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). 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). 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.

Kim et al. 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.

A high fitness level or regular exercise is related to a low prevalence of chronic diseases, such as obesity and hypertension). In addition, low fitness is closely associated with mortality.

Many studies have reported that obesity, including abdominal obesity, is related to fitness level as well as chronic disease. 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 (KNUT 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,
Assessment recommendations in the book

All methods used to assess body composition followed could interrupt the electronic current during measurements. The participants were advised to wear light clothing and remove all metal items that might interfere with the impedance measurements. The participants were told to consume a balanced diet and avoid strenuous exercise for at least 4 hours before the impedance measurements. The participants were also asked to drink at least 2 liters of water per day. All participants were prohibited from consuming caffeine or alcohol 12 hours before the tests.

The cardiovascular fitness (VO2max) level was determined by a graded exercise test using a treadmill (Quark Series, P/N: C09073-02-99, Cosmed Cardiopulmonary Diagnostics, Rome, Italy). Maximum oxygen consumption, VO2max, was estimated by a graded exercise test using a treadmill (Quark Series, Cosmed Cardiopulmonary Diagnostics, Rome, Italy). Maximum oxygen consumption was estimated to the nearest 0.5 cm; at the end of a normal expiration.

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Table 1. Subjects’ characteristics

<table>
<thead>
<tr>
<th>Variables</th>
<th>Male (n = 25)</th>
<th>Female (n = 16)</th>
<th>Total (n = 41)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>22.6±1.2</td>
<td>19.6±0.5</td>
<td>21.4±1.7</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>175.0±4.3</td>
<td>162.2±3.9</td>
<td>170.0±7.5</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>73.2±10.7</td>
<td>59.5±8.1</td>
<td>67.8±11.8</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>23.9±3.1</td>
<td>22.6±2.7</td>
<td>23.4±3.0</td>
</tr>
<tr>
<td>Body fat (%)</td>
<td>16.9±5.5</td>
<td>27.9±5.2</td>
<td>21.2±7.6</td>
</tr>
<tr>
<td>Basal metabolic rate (kcal)</td>
<td>1,683.9±158.2</td>
<td>1,288.1±85.4</td>
<td>1,529.4±236.6</td>
</tr>
<tr>
<td>VO2 max (ml/kg/min)</td>
<td>47.7±4.9</td>
<td>38.4±4.3</td>
<td>44.1±6.5</td>
</tr>
<tr>
<td>Waist circumference (cm)</td>
<td>85.2±7.3</td>
<td>76.8±6.3</td>
<td>81.9±8.0</td>
</tr>
<tr>
<td>Mid-thigh circumference (cm)</td>
<td>59.4±6.2</td>
<td>52.8±4.7</td>
<td>56.5±6.2</td>
</tr>
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Data are shown as the mean ± SD.

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

<table>
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<th>Variables</th>
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<td>Waist circumference (cm)</td>
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*p < 0.05, as determined by Spearman’s correlation analysis

50, 256, 512, and 1,024 kHz through eight tactile electrodes: two in contact with the palm and thumb of each hand and two in contact with the anterior and posterior aspects of the sole of each foot15. All participants were prohibited from eating 4 h before, exercising 2 h before, and urinating just before the impedance measurements. The participants were told to wear light clothing and remove all metal items that could interrupt the electronic current during measurements. All methods used to assess body composition followed recommendations in the book Applied Body Composition Assessment16. 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, P/N: C09073-02-99, Cosmed Cardiopulmonary Diagnostics, Rome, Italy). Maximum oxygen consumption, VO2max, was estimated by a graded exercise test using a treadmill (Quark Series, Cosmed Cardiopulmonary Diagnostics, Rome, Italy). Maximum oxygen consumption was estimated to the nearest 0.5 cm; at the end of a normal expiration.

Vo2max (ml/kg/min) was 47.7±4.9 in males and 38.4±4.3 in females. 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 73.2±10.7 kg, and that of the females was 59.5±8.1 kg. The mean BMI of the males was 23.9±3.1 kg/m², and that of the females was 22.6±2.7 kg/m². The mean percent body fat of the males was 16.9±5.5%, and that of the females was 22.6±2.7%. The mean basal metabolic rate of the males was 38.4±4.3 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. The mean mid-thigh circumference of the males was 59.4±6.2 cm, and that of the females was 52.8±4.7 cm.

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RESULTS

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 BMI of the males was 23.9±3.1 kg/m², and that of the females was 22.6±2.7 kg/m². The mean waist circumference of the males was 85.2±7.3 cm, and that of the females was 76.8±6.3 cm. The mean mid-thigh circumference of the males was 59.4±6.2 cm, and that of the females was 52.8±4.7 cm.

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 = 0.0185, p = 0.492), but it did correlate negatively with mid-thigh circumference (r = 0.572, p = 0.021).

Thus, the use of the nonparametric Spearman’s correlation analysis to examine the correlation between waist circumference and VO2max and between mid-thigh circumference and VO2max. A p value < 0.05 was considered to indicate statistical significance. All analyses were performed using the PASW Statistics software (ver. 18.0; SPSS Inc., Chicago, IL, USA).
Discussion

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 with 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 VO2max 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.

References