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**Original Article**

# Relative Importance of Central and Peripheral Adiposities on Cardiometabolic Variables in Females: A Japanese Population-Based Study

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## Abstract

In epidemiological studies, there is little evidence regarding the relative impact of central adiposity and peripheral adiposity on cardiometabolic risk factors, especially in Asian populations. This study investigated associations between central-to-peripheral fat ratios and cardiometabolic variables using data from a population-based study of Japanese women. The source population was composed of 1800 women aged 50 yr or older at the 15th- to 16th-yr follow-up survey of the Japanese Population-Based Osteoporosis Cohort Study. This study analyzed cross-sectional data from 998 women for whom complete information about body fat variables according to dual-energy X-ray absorptiometry, cardiometabolic variables, and potential confounding factors was available. Both before and after adjusting for potential confounding factors, trunk-to-appendicular fat ratios showed significant ($p < 0.05$) correlations with brachial–ankle pulse wave velocity, serum lipids, and hemoglobin A1c levels. Relationships between fat ratios and cardiometabolic variables were independent of relationships between fat volumes (in whole body or in trunk) and cardiometabolic variables. Furthermore, relationships between trunk-to-appendicular fat ratios and cardiometabolic variables were observed among women in the lowest tertile of total body fat (brachial–ankle pulse wave velocity, $\beta = 0.08$; high-density lipoprotein cholesterol, $\beta = -0.32$; low-density lipoprotein cholesterol, $\beta = 0.15$; and hemoglobin A1C, $\beta = 0.16$; $p < 0.05$, respectively). Central adiposity is more related to cardiometabolic variables than peripheral adiposity. Information on central-to-peripheral fat ratios is particularly valuable for the evaluation of relatively thin Japanese women.

**Key Words:** Body fat distribution; densitometry; epidemiology; risk factors.

## Introduction

Central obesity has been reported to better predict cardiometabolic disease than general obesity *(1–4)*. In most epidemiological studies, central fat deposition has been estimated via simple measures, such as waist circumference

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(1–4). Waist circumference, however, is an indirect index of abdominal obesity, measuring both lean and adipose tissue. Dual-energy X-ray absorptiometry (DXA) is a non-invasive technique that directly determines fat mass (FM) volume for either the whole body or regions such as the arms, legs, and trunk (5). The majority of studies have used DXA as a criterion to assess the accuracy of other body FM measurements (6). DXA enables the accurate evaluation of FM deposition, and is particularly useful for examining relationships between central adiposity and cardiovascular disease (7).

Few studies, however, have investigated the contributions of central and peripheral FM volumes independently of each other. Individuals with high central FM volumes also have high peripheral FM volumes (8). The strong correlations between central FM and peripheral FM (8) interfere with the assessment of the individual impact of each region's FM. On the other hand, studying fat distribution patterns is informative for assessing the relative importance of central and peripheral FM. The pattern of fat distribution can be expressed as the ratio between central and peripheral adiposities. Most previous studies of fat distribution and disease have relied on indirect anthropometric measures such as the waist-to-hip ratio (9–11). There are limited numbers of studies focused on DXA-derived measures of regional fat distribution patterns and cardiometabolic risk (12–16). Studies from European (12,13,15) and North American populations (14,16) have reported associations between cardiometabolic risk and fat distribution.

The disease risks associated with obesity differ among different ethnicities. Asians have an elevated risk of cardiometabolic disease at a lower body mass index (BMI), as compared with Caucasians (17–19). Greater central-to-peripheral FM ratios have also been reported in women of Asian ancestry (20). There have not yet been any studies focused on the relationship between cardiometabolic risk and central-to-peripheral FM ratios measured by DXA in Asian populations, except for childhood studies (8).

The Japanese Population-Based Osteoporosis (JPOS) Cohort Study is a large-scale epidemiological study of Japanese women randomly selected from 7 areas throughout Japan (21). Here, we investigate the association between cardiometabolic risk and fat distribution, as measured by DXA, based on data from the JPOS Cohort Study after adjusting for various potential confounding factors.

## Methods

### *Study Population*

The source population was composed of 1800 women aged 50 yr or older in 4 study areas at the 15th- to 16th-yr follow-up survey of the JPOS Cohort Study, which was conducted in 2011 and 2012. At the JPOS baseline survey, 50 subjects were selected from each of the 5-yr age groups, ranging from 15 to 79 yr, in 7 study areas in Japan. Each area had 650 subjects, with a total of 4550 subjects (22). The 4 areas selected for the 15th- to 16th-yr follow-up survey were (1) Memuro Town, (2) Nishi-Aizu Town, (3) Joetsu City, and (4) Sangawa Town (Sanuki City), as previously described (22). Of the 1800 women selected, 1616 women completed the baseline study and 1063 women participated in the 15th- to 16th-yr follow-up survey (21). Of the participants in the 15th- to 16th-yr follow-up survey, the present study analyzed cross-sectional data from 998 women who provided complete information about body fat variables by DXA, cardiometabolic variables, age, caloric intake, alcohol consumption, salt intake, smoking habits, activity energy expenditure, and menopausal status. The subjects represented 55.4% of the source population. The protocol of the JPOS Cohort Study was approved by the Ethics Committee of the Kinki University School of Medicine. The study was performed in accordance with the ethical standards set forth in the Declaration of Helsinki. All participants received printed information regarding study procedures and provided written consent before enrolling in the study.

### *Body Fat Measurement*

Whole-body and regional FM volumes were measured using a single DXA scanner (QDR-4500A; Hologic Inc., Bedford, MA) in a mobile test room. The subjects wore light clothing without metal objects and lay in a supine position on the table of the densitometer. Whole-body, trunk, and appendicular (both arms and both legs) FMs were individually evaluated. Trunk FM reflects fat deposition in the overall regions of the chest, abdomen, and pelvis. Both arms, both legs, and the head were isolated from the trunk using computer-generated default lines, with manual adjustments using specific anatomical landmarks (chin, center of the glenohumeral joint, and femoral neck axis) in the anterior view planogram (5). Whole-body and regional FM volumes were evaluated using height-normalized FM indices (whole-body FM index, trunk FM index, and leg FM index), which were calculated as FM volume (in kilogram) divided by height squared (in square meter) (23,24).

### *Measurement of Blood Pressure and Estimation of Arterial Stiffness*

Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were recorded using an automated device (BP-203i; Omron Colin, Tokyo, Japan). Measurements were performed with the right arm supported at the level of the heart in a quiet, seated position, after resting for 5 min. The mean value of 2 readings was used for analysis. Brachial–ankle pulse wave velocity (baPWV) was measured using a BP-203RPE II (form PWV/ABI; Colin, Komaki, Japan) after the subjects rested in the supine position for 5 min, and the mean of the left and right values was used for analysis.

### *Other Variables*

Interviews were conducted by trained nurses using a structured questionnaire to determine menstrual history,