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## Ethnic differences in abdominal visceral fat accumulation between Japanese, African-Americans, and Caucasians: a meta-analysis

**Abstract** A meta-analysis was performed in order to test the hypothesis that Japanese have a greater amount of abdominal visceral fat (AVF) relative to abdominal subcutaneous fat (ASF) than Caucasians. Data were derived from published studies that included mean values for AVF and ASF areas, measured using computed tomography, and age for native Japanese, African-Americans, and Caucasians of both genders. Mean values from each study were used as single data points. A significant difference in AVF was observed between Japanese and Caucasian populations after adjusting for ASF, age, and sex ( $p < 0.05$ ). However, the difference in AVF between Japanese and Caucasian females was lower than that between African-American and Caucasian females.

**Key words** Abdominal visceral fat • Fat distribution • Japanese Ethnicity • Meta-analysis

### Introduction

Japanese people are known to be susceptible to type 2 diabetes mellitus, cardiovascular disease, and hypertension despite a relatively low body mass index (BMI) [1, 2]. Possible reasons for this predisposition may be a higher percentage of body fat relative to BMI compared to Caucasians [3] and/or a greater amount of abdominal visceral fat (AVF) relative to abdominal subcutaneous fat (ASF). Excess AVF is recognized as a major risk factor for the metabolic disorders. [1]. While Asians have relatively more subcutaneous fat on the trunk [4], it has been shown that Pima Indians, who are of the same origin as eastern Asians, do not have similar AVF [5]. Recently, Park et al. [6] reported that Asians living in the USA have a greater amount of AVF relative to ASF. We therefore carried out a meta-analysis of published studies on anthropometric parameters to examine native Japanese people in comparison with AVF and ASF for other ethnic groups.

### Methods

Analyzed data were derived from published studies that included information about sex, mean values of AVF and ASF measured using computed tomography at the L4–L5 level, and age for native Japanese and Caucasian and African-American women. No data were obtained for African-American men.

Papers in English and Japanese were searched using PubMed and Igaku Chuo Zasshi (Japan Centra Revuo Medicina), respectively. The key words used in the PubMed search were (intra abdominal OR visceral) AND (fat OR adipose) AND (computed OR CT OR MRI OR area), with the search being limited to human (not animal) studies and the English language. The following inclusion criteria were used for the study: (1) Stated ethnicity of the subjects in papers for Caucasians or African-Americans. Subjects in studies carried out in Japan were regarded as Japanese if no information on ethnicity was given, as it is extremely rare for

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Caucasians or African-Americans to be included in studies in Japan; (2) a study cohort of at least ten subjects with a mean age of greater than 20 years and without significant disease entities such as coronary heart disease or diabetes mellitus; (3) in intervention studies, only data prior to the intervention were used; and (4) only one data point was obtained from each study sample (for example, the HERITAGE Family Study). In the case where several means for groups were given in a study (e.g., obese vs. lean, older vs. younger), weighted mean values of AVF, ASF, and age were calculated and used in the statistical analyses. As a result, 18 data points for Caucasian females, ten for Caucasian males, seven for Japanese females, 15 for Japanese males, and seven for African-American females were entered into the meta-analysis.

Analysis of covariance (ANCOVA) with race, mean age, sex, and ASF as independent variables was used to compare AVF values adjusted for age, sex, and ASF among ethnic groups. Mean body mass index (BMI;  $\text{kg}/\text{m}^2$ ) in each study was calculated as mean body weight divided by squared mean height if mean BMI values obtained from individual measurements were not provided. Values with  $p < 0.05$  (two-tailed tests) were considered significant.

## Results

Mean AVF and ASF obtained from the selected studies are summarized in Figure 1. Mean ASF in the Japanese populations was significantly lower than in Caucasians ( $177.9 \pm 73.0$  vs.  $287.5 \pm 133.1 \text{ cm}^2$ ), while mean age in the Japanese cohorts was higher than in Caucasian groups

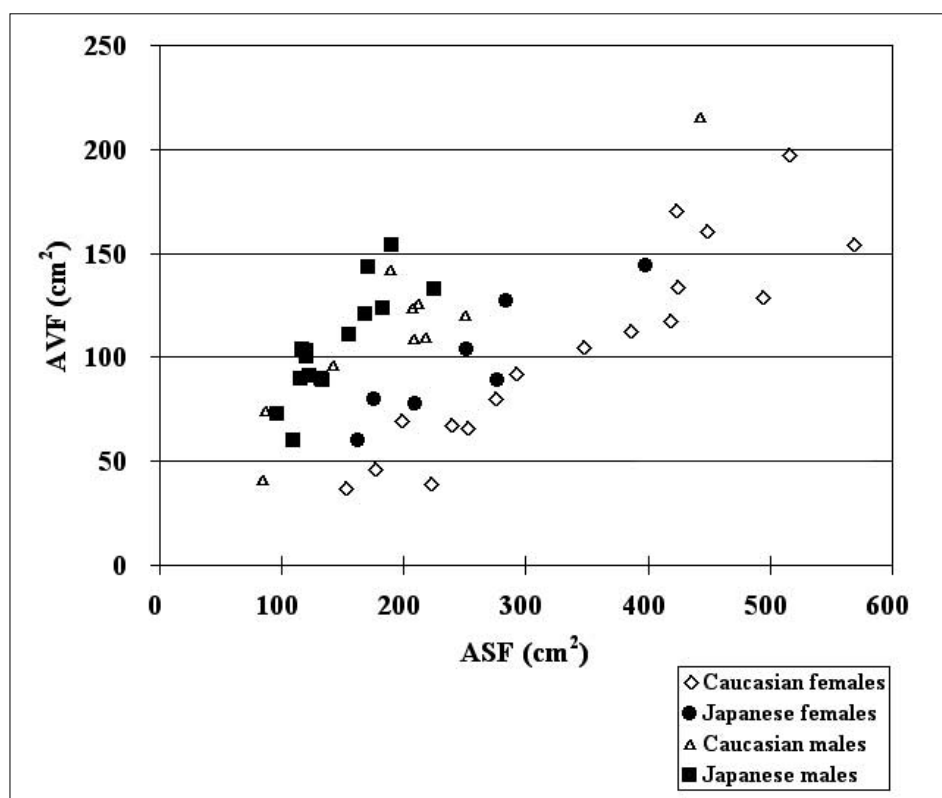
( $49.5 \pm 9.6$  vs.  $39.6 \pm 8.9$  years). Both BMI ( $26.0 \pm 2.7$  vs.  $28.7 \pm 5.1 \text{ kg}/\text{m}^2$ ) and AVF ( $103.0 \pm 26.6$  vs.  $107.3 \pm 47.0 \text{ cm}^2$ ) were similar in the Japanese and Caucasian populations, respectively. After adjusting for the effects of age, sex, and ASF using ANCOVA, a significant difference of  $15 \text{ cm}^2$  was observed for AVF between Japanese and Caucasian subjects.

The adjusted mean difference of AVF between Japanese and Caucasians was significantly lower than that between African-Americans and Caucasians ( $16 \text{ cm}^2$  vs.  $38 \text{ cm}^2$ , respectively). Thus, the ethnic difference for AVF between Japanese and Caucasian females, adjusted for ASF and age, was considerably smaller than that between African-Americans and Caucasians.

## Discussion

The present study shows that Japanese have higher AVF relative to ASF than Caucasians. This difference may explain, in part, the higher predisposition to type 2 diabetes mellitus and associated cardiovascular complications in the Japanese population.

Several studies have reported that African-American females have a lower amount of AVF than Caucasians [7], a finding that may explain the lower prevalence of metabolic disorders in African-Americans despite the occurrence of very high BMIs in this ethnic group. Comparison



**Fig. 1** Relationship between abdominal visceral fat (AVF) and abdominal subcutaneous fat (ASF) area in Japanese and Caucasian subjects

of AVF between Asians and the other ethnicities has been limited to the study of Park et al. [6], who found that Asian-Americans have a higher amount of AVF relative to ASF. While our study confirmed this finding, the adjusted differences in AVF were considerably lower than the difference between African-American and Caucasian females. It is not clear whether genetic or environmental/behavioral factors, acting, solely or in combination, contribute to the increased AVF in the Japanese population. However, as few environmental/behavioral factors have been shown to strongly affect AVF/ASF distribution [8] and results similar to those of the present study have been reported for Asians living in the USA [6], it is most probable that genetic factors are the major determinants of the marginally increased AVF in Japanese subjects. Future research on these genetic factors is therefore warranted.

In conclusion, this meta-analysis demonstrates that Japanese have a significantly greater amount of AVF compared to Caucasians after adjusting for age, sex, and ASF. However, this difference is lower than that doserved between African-American and Caucasian female subjects. This is the first study comparing AVF between Asians and Caucasians and we are unaware of any study that has investigated differences in AVF between native Japanese and Caucasians.

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