Correlation between waist and mid-thigh circumference and cardiovascular fitness in Korean college students: a case study

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Abstract. [Purpose] We investigated whether waist and mid-thigh circumference correlated with cardiovascular fitness (VO\textsubscript{2max}) in a selected sample of Korean college students. [Subjects and Methods] The subjects were 41 college students (25 males, 16 females; age, > 19 years) who visited the sports medicine laboratory at the Korea National University of Transportation in Chungju-si, Republic of Korea, to undergo measurements of body composition, cardiovascular fitness, and waist and mid-thigh circumference. [Results] VO\textsubscript{2max} did not correlate with waist circumference or mid-thigh circumference in males, whereas VO\textsubscript{2max} was negatively correlated with mid-thigh circumference, but not waist circumference, in females. [Conclusion] Mid-thigh circumference was not associated with cardiovascular fitness or waist in male college students. However, it was associated with cardiovascular fitness in female college students. Well-designed studies are needed to investigate this further.

Key words: Cardiovascular fitness, Mid-thigh circumference, Waist circumference

INTRODUCTION

According to the 2013 Korea National Health and Nutrition Examination Survey, the prevalence of obesity was 37.6% in men and 25.1% in women aged ≥ 19 years in the Republic of Korea\textsuperscript{1).} This finding indicates that approximately one-third of Koreans are obese and that obesity is becoming a serious public, social, and national health issue in the Republic of Korea.

Obesity, particularly abdominal obesity, is strongly associated with an increased risk of cardiovascular disease, type-2 diabetes, hypertension, hyperglycemia, dyslipidemia, musculoskeletal diseases, genetic diseases, and some cancers\textsuperscript{2, 3).} Thus, it is important to prevent and treat chronic diseases, such as obesity, because the economic losses from chronic diseases are sufficient to cause social problems\textsuperscript{4, 5).}

Kim et al.\textsuperscript{6)} demonstrated that low thigh muscle mass was closely associated with diabetes and preventing chronic disease. Since that study was published, many others have reported relationships between thigh muscle mass (or fat mass) and clinical predictors, such as the homeostasis model assessment-estimated insulin resistance, triglycerides, and total cholesterol\textsuperscript{7, 8).}

A high fitness level or regular exercise is related to a low prevalence of chronic diseases, such as obesity and hypertension\textsuperscript{9–13).} In addition, low fitness is closely associated with mortality\textsuperscript{14).}

Many studies have reported that obesity, including abdominal obesity, is related to fitness level as well as chronic disease\textsuperscript{10).} Thus, in this pilot study, we investigated the relationship between waist circumference and cardiovascular fitness (VO\textsubscript{2max}). We also examined the relationship between thigh circumference and cardiovascular fitness (VO\textsubscript{2max}), because there is a reported relationship between thigh circumference and chronic disease, and fitness level is related to chronic disease.

SUBJECTS AND METHODS

Subjects

This study included 41 college students (25 males, 16 females; age, > 19 years) who visited the Sports Medicine Laboratory at the Korea National University of Transportation in Chungju-si, Republic of Korea, to undergo measurements of body composition, cardiovascular fitness, and waist and mid-thigh circumference. All participants provided informed consent, and this study conformed to the principles outlined in the Declaration of Helsinki. The study design was approved by the Institutional Review Board at the Korea National University of Transportation (KNU IRB-15).

The parameters measured included body composition (weight, percent body fat, and basal metabolic rate), cardiovascular fitness (VO\textsubscript{2max}), waist circumference, and mid-thigh circumference. The body composition instrument (InBody 720, Biospace, Seoul, Republic of Korea) measured resistance of the arms, trunk, and legs at frequencies of 1, 5,
All methods used to assess body composition followed recommendations in the book Applied Body Composition Assessment (P/N: C09073-02-99, Cosmed Cardiopulmonary Diagnostics, Rome, Italy). The body mass index (BMI, kg/m²) of each participant was calculated based on weight, height, and body composition (weight, % body fat, and basal metabolic rate). Cardiovascular fitness (VO₂max) level was determined by a graded exercise test using a treadmill (Quark Series, Chicago, IL, USA).

The subjects’ characteristics are shown in Table 1. The mean age of the males (n = 25) was 22.6 ± 1.2 years, and that of the females (n = 16) was 19.6 ± 0.5 years. The mean height of the males was 175.0 ± 4.3 cm, and that of the females was 162.2 ± 3.9 cm. The mean weight of the males was 73.2 ± 10.7 kg, and that of the females was 59.5 ± 8.1 kg. The mean VO₂max of the males was 47.7 ± 4.9 mL·kg⁻¹·min⁻¹, and that of the females was 38.4 ± 4.3 mL·kg⁻¹·min⁻¹. The mean waist circumference of the males was 85.2 ± 7.3 cm, and that of the females was 76.8 ± 6.3 cm.

Data are shown as the mean ± SD.

### Table 1. Subjects’ characteristics

| Variables            | Male (n = 25)     | Female (n = 16) | Total (n = 41) |
|----------------------|------------------|----------------|---------------|
| Age (years)          | 22.6 ± 1.2       | 19.6 ± 0.5     | 21.4 ± 1.7    |
| Height (cm)          | 175.0 ± 4.3      | 162.2 ± 3.9    | 170.0 ± 7.5   |
| Weight (kg)          | 73.2 ± 10.7      | 59.5 ± 8.1     | 67.8 ± 11.8   |
| Body mass index (kg/m²) | 23.9 ± 3.1       | 22.6 ± 2.7     | 23.4 ± 3.0    |
| Body fat (%)         | 16.9 ± 5.5       | 27.9 ± 5.2     | 21.2 ± 7.6    |
| Basal metabolic rate (kcal) | 1,683.9 ± 158.2  | 1,288.1 ± 85.4 | 1,529.4 ± 236.6 |
| VO₂max (ml/kg/min)   | 47.7 ± 4.9       | 38.4 ± 4.3     | 44.1 ± 6.5    |
| Waist circumference (cm) | 85.2 ± 7.3       | 76.8 ± 6.3     | 81.9 ± 8.0    |
| Mid-thigh circumference (cm) | 59.4 ± 6.2       | 52.8 ± 4.7     | 56.5 ± 6.2    |

### Table 2. Results of Spearman’s correlation analysis for associations between waist and mid-thigh circumference and VO₂max

| Variables                | Male (n = 25) | Female (n = 16) |
|--------------------------|---------------|-----------------|
| Waist circumference (cm) | 0.237         | −0.185          |
| Mid-thigh circumference (cm) | 0.189       | −0.572*         |

*p < 0.05, as determined by Spearman’s correlation analysis.

RESULTS

The results of Spearman’s correlation analysis for associations between waist circumference and VO₂max and between mid-thigh circumference and VO₂max are shown in Table 2. VO₂max in males did not correlate with waist circumference (r = 0.237, p = 0.254) or mid-thigh circumference (r = 0.189, p = 0.367). VO₂max in females did not correlate with waist circumference (r = −0.185, p = 0.492), but it did correlate negatively with mid-thigh circumference (r = −0.572, p = 0.021).
The purpose of this study was to examine the relationships between waist and mid-thigh circumference and cardiovascular fitness in Korean college students. The results show that cardiovascular fitness was only associated with thigh circumference in female students.

Many studies have reported that a large waist circumference and obesity are related to low fitness levels. However, this trend is prevalent in obese and elderly subjects due to aging. This finding suggests that a large waist circumference is related to low fitness levels in subjects in poor physical condition. We found no relationship between waist circumference and fitness level in young college students, indicating that total fat mass, rather than waist circumference, is related to fitness level.

Moreover, previous studies have demonstrated that low thigh muscle mass is related to chronic disease in obese subjects. Nevertheless, we found no relationship between thigh circumference and fitness level in male college students with a relatively high fitness level. Interestingly, a small thigh circumference was correlated with a high fitness level in the female students, suggesting that a large thigh circumference in female college students reflects fat mass rather than muscle mass. Thus, a large thigh circumference may be related to a high fat mass, resulting in a low fitness level. Various authors have suggested that VO_{2\text{max}} is associated with the incidence of lifestyle-related diseases, all-cause mortality, and continued ability to perform aerobic activity; thus, it is important to maintain a healthy physical condition to improve fitness. Well-designed studies are necessary to study these factors.

This study had some limitations. Because the participants were recruited from one university in Chungju-si, Republic of Korea, they do not represent all Korean college students. Furthermore, we only evaluated a small number of students (n = 41); thus, the results may be unreliable. Moreover, because mid-thigh circumference is not completely representative of the level of thigh muscle mass (or fat mass), it lacks validation. Nevertheless, the major strength of this study was that it focused on determining if waist or mid-thigh circumference was correlated with cardiovascular fitness, which was investigated for the first time in Korea in this pilot study.

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