OPEN

Association Between Skeletal Muscle Mass and Cardiovascular Risk Factors in Occupational Sedentary Population

A Cross-sectional Study

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Objective: The aims of this study were to determine the association of skeletal muscle mass with three cardiovascular risk factors and explore a simple and clinically feasible indicator for identifying high-risk groups of cardiovascular diseases in occupational sedentary population. **Methods:** We recruited 7316 occupational sedentary participants older than 18 years from the Health Management Center of Tianjin Union Medical Center. Age-adjusted logistic regression was used to analyze the association between skeletal muscle mass index (SMI) and cardiovascular risk factors. **Results:** There were significant positive associations between SMI, especially arm SMI, and cardiovascular risk factors in both male and female subjects (odds ratio, 1.28 to 5.02; $P < 0.001$). **Conclusions:** Our findings suggest that measurements of skeletal muscle mass, particularly in the arms, may help identify individuals at high risk for cardiovascular disease in an occupationally sedentary population.

Keywords: cardiovascular risk factors, dyslipidemia, hyperglycemia, hypertension, sedentary, skeletal muscle mass

Cardiovascular disease (CVD) is the leading cause of both death and premature death worldwide in both male and female subjects.[1,2] It also ranks first among the causes of death in China and is the cause of 40% of deaths in the Chinese population.[3] Previous studies have shown that hypertension, high non–high-density lipoprotein cholesterol (HDL-C), and diabetes were independent risk factors for CVD, and the study from the Global Burden of Disease Study showed that 21% of the morbidity and mortality of CVD were attributed to hypertension.[4,5] In addition, studies have shown that sedentary behavior and physical inactivity are strongly associated with a higher risk of developing CVD.[6–8] Finding an indicator to identify the high-risk group of CVDs in this population will be a valuable exploration.

Body composition analysis, a method that is widely used in clinical practice currently, can obtain accurate and stable measurements under well-controlled conditions, which is very beneficial for conducting relevant research.[9] Body composition analysis can obtain more information of body composition than traditional body measurements such as height, weight, waist circumference and so on. Indicators of body composition such as skeletal muscle mass and visceral fat area have significant differences between male and female subjects,[10] and the sex differences in body composition affect their association with CVD morbidity and all-cause mortality.[11] In recent years, there is growing evidence that skeletal muscle mass plays a key role in the development of CVD.[12] Besides, other studies have shown that dysfunction of visceral adipose tissue in obese individuals underlies insulin resistance and chronic inflammation, both of which are associated with the development of various chronic diseases and sarcopenia.[13] For example, studies had shown that sarcopenia was significantly associated with several metabolic diseases.[14] In addition, myokines (such as interleukin 6 [IL-6], irisin, fibroblast growth factor 21, myostatin) secreted by skeletal muscle interact with multiple organ tissues and have a wide range of effects on body metabolism.[15,16] Therefore, skeletal muscle mass may be a good potential indicator for identifying people at high risk of CVD. However, research on the association between skeletal muscle mass and cardiovascular risk factors in occupationally sedentary populations remains limited, and even fewer studies have examined the sex differences of the association.

The objectives of our study were to determine the association of skeletal muscle mass with three cardiovascular risk factors in an occupationally sedentary population and further analyze the association between skeletal muscle mass in different parts of the body and cardiovascular risk factors to explore a simple and clinically feasible indicator for identifying high-risk groups of the CVD in clinical practice.

METHODS

Study Design and Populations

The target population for this cross-sectional study was the group of participants who had an annual physical examination at the Health Management Center of Tianjin Union Medical Center and agreed to participate in body composition analysis and blood biochemical examination. The occupationally sedentary population was defined as those who work in a sedentary position for long periods (sitting for >6 hours a day) and have no regular physical activity in their spare time. All participants who met the criteria for occupational sedentary population were included in the study from September 2019 to December 2020. In addition, to minimize the loss of sample size, we did not exclude the subjects with missing blood glucose data. A

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Ethical considerations and disclosures: This study was approved by the institutional review board of Tianjin Union Medical Center, Nankai University Affiliated Hospital (no. 2021C06). All participants were informed about the study objectives and examination procedures in detail and were asked to sign the informed consent form before they were enrolled.

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Data Availability: The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

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separate database with a sample size of 5120 was created for subsequent analyses related to blood glucose indicator. Finally, after excluding participants who could not provide all the required information, 7316 eligible subjects were enrolled in the study.

This study was conducted in accordance with the principles for human experimentation as defined in the Declaration of Helsinki and International Conference on Harmonization Good Clinical Practice guidelines and approved by the institutional review board of Tianjin Union Medical Center. All participants were informed about the study objectives and examination procedures in detail and were asked to sign the informed consent form before they were enrolled.

Assessment of Cardiovascular Risk Factors

Blood pressure was measured by an electronic sphygmomanometer (AC-05C; Ling Qian, Shenzhen, China). The histories of hypertension or taking antihypertensive medication were recorded before the blood pressure measurement was performed. Then, the blood pressure of the participants was measured after a 10-minute rest. Blood biochemical indicators, including fasting plasma glucose, triglycerides, total cholesterol, low-density lipoprotein cholesterol, HDL-C, alanine aminotransferase, serum creatinine, and serum uric acid, were analyzed using an automatic biochemical analyzer (TBA-120FR; Toshiba, Tokyo, Japan), and the venous blood samples for biochemical analysis were drawn from an antecubital vein after overnight fasting. Hypertension, dyslipidemia, and hyperglycemia were considered as cardiovascular risk factors in the study. Hypertension was defined as systolic blood pressure ≥140 mm Hg or diastolic blood pressure ≥90 mm Hg or treatment with antihypertensive medications. Hyperglycemia was defined as fasting plasma glucose >6.0 or being treated with hypoglycemic agents. Dyslipidemia was defined as triglycerides ≥2.3 mmol/L or low-density lipoprotein cholesterol ≥4.1 mmol/L or HDL-C <1.0 mmol/L or total cholesterol ≥6.2 mmol/L, or being treated with medications according to the Chinese Guidelines for the Management of Dyslipidemia in Adults (2016).[17]

Body Composition Measurement

Body composition analysis was performed using a multielectrode bioelectrical impedance analyzer (In body 770; Bio-space Inc, Seoul, Korea). All participants who underwent body composition analysis were asked, "Whether they had taken any medications related to skeletal muscle health, such as glucocorticoids, opioids, antibiotics, etc., in the last six months." Eligible participants were required to perform body composition analysis with light clothing and barefoot subsequently after blood samples were collected. The soles of feet and palms of hands were wiped separately with clean water to ensure full contact with the electrodes before the measurement. Detailed steps on body composition measurement can be found in our previous study.[18] The indicator we were interested in was the skeletal muscle mass of different parts of the body, including total body skeletal muscle mass, appendicular skeletal muscle mass, and trunk skeletal muscle mass. The skeletal muscle mass index (SMI) as an independent variable in the study was defined as skeletal muscle mass divided by the square of height, including total SMI, leg skeletal muscle mass index (LSMI), arm skeletal muscle mass index (ASMI), and trunk skeletal muscle mass index (TSMI). In addition to body composition, height and weight were measured using an automatic height-weight instrument (DST-600; Donghuayuan, Beijing, China).

Statistical Analysis

The descriptive data were presented as means (SD) or median (interquartile range) for continuous variables and percentages for categorical variables. Trend and between-group analyses were performed using analysis of variance and Pearson χ^2 test. Cardiovascular risk factors (hypertension, hyperglycemia, and dyslipidemia) were used as dependent variables, and SMI was used as an independent variable. For further analysis, after quartile conversion of independent variables, age-adjusted logistic regression was used to estimate the odds ratio (OR) and 95% confidence interval (CI) and analyze the association between SMI and cardiovascular risk factors. Besides, we performed subgroup analysis based on relative skeletal muscle mass in different parts of the body. SAS 9.4 for Windows (SAS Institute Inc, Cary, NC) was used for statistical analyses. All P values were derived from two-sided tests, and the significance level was set at $P < 0.05$.

RESULTS

Screening of Study Subjects

A total of 7546 occupationally sedentary individuals were included in the study from September 2019 to December 2020. Subsequently, during data collection, 181 participants were excluded because of incomplete information, including lack of results of biochemical analysis and body composition; 45 participants were excluded because of histories of cancer, which might lead to confounding effects on the study results because of significant changes in lifestyle; and five individuals were excluded because of extreme values (outside the range of mean ± 3 SD). Finally, 7316 eligible subjects were enrolled in the study.

Characteristics of Participants

The mean age of the subjects was 42.8 (SD, 13.8) years, and 44.8% were male (Table 1). The mean values of blood pressure and blood biochemical parameters of the participants were all within the reference range, that is, the 95% range of values obtained by the same method of measurement for the general population. The prevalence of hypertension, dyslipidemia, and hyperglycemia among the subjects was 25.8%, 53.1%, and 13.7%, respectively, and the prevalence was higher in male than in female subjects ($P < 0.001$). Besides, The SMI levels of subjects with three cardiovascular risk factors were

TABLE 1. Characteristics of the Population According to Gender*

	Total (n = 7316)	Male (n = 3277)	Female (n = 4039)	*P*
Age, y	42.8 (13.8)	43.7 (14.0)	42.0 (13.6)	<0.01
Height, cm	166.3 (8.4)	172.9 (6.3)	161.0 (5.6)	<0.01
Weight, kg	68.0 (13.8)	77.9 (11.9)	60.0 (9.2)	<0.01
BMI, kg/m^2	24.5 (3.7)	26.0 (3.4)	23.2 (3.4)	<0.01
SMM, kg	25.9 (6.0)	31.6 (4.2)	21.5 (2.6)	<0.01
FFM, kg	47.1 (9.9)	56.0 (7.0)	39.8 (4.4)	<0.01
BFM, kg	20.88 (6.72)	21.78 (7.06)	20.15 (6.33)	<0.01
SBP, mm Hg	124.1 (17.9)	129.8 (16.9)	119.4 (17.3)	<0.01
DBP, mm Hg	77.7 (10.9)	81.2 (10. 9)	74.8 (10.0)	<0.01
FPG,† mmol/L	5.41 (1.2)	5.6 (1.4)	5.3 (1.0)	<0.01
TC, mmol/L	5.07 (1.0)	5.05 (0.9)	5.08 (1.0)	0.33
TG, mmol/L	1.3 (0.9)	1.5 (1.1)	1.1 (0. 8)	<0.01
HDL-C, mmol/L	1.6 (0.4)	1.4 (0.3)	1.7 (0.4)	<0.01
LDL-C, mmol/L	2.7 (0.6)	2.7 (0.6)	2.7 (0.6)	0.84
Hypertension, n (%)	1887 (25.8)	1187 (36.2)	700 (17.3)	<0.01
Dyslipidemia, n (%)	3887 (53.1)	1983 (60.5)	1904 (47.1)	<0.01
Hyperuricemia, n (%)	1057 (14.4)	766 (23.4)	291 (7.2)	<0.01
Hyperglycemia,† n (%)	704 (13.7)	394 (18.4)	310 (10.4)	<0.01
History of diseases				
Diabetes, n (%)	247 (3.4)	154 (4.7)	93 (2.3)	<0.01
Hypertension, n (%)	454 (6.2)	296 (9.0)	158 (3.9)	<0.01
CHD, n (%)	107 (1.5)	80 (2.4)	27 (0.7)	<0.01

BFM, body fat mass; BMI, body mass index; CHD, coronary heart disease; DBP, diastolic blood pressure; FFM, fat-free mass; FPG, fasting plasma glucose; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; SBP, systolic blood pressure; SMM, skeletal muscle mass; TC, total cholesterol; TG, triglycerides.

*Continuous variables are presented as mean (SD) or median (interquartile range); categorical variables are presented as n (%).

†Sample size for statistical analysis was 5120 (male, n = 2142; female, n = 2978).

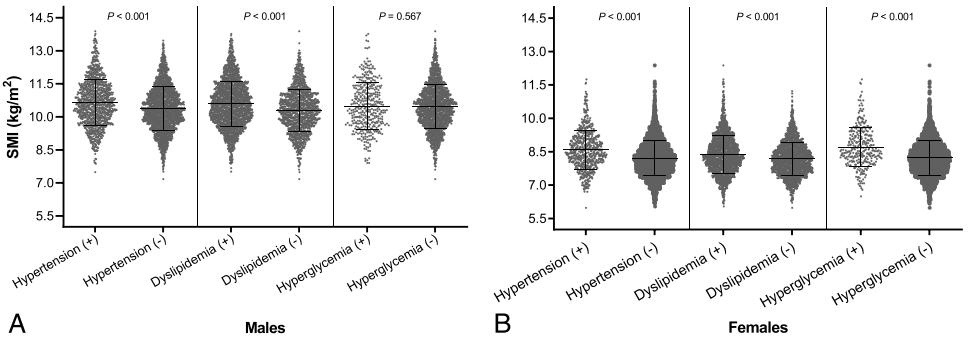

FIGURE 1. Distribution of SMI among male (A) and female subjects (B) according to health status. SMI, skeletal muscle mass index.

significantly higher than those without three risk factors among female subjects, and the subjects with hypertension and dyslipidemia were significantly higher than those without these the two risk factors among male subjects ($P < 0.001$) (Fig. 1).

After dividing SMI into quartiles, a steady increase was observed in the prevalence of the three cardiovascular risk factors with the rise of SMI, except for hyperglycemia in male subjects. When quartile division was performed for ASMI, stable prevalence elevations were observed across all three cardiovascular risk factors with increasing ASMI levels (Fig. 2).

SMI and Cardiovascular Risk Factors

After quartile division of SMI, it was shown that participants in the highest quartile interval had significantly higher risk of hypertension (male: OR, 2.61 [95% CI, 2.10 to 3.25]; female: OR, 2.89 [95% CI, 2.18 to 3.86]) dyslipidemia (male: OR, 2.36 [95% CI, 1.92 to 2.91]; female: OR, 1.28 [95% CI, 1.05 to 1.56]), and hyperglycemia (male: OR, 2.15 [95% CI, 1.52 to 3.06]; female: OR, 5.02 [95% CI, 3.24 to 7.98]) compared with those in the lowest quartile (Table 2). A comparable risk was observed between SMI and hypertension in both male and female subjects, and the OR increased significantly faster in female than in male subjects at high levels of SMI. A significantly higher risk was observed between SMI and dyslipidemia in male subjects compared with female subjects. For the association of SMI with hyperglycemia, the OR value was significantly higher in female subjects, and the OR value increased the fastest compared with the other two cardiovascular risk factors.

Subgroup Analysis

Further subgroup analysis explored the association between SMI in different parts of the body and cardiovascular risk factors

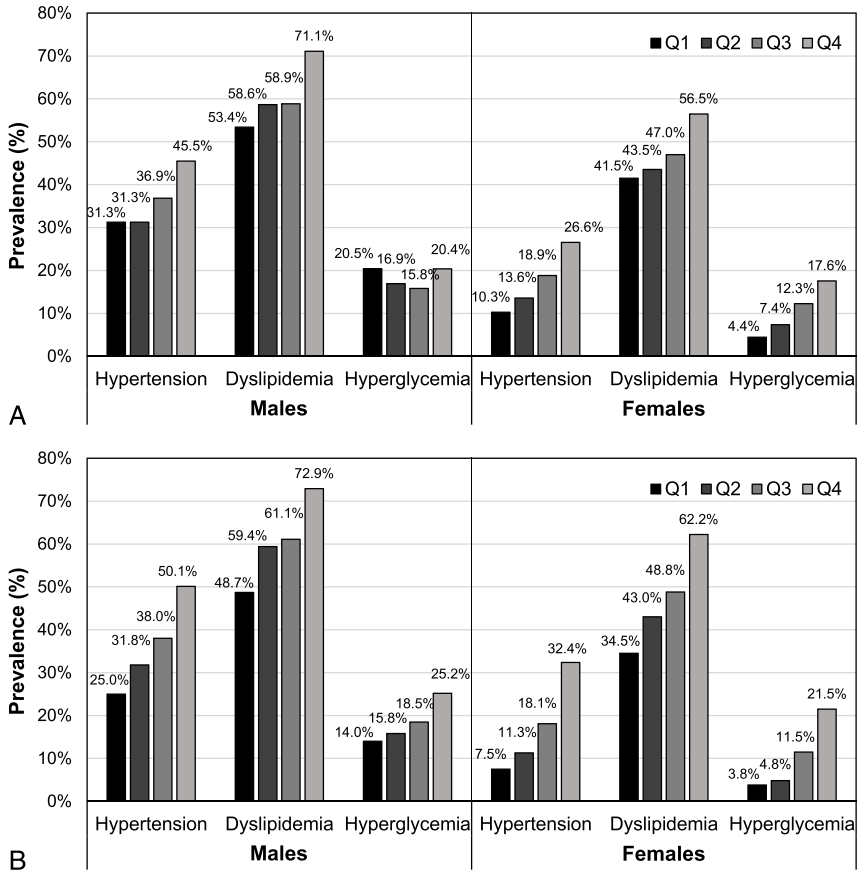

FIGURE 2. Changes in prevalence based on the SMI (A) and ASMI (B) quartiles in male and female subjects. ASMI, arm skeletal muscle mass index; Q, quartile; SMI, skeletal muscle mass index.

TABLE 2. Age-Adjusted Logistic Regression Analysis for Associations Between SMI and Cardiovascular Risk Factors in Male and Female Subjects*

	Hypertension		Dyslipidemia		Hyperglycemia	
Variables	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Q1	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Q2	1.13 (0.91–1.41)	1.20 (0.88–1.64)	1.28 (1.05–1.56)	0.88 (0.72–1.07)	1.04 (0.73–1.47)	1.65 (1.02–2.73)
Q3	1.68 (1.35–2.10)	1.53 (1.14–2.07)	1.34 (1.10–1.64)	0.83 (0.68–1.01)	1.36 (0.95–1.95)	2.61 (1.66–4.18)
Q4	2.61 (2.10–3.25)	2.89 (2.18–3.86)	2.36 (1.92–2.91)	1.28 (1.05–1.56)	2.15 (1.52–3.06)	5.02 (3.24–7.97)
P for trend†	<0.001	<0.001	<0.001	0.019	<0.001	0.001

Values are ORs (95% CIs) unless otherwise indicated.
*Each unit represents an SD.
†*P* values for linear trends were calculated using the median value of quartiles of SMI.
CI, confidence interval; OR, odds ratio; Q, quartile; SMI, skeletal muscle mass index.

(Fig. 3). Analysis of SMI in different parts of the body showed that the highest ORs were found for ASMI with three cardiovascular risk factors in both male and female subjects (male: 2.72 to 3.23; female: 1.68 to 4.29), and all were statistically significant ($P < 0.001$). However, no significant association was observed between LSMI and TSMI and dyslipidemia in female subjects ($P = 0.051$ for LSMI, $P = 0.932$ for TSMI). After further adjustment for visceral fat area, ASMI remained significantly associated with the three cardiovascular risk factors (Table 3). The results of the subgroup analysis showed that the association of ASMI with the three risk factors was the most robust in both male and female subjects. In addition, the association of SMI with the three cardiovascular risk factors was more robust in male subjects compared to female subjects.

DISCUSSION

The results of this study showed that SMI was significantly associated with hypertension, dyslipidemia, and hyperglycemia in both

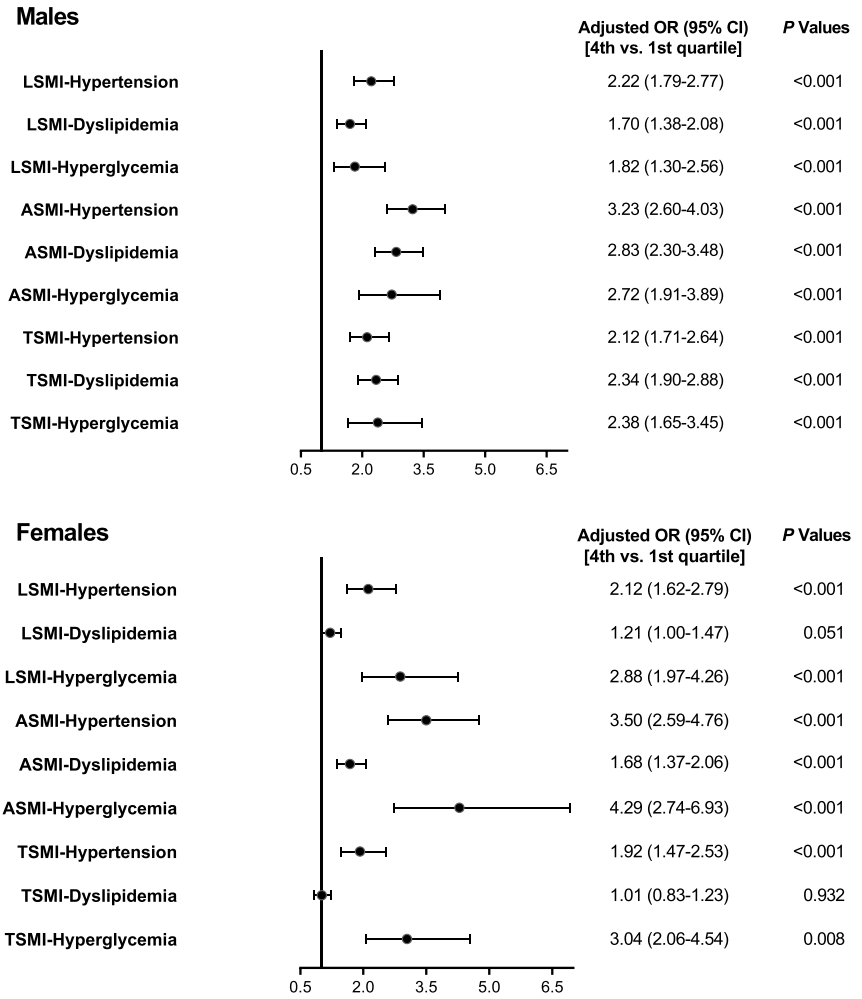

FIGURE 3. Age-adjusted logistic regression of the association of skeletal muscle mass in different parts of the body with three cardiovascular risk factors. ASMI, arm skeletal muscle mass index; LSMI, leg skeletal muscle mass index; TSMI, trunk skeletal muscle mass index.

TABLE 3. Association of Skeletal Muscle Mass Index in Different Parts of the Body With Three Cardiovascular Risk Factors

	Hypertension		Dyslipidemia		Hyperglycemia	
Variables	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
LSMI						
Model 1*	2.22 (1.79–2.77)†	2.12 (1.62–2.79)	1.70 (1.38–2.08)	1.21 (1.00–1.47)	1.82 (1.30–2.56)	2.88 (1.97–4.26)
Model 2‡	1.35 (1.07–1.71)	1.44 (1.08–1.92)	1.03 (0.83–1.29)	0.80 (0.65–0.98)	1.37 (0.95–1.96)	2.12 (1.42–3.18)
ASMI						
Model 1	3.23 (2.60–4.03)	3.50 (2.59–4.76)	2.83 (2.30–3.48)	1.68 (1.37–2.06)	2.72 (1.91–3.89)	4.29 (2.74–6.93)
Model 2	1.79 (1.40–2.29)	2.29 (1.64–3.23)	1.63 (1.29–2.05)	0.91 (0.72–1.15)	1.62 (1.12–2.35)	3.14 (1.92–5.30)
TSMI						
Model 1	2.12 (1.71–2.64)	1.92 (1.47–2.53)	2.34 (1.90–2.88)	1.01 (0.83–1.23)	2.38 (1.65–3.45)	3.04 (2.06–4.54)
Model 2	1.73 (1.38–2.17)	1.66 (1.26–2.20)	1.90 (1.53–2.36)	0.85 (0.70–1.04)	2.14 (1.48–3.13)	2.69 (1.82–4.05)

Values are ORs (95% CIs) unless otherwise indicated.

*Model 1: adjusted for age.

†First versus fourth quartiles of skeletal muscle mass index in different parts of the body.

‡Model 2: further adjusted for visceral fat area.

ASMI, arm skeletal muscle mass index; CI, confidence interval; LSMI, leg skeletal muscle mass index; OR, odds ratio; TSMI, trunk skeletal muscle mass index.

male and female subjects, and the ORs of these three cardiovascular risk factors increased significantly with the increase in SMI. Among the SMI in different parts of the body, the most robust association was observed in the ASMI with three cardiovascular risk factors. Besides, compared with male subjects, a rapid increase was observed in the OR of cardiovascular risk factors in female subjects when SMI levels were at higher levels.

In contrast to the results of previous studies, we found a positive association between SMI and cardiovascular risk factors, whereas previous studies showed a significant negative association between them. A study conducted by Srikanthan et al[19] showed that higher muscle mass was associated with lower risk of CVD and mortality in male and female subjects. Similarly, another study found that increased muscle mass was associated with a reduced risk of CVD development among young adults.[20] Furthermore, Kim et al[21] investigated the optimal cutoff value of skeletal muscle mass by evaluating the association between skeletal muscle mass and cardiovascular risk factors in the general population and found that lower skeletal muscle mass was associated with increased risk of several cardiovascular factors. However, the above studies were either based on the general population or used weight-adjusted skeletal muscle mass as the indicator, which were different from our study population and indicators.

The significant positive association between skeletal muscle mass and cardiovascular risk factors in sedentary individuals may be due to several reasons. First, skeletal muscle, as an endocrine organ, can secrete a variety of myokines, which are important factors that mediate the effect of skeletal muscle on body metabolism.[22] Skeletal muscle produces myokines through the stimulation of muscle via physical activity and then regulates the glucose and lipid metabolism. Irisin, a myokine, has been confirmed to be associated with systolic blood pressure. Elevated levels of irisin were associated with the development of hypertension and hypertension-related stroke.[23] Therefore, one possible explanation for our results is that the increased skeletal muscle mass may passively cause the increase in irisin level, which will promote the development of hypertension. Simultaneously, the lack of stimulation of skeletal muscle caused by long-term inactivity will reduce the secretion of beneficial myokines (IL-6, IL-15, fibroblast growth factor 21, CTRP15, FSTL1) and then lead to the attenuation of the regulation of glucose and lipid metabolism. Second, those with a higher skeletal muscle mass are more prone to protein catabolism in the presence of long-term physical inactivity, which may produce more branched-chain amino acids (BCAAs). On the one hand, BCAAs and related metabolites are considered as biomarkers of insulin resistance, diabetes, and CVD.[24] On the other hand, elevated circulating levels of BCAAs and of their keto acids, as well as impaired catabolism of these amino acids, are implicated in the development of insulin resistance and its sequelae, including type 2 diabetes, CVD, and some cancers.[25] In addition, a large number of previous studies have confirmed that insulin resistance is characterized by elevated serum insulin level, and it is an independent risk factor of diabetes. The rise of insulin can increase blood pressure via several mechanisms: increased renal sodium reabsorption, activation of the sympathetic nervous system, alteration of transmembrane ion transport, and hypertrophy of resistance vessels.[26] Finally, a recent study has shown that more sedentary time is associated with higher concentrations of total testosterone and calculated free testosterone, which acts as an anabolic hormone that promotes skeletal muscle growth.[27,28] In addition, occupational sedentariness is often accompanied by excessive stress and physiological stress responses, which may cause disturbances in the body's hormone metabolism and sequentially cause pathological growth of skeletal muscle. Based on the above evidence, we can speculate that in the long-term sedentary population, higher skeletal muscle mass is closely related to abnormal metabolism, which may further promote the occurrence and development of cardiovascular-related risk factors.

Another notable result was significant sex differences, especially in the association between skeletal muscle mass and dyslipidemia. On the one hand, the OR of female subjects increased faster than that of male subjects when the SMI is at a higher level; on the other hand, there are significant differences in the association between SMI and three cardiovascular risk factors in male and female subjects. One possible explanation for the sex differences in our results is dissimilarities in gene expression and sex hormones between male and female subjects.[29] However, the underlying mechanism regarding the sex difference in the association of SMI with cardiovascular risk factors remains unknown.

In a further subgroup analysis, we explored the association between SMI in different parts of the body and cardiovascular risk factors. The results showed that ASMI had a significant positive association with three cardiovascular risk factors and had a more robust association with them than SMI, LSMI, and TSMI in both male and female subjects. One possible explanation is that changes in skeletal muscle mass of the arms are much smaller than that in other body parts. The increase in arm skeletal muscle mass is often accompanied by fewer changes in peripheral fat, which may affect the association between skeletal muscle mass and cardiovascular risk factors. The above speculation can be confirmed in our further adjusted model (adjusting for visceral fat area), which could show that the association between ASMI and the three cardiovascular risk factors was least affected compared with LSMI and TSMI. In addition, a study conducted by Ye et al[30] showed that arm lean body mass was positively associated with hypertension, which was consistent with our results. However, evidence regarding the association of arm skeletal

muscle mass with two other cardiovascular risk factors remains limited.

There are some strengths in our study. First, we have a large sample size of participants, which can ensure the representativeness and extrapolation of our data. Second, all data collected were measured in strict accordance with the standard processes to ensure the reliability and robustness of our results. Third, we separately analyzed the association of SMI from different parts of the body with cardiovascular risk factors, and we further adjusted for visceral fat area, considering the effect of body fat, which provides a possible direction for further exploration of related mechanisms. However, some limitations could not be ignored. One of the study's limitations is that some covariates, such as demographic characteristics, physical activity, and dietary and lifestyle information, were not included in the study, which limited our interpretation of the results and made it impossible to further clarify the underlying mechanism. In addition, because the study was conducted during the COVID-19 epidemic, the resulting negative emotions (eg, anxiety and depression)[31] in participants may indirectly affect changes in skeletal muscle mass, such as increasing the risk of skeletal muscle loss and therefore, to some extent, bias the results. Another limitation was that the subjects included in the study were the population receiving their routine physical examination, and postload glucose was not included in the examination, which might miss some information on hyperglycemia. These two factors above may lead to an underestimation of our results. Finally, we could not know whether changes in skeletal muscle mass were causally associated with the development of cardiovascular risk factors because it was a cross-sectional study. Although a robust positive association between skeletal muscle mass and cardiovascular risk factors was shown in our results, they may have a dual effect of cause and effect. Because the purpose of the present study was to find a body phenotype as a robust indicator of cardiovascular risk factors, this limitation did not affect our conclusions.

CONCLUSIONS

Relative skeletal muscle mass, particularly the ASMI, had significant positive association with three cardiovascular risk factors in both male and female subjects. The results suggest that changes in the skeletal muscle mass of arms might be a good indicator for CVD, and the measurements of skeletal muscle mass in the arms might help identify people at high risk for CVD in an occupationally sedentary population. However, the associations between skeletal muscle mass of different body parts and CVD were inconsistent, especially after adjusting the visceral fat area; the underlying mechanism still needs to be further elucidated by well-designed cohort studies or randomized controlled trials.

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