndrome that is observed in adults with obesity, which is a condition of reduced lean body mass in the context of excess adiposity (6). Sarcopenia obesity is most often reported in older people, as both risk and prevalence increase with age (7). Even few studies found that obesity exacerbates sarcopenia, increases the infiltration of fat into muscle, lowers physical function and increases the risk of mortality (8-10), the metabolic profile and other characteristics of sarcopenia obesity were not well understood.

In this study, we got the cross-sectional data from the West-

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China Health and Aging Trend (WCHAT) study. We aimed to identify the prevalence, lifestyle factors, chronic disease prevalence, and assessing the metabolic profile, comparing key differences (versus non-sarcopenia/non-obesity (H)) in a cohort of subjects with sarcopenia/non-obesity (S), non-sarcopenia/obesity (O) and sarcopenia obesity (SO) in multi-ethnic West China.

Method

The current research is a cross-sectional study using baseline data of the WCHAT study, which was approved by the Ethical Review Committee (reference: 2017-445). Data were collected from 4 provinces in West China, including Yunnan, Guizhou, Sichuan, and Xinjiang.

Study participants

All participants aged 50 years old or older were enrolled. Participants were recruited by convenience and asked verbally by the researchers about their willingness to take part in the study. Before the investigation, informed consent was signed and obtained by each participant. In this study, we have muscle mass data for 4,500 participants. Thus, we included these participants in the current analysis.

Demographic and anthropometric data collection

The baseline demographic information included the followings: (1) General personal data: age, gender, marital status, educational level, ethnic background; (2) Lifestyle characteristics: sleep quality, tea-drinking, alcohol drinking, smoking, housework doing. Anthropometric measurements include height, weight, body mass index (BMI), waist circumference (WC), body fat percentage.

Sarcopenia assessment

Sarcopenia was measured by the recommended diagnostic algorithm of AWGS which included muscle mass, muscle strength, and physical performance. Muscle mass was measured by bioimpedance analysis using an Inbody 770 (BioSpace, Seoul, Korea), which was a convenient method for the measurement of muscle mass (11-13). This method was also validated in China (14). Low muscle mass was defined as the skeletal muscle mass index (ASMI, ASM/height2) of 7.0 kg/m2 in men and, 5.7 kg/m^2 in women. Muscle strength was assessed with the dominant hand using a dynamometer (EH101; Camry, Zhongshan, China). Tests were performed on two independent occasions and the largest value was recorded. The threshold todefine low grip strength was 26kg and 18kg for men and women, respectively (15). Usual walking speed was measured over 4 m. For sarcopenia definition in terms of low gait speed, the cut-off value was 0.8 m/s (11).

Sarcopenia obesity assessment

Participants were classified as obese if their percentage body fat measured by BIA was in the highest quintile (cutoff values: 34.3% for men, 42.1% for women). Based on the presence/absence of sarcopenia and obesity, participants were categorized into four groups: S, O, SO, and H.

Assessment of cognitive decline and chronic diseases

Cognitive status was measured using a 10-item Short Portable Mental Status Questionnaire (SPMSQ). For SPMSQ scoring, 0~2 indicated complete cognitive function, 3~4 indicated mild cognitive functional impairment, 5~7 indicated moderate cognitive function impairment, and 8~10 indicated severe cognitive function impairment. This judgment was based on educational level (16). A medical history of chronic disease was self-reported. These disease conditions included hypertension, osteoarticular disease, lung disease and diabetes mellitus. Chronic diseases comorbidities were considered as having two or more chronic diseases.

Assessment of sleep quality and nutrition status

Sleep quality was assessed using the Pittsburgh sleep quality index (PSQI). Scores >5 were considered poor self-reported sleep quality which was previously used in the Chinese population (17). Nutrition status was graded using MNA-SF on a scale of 0-14, with 0~7 indicate poor nutrition status, 8~11 indicate mild poor nutrition status, 12~14 indicate good nutrition status and this was already validated in the Chinese population (18).

Blood sample measurements

Fasting venous blood samples were drawn in the morning, with the participants in a sitting position. Blood handling and collection were carried out under strictly standardized conditions. Serum albumin, fasting glucose, cholesterol, hemoglobin, triglyceride levels and other metabolites were measured.

Statistical analysis

We test the normality of variables using R version 3.6.1. The measurement data is expressed by mean±SD. For the normal distribution variables, the difference between the groups is compared by the independent sample T-test and the count data is expressed in %, using the $\chi 2$ test. We used the $\chi 2$ test to determine whether the prevalence of chronic condition including depression and cognition impairment differed by sarcopenia status. A value of $P<0.05$ (two-side) was considered to be statistically significant.

Multinomial logistic regression was used to predict the probability of category membership for a dependent variable with two or greater classifications, based on multiple independent variables. The model was adjusted by the age, sex and ethnic groups.

Table 1
Anthropometric measures of study participating (n=4500)

Anthropometric measures	Healthy N=2833 (63.0)	Obesity N=798 (17.7)	Sarcopenia N=750 (16.7)	Sarcopenia obesity N=119 (2.6)	P value
Height(cm)	157.5(7.8)	155.9(8.3)	152.9(7.9)	151.3(9.4)	<.001
Weight(kg)	62.1(9.3)	72.9(10.3)	50.3(7.8)	61.0(9.8)	<.001
BMI (kg/m^2)	25.0(2.8)	30.1(3.3)	21.3(2.1)	26.3(2.2)	<.001
BMI<18.5	28(1.0)	0(0.0)	69(9.2)	0(0.0)	<.001
18.5≤BMI<24	977(34.5)	5(0.6)	612(81.6)	11(9.2)	
24≤BMI<27	1170(41.3)	97(12.2)	68(9.1)	69(58.0)	
BMI≥27	658(23.2)	696(87.2)	1(0.1)	39(32.8)	
waist circumference(cm)	86.6(8.8)	98.1(10.6)	77.8(7.9)	89.4(9.9)	<.001
Body fat percentage (%)	32.1(6.5)	42.8(4.8)	29.4(7.0)	41.9(4.9)	<.001
ASMI (kg/m^2)	6.8(0.8)	7.0(0.9)	5.7(0.7)	5.9(0.7)	<.001

Data are shown using % or mean (standard deviation). P values were calculated with chi-squared tests and one-way analysis of variance (ANOVA) for categorical and continuous variables, respectively. BMI, body mass index; ASMI, appendicular skeletal muscle mass index.

Results

Characteristics of the study participants

Overall, we enrolled 4,500 participants aged 50 years or older in the study. The proportions of H, O, S, SO were 63.0%, 17.7%, 16.7% and 2.6%, respectively. Table 1 summarizes the anthropometric measures between participants in the four groups. One-way ANOVA analysis of variance detected statistically significant differences ($p<0.001$) among these four groups in the height, weight, BMI, waist circumference, body fat percentage and ASMI. Table 2 summarizes the demographic characteristics of participants in the four groups. It also shows significant differences ($p<0.001$) among groups in age, gender, ethnic groups, educational level, marriage status, tea-drinking, smoking and cognitive status. Specifically, both S and SO tend to be older, lower educational level, without a spouse, smoking, comorbidity of chronic disease, poor nutrition status, depression and cognitive decline compared to H.

Table 3 summarizes the metabolic profile of the four groups. It also shows significant differences ($p<0.001$) among groups in the level of insulin, fasting glucose, triglyceride, cholesterol, HDL, LDL, vitamin D, total protein, albumin, prealbumin, WBC, GPR, LPR, uric acid, ALT and PTC. Specifically, S showed a marked decrease in insulin, prealbumin and vitamin D level, but a higher level of PTC compared to H.

Prevalence rates of O, S and SO

The prevalence of S and SO both displayed an age-related increasing pattern in men and women. While in the O group, it showed an age-related decreasing pattern in men and women. In Han and Qiang ethnic groups, the prevalence of both S and SO in men was higher than in women. While in the Yi ethnic group, it was the opposite. And the prevalence of O is higher in women than men in Han, Qiang and Yi. Totally, the prevalence of S and SO was higher in men than in women, while the prevalence of O was higher in women than in men (Table 4).

The key differences of S, O and SO compared to H

Table 5 shows the results of multinomial logistic regression analysis adjusting for age, sex and ethnic groups for key differences among the four groups. For the grip strength and gait speed, compared to the H group, we observed a reduction in all the other three groups. Key differences in S cohort were highlighted by a significantly decrease in Vitamin D, triglyceride, albumin, fasting glucose, insulin, creatinine, ALT, nutrition scores and increase in HDL, GPR, AST and PTC.

Conversely, key differences in SO cohort were observed only for an increase in cholesterol, LDL, total protein and uric acid and only decrease in vitamin D. Furthermore, key differences in O cohort were observed an increase in triglyceride, cholesterol, LDL, total protein, glucose, insulin, WBC, uric acid, ALT and nutrition scores, but a decrease in HDL and vitamin D level.

Discussion

In our study, we compared S, O, SO with H among multi-ethnic participants aged 50 years or older. We presented the prevalence, the lifestyles, the chronic disease profile, and the metabolic profile of the four groups, and we compared the key differences among the four groups in the metabolic profile.

This study showed the prevalence of both S and SO was age increased pattern. This is in accordance with many studies (3, 19). As the major age-related changes in body composition include an increase in body fat and a decline in skeletal muscle, leading to increased proinflammatory cytokines, oxidative

Table 2
Demographic characteristics of study participants (n=4500)

Demographic characteristics		Healthy N=2833 (63.0)	Obesity N=798 (17.7)	Sarcopenia N=750 (16.7)	Sarcopenia obesity N=119 (2.6)	P value
Age, years		60.8(7.5)	61.9 (7.6)	68.0(8.7)	68.0(9.3)	<.001
Gender	Female	1834(64.7)	529(66.3)	452(60.3)	58(48.7)	<.001
	Male	999(35.3)	269(33.7)	298(39.7)	61(51.3)	
Ethnics						<.001
Han		1252(44.2)	254(31.8)	382(50.9)	49(41.2)	
Zang		645(22.8)	364(45.6)	164(21.9)	60(50.4)	
Qiang		782(27.6)	144(18.0)	118(15.7)	6(5.0)	
Yi		115(4.1)	24(3.0)	71(9.5)	3(2.5)	
Others		39(1.4)	12(1.5)	15(2.0)	1(0.8)	
Educational level						<.001
No formal education		744(26.3)	228(28.6)	284(37.9)	38(31.9)	
Elementary school		887(31.3)	274(34.3)	251(33.5)	36(30.3)	
Middle school		652(23.0)	135(16.9)	108(14.4)	26(21.8)	
High school or higher		550 (19.4)	161(20.2)	107(14.3)	19(16.0)	
Marital status						<.001
Single		12 (0.4)	11 (1.5)	6(0.8)	2(1.8)	
Married		2353(86.9)	612(82.5)	541(76.0)	87(76.3)	
Divorced		37(1.4)	15(2.0)	14(2.0)	1(0.9)	
Widowed		305(11.3)	104(14.0)	151(21.2)	24(21.1)	
Life-styles						
Drink tea history	No	1436(53.3)	326(44.2)	402(56.9)	45(39.5)	<.001
	Yes	1260(46.7)	412(55.8)	304(43.1)	69(60.5)	
Drink alcohol history	No	1992(73.9)	567(76.8)	532(75.2)	94(82.5)	.090
	Yes	705(26.1)	171(23.2)	175(24.8)	20(17.5)	
Smoking history	No	2239(83.0)	646(87.5)	538(76.2)	95(83.3)	<.001
	Yes	459(17.0)	92(12.5)	168(23.8)	19(16.7)	
Sleeping quality	Good	1459 (54.0)	389 (52.6)	340(48.0)	63(55.3)	.038
	Bad	1245(46.0)	350(47.4)	369(52.0)	51(44.7)	
Comorbidity of chronic disease	No	703(24.8)	231(28.9)	165(22.0)	27(22.7)	.014
	Yes	2130(75.2)	567(71.1)	585(78.0)	92(77.3)	
Hypertension		613(21.6)	278(34.8)	143(19.1)	33(27.7)	<.001
Lung disease		93(3.3)	50(6.3)	52(6.9)	8(6.7)	.001
Diabetes mellitus		189(6.7)	55(6.9)	51(6.8)	14(11.8)	.200
Osteoarticular disease		224(19.6)	78(19.3)	83(26.3)	11(19.0)	.055
Nutrition status	Good	1197(46.3)	389(54.9)	92(14.4)	52(51.5)	<.001
	Mild poor	1351(52.2)	317(44.7)	495(77.7)	49(48.5)	
	Poor	38(1.5)	3(0.4)	50(7.8)	0(0.0)	
Cognitive status	Good	2397(89.0)	626(85.1)	543(76.9)	94(82.5)	<.001
	Mild decline	237(8.8)	94(12.8)	103(14.6)	12(10.5)	
	M/S decline	60(2.2)	16(2.2)	60(8.5)	8(7.0)	

Note. Data are shown using % or mean (standard deviation). P values were calculated with chi-squared tests and one-way analysis of variance (ANOVA) for categorical and continuous variables, respectively. Others=other ethnic groups including Zhuang, Manchu, Hui, Mongolia, Tujia. GDS-15=short form Geriatric Depression Scale M/S=moderate/severe.

Table 3
Metabolic characteristics of study participants (n=4500)

Metabolic characteristics	Healthy	Obesity	Sarcopenia	Sarcopenia obesity	p value
Insulin 0 (uU/ml)	8.1 (9.2)	11.9 (11.7)	5.6 (5.0)	8.8 (6.9)	<.001
Fasting glucose(mmol/L)	5.5(1.7)	5.8(1.8)	5.4(1.8)	5.8(2.4)	<.001
Triglyceride(mmol/L)	1.9(1.9)	1.9(1.3)	1.6(1.5)	1.8(1.0)	<.001
Cholesterol(mmol/L)	4.8(0.9)	4.9(0.9)	4.7(1.0)	5.0(0.9)	.001
HDL (mmol/L)	1.3(0.3)	1.2(0.3)	1.4(0.4)	1.2(0.3)	<.001
LDL (mmol/L)	2.6(0.9)	2.8(0.8)	2.6(0.8)	2.9(0.8)	<.001
Vitamin D (ng/mL)	19.7(6.2)	17.5(5.8)	18.6(6.4)	18.0(7.1)	<.001
Total protein(g/L)	71.7 (6.2)	73.0 (4.6)	70.9 (5.3)	72.6 (4.8)	<.001
Albumin(g/L)	44.4(3.0)	44.4(3.0)	43.2(3.4)	43.8(3.2)	<.001
Prealbumin(g/L)	291.7 (169.2)	282.6 (104.3)	261.3 (112.7)	269.8 (47.4)	<.001
WBC (10^9/L)	5.8(1.6)	6.1(1.6)	5.9(2.0)	6.2(1.7)	<.001
GPR (%)	60.8 (8.4)	61.3 (8.6)	62.3 (9.4)	63.0 (7.9)	<.001
LPR (%)	31.8 (7.8)	31.3 (7.8)	30.5 (8.7)	29.8 (7.3)	<.001
Uric Acid (umol/L)	323.8 (79.2)	353.6 (87.6)	316.0 (83.7)	356.6 (93.5)	<.001
CREA (umol/L)	80.8 (20.0)	79.1 (14.0)	80.0 (18.5)	82.4 (16.0)	.080
Urea (mmol/L)	5.4 (1.6)	5.3 (1.5)	5.5 (1.7)	5.3 (1.7)	.053
ALT (U/L)	27.9 (19.5)	31.9 (20.1)	23.0 (14.7)	25.8 (14.6)	<.001
AST (U/L)	29.1 (13.4)	29.6 (12.7)	30.0 (18.2)	28.4 (12.0)	.296
TSH (mU/L)	3.4 (2.7)	3.6 (3.1)	3.5 (4.4)	3.5 (2.8)	.724
PTC (nmol/L)	341.7 (136.9)	337.6 (138.5)	373.0 (179.0)	358.5 (133.3)	<.001

Data are shown mean (standard deviation). P values were calculated with one-way analysis of variance (ANOVA). Insulin 0, fasting plasma insulin. HDL, high-density lipoprotein; LDL, low-density lipoprotein. WBC, white blood cells. GPR, neutrophils ratio. LPR, lymphocyte ratio. CREA, creatinine. ALT, alanine transaminase. AST, aspartate aminotransferase. TSH, thyroid stimulation hormone. PTC, adrenal cortisol.

Table 4
Prevalence rates of non-sarcopenia/obesity, sarcopenia/non-obesity, sarcopenia obesity according to age, sex, and ethnics (n=4500)

Groups	Category	Obesity		Sarcopenia		Sarcopenia obesity	
		Men	Women	Men	Women	Men	Women
Age	50-59	18.6%	17.3%	8.2%	7.7%	2.4%	1.1%
	60-69	16.5%	20.7%	17.0%	16.6%	3.7%	1.5%
	70-79	14.3%	17.8%	35.1%	35.6%	5.8%	5.1%
	≥80	2.7%	9.0%	64.9%	56.7%	8.1%	11.9%
Ethnics	Han	10.9%	14.2%	23.7%	17.8%	3.3%	2.1%
	Zang	29.8%	29.3%	12.3%	14.0%	6.8%	3.4%
	Qiang	9.3%	16.1%	15.6%	8.9%	1.1%	0.3%
	Yi	10.7%	11.6%	24.0%	38.4%	0.0%	2.2%
Total	≥50 yr old	16.5%	18.4%	18.3%	15.7%	3.7%	2.0%

Note. Values are presented as prevalence rate in same age-groups divided by gender and presented as prevalence rate in same ethnic group divided by gender.

Table 5
Factors associated with non-sarcopenia/obesity, sarcopenia/non-obesity and sarcopenia obesity (n=4500)

Independent variables	Healthy	Sarcopenia	Obesity	Sarcopenia obesity
	β; OR; CI 95%	β; OR; CI 95%	β; OR; CI 95%	β; OR; CI 95%
Handgrip (kg)	1.0	-0.02; 0.98(0.97-1.00)	-0.11; 0.90(0.88-0.91)	-0.13; 0.88(0.85-0.92)
Gait speed (m/s)	1.0	-0.65; 0.52(0.36-0.76)	-1.18; 0.31(0.20-0.48)	-1.48; 0.23(0.09-0.60)
Metabolic profile				
Vitamin D (ng/mL)	1.0	-0.05; 0.95(0.94-0.97)	-0.03; 0.97(0.96-0.99)	-0.04; 0.96(0.93-0.99)
TG (mmol/L)	1.0	0.05; 1.06(1.01-1.10)	-0.20; 0.82(0.75-0.89)	NS
CHL (mmol/L)	1.0	0.10; 1.11(1.02-1.21)	NS	0.30; 1.35(1.12-1.63)
HDL (mmol/L)	1.0	-1.26; 0.28(0.21-0.39)	1.12; 3.07(2.33-4.05)	NS
LDL (mmol/L)	1.0	0.15; 1.16(1.05-1.28)	NS	0.37; 1.45(1.15-1.83)
Total protein(g/L)	1.0	0.03; 1.03(1.01-1.05)	NS	0.03; 1.03(1.00-1.06)
Albumin(g/L)	1.0	NS	-0.05; 0.96(0.93-0.99)	NS
Prealbumin(g/L)	1.0	NS	-0.003; 1.00(0.995-0.998)	NS
Glucose(mmol/L)	1.0	0.08; 1.08(1.04-1.13)	-0.06; 0.94(0.88-1.00)	NS
Insulin 0 (uU/ml)	1.0	0.05; 1.05(1.03-1.06)	-0.16; 0.86(0.83-0.88)	NS
WBC (10^9/L)	1.0	0.12; 1.12(1.07-1.18)	NS	NS
GPR (%)	1.0	NS	0.01; 1.01(1.00-1.02)	NS
LPR (%)	1.0	NS	NS	NS
Uric Acid (umol/L)	1.0	0.01; 1.01(1.005-1.007)	-0.003; 1.00(0.995-0.998)	0.003; 1.00(1.001-1.005)
CREA (umol/L)	1.0	NS	-0.02; 0.98(0.97-0.99)	NS
Urea (mmol/L)	1.0	NS	NS	NS
ALT (U/L)	1.0	0.01; 1.01(1.01-1.02)	-0.02; 0.98(0.98-0.99)	NS
AST (U/L)	1.0	NS	0.01; 1.01(1.00-1.01)	NS
TSH (mU/L)	1.0	NS	NS	NS
PTC (nmol/L)	1.0	NS	0.001;1.00(1.00-1.001)	NS
Nutrition scores	1.0	0.15; 1.16(1.07-1.26)	-0.46; 0.63(0.59-0.68)	NS

Note. A multinomial logistic regression analysis was used for estimating adjusted key differences. The model was adjusted by the covariates age, sex, ethnic groups. TG, Triglyceride. HDL, high-density lipoprotein; LDL, low-density lipoprotein. NS, not statistically significant. CHL, Cholesterol. Insulin 0; Fasting plasma insulin. WBC, white blood cells. GPR, neutrophils ratio. LPR, lymphocyte ratio. CREA, creatinine. ALT, alanine transaminase. AST, aspartate aminotransferase. TSH, thyroid stimulation hormone. PTC, adrenal cortisol. All shown data was significantly that $P<0.05$..

stress, insulin resistance, and hormonal changes (20-22).

This study showed that vitamin D levels are decreased in the groups whether having sarcopenia or obesity, or both, compared to the healthy group. Research has shown that low vitamin D level was both associated with obesity and sarcopenia (23-25). For obesity, due to their sedentary lifestyle and less outdoor activity, low sun exposure got in obese individuals, leading to less vitamin D production (26). On the other hand, the low vitamin D status takes part in the development of obesity by modulating adipocyte differentiation and lipid metabolism (25). For sarcopenia, different biological mechanisms by vitamin D might regulate skeletal muscle function have been evaluated, such as the direct biological role of the active vitamin D form in the regulation of genes and signaling pathways affecting calcium and phosphate homeostasis, proliferation and differentiation of muscle cells (27, 28). Besides, Vitamin D could bind to the VDR receptor on muscle fibers and increases their size, improving muscle strength and physical performance (29). A cohort study found that a high serum vitamin D level in mid- and late-life was associated with reduced odds of multiple adverse body composition, especially osteosarcopenic obesity (30). All of these studies indicate the supplement of vitamin D in the elderly is reasonable.

Our study found the S group had a decrease in the level of albumin and prealbumin compared with H. Many studies found the low level of albumin was associated with muscle loss and was considered as a risk factor of sarcopenia (31-33). Low albumin was shown to lead to more antioxidant capacities, causing more oxidative damage and therefore muscle breakdown (34, 35). Moreover, albumin could activate

the phosphatidyl-inositol 3-kinase pathway, leading to muscle hypertrophy (36). And we found the O and SO groups did not show significant differences in albumin compared with H. However, a study showed that obesity and morbid obesity were associated with higher odds of hypoalbuminemia in adults without liver disease or renal failure (37). Future research should be done to investigate the relationship between obesity, sarcopenia obesity and albumin.

Interestingly, we found the O group has a higher fasting plasma insulin and S group has lower fasting plasma insulin compared to H. The research found that a lack of insulin or insulin resistance leads to accelerated development of sarcopenia. The mechanism study was found that insulin could mediate accretion of muscle mass through activation of p38 mitogen-activated protein kinase (MAPK) and mammalian target of rapamycin (mTOR)/p70S6 kinase, and thus stimulating mRNA translation (38). A previous study found that elevated fasting insulin levels increase the risk of abdominal obesity in Korean men (38). And the elevated fasting insulin level was also reported to be positively associated with the visceral fat area in computed tomography scans among adults and children (39). However, in our study, we found that the level of fasting insulin level was not significantly different in SO group compared with H. A recent research also found that sarcopenic obesity does not appear to confer greater risk for incident metabolic syndrome or insulin resistance than obesity alone in community-dwelling older men (40). Whether there exists a relationship between sarcopenic obesity and fasting plasma insulin needs further research.

Specifically, we found that only S group has a higher ratio of adrenal cortisol than H. Cortisol takes part in various physiological mechanisms like metabolism, the immune response, and the body's response to stress. And cortisol is mostly triggered by stress-induced activation of the hypothalamic–pituitary–adrenal axis (HPA). It was found that a relative increase in cortisol may reflect the presence of stress and stimulate muscle catabolism through inducing atrogin-1 and MuRF-1 in the ubiquitin-proteasome system, thus causing protein degradation of skeletal muscle, leading to sarcopenia (41-43). However, we did not find a significant difference between O, SO and H in the level of adrenal cortisol. While the research found substantial evidence of differential HPA axis activity in both generalized and abdominal obesity (44). But this also remains controversial that another research found that cortisol level is lower in overweight or class I obese women than in lean women and that research also found that both extreme underweight and overweight states could activate the HPA axis, result of hypercortisolemia, contributing to increased adiposity in the setting of caloric excess (45). This might need deeper research to find out whether sarcopenia obesity and obesity were associated with adrenal cortisol.

Moreover, we found a reduced alanine transaminase (ALT) level in S compared to H. Study showed that reduced ALT levels in older individuals could be a marker of frailty, disability, and sarcopenia, and also an independent predictor of adverse outcomes (46). Besides, High serum aspartate aminotransferase (AST) was found to be highly prevalent in older underweight people and might reflect skeletal muscle pathology (47). But in a Chinese community-dwelling population, the prevalence of metabolic syndrome and its components (including central obesity and high TG) was found to increase with an elevation in serum ALT levels within normal range (48). While the prevalence of elevated ALT did not exhibit a linear change with elevated BMI between 1999 and 2014 in U.S. adolescents (49). Whether there exists some relationship between sarcopenic obesity and ALT or AST needs to be explored further.

Overall, we found that both S and SO had an age-related prevalence increasing pattern, lower educational level, without spouse, smoking, comorbidity of chronic disease, poor nutrition status, depression and cognitive decline compared to H, and S seems to be worse than SO. Specifically, we found the S group looks like in a worse metabolic profile than SO compared to H, while O group was opposite to S group in some blood index like triglyceride, high-density lipoprotein, fasting glucose, fasting insulin, alanine transaminase and nutrition scores. As a result of a less harmful metabolic profile in SO compared to H, it seems like SO group was benefited from obesity. Previous research has a similar result showing that S subjects appear more vulnerable than SO and sarcopenia is closely related with an increase in the risk of hip–femur fractures, inflammation, edema, and malnutrition[50]. More metabolic profile changes in comparing S, O and SO need to be investigated.

Limitations

The strengths of this study were its large study sample. However, careful adjustment should be made for important confounders of the association under study, including lifestyle variables and dietary intake. Besides, no repeated measures of metabolic testing were available and there might be some testing error. Moreover, our study was an observational cross-sectional study, and a causal relationship between metabolic change in the sarcopenia or sarcopenia obesity should be investigated in the follow-up. In the end, persons who came to participate in our study are relatively younger, healthier and there existed some kind of bias in the whole study.

Conclusions

This study demonstrated that S, O and SO particpants demonstrate distinct differences in life-styles, chronic disease profile, and metabolic profiles. The prevalence of S and SO has an aging increasing pattern but O has an aging decrease pattern. Both S and SO tend to be older, lower educational level, without a spouse, smoking, comorbidity of chronic disease, poor nutrition status, depression and cognitive decline compared to H, and S seems to be worse than SO. Besides, the metabolic profile showing that S subjects had the worst

metabolic profile. However, O subjects have some contrary metabolic factors to S. While SO seemed to be profit from the "obesity," with better nutritional status and metabolic profile than S.

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