Archives of Gerontology and Geriatrics 72 (2017) 12–18

Contents lists available at ScienceDirect

Archives of Gerontology and Geriatrics

journal homepage: www.elsevier.com/locate/archger

Gender difference in the association between lower muscle mass and metabolic syndrome independent of insulin resistance in a middle-aged and elderly Taiwanese population

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ARTICLE INFO

Keywords:
Lower muscle mass
Sarcopenia
Metabolic syndrome
Gender difference
Insulin resistance

ABSTRACT

Background: Loss of muscle mass was reported to be associated with metabolic syndrome (MetS), but little is known about the gender difference. Thus, the aim of this study was to evaluate the relationship between lower muscle mass and MetS and determine whether there was any gender difference or not.
Methods: A total of 394 middle-aged and elderly Taiwanese adults (138 males and 256 females) were enrolled and completed our health survey. They were stratified into three groups according to appendicular skeletal muscle mass divided by weight. Participants distributed into the lower tertile were defined as people having lower muscle mass. MetS was defined using the Adult Treatment Panel III Asian diagnostic criteria. Multivariate logistic regression analysis was performed to assess the association between muscle and MetS.
Results: We found an inverse association between MetS and muscle mass in both males and females. Participants with lower muscle mass had a higher risk of MetS in univariate analysis. The same results were observed when adjusted for age and when also adjusted for living condition factors. However, after additional adjustment for potential confounders and HOMA-IR, we only found it to be statistically significant in the female group (OR in male = 3.60; 95% CI = 0.62–20.83, p = 0.153; OR in female = 3.03; 95% CI = 1.16–7.94, p = 0.024).
Conclusions: We examined the relationship between lower muscle mass and metabolic syndrome in a middle-aged and elderly Taiwanese population. We found that lower muscle mass was associated with the risk of metabolic syndrome in the aged, particularly in females.

1. Introduction

Metabolic syndrome (MetS), which is known to be an increasing global health burden, is a common metabolic disorder resulting from a cluster of interacting metabolic risk factors including glucose intolerance, insulin resistance, abdominal obesity, hypertension, and dyslipidemia (Eckel, Grundy, & Zimmet, 2005). It was reported that MetS increased the risk of diabetes, cardiovascular disease, and all-cause mortality (Ford, 2005b). Some previous studies showed that the prevalence of MetS differed in age, sex, and ethnicity (Ford, 2005a; Hildrum, Mykletun, Dahl, & Midthjell, 2009; Lin, Caffrey, Chang, & Lin, 2010). Other studies conducted in Taiwan found that MetS is a common disease among middle-aged and elderly individuals (Hwang, Bai, & Chen, 2006; Tsou & Chang, 2013; Tsou, Chang, Huang, & Hsu, 2014).

In addition to MetS, lower muscle mass and sarcopenia are other highly prevalent problems in middle-aged and elderly populations (Iannuzzi-Sucich, Prestwood, & Kenny, 2002; Osuna-Pozo et al., 2014). The leading characteristic of sarcopenia is the loss of muscle mass with increasing age (Limpawattana, Kotruchin, & Pongchaiyakul, 2015), which starts at the age of 40 at the rate of 8% per decade and increases to 15% per decade after the age of 70 (Kim & Choi, 2013). Sarcopenia has a crucial negative impact on seniors' physical activity, independence and quality of life (Yu, 2015). Sarcopenic obesity, which refers to elevated body fat mass combined with reduced muscle mass, has also been proposed as characterizing age-related changes in body composition in elderly people (Roubenoff, 2004).

It is known that muscles use large amounts of glucose

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http://dx.doi.org/10.1016/j.archger.2017.04.006
Received 31 August 2016; Received in revised form 21 April 2017; Accepted 26 April 2017
Available online 08 May 2017

(Karlsson & Zierath, 2007), and lower muscle mass is believed relating to an adverse glucose metabolism (Srikanthan, Hevener, & Karlamangla, 2010) and a higher prevalence of cardiovascular disease (Oterdoom et al., 2009). It is also known that MetS is closely associated with cardiovascular risk and type 2 diabetes mellitus in the middle- and old-aged populations (Miranda, DeFronzo, Califf, & Guyton, 2005; Mottillo et al., 2010). Thus, previous studies, which focused mainly on elderly people having lower muscle mass or sarcopenia, investigated the relationship between muscle mass and metabolic risk factors (Chung, Kang, Lee, Lee, & Lee, 2013; Lim et al., 2010). It had been reported that sarcopenia defined in terms of muscle mass and sarcopenic obesity had a significant relationship with metabolic syndrome (Lee, Hong, Shin, & Lee, 2016).

In a study conducted in an US population, lower muscle mass was found to increase insulin resistance in both obese and non-obese subjects (Srikanthan et al., 2010). Another study conducted in the Korean population found that sarcopenia increased the risk of metabolic abnormalities beyond what was predicted by the abdominal obesity category (Park et al., 2014). Another study conducted in the Korean population pointed to statistically significant associations between sarcopenia, defined in terms of muscle mass and sarcopenic obesity, with metabolic syndrome (Lee et al., 2016). However, little is known about the gender difference in the relationship between lower muscle mass and metabolic risk factors in the middle- and old-aged Taiwanese populations.

We therefore aim in the following pages to determine whether there was a higher risk of MetS and any gender difference when lower muscle mass is compared to middle and higher muscle mass. Additionally, if there was gender difference, we might evaluate which sex should be more aware of their body composition and muscle mass loss problem, and discuss the possibilities of the reasons.

2. Materials and methods

2.1. Study design and population

The present study was a cross-sectional and observational study based on a health survey conducted by Linkou Chang Gung Memorial Hospital in 2014. The 400 participants were 50–90 year-olds randomly selected from the residents of Guishan district, Taoyuan City, Taiwan. The subjects completed our health questionnaires, body composition analysis, and laboratory tests. Subjects who did not undergo bioelectrical impedance analysis (BIA) and with incomplete data were excluded (n = 6). Finally, a total of 394 subjects (138 males and 256 females) were included in our analysis. This study was approved by the institutional review board (IRB) of the study hospital and written informed consent was given by all the participants before enrollment.

2.2. Parameter measurements

The contents of the health survey included questionnaires of age, marital status (currently married or not), living status (living alone or not), exercise times (exercising ≥3 times/week or not), food intake (eating fruits or vegetables ≥3 times/week or not), alcohol intake (drinking ≥2 days/week or not), and smoking status (current smoker or not). The health survey also contained the measurements of waist circumference (WC), and blood pressure. Body weight and height were measured with the subjects dressed in light clothing and barefoot. Body mass index (BMI) was calculated as an individual's body weight (kg) divided by their height squared (m^2). Waist circumference was taken midway between the inferior margin of the last rib and the crest of the ilium in the horizontal plane whilst in an upright position. Resting systolic and diastolic blood pressures were measured at least two times. Body composition was analyzed using an 8-contact electrode bioelectrical impedance analysis (BIA) device (Tanita BC-418, Tokyo, Japan), which was used to measure participants' appendicular skeletal muscle mass (ASM) and total body fat mass (kg). The participants stood upright with their arms abducted apart from their trunk and legs slightly spread. ASM was calculated as the sum of muscle mass estimated individually for two arms and two legs. For biochemistry laboratory examinations, values were analyzed in the central laboratory of Linkou Chang Gung Memorial Hospital, including fasting blood glucose (FBG), serum total cholesterol, low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C), triglycerides (TG), and homeostatic model assessment of insulin resistance (HOMA-IR) levels.

2.3. Definition of lower muscle mass

Appendicular skeletal muscle mass (ASM) was measured by an 8-contact electrode bioelectrical impedance analysis (BIA) device. According to a previous study, ASM divided by weight (ASM/Wt) was more closely associated with MetS (Lim et al., 2010). Thus, we used ASM divided by weight (ASM/Wt) for evaluating lower muscle mass status. Participants were divided into three groups according to ASM/Wt ratio and people distributed into the lower ASM/Wt tertile were defined as people having lower muscle mass. The same applied to the middle and higher tertiles. For males, the lower, middle, and higher ASM/Wt tertiles each had 46 participants. For females, 86 participants were in the lower ASM/Wt tertile, and 85 participants were in the middle and higher ASM/Wt tertiles.

2.4. Definition of MetS

Based on the Third Adult Treatment Panel (ATP III) Asian diagnostic criteria of the National Cholesterol Education Program (NCEP) (2002); Grundy et al., 2005; Tan, Ma, Wai, Chew, & Tai, 2004), the diagnosis of metabolic syndrome in our study was defined as a subject presenting at least 3 of the 5 following factors: (1) abdominal obesity (abdominal waist circumference > 90 cm in men or > 80 cm in women); (2) high serum triglycerides (serum TG ≥150 mg/dL or under treatment); (3) decreased serum high-density lipoproteins cholesterol (serum HDL-C < 40 mg/dL in men and < 50 mg/dL in women or under treatment); (4) high blood pressure (a systolic blood pressure ≥130 mmHg and/or diastolic pressure ≥85 mmHg, under treatment, or already diagnosed with hypertension); (5) hyperglycemia (FBG ≥100 mg/dL, under treatment, or previously diagnosed with diabetes mellitus).

2.5. Statistical analysis

We used SPSS version 19.0 (SPSS Inc., Chicago, IL) to perform the statistical analysis. The data were presented as n (%) for categorical variables and mean ± standard deviation (SD) for continuous variables. The categorical variables, including marital status (currently unmarried or not), living status (living alone or not), eating habits (vegetarian or not), exercise times (exercising ≥3 times/week or not), food intake (eating fruits or vegetables ≥3 times/week or not), alcohol intake (drinking ≥2 days/week or not), smoking status (current smoker or not) and MetS (meeting the criteria or not), were compared using Chi-square or Fisher's exact test. The continuous variables, including age, waist circumference, BMI, ASM, ASM/Wt, total body fat mass, total body fat percentage, SBP, DBP, FBG, serum total cholesterol, LDL-C, HDL-C, TG, and HOMA-IR levels, were compared using the independent t-test or one-way ANOVA. Linear trend test was applied to identify the association of ASM/Wt with the prevalence of metabolic syndrome. In addition, a binary logistic regression model was performed to evaluate the association of muscle mass defined by ASM/Wt with metabolic syndrome after adjusting for age, regular exercise ≥3 times/week, current smoker, alcohol intake ≥2 days/week, eating fruits or vegetables ≥3 times/week, FBG, HDL-C, TG, SBP, DBP, and HOMA-IR. In our study, a p-value < 0.05 was considered statistically significant.