

# The Relationship Between BMI and Body Composition in Exercise-trained Men and Women

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## Abstract

**Introduction:** The notion that individuals with a low body mass index (BMI) exhibit higher body fat percentages than those with a higher BMI is popular within the fitness industry. This is often referred to as the “skinny-fat” phenotype. The purpose of this cross-sectional investigation was to examine the relationship between BMI and body composition in a group of male and female resistance- and endurance-trained individuals.

**Methods:** One hundred and fifteen exercise-trained individuals (n = 57 male, n = 58 female) were assessed for body composition via the Bod Pod<sup>®</sup>. Body weight, lean body mass, fat mass and BMI was ascertained. The relationship between BMI and body fat percentage were assessed with correlations.

**Results:** Males had statistically greater (p < 0.05) height, body weight, lean body mass, and BMI compared to females. Furthermore, males had significantly lower (p < 0.05) fat mass and body fat percentage than females. Moreover, there was a moderately positive correlation (r = 0.5069 male, p < 0.001; r = 0.5196 female, p < 0.001) between BMI and body fat percentage.

**Conclusions:** There is a moderately positive relationship between BMI and body fat percentage in strength- and endurance-trained individuals. Furthermore, individuals with a higher BMI also tended to have a greater body fat percentage.

**Key Words:** body composition, endurance, strength

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## Introduction

The notion of a “skinny-fat” phenotype stems from the idea that aerobic exercise promotes a loss of body weight with a concurrent gain in body fat percentage. Yet, there is a plethora of data showing that regular aerobic exercise results in a loss of fat mass as well as a decrement in body fat percentage. For instance, a 10-week aerobic exercise program resulted in a small decrease in energy intake and an associated decrease in percentage of body fat in obese adolescents.<sup>1</sup> Also, 12 weeks of regular aerobic exercise led to significant reductions in body weight and body fat percentage in the obese.<sup>2</sup> Thus, the purpose of this investigation was to determine the relationship between BMI and body composition in a large cohort of exercise-trained individuals.

## Methods

### Participants

A total of 115 (n = 57 male, n = 58 female) exercise-trained individuals volunteered for this cross-sectional investigation. The university's Human Subjects Institutional Review Board approved all procedures involving human subjects; this was in accordance with the Helsinki Declaration and written informed consent was obtained prior to participation.

*Protocol*

Height was measured using standard anthropometry and total body weight was measured using a calibrated scale. Body composition was assessed by whole body densitometry using air displacement via the Bod Pod® (COSMED USA, Concord CA). All testing was performed in accordance with the manufacturer's instructions. Subjects were instructed to come into the lab after a 3-hour fast and no prior exercise 24-hours prior. They voided prior to testing. Subjects were tested while wearing only tight fitting clothing (swimsuit or undergarments) and an acrylic swim cap. The subjects wore the same clothing for all testing. Thoracic gas volume was estimated for all subjects using a predictive equation integral to the Bod Pod® software. Each subject was tested at least twice. The calculated value for body density used the Siri equation to estimate body composition. Data from the Bod Pod® included body weight, % body fat, lean body mass and fat mass. The Bod Pod was calibrated the morning of the testing session as well as between each subject.

*Statistical Analysis*

Data is provided as the mean ± SD. Independent samples t-test were utilized to assess any differences between males and females. Then multiple correlation analyses were utilized to assess relationships regarding body mass index and body fat percentage in both males and females. A p ≤ 0.05 was considered statistically significant a priori and all statistics were analyzed using IBM SPSS 24.0 (version 24.0, IBM Inc, Armonk, NY).

**Results**

The 57 male subjects were comprised of the following: 12 swimmers, 9 stand-up paddlers, 4 distance runners, and 32 self-identified as resistance-trained (i.e., that were their primary exercise mode). The 58 female subjects were comprised of: 21 resistance-trained, 23 swimmers, 12 stand-up paddlers, 1 distance runner and 1 cyclist. The subjects' physical characteristics are shown in Table 1. All subjects were grouped by sex. Male subjects demonstrated significantly greater (p < 0.05) height, weight, lean body mass, and BMI than females. Also, males had significantly lower (p < 0.05) fat mass and body fat % than females. There was however no difference in age. There was a statistically significant relationship between BMI and body fat percentage for both males and females (see Figures 1 and 2). In general, as BMI increased, body fat percentage tended to increase. The correlation between BMI and body fat percentage was moderately positive.

Table 1. Physical characteristics.

	Male (n = 57)	Female (n = 58)
<b>Age</b> (years)	29.8 ± 9.7	28.0 ± 9.9
<b>Height</b> (meters)	1.8 ± 0.1*	1.7 ± 0.1
<b>Weight</b> (kg)	80.6 ± 11.0*	62.5 ± 7.6
<b>Lean Body Mass</b> (kg)	70.4 ± 15.2*	48.6 ± 5.0
<b>Fat Mass</b> (kg)	11.8 ± 5.9*	14.0 ± 4.6
<b>BMI</b>	26.0 ± 3.3*	22.6 ± 2.5
<b>Body Fat</b> (%)	14.2 ± 5.5*	21.9 ± 5.7

Data are Means ± SD

\*Indicates significantly greater than females, p < 0.05 for all.

### Relationship between BMI and Body Fat % - Men

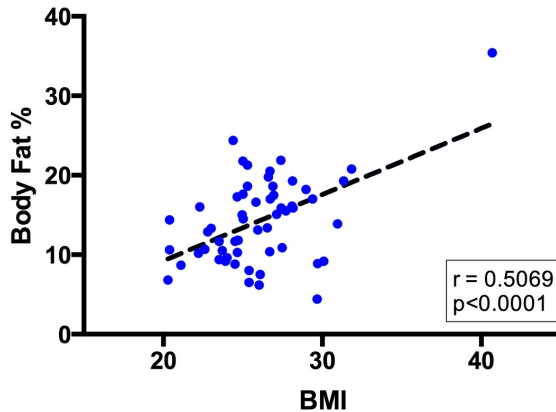


Figure 1. There was a moderately significant relationship between BMI and body fat percentage in males.

### Relationship between BMI and Body Fat % - Women

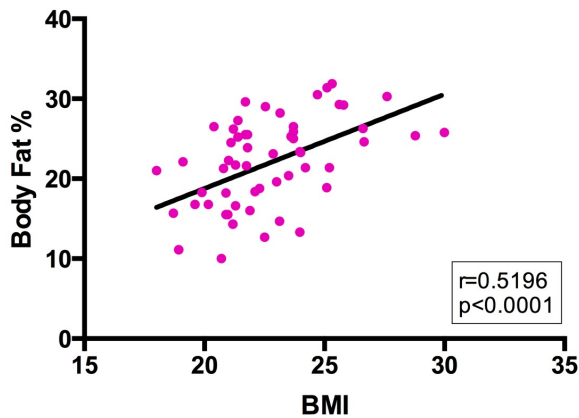


Figure 2. There was a moderately significant relationship between BMI and body fat percentage in females.

### Discussion

Currently, the data suggests that higher BMIs are associated with higher body fat percentages in exercise-trained men and women. The notion of a “skinny-fat” phenotype stems from the notion that individuals that perform high levels of aerobic training decrease their body weight with a concomitant increase in body fat percentage. Yet our data suggests that individuals with a higher BMI tend to have the greatest body fat percentage. In a 20-year follow-up of track and field athletes, those that performed the most endurance training had the lowest body fat percentages.<sup>3</sup> In a classic comparison of endurance versus power athletes, Marti and Howald investigated the alterations in their physical characteristics over a 15-year period from 1973 to 1988.<sup>4</sup> They found that distance runners had much lower body fat percentage (12.5%) than bobsledders (22.1%). Certainly, there is evidence that aerobic training may lower in some instances lean body mass. One investigation showed that in young women, doing aerobic exercise for 12 weeks promoted a loss of body weight, % body fat and BMI as well as a loss of lean body mass.<sup>5</sup> However, a loss of lean body mass should not be conflated with a gain in body fat percentage. In conclusion, based on a cross-sectional analysis of a wide variety of exercise-trained men and women, it is apparent that those with the highest BMIs also tend to have the higher body fat percentage.

### Media-Friendly Summary

Is there a “skinny-fat” body type in individuals that exercise? Not according to this observational study. In actuality, exercise-trained individuals with higher BMIs also tend to have higher body fat percentages. This is contrary to popular thought in the fitness industry.

## References

1. Thivel D, Chaput JP, Adamo KB, Goldfield GS. Is energy intake altered by a 10-week aerobic exercise intervention in obese adolescents? *Physiology & behavior*. Aug 2014;135:130-134.
2. Lee SS, Yoo JH, Kang S, et al. The Effects of 12 Weeks Regular Aerobic Exercise on Brain-derived Neurotrophic Factor and Inflammatory Factors in Juvenile Obesity and Type 2 Diabetes Mellitus. *J Phys Ther Sci*. Aug 2014;26(8):1199-1204.
3. Pollock ML, Mengelkoch LJ, Graves JE, et al. Twenty-year follow-up of aerobic power and body composition of older track athletes. *Journal of applied physiology*. May 1997;82(5):1508-1516.
4. Marti B, Howald H. Long-term effects of physical training on aerobic capacity: controlled study of former elite athletes. *Journal of applied physiology*. Oct 1990;69(4):1451-1459.
5. Kostrzewa-Nowak D, Nowak R, Jastrzebski Z, et al. Effect of 12-week-long aerobic training programme on body composition, aerobic capacity, complete blood count and blood lipid profile among young women. *Biochemia medica*. 2015;25(1):103-113.