

# The Relationship between Waist Circumference and Abdominal Fat Measured by Ultrasonography in Healthy Adult Men

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**Abstract.** [Purpose] We examined the relationship between waist circumference (WC) and accumulated abdominal fat measured by ultrasonography in healthy adult men. [Subjects] The study subjects were 20 healthy men. [Methods] The measured items were maximum preperitoneal fat thickness (PFT), minimum subcutaneous fat thickness (SFT), and WC. PFT and SFT were measured by ultrasonography. Associations between PFT, SFT, and WC were evaluated using Pearson's correlation coefficients. Study subjects were divided into two groups: those with WC < 85 cm and those with WC ≥ 85 cm. This cut-off was based on Japanese reference values. These groups were then compared for differences in PFT using the independent-sample t test. [Results] There was a moderately significant correlation between PFT and WC ( $r = 0.56$ ,  $p < 0.05$ ). In contrast, there was no significant correlation between SFT and WC ( $r = 0.15$ ;  $p = 0.52$ ). Furthermore, the group with WC ≥ 85 cm had higher PFT values than the group with WC < 85 cm. [Conclusion] Our findings support the hypothesis that WC is a simple anthropometric index of intra-abdominal fat accumulation in healthy adult men.

**Key words:** Waist circumference, Intra-abdominal fat, Ultrasonography

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## INTRODUCTION

Obesity and being overweight are major public health problems. In 2008, 1.5 billion adults aged 20 years and older were overweight, of which, over 200 million men and nearly 300 million women were obese<sup>1)</sup>. Obesity and being overweight pose major risks for serious chronic diseases, including type 2 diabetes, cardiovascular disease, hypertension, stroke, and certain types of cancer. In particular, the accumulation of adipose tissue, predominantly in the abdominal cavity, plays a major role in the development of metabolic syndrome and cardiovascular disease<sup>2)</sup>. Therefore, estimating the amount of accumulated abdominal fat is important.

Currently, a computed tomography scan at the abdominal level is recognized as the standard method for determining accumulated abdominal fat<sup>3)</sup>. However, exposure to ionizing radiation, high cost, and low availability prevent the widespread use of computed tomography in clinical and epidemiologic studies. Therefore, alternative, simple, and noninvasive methods of assessing abdominal fat accumulation are being increasingly used. These methods include anthropometric indices such as waist circumference (WC) and ultrasonography<sup>4-8)</sup>.

Ultrasonography is a reliable and convenient method for quantifying the amount of abdominal fat, and a variety of ultrasonographic values have been reported as useful<sup>4-8)</sup>. However, few previous studies have considered the relationship between WC and abdominal fat accumulation

measured by ultrasonography. Therefore, we examined the relationship between WC and accumulated abdominal fat measured by ultrasonography in healthy adult men.

## METHODS

The study subjects were 20 healthy men (mean age, 30.5 ± 4.9 years). Each subject provided his informed consent to participation in this study, which was approved by the Ethics Committee of the Heisei College of Health Sciences.

The measured items were maximum preperitoneal fat thickness (PFT), minimum subcutaneous fat thickness (SFT), and WC. PFT and SFT were measured by ultrasonography using an ultrasonographic system (Famio SSA-530A; Toshiba Corp, Tokyo, Japan), as described by Suzuki et al.<sup>4)</sup>. Briefly, a subject was examined in the supine position. All images were captured immediately after inspiration to avoid the effects of respiratory status and abdominal wall tension. PFT and SFT were measured by longitudinal scanning from the xiphoid process to the umbilicus along the linea alba using an 8.0-MHz linear probe. PFT was defined as the thickness of fat tissue between the liver surface and linea alba. SFT was defined as the thickness of fat tissue between the skin fat interface and the linea alba. WC was measured at the level of the navel.

Statistical analyses were performed using SPSS software version 13.0 (SPSS Japan, Inc., Tokyo, Japan). Associations between PFT, SFT, and WC were evaluated using Pearson's correlation coefficients. Study subjects were divided into

two groups: those with WC < 85 cm and those with WC ≥ 85 cm. This cut-off was based on Japanese reference values. These groups were then compared for differences in PFT using the independent-sample t test; p values of <0.05 were considered statistically significant.

## RESULTS

The study subjects' characteristics are shown in Table 1. There was a moderately significant correlation between PFT and WC ( $r = 0.56$ ,  $p < 0.05$ ). In contrast, there was no significant correlation between SFT and WC ( $r = 0.15$ ;  $p = 0.52$ ). Furthermore, the group with WC ≥ 85 cm had higher PFT values than the group with WC < 85 cm (Table 2).

## DISCUSSION

We investigated the relationship between WC and abdominal fat in healthy adult men and found a moderately significant correlation between PFT and WC. In contrast, there was no significant correlation between SFT and WC. A previous study reported that WC could be used to estimate intra-abdominal fat accumulation<sup>9)</sup>. The simplicity, low cost, and acceptable accuracy of this index have led to its use as an indicator of cardiovascular risk in several epidemiological studies<sup>10,11)</sup>. However, WC includes skinfold thickness in addition to intra-abdominal fat, which may be a potential disadvantage. Bonora et al.<sup>12)</sup> reported that WC appeared to better quantify subcutaneous fat than visceral fat. We found that WC was significantly correlated with PFT, while it was not correlated with SFT. Ribeiro-Filho et al.<sup>6)</sup> reported that there were differences in WC, visceral fat, and subcutaneous fat between patients with visceral obesity and nonvisceral obesity. Consequently, WC and ultrasonography measures of visceral fat thickness were higher in patients with visceral obesity than in those without visceral obesity. However, there was no significant difference in subcutaneous fat. Kim et al.<sup>7)</sup> also investigated the possible relationships between visceral fat thickness measured by ultrasonography and WC. They found a relationship between visceral fat thickness and WC, but not between visceral fat thickness and SFT. The results of these previous studies support our findings.

Moreover, the group with WC ≥ 85 cm had higher PFT values than the group with WC < 85 cm. WC has been the most commonly used anthropometric parameter to identify and quantify intra-abdominal fat deposition. Our findings support the hypothesis that WC is a simple anthropometric index of intra-abdominal fat accumulation in healthy adult men.

**Table 1.** Characteristics of Subjects (n=20)

Age (yr)	30.5 ± 4.9
Waist circumference (cm)	82.2 ± 7.3
PFT (mm)	10.4 ± 5.6
SFT (mm)	6.2 ± 3.9

Values expressed as the mean ± standard deviation. PFT: maximum preperitoneal fat thickness. SFT: minimum subcutaneous fat thickness

**Table 2.** Comparisons of PFT

	WC < 85 cm (n = 12)	WC ≥ 85 cm (n = 8)
PFT (mm)	7.9 ± 4.6	14.2 ± 5.1*

Values expressed as the mean ± standard deviation. PFT : maximum preperitoneal fat thickness. WC : waist circumference. \* significant difference from the group with WC < 85 cm ( $p < 0.05$ )

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