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Association between leukocyte count and sarcopenia in postmenopausal women: The Korean National Health and Nutrition Examination Survey

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ABSTRACT

Objective: To investigate the association between leukocyte counts and sarcopenia according in postmenopausal women.
Study design: Cross-sectional study.
Main outcome and measures: We examined the relationship between leukocyte counts and sarcopenia in 2152 post-menopausal Korean women who participated in the 2010–2011 Korean National Health Examination and Nutrition Survey. Sarcopenia was defined as an appendicular skeletal muscle mass (ASM) divided by weight (%) that was greater than 1 SD below the mean of young adults. The odds ratios (ORs) for sarcopenia were calculated using multiple logistic regression across leukocyte count quartiles (Q1: ≤4710, Q2:4720–5600, Q3:5610–6600, and Q4: ≥6610 cells/μL) after adjusting for confounding variables.
Results: The prevalence of sarcopenia gradually increased in accordance with leukocyte quartiles. Compared with the lowest quartile of leukocyte counts, the corresponding OR (95% CI) of the highest quartile of leukocyte counts for sarcopenia was 2.41 (1.12–5.22) after adjusting for age, waist circumference, cigarette smoking, alcohol intake, regular exercise, blood pressure, fasting plasma glucose, triglyceride, and HDL-cholesterol.
Conclusions: Leukocyte counts were positively related to a higher risk of sarcopenia in postmenopausal women.

1. Introduction

The term sarcopenia, derived from the Greek for 'poverty of flesh', was first introduced in 1989 by Rosenberg to describe age-related involuntary loss of muscle mass [1].

In women, sarcopenia usually develops during the menopausal period, and is highly prevalent in postmenopausal women [2,3], leading to functional restrictions and physical disability, fractures, and premature mortality [4,5]. Thus, the early identification of postmenopausal women with sarcopenia is considered to be important from a public health perspective.

Multifactorial mechanisms may be interrelated in the development of sarcopenia in postmenopausal women. In addition to age, physical inactivity, and nutritional factors, the decline in estrogen levels in postmenopausal women has detrimental effects on skeletal muscle mass and strength [6]. More recently, higher levels of inflammatory cytokines have also been a focus of research on the development of sarcopenia [7,8].

The leukocyte count is broadly recognized worldwide as measure of inflammation. It is a simple, fast, and reasonable prognostic marker of inflammation used in standard clinical practice. Recently, the leukocyte count, in addition to its value as a marker of infection or inflammation, has become a useful predictor of certain diseases. Higher leukocyte counts, even within the normal range, have been associated with cardiovascular disease (CVD), type 2 diabetes, and metabolic syndrome [9,10].

In light of these findings, we would expect a positive association between inflammatory markers and sarcopenia in postmenopausal women. Thus, we examined the associations between the leukocyte count and sarcopenia in a representative sample of postmenopausal Korean women.

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Table 1
Clinical characteristics of the study population leukocyte count quartiles.[a]

	Leukocyte count quartiles (cells/μL)					*P* value[b]
	Total	*Q*1(≤4710)	*Q*2(4720–5600)	*Q*3(5610–6600)	*Q*4(≥6610)	
n	2152	534	539	538	541	
Age (years)	60.2 (0.4)	58.8 (0.5)	59.0 (0.7)	60.3 (0.7)	62.5 (0.8)	<0.001
Body mass index (kg/m^2)	24.1 (0.1)	24.0 (0.2)	24.3 (0.2)	24.6 (0.2)	24.4 (0.3)	<0.001
Waist circumference (cm)	81.9 (0.3)	80.1 (0.5)	81.3 (0.5)	82.6 (0.4)	83.9 (0.5)	<0.001
ASM (kg)	14.0 (0.1)	14.2 (0.1)	14.2 (0.1)	14.0 (0.1)	13.7 (0.1)	0.011
ASM/Wt (%)	24.6 (0.1)	25.2 (0.2)	24.7 (0.2)	24.3 (0.1)	24.0 (0.2)	<0.001
Total body fat mass (kg)	20.1 (0.2)	19.2 (0.3)	20.1 (0.3)	20.6 (0.3)	20.6 (0.3)	0.001
Systolic blood pressure (mmHg)	126.9 (0.6)	122.8 (1.5)	122.6 (14)	122.7(1.2)	124.0 (1.2)	0.838
Diastolic blood pressure (mmHg)	80.9 (0.5)	80.4 (1.0)	81.2 (1.2)	80.0 (0.9)	82.1 (0.8)	0.364
Fasting plasma glucose (mg/dl)	99.0 (0.5)	95.3 (0.9)	96.4 (0.7)	100.1 (1.0)	104.0 (1.5)	<0.001
Total cholesterol (mg/dl)	200.0 (0.9)	196.3 (2.0)	199.8 (1.8)	201.5 (1.8)	202.4 (1.7)	0.120
Triglyceride (mg/dl)	132.8 (2.1)	105.3 (3.3)	132.3 (4.7)	135.7 (4.2)	156.4 (4.6)	<0.001
HDL-cholesterol (mg/dl)	53.5 (0.4)	56.0 (0.9)	54.8 (0.8)	52.7 (0.6)	51.7 (0.7)	0.001
HOMA-IR	2.6 (0.1)	2.2 (0.1)	2.4 (0.1)	2.9 (0.1)	3.1 (0.1)	<0.001
Current smoking (%)	45.7 (1.8)	42.5(3.7)	40.8 (3.6)	52.9 (3.8)	46.3 (3.5)	0.073
Alcohol drinking (%)	72.5 (1.9)	66.7 (4.2)	71.1(3.9)	72.2 (3.8)	79.7 (2.9)	0.036
Regular exercise (%)	57.1 (1.8)	61.3 (3.9)	56.0 (4.2)	58.2 (4.0)	52.7 (4.2)	0.524
Diabetes mellitus	10.2 (0.8)	7.9 (1.6)	6.7 (1.1)	9.1 (1.3)	16.9 (2.1)	<0.001
Hypertension	36.0 (1.4)	27.5 (2.3)	28.2 (2.5)	43.6 (2.4)	44.3 (2.7)	<0.001
Stroke	2.3 (0.3)	2.0 (0.6)	1.4 (0.4)	2.7 (0.7)	3.0 (0.8)	0.886
Coronalry heart disease	4.5 (0.5)	6.4 (1.2)	3.8 (0.9)	3.7 (0.9)	4.2 (0.9)	0.187

Abbreviations: ASM, appendicular skeletal muscle mass; ASM/WT, ASM divided by weight; HOMA-IR, homeostasis model assessment estimate of insulin resistance.
[a] Data are expressed as the mean (SE) or percentage.
[b] *P*-values were calculated using 1-way ANOVA test or chi-square test.

2. Methods

2.1. Study population

This study was based on data obtained from the 2010 to 2011 Korean National Health Examination and Nutrition Survey (KNHANES); a cross-sectional and nationally-representative survey conducted by the Korean Ministry of Health and Welfare. The sampling units were households selected through a stratified, multistage, probability-sampling design based on geographic area, sex and age group, using household registries. Sampling weights indicating the probability of being sampled were assigned to each participant, thus producing results that represent the entire Korean population. Participants completed four parts of a questionnaire that consisted of a Health Interview Survey, a Health Behavior Survey, a Health Examination Survey and a Nutrition Survey. At the time of the 2010–2011 KNHANES, citizens were informed that they had been randomly selected as a household to voluntarily participate in the nationally representative survey conducted by the Korean Ministry of Health and Welfare, and that they had the right to refuse to participate in accordance with the National Health Enhancement Act supported by the National Statistics Law of Korea. The participants provided written informed consent to participate in the study. The Korea Centers for Disease Control and Prevention obtained participants consent to use blood samples for additional academic purposes. The health examinations included a medical history, a physical examination, a questionnaire about health-related behaviors, and anthropometric and biochemical measurements. Physical examinations were performed by trained medical staff following standardized procedures. Menopause was defined by amenorrhea for 12 consecutive months, in the absence of a clear biological or physiological cause ($n = 2728$). We excluded women with the following medical conditions: a previous history of hysterectomy, oophorectomy, hormone replacement therapy, cancer, chronic kidney disease, chronic liver disease, rheumatologic disease, coronary artery disease, or cerebrovascular diseases ($n = 576$). After these exclusions, 2152 post-menopausal women were included in our final analysis. KNHANES was approved by the Institutional Review Board of the Korea Centers for Disease Control and Prevention (IRB No. 2010-02CON-21-C, 2011-02CON-06-C).

2.2. Data collection

Height was measured to the nearest 0.1 cm with a measuring rod attached to a balanced beam scale (Seca 225, Seca, Germany) using a Frankfurt horizontal plane with subjects standing as straight as possible and inhaling deeply. Body weight was measured with the subject wearing light indoor clothing without shoes using a digital electronic scale after adjusting the scale to zero before the subject stepped on the scale (GL-6000-20, G-tech, Korea). Body mass index (BMI) was calculated as the ratio of weight (kg) to height^2 (m^2). Participants were asked about lifestyle behaviors, including cigarette smoking and alcohol consumption. Smoking status was categorized as current smoker (a person who smokes cigarettes daily) and not-current smoker (a person who has never smoked or who smoked in the past but who does not currently smoke cigarettes). Alcohol consumption was assigned to two categories based on how often participants consumed any type of alcohol, namely, current drinker (a person who drinks alcohol, even once a month) and not-current drinker (a person who drinks less than once a month). Subjects completed the International Physical Activity Questionnaire (IPAQ) to determine the frequency of physical activity. If participants were being treated for any disease, they were asked for data regarding their diagnosis as well as a list of medications currently being taken. Completed questionnaires were reviewed by trained staff and entered into a database. Participants were also divided into two groups, consisting of difficulty in walking and no difficulty in walking, according to their degree of physical activity.

After a 12-h overnight fast, blood samples were obtained from an antecubital vein of the study subjects. Leukocyte counts were quantified using an automated blood cell counter (ADIVA 120, Bayer, Tarrytown, NY, USA). Fasting plasma glucose, total cholesterol, triglyceride, and high-density lipoprotein (HDL)-cholesterol levels were measured using a Hitachi 700-110 chemistry analyzer (Hitachi, Tokyo, Japan). Fasting serum insulin concentrations were measured using an INS-Irma γ-counter with an immunora-