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Association of platelet count with sarcopenic obesity in postmenopausal women: A nationwide population-based study

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ABSTRACT

Objectives: The aim of this study was to examine the relationship between platelet count and sarcopenic obesity in postmenopausal women.
Method: This cross-sectional study was conducted using nationally representative data. A total of 2810 postmenopausal women who participated in the 2008–2011 Korea National Health and Nutrition Examination Survey were included in this study. Sarcopenic obesity was defined by a sarcopenia criterion and an obesity criterion. Platelet counts were divided into quartiles as follows: Q, 150–222; Q2, 223–257; Q3, 258–294, and Q4, 295–450 (10^3/μl). Multiple logistic regression analysis was performed to examine the association between platelet count quartile and sarcopenic obesity after adjusting for confounding factors.
Results: The prevalence of sarcopenic obesity in postmenopausal women was 14.8%. Compared to the lowest platelet quartile, the odds ratios and 95% confidence intervals for sarcopenic obesity in the highest quartile were 1.98 (1.36–2.89) in the unadjusted model; 1.93 (1.31–2.83) after adjusting for age; and 1.65 (1.23–2.65) after adjusting for age, systolic blood pressure, homeostatic model assessment insulin resistance (HOMA-IR), triglyceride, total cholesterol, total calorie intake, regular exercise, current smoking status, and education level.
Conclusions: Elevated platelet count (i.e. towards the upper end of the normal range) was significantly associated with sarcopenic obesity in postmenopausal women.

1. Introduction

The older population is increasing rapidly worldwide [1]. According to the World Population Prospects (2017 Revision), life expectancy at birth is expected to increase from 71 years in 2010 to 77 years in 2050. Moreover, approximately 49.6% of the world's population is female [2]. Physiologically, aging is associated with progressive accumulation of molecular and cellular damage [3]. With aging, quantitative changes in body composition occur, including decreased skeletal muscle mass (sarcopenia) and an accompanying increase in fat mass [4]. Low muscle mass with excess adipose tissue is defined as sarcopenic obesity [5]. Sarcopenic obesity can lead to increased metabolic risk due to two different pathologic conditions [5]. Emerging evidence indicates that sarcopenic obesity contributes to a wide range of health problems, including cardiovascular disease, metabolic syndrome, insulin resistance, and mortality [5].

The pathophysiology of sarcopenic obesity is complex and interrelated with other factors. Hormonal changes, sedentary behavior, and inadequate nutrition could interact with and accelerate sarcopenic obesity [6]. Some studies have concluded that women tend to have significant muscle weakness around the time of menopause [7]. The decreased estrogen levels associated with menopause have also been proposed to be associated with the decline of muscle mass and the increase of total body fat [8]. Chronic inflammation and insulin resistance have been also proposed as important risk factors for sarcopenic obesity [5].

Recently, platelets have been shown to have a role in inflammation in addition to their classic role in hemostasis [9]. Jesri et al. [10] reported that people with metabolic syndrome had higher platelet counts, while Samocha et al. [11] demonstrated a significant association between platelet count, obesity, and chronic inflammation in women. In light of these findings, we hypothesized that platelet count is positively associated with sarcopenic obesity.

Based on previous studies [8,12], postmenopausal women have a higher risk of being diagnosed with sarcopenic obesity. In addition, women spend approximately 30 years in the postmenopausal state

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during their lifetime and the number of postmenopausal women is increasing rapidly [2,12].

Considering the adverse effect of sarcopenic obesity on the health of postmenopausal women, early detection and prevention of sarcopenic obesity is important. One potential way to achieve these goals is by identifying possible risk factors. Therefore, the aim of our study was to investigate the relationship between platelet count and sarcopenic obesity in postmenopausal women.

2. Methods

2.1. Study population

This study was conducted using data from the 2008–2011 Korea National Health and Nutrition Examination Survey (KNHANES). The KNHANES aimed to assess the health and nutritional status of the noninstitutionalized Korean population and adopted a stratified multistage probability sampling design [13]. The KNHANES has been conducted since 1998; some survey items have changed partially over the years. Between July 2008 and May 2011, body composition was assessed using whole body dual energy X-ray absorptiometry (DXA) (QDR 4500A; Hologic Inc., Bedford, MA, USA). Health interviews and health examinations were performed in equipped mobile examination centers by trained medical staff.

We included 4812 postmenopausal women who underwent DXA during the 2008–2011 KNHANES. Menopause status was determined by a self-reported questionnaire, excluding women who did not respond to the above questions.

We excluded women who received hormone therapy and women who had missing data for one of the following items: blood samples, anthropometric variables, and health questionnaires. We also excluded women with a platelet count $< 150 * 10^3/\mu l$ or $> 450 * 10^3/\mu l$, both of which are outside the normal range. A total of 2810 postmenopausal women were included in the final analysis. The Institutional Review Board of the Korea Centers for Disease Control and Prevention (KCDC) approved this study. Informed consent was also obtained from all survey participants before the survey.

2.2. Covariates

Body mass index (BMI) was calculated as the ratio of weight (kg) to height squared (m^2). Height was measured to the nearest 0.1 cm with the participant standing erect using a stadiometer (Seca 225, Seca, Germany, max 230 cm). Body mass was measured to the nearest 0.1 kg using digital scales (GL-6000-20, G-tech, Korea, max 200 kg) with the participant wearing only a light gown and standing barefoot. Household income was calculated as normalized income (total household income divided by the square root of the number of household members) and classified into quartiles. For the level of education, each participant recorded the final level at which her education had been completed. Four education levels were used: completion of elementary school, middle school, high school, and college. Blood pressure (BP) was measured on the right arm using a standard mercury sphygmomanometer (Baumanometer; Baum, Copiague, NY, USA). After fasting since midnight, blood samples were obtained from the antecubital vein. Fasting plasma glucose, triglyceride, and high-density lipoprotein (HDL) cholesterol levels were measured using a chemistry analyzer (Hitachi Co., Tokyo, Japan). Fasting serum insulin was measured by an immunoradiometric assay (1470 WIZARD gamma counter, PerkinElmer, Finland). The homeostasis model assessment estimate of insulin resistance (HOMA-IR) was calculated using the following formula: fasting plasma glucose (mmol/l) × fasting insulin (IU/ml) / 22.5. Information about dietary intake was collected by the 24 h recall method performed by trained dietitians. Daily calorie intake was calculated with Can-Pro 2.0, a nutrient intake assessment software program developed by the Korean Nutrition Society [14]. Physical activity was measured by the International Physical Activity Questionnaire (IPAQ). Regular exercise was defined as performing at least 20 min of vigorous intensity physical activity at least three days a week or at least 30 min of moderate intensity physical activity and/or walking at least five days a week. A current smoker was defined as an individual who was currently smoking and who had smoked > 100 cigarettes during her lifetime. Alcohol ingestion was defined as consuming > 5 glasses and consuming alcohol > 2–3 times per week.

2.3. Measurement of body composition and definition of sarcopenic obesity

Body composition was determined by DXA scanning. The scanners were located in the mobile examination centers and were regularly calibrated through an internal surveillance system, which periodically measured bone and soft tissue equivalent reference standards during patient examinations. Bone mineral content (BMC, g), bone mineral density (BMD, g/cm^2), fat mass (g), lean body mass (g), and total fat percentage (fat mass/total mass × 100) were recorded during the survey. Body composition data were collected from the following predefined anatomical regions: head, arms, legs, trunk, pelvic region, and whole body. Appendicular skeletal mass (ASM) was defined as the sum of the arm and leg muscle masses. The ASM-adjusted BMI was used to determine the cut-off value for sarcopenia according to the new Foundation for the National Institutes of Health (FNIH) Sarcopenia Project criteria [15]. Specifically, the cut-off value for sarcopenia was an ASM-adjusted BMI < 0.512 for women. Excess body fat was defined as the upper two quintiles of the total fat percentage (%) [16]. A person who met the two following criteria was defined as having sarcopenic obesity: 1) ASM/BMI < 0.512; and 2) total body fat in the upper two total body fat quintiles (%).

2.4. Statistical analysis

All statistical analyses in this study were performed using sample weights assigned to sample participants. Detailed information regarding the survey's sampling design has been summarized previously [13]. Data are presented as means ± standard errors (SEs) or percentages ± SEs. Participants were categorized into quartiles based on platelet count as follows: Q, 150–222; Q2, 223–257; Q3, 258–294; and Q4, 295–450 ($10^3/\mu l$). Differences between platelet count quartiles were analyzed using weighted one-way analysis of variance (ANOVA) for continuous variables and the weighted Chi-square test for categorical variables. To identify factors significantly associated with sarcopenic obesity, a univariate analysis was performed. All variables that were closely associated with sarcopenic obesity were entered into a multivariate model.

Multiple logistic regression analysis was conducted to evaluate the association between platelet count quartile and sarcopenic obesity in postmenopausal women after adjusting for confounding factors. The odds ratios (ORs) and 95% confidence intervals (CIs) were calculated after adjusting for age in model 1 and after additionally adjusting for SBP, HOMA-IR, triglyceride, total cholesterol, total calorie intake, regular exercise, current smoking status, and education level in model 2. All analyses were performed using SPSS statistical software, version 23.0 (SPSS version 23.0; IBM Corp., Armonk, NY, USA). Statistical significance was set at $P < 0.05$.

3. Results

Table 1 presents the general characteristics of the study population according to the presence of sarcopenic obesity. In total, 2810 postmenopausal women (mean age, 62.0 ± 0.3 years) were included in this study. The mean ASM (kg) and total body fat percentage (%) were 14.0 ± 0.1 (kg) and 34.5 ± 0.2 (%), respectively. Participants with sarcopenic obesity were significantly older and had significantly greater BMI, total body fat (%), SBP, HOMA-IR, total cholesterol, and