

# Research

## Anthropometric Changes in Female Collegiate Athletes Apparent Within 4 Weeks of a Yoga Intervention

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### Abstract

Yoga is associated with a spectrum of health benefits (e.g., flexibility, balance, strength, and stress management) in diverse populations. Fewer studies have explored yoga's relationship with body composition; this is the first study investigating the effect of yoga on body composition in collegiate athletes. We enrolled 14 Division 1 female athletes (age 18–22) who were active competitors in either track and field or cross-country running. All subjects underwent baseline body composition testing using a Fit3D imaging device. We recorded body fat percentage, waist circumference, hip circumference, and waist-to-hip ratio. Subjects were randomly assigned to either an experimental group ( $n = 7$ ) or control group ( $n = 7$ ). The experimental group participated in 60 minutes of in-person, guided yoga twice weekly. After 4 weeks, both experimental and control groups underwent follow-up testing. Differences in body composition changes were assessed using paired-sample and independent-sample  $t$  tests as appropriate. There were no differences between groups at baseline ( $p > 0.130$ ). At follow-up, trending differences were observed between groups in body fat percentage ( $p = 0.073$ ), waist circumference ( $p = 0.080$ ), and hip circumference ( $p = 0.057$ ). Participants in the yoga intervention experienced reductions in waist circumference ( $p = 0.021$ ) and waist-to-hip ratio ( $p = 0.020$ ). Control subjects experienced increases over time in body fat percentage ( $p = 0.017$ ), waist circumference ( $p = 0.036$ ), and hip circumference ( $p = 0.002$ ). These results indicate that yoga may have a protective effect against adverse changes in adiposity. Accordingly, trainers, coaches, and clinicians may consider incorporating yoga practice as a weight-management tool. Future research should examine whether these results are consistent in larger and more heterogeneous samples. *Molgaard et al. Int J Yoga Therapy 2025(35). doi: 10.17761/2025-D-24-00023.*

**Keywords:** yoga, obesity, stress management, weight management, female collegiate athletes

### Abbreviation Used

HPA = hypothalamic-pituitary-adrenal (axis)

### Introduction

#### Obesity and Its Implications

According to the U.S. Centers for Disease Control and Prevention, 42.4% of adults and 19.3% of children and adolescents in the United States were considered obese in 2017–2018.<sup>1,2</sup> Obesity is associated with numerous adverse health outcomes, including increased risk of cardiovascular disease, hypertension, diabetes, dyslipidemia, and metabolic syndrome.<sup>3</sup> Beyond physical health, obesity can also have significant psychosocial consequences, such as elevated rates of anxiety and depression.<sup>3</sup> Although the underlying cause of obesity may appear straightforward—an imbalance where more calories are consumed than expended—successful treatment is far more complex and involves the interplay of physiology, psychology, and environmental factors.<sup>3–5</sup> Addressing obesity therefore requires a holistic approach that considers these various internal and external influences.

An increasing body of evidence supports the role of stress in obesity. Chronic stress involves repeated activation of the hypothalamic-pituitary-adrenal (HPA) axis and the sympathetic nervous system, responsible for the body's "fight, flight, or freeze" response, causing the prolonged release of cortisol and catecholamines such as epinephrine.<sup>6</sup> Although such a response is adaptive in short-term scenarios, chronic activation of these systems can lead to pathological outcomes, including weight gain and obesity.<sup>6–8</sup> Elevated levels of glucocorticoids, particularly cortisol, are associated with increased appetite for calorie-dense, carbohydrate-rich foods and a greater tendency to store fat in the abdominal region.<sup>8–13</sup>

The relationship between stress and obesity is not just physiological. The link can also be behavioral, as chronic stress has been shown to alter food preferences and promote emotional

eating.<sup>9–11</sup> Given the prevalence of stressors in modern life, managing stress is crucial for addressing obesity. Yoga is one practice that has demonstrated promise in stress management and, by extension, obesity reduction.

## Yoga History and Modern Applications

Traditional yoga, which originated in ancient India and was developed as a holistic approach to addressing mental, emotional, and spiritual well-being, comprises eight major components: *yama* (universal ethics), *niyama* (individual ethics), *asana* (physical postures), *pranayama* (breath control), *pratyahara* (control of the senses), *dharana* (concentration), *dhyana* (meditation), and *samadhi* (blissful absorption).<sup>14–16</sup> Each modern form of yoga is derived from these traditional practices, although their emphasis may vary. Contemporary yoga practices are diverse, ranging from meditative and slow-paced styles such as yin yoga to physically challenging, fast-paced practices like vinyasa yoga. Despite the diversity in execution, the central tenets of controlled breathing, physical postures, and meditation remain consistent across most styles.<sup>17</sup> Yoga's influence on both physical and mental health outcomes has led to increased interest in its effects on body composition and stress.

Yoga has been found to influence the body's stress response by downregulating the HPA axis and sympathetic nervous system, resulting in improved cortisol levels and heart rate variability.<sup>15,18,19</sup> Studies have shown that yoga can reduce salivary cortisol,<sup>20,21</sup> lower blood glucose levels,<sup>22</sup> and decrease heart rate and blood pressure.<sup>23,24</sup> These changes suggest that yoga may temper the chronic activation of the stress-response systems that contribute to obesity and other negative health outcomes.

In addition to physiological benefits, yoga has been shown to positively influence psychological behaviors associated with weight loss. Research suggests that yoga enhances mindfulness, which is the act of consciously bringing attention to thoughts, feelings, and emotions that arise in the present moment, and observing them in a nonjudgmental manner.<sup>17,25,26</sup> This increase in awareness, in turn, promotes healthier eating habits, such as mindful eating, increased fruit and vegetable consumption, and reduced fast-food intake.<sup>26–29</sup> Mindfulness helps individuals to recognize emotions beyond hunger, such as stress or boredom, and thus reduces emotional eating behaviors.<sup>17</sup> These psychological shifts may assist individuals in adopting a more balanced approach to food, which is crucial in addressing obesity.

## Research Objective and Hypothesis

The influence on both physiological and psychological parameters makes yoga a potentially valuable tool for addressing an issue as complex as weight management. Research in this field is particularly limited in demographics that already have structured exercise programs and regimented nutrition. Thus, the aim of the present study was to investigate the effects of a structured yoga intervention on the anthropometric characteristics of female Division 1 collegiate athletes, a population that likely meets these

criteria and experiences high levels of stress from the demands of balancing academic responsibilities with the need to perform as competitive athletes. Compared with the control group, we hypothesized that the athletes participating in the yoga intervention would experience changes in body composition associated with decreased stress, such as decreased deposition of visceral adiposity.

## Methods

We enrolled 14 female athletes (age 18–22) at a Division 1 university in central California. Inclusion criteria were current undergraduate standing, female sex, and active participation in collegiate track and field or cross-country running. The exclusion criterion was any injury or physical limitation that would prevent full participation in all yoga poses. This study was approved by the Institutional Review Board of the University of the Pacific.

All subjects underwent baseline testing using the Fit3D body scanning system (version 4.3, Fit3D, Inc.), which uses three-dimensional imaging to compute body composition. We recorded body-fat percentage, waist circumference, hip circumference, and waist-to-hip ratio. Subjects were then assigned, using random numbers, to either the experimental group ( $n = 7$ ) or the control group ( $n = 7$ ). Prior to the intervention, the experimental group was given a familiarization session to introduce them to the specific type of yoga that would be utilized during the study.

The experimental group then participated in 60 minutes of in-person yoga twice a week together as a cohort, guided by a yoga teacher registered at the 200-hour level by Yoga Alliance. This instructor was trained specifically in ashtanga yoga, as well as the “Native Series,” which is a blend of ashtanga and Bikram yoga practices. The instructor used the Native Series for the guided practice sessions; this included standing and seated components, and combined Bikram and ashtanga yoga to target postures in the posterior, anterior, lateral, and transverse planes. Each yoga session throughout the study was performed in a 75°F room and included the same asana, in the same sequence, to the same breath count. Each asana was held for five guided breaths. See Supplement A for the yoga sequence utilized during each session.

We did not standardize diet or exercise outside of the yoga sessions. However, programming and monitoring of exercise behavior for all athletes was completed by the same strength coach, and all athletes had free access to the same standardized meals for breakfast, lunch, and dinner. After 4 weeks, both experimental and control groups were re-tested using the Fit3D body scanning system, exporting the same parameters. All subjects were retained from pre-test to post-test.

Analyses were conducted using SPSS (version 26.0, IBM Corp.). Basic descriptive statistics were generated (means, standard deviations). Paired-sample  $t$  tests evaluated group changes from baseline to follow-up. Independent-sample  $t$  tests compared values between the experimental and control groups.

Significance (two-tailed) was set at  $p < 0.05$ . Owing to the small sample, trends were considered at  $p < 0.08$ . Exact significance of all comparisons is reported.

## Results

Across the total sample, at baseline, body fat was  $25.3\% \pm 4.4\%$ , waist circumference was  $31.6 \pm 2.5$  inches, hip circumference was  $38.8 \pm 2.7$  inches, and waist-to-hip ratio was  $0.80 \pm 0.04$ . Prior to the yoga intervention there were no differences between the intervention and control groups in body-fat percentage ( $p = 0.905$ ), waist circumference ( $p = 0.133$ ), hip circumference ( $p = 0.239$ ), or waist-to-hip ratio ( $p = 0.653$ ). While collecting baseline measurements, the equipment failed to generate values for the body weight, fat mass, lean mass, waist circumference, waist-to-hip ratio, and body-fat percentage of one participant in the yoga intervention group. See Table 1 for participants' baseline details.

At follow-up, trending differences were observed between groups in body-fat percentage ( $p = 0.073$ ), waist circumference ( $p = 0.080$ ), and hip circumference ( $p = 0.057$ ). In the yoga intervention, paired-sample  $t$  tests found significant reductions in waist circumference ( $p = 0.021$ ) and waist-to-hip ratio

( $p = 0.020$ ) (Table 2). In the control subjects, significant increases were detected over time in body-fat percentage ( $p = 0.017$ ), waist circumference ( $p = 0.036$ ), and hip circumference ( $p = 0.002$ ) (Table 2).

## Discussion

After 8 twice-weekly sessions of 60-minute guided yoga, female collegiate athletes experienced improvement in waist circumference and waist-to-hip ratio. Perhaps more important is the apparent protective effect of the program against the tendency to *increase* body-fat percentage, waist circumference, and hip circumference, as was observed in the control group. A possible explanation for the differences detected in waist circumference and waist-to-hip ratio is a change in circulating cortisol.<sup>30</sup> Although we did not measure stress biomarkers to confirm this relationship, an existing body of research indicates that yoga effectively reduces stress<sup>31</sup> and improves other mental health outcomes that contribute to overall well-being, such as by improving mood.<sup>32</sup> Another possible explanation for our findings is the supplemental exercise itself, consisting of 8 total hours of a particularly strenuous form of yoga.

**Table 1.** Anthropometric Characteristics of All Subjects Prior to the Yoga Intervention

Characteristic	Yoga (n = 7)	Control (n = 7)	p Value
Age (years)	19.860 ± 0.690	21.140 ± 1.069	0.020
Body weight (lb)	132.643 ± 11.929 <sup>a</sup>	150.286 ± 24.538	0.113
Fat mass (lb)	34.083 ± 6.675 <sup>a</sup>	39.371 ± 14.276	0.425
Lean mass (lb)	100.567 ± 6.943 <sup>a</sup>	110.914 ± 10.944	0.072
Waist circumference (in)	30.483 ± 1.679 <sup>a</sup>	32.586 ± 2.761	0.133
Hip circumference (in)	37.914 ± 1.340	39.686 ± 3.534	0.239
Waist:hip ratio	0.792 ± 0.037 <sup>a</sup>	0.803 ± 0.049	0.653
Body fat (%)	25.182 ± 3.120 <sup>a</sup>	25.493 ± 5.524	0.905

<sup>a</sup>n = 6.

**Table 2.** Paired-Sample  $t$  Tests for Yoga and Control Group Subjects

	Pre-Test	Post-Test	95% CI of Difference	p Value
<b>Yoga</b>				
Body weight (lb)	132.643 ± 11.929	133.700 ± 12.107	-3.583, 1.469	0.345
Fat mass (lb)	33.660 ± 7.372	34.120 ± 6.709	-2.653, 1.733	0.591
Lean mass (lb)	99.700 ± 7.391	101.800 ± 8.002	-4.520, 0.320	0.074
Waist circumference (in)	30.120 ± 1.591	30.940 ± 1.718	-1.437, -0.203	0.021*
Hip circumference (in)	37.914 ± 1.340	37.686 ± 1.255	-0.063, 0.520	0.103
Waist:hip ratio	0.786 ± 0.038	0.808 ± 0.044	-0.038, -0.006	0.020*
Body fat (%)	25.082 ± 3.477	24.982 ± 3.014	-1.582, 1.782	0.877
<b>Control</b>				
Body weight (lb)	150.286 ± 24.53	150.929 ± 24.408	-2.760, 1.474	0.486
Fat mass (lb)	39.371 ± 14.276	44.271 ± 14.327	-7.980, -1.820	0.008*
Lean mass (lb)	110.914 ± 10.944	106.657 ± 11.256	0.648, 7.867	0.028*
Waist circumference (in)	32.586 ± 2.761	33.329 ± 3.008	-1.416, -0.067	0.036*
Hip circumference (in)	39.686 ± 3.534	40.729 ± 3.37	-1.523, -0.563	0.002*
Waist-to-hip ratio	0.803 ± 0.049	0.800 ± 0.035	-0.031, 0.037	0.842
Body fat (%)	25.493 ± 5.524	28.757 ± 4.834	-5.708, -0.821	0.017*

\*Statistically significant ( $p < 0.05$ ).

In the yoga group, significant reductions in waist circumference and waist-to-hip ratio were found following the 4-week intervention. The control group showed significant *increases* in body-fat percentage, waist circumference, and hip circumference.

CI = confidence interval.

Behavioral changes other than the yoga intervention may account for some of these intergroup differences. Qualitative assessment by the strength coach indicated that the yoga participants experienced improvements in body awareness throughout the intervention, with particular emphasis on posture (spinal and pelvic control) and breathing during exercise. Confidence with exercise was also noted, which may contribute to more participation outside of the yoga sessions. However, as all athletes were competitors at the same institution, with exercise programs written and overseen by the same strength coach, these training differences were likely modest. Similarly, as all athletes had access to the same preprepared meals, food selection is unlikely to have exerted a substantial influence on outcomes.

Limitations to external validity include the small sample size, exclusion of males, narrow age range, limited sport diversity, and absence of physical activity logs, dietary logs, and the use of a validated questionnaire measuring stress levels pre- and postintervention that could contribute to an explanation of the differences observed between groups. Additional limitations include the lack of an active control group, which would help to account for any socialization effects of the intervention, and the implementation of a yoga protocol that has not been previously validated. Despite these limitations, the trending changes observed in the yoga participants, and the apparent protective effect of the yoga intervention on adverse changes to body composition, are compelling. Future research should examine whether the results of this study can be replicated in a more heterogeneous group of exercising adults, taking into account other variables that were not examined in the present study, such as stress biomarkers, influence of mindfulness, nutritional monitoring, different types of yoga, and differing levels of prior yoga experience.

## Conclusions

Our findings indicate that yoga may confer a protective effect against increases in body-fat percentage, waist circumference, and hip circumference, and the practice may improve waist-to-hip ratio. These results were apparent within 1 month of practice. Our findings suggest that yoga may improve exercise behavior through enhanced body awareness and exercise confidence, and that it may also have psychological and physiological effects on stress management, improve glucose metabolism, and help the body to store adiposity in a healthier manner, depositing it in areas other than the abdomen, as is commonly seen in individuals experiencing chronic stress. Through these mechanisms, yoga may prove to be a helpful weight-management tool, particularly in times of elevated stress. Further research is necessary to examine this relationship among yoga, the psychological and physiological aspects of stress management, and body composition.

## Conflict-of-Interest Statement

The authors declare that they have no known conflicts of interest associated with this publication, and no financial support was

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## Supplement A. Sequence Used During Each Session of the Yoga Intervention

### Warmup

- Sun salutation A × 3
- Sun salutation B × 2

### Main Sequence

- Forward fold
- Triangle pose
- Revolved triangle pose
- Side angle pose
- Revolved side angle pose
- Wide-leg forward fold (hands on ground, hands clasped behind back, hands to feet)
- “Railroad” knee to nose (*parsvottanasana*)
- Standing single-leg hold (sagittal and lateral)
- Dancer pose
- Tree pose
- Warrior I
- Warrior II
- Vinyasa* (flow) to the floor
- Seated staff pose
- Seated forward fold

- Reverse plank
- Single-leg forward fold
- Hero's pose
- Supine hero's pose
- Seated spinal twist (*marichyasana*) A
- Seated spinal twist B

### Cool-Down

- Pigeon pose
- Boat pose
- Bound angle pose (*baddha konasana*) A
- Bound angle pose B
- Seated wide-leg forward fold
- Bridge pose
- Wind-relieving pose
- Plow pose
- Fish pose
- Lotus pose

*Savasana* (corpse pose; final relaxation)