Weight and Body-Composition Change During the College Freshman Year in Male General-Population Students and Army Reserve Officer Training Corps (ROTC) Cadets

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**Purpose:** To examine relationships between changes in body weight, body composition, and fitness level in male students of the general population and those in the Army Reserve Officer Training Corps (ROTC) program during the freshman year of college. **Methods:** Thirty-seven (18.4 ± 0.7 yr) healthy, nonsmoking, first-semester-resident male students were divided into 3 groups: low active (LA), high active (HA), and ROTC. Baseline (beginning of freshman year) and 6-month follow-up measurements included anthropometry, body composition (by DXA), 3-day food records, and physical activity (PA) assessment. **Results:** Weight and body-mass index did not change significantly within or among groups. HA participants compared with LA and ROTC had a significant decrease in body fat (–1.6% ± 2.5% vs. 1.9% ± 1.2% and 0.8% ± 2.2%, respectively). They also had a significant increase in lean mass compared with LA and ROTC (1.8 ± 1.1 kg vs. –0.2 ± 2.0 kg and 0.2 ± 1.7 kg, respectively). All \( p \) values were <.05. ROTC and LA participants were similar in all measures of body composition and PA and had significantly lower PA levels than the HA group. No significant relationships were observed between dietary variables and body-composition changes. **Conclusions:** These results suggest that higher PA was the most powerful determinant in achieving favorable body-composition outcomes. In addition, current physical training conducted by ROTC at Florida State University (which seems to be a practice nationwide) might not be sufficient to offset gains in body fat.

**Keywords:** body fat, muscle mass, physical activity, fitness level

Overweight and obesity are at 70.5% and 61.6% of the respective populations of men and women in the United States (Rosamond et al., 2007) and are associated with direct and indirect health care costs of 92.6 billion 2002 dollars (Finkelstein, Fiebelkorn, & Wang, 2003; Rosamond et al., 2008). In the military, the prevalence of overweight and obesity among men and women is 34% and 38%, respectively (Bathalon et al., 2006), and the Department of Defense spends an estimated $1.1 billion on associated health care costs (Dall et al., 2007). The Department of Defense’s recent readiness report titled Too Fat to Fight states that the most frequent young adults’ military ineligibility is overweight, creating a potential threat to national security, and this sentiment is publicized by popular media today (“Mission Readiness,” n.d.). The U.S. Army employs structured physical activity programs as part of its training philosophy to maintain the physical fitness of the fighting force. In addition, the Army requires that height, weight, and body-fat standards be met, so that soldiers will reflect fitness, as well as uphold military standards of appearance (Department of the Army Weight Control Program, 2006).

However, in recent years, to meet the increased recruiting quotas, soldiers are being recruited at heavier weights than previously allowed at entry, thereby exceeding weight-for-height standards (Hsu, Nevin, Tobler, & Rubertone, 2007). Typically, soldiers initially lose weight due to the intense nature of physical conditioning during basic training, which lasts approximately 9 weeks. After basic training, soldiers enter advanced individual training, where they are trained for their respective occupational specialties but are also granted additional freedoms such as traveling off base, eating meals outside the base dining halls, and having food or snacks in the barracks. It is during advanced individual training when some soldiers are regaining weight lost during basic training and once again exceeding weight-for-height standards (Friedl, Vogel, Bovee, & Jones, 1989).

Similarly, trends in weight gain have been observed in students entering universities, as they transition to a new environment and undergo an adjustment period, also characterized by increased control over their own lifestyle choices (Delinsky & Wilson, 2008; Economos, Hildebrandt, & Hyatt, 2008; Pliner & Saunders, 2008). While the weight change is not typically as high as the popular media has touted it to be (see review on “Fresh-
man 15,” Crombie, Ilich, Dutton, Panton, & Abood, 2009) and characteristics of this weight change have only been quantified in a few studies (Butler, Black, Blue, & Gretebeck, 2004; Hoffman, Policastro, Quick, & Lee, 2006; Lowe et al., 2006; Morrow et al., 2006), small changes in weight, if continued, may add up to substantial increases in weight and subsequent risk of chronic disease. The decline in physical activity might be a cause for increased weight, ready access to recreational facilities that most universities offer. Higher energy intakes and reduced physical activity set the stage for unfavorable body-composition changes and increased risks for some chronic diseases in both military and student populations.

Therefore, the purpose of this study was to examine the relationships between changes in body weight and body composition, as well as fitness level, in freshman students of the general population and those participating in the Army Reserve Officer Training Corps (ROTC) program during the freshman year.

Methods

Subjects

Forty entering freshman male students, including ROTC cadets, age 18–21 years were recruited during the first 2 months of the fall semester (September–October) to participate in a 6-month study. The ROTC program is a university-based training for the U.S. Army in which student cadets receive merit-based scholarships in return for active military service on graduation. Inclusion criteria included being first-semester men age 18–25 years, being free from any major medical condition such as cardiovascular or metabolic disease or any physical condition that would prevent them from completing the physical fitness test (including lower back pain or musculoskeletal injuries), being a nonsmoker, not taking medication known to affect weight or metabolic rate, and residing on campus in residence halls for the duration of the study. The ROTC cadets had mandatory physical training 3 days/week (including warm-up: 1 min walk/slow jog, 2–3 min of stretching, and 2–3 min of calisthenics; conditioning: 20–45 min of exercises for cardiorespiratory and muscular strength activity; and cooldown: 2–3 min of low-intensity exercises and 3–4 min of stretching; ~180 min/week; Department of the Army Weight Control Program, 2006). Cadets participating in ROTC but not contracted (contract pending) were not recruited because physical training was not required of contract-pending cadets. A total of N = 40 subjects were recruited, of which N = 37 completed all measurements (3 failed to remain contracted to ROTC). Participants signed an informed consent that was approved by the Florida State University institutional review board and subsequently completed a physical activity readiness questionnaire to assess risks for exercise testing.

The general-student-population participants were divided into two groups: low active (LA, n = 12) and high active (HA, n = 12) based on their score on the Godin Leisure-Time Exercise Questionnaire (GLTEQ; Godin & Shephard, 1985), as described following. The mean score on the GLTEQ questionnaire was 67, and subjects were classified as HA if they scored >67 and LA if they scored <67. The ROTC cadets (n = 13) composed the third group.

Laboratory and field measurements were taken at baseline (beginning of freshman year) and after 6 months and included body composition, circumference-based equations, 3-day food records, and physical activity assessment (GLTEQ). At baseline, all subjects completed the Army Physical Fitness Test (APFT).

Anthropometric and Body-Composition Measurements

Height was measured without shoes to the nearest 0.1 cm using a wall-mounted stadiometer (Medart, St. Louis, MO). Weight in indoor clothing was measured to the nearest 0.1 kg on a digital scale (Seca, Model 707, Seca Corp., Columbia, MD). The values were used to calculate body-mass index (BMI, kg/m^2). A Lunar iDXA densitometer (GE Medical Systems, Madison, WI) with Encore 2006 software (version 13.11.016) was used to measure body composition, yielding the analyses of segmented body regions, as described previously (Ilich, Zito, Brownbill, & Joyce, 2000). During DXA measurements, the participants were in indoor clothing without any metal parts (including zippers) and were advised not to drink coffee or other caffeinated drinks for the 3 hr before measurements. Total percent body fat, gynoid and android percent fat, android-to-gynoid ratio, and the amounts of total body fat and lean mass were analyzed, as well. The quality analysis for the densitometer was conducted daily using a standard aluminum spine block (phantom) provided by the manufacturer. Measurements of the phantom were within the manufacturer’s precision standard with coefficient of variation (CV) <.5%. The %CVs for total-body lean and fat tissue were 1.5% and 1.9%, respectively, based on the three repeated measures of 10 subjects.

Circumference measures were performed as outlined in Army Regulation 600–9 (Department of the Army Weight Control Program, 2006). Using a Gulick measuring tape (Model #4192G, US Medical, Raleigh, NC), the subjects were measured to the nearest 0.1 cm at the following sites: neck (inferior to the larynx, but not including a significant portion of the trapezius muscles), abdomen (on gentle exhalation and in a horizontal plane around the abdomen at the level of the iliac crest laterally), waist (narrowest part of the torso, above the naval and below the lower rib margin), and hip (widest protuberance of the hip/buttocks region). The average of two measurements for each site was recorded. Waist-to-hip ratios were calculated.

Physical Activity Assessment

To assess participation in physical activity, subjects completed the GLTEQ at baseline and at the end of the
study (6 months). The GLTEQ is a reliable and valid tool for assessing physical activity or exercise behavior (Godin & Shephard, 1985; Jacobs, Ainsworth, Hartman, & Leon, 1993; Miller, Freedson, & Kline, 1994; Sallis, Buono, Roby, Micale, & Nelson, 1993) and was associated with maximal oxygen consumption (VO2max; Godin & Shephard, 1985). The subjects recorded the number of times that they engaged in strenuous-, moderate-, and mild-intensity exercise lasting longer than 15 min over a 1-week period. Examples of exercise types were given for each level of intensity. Each subject’s answers were multiplied by 9, 5, and 3 MET hours for strenuous-, moderate-, and mild-intensity activity, respectively, to achieve a score. The mean score of all general-population students was used to classify them into HA and LA groups as described previously.

**Cardiovascular Assessment and Fitness Testing**

Resting blood pressure and heart rate were measured using the digital monitor (Model HEM-780N2, Omron Healthcare, Inc., Bannockburn, IL) after the subject had been seated for 10 min and after administration of questionnaires but before any fitness testing. Three measurements were obtained over the nondominant arm, and the average was recorded.

All subjects performed the APFT at baseline in accordance with the procedures outlined in the **Army Field Manual** (U.S. Army, 1998) to assess physical fitness. All tests were performed in the morning, after the blood-pressure measurements and GLTEQ questionnaire completion. The test included three activities (separated by 10-min recovery periods) to test both muscle endurance and assess VO2max, in the following order: 2 min of push-ups, 2 min of sit-ups, and a timed 2-mile (~3.2 km) run. Each subject was instructed on the performance standard of each exercise, and each subject demonstrated the event to the researcher to ensure that the exercise was performed correctly, before initiation of the test. Subjects were encouraged to go to muscle failure, to the point at which no further repetitions could be performed, or until time expired. Raw and point scores were recorded. Point scores were obtained using the individual’s raw score and age and scoring standards outlined in **Army Field Manual 21-20** (U.S. Army, 1998). VO2max was estimated using the equation from **Army Field Manual 21-20** and recorded to the nearest hundredth in ml · kg⁻¹ · min⁻¹:

$$\text{VO}_{2\text{max}} = 99.7 - [3.335 \times (2\text{-mile-run time in minutes})]$$

**Dietary Assessment**

Dietary intake was estimated using 3-day food records (2 representative weekdays and 1 weekend day) collected at baseline and at the end of study. Subjects were instructed on how to record their intake by a registered dietitian, and food records were reviewed with each subject to clarify any unclear food or beverage entry. Subjects were asked to refrain from taking any dietary supplements aside from a multivitamin/mineral, but all supplements reported by subjects were recorded. Food records were analyzed for all macro- and micronutrients by Nutribase software version 6.2 (Cybersoft, Inc., AZ).

**Data Analysis**

Data were analyzed using SPSS version 18. To assess relationships between body composition and fitness level, Pearson’s product–moment correlations were calculated with scatter plots to test for outliers. One-way analyses of variance (ANOVA) and covariance (ANCOVA) were used to determine significant differences between groups and changes in variables over time. When significant differences were found, post hoc Tukey’s tests were performed to identify specific group differences. Statistical significance was accepted at $p < .05$. Sample size was determined using the effect size calculated from means and standard deviations for each group. Resting diastolic blood pressure was significantly higher in the LA group than in the HA and ROTC groups at baseline; however, for all groups it was below 75 mmHg (Table 2).

After 6 months, the increase in the amount and percent of android, gynoid, and total-body fat was the highest in LA subjects, followed by ROTC, while HA participants lost fat mass in each of the regions (Table 3). In addition, HA subjects had a significantly greater increase in lean mass than LA and ROTC subjects. The differences between HA and ROTC approached significance for change in total-body-fat percent ($p = .05$). LA and ROTC subjects were not statistically different from each other for any body-composition changes.

All but 1 subject in the HA group gained lean mass, while all lost fat mass. In the LA group, only half gained lean mass and all gained fat mass, while 76% of ROTC cadets gained lean mass and 76% gained fat mass. When all subjects (including ROTC) were divided by mean score on the GLTEQ into HA and LA groups, the comparison was similar for gains in fat and lean mass. In that context, 81% of LA subjects gained fat mass, versus only 38% of HA subjects, whereas 94% of HA subjects gained lean mass versus 52% of LA subjects, after 6 months.

The scores on the GLTEQ at baseline and 6-month follow-up among subjects divided by groups are presented in Figure 1. Although LA and HA subjects were assigned to their respective groups based on baseline scores on the GLTEQ, scores of LA subjects remained...
significantly lower than those of HA at 6 months. Scores for ROTC were not different from those for LA but were significantly lower ($p < .05$) than those of the HA subjects at both baseline and 6 months. There were significant relationships observed between body composition and fitness level. Inverse relationships were found between VO$_{2\text{max}}$ and fat mass ($R^2 = .285, p < .01$), BMI ($R^2 = .239, p < .01$), and percent body fat ($R^2 = .267, p < .01$), as well as between APFT total score and fat mass ($R^2 = .341, p < .01$), BMI ($R^2 = .219, p < .01$), and percent body fat by DXA ($R^2 = .320, p < .01$).

Table 4 presents selected dietary variables at baseline and after 6 months for all subjects. There were no significant differences among groups at baseline, follow-up, or change from baseline to follow-up for selected dietary variables, including daily energy intake and energy intake per kilogram body weight. There were no significant associations among baseline energy intake per kilogram body weight and changes in weight, BMI, or any body-composition parameters. In addition, paired $t$ tests were used to examine differences by each group between baseline and follow-up daily energy intake and energy intake per kilogram body weight, but again, no significant differences were observed. Similar observations were noted for alcohol intake among or within the groups (Table 4). Figure 2 presents the average daily energy intake of participants in each group. Although the HA group had the lowest daily energy intake, there was no statistically significant difference between groups. Similar trends were noted with the daily energy intake normalized for kilograms body weight.

**Discussion**

Significant differences were observed for change in body-composition variables between baseline and 6 months among groups. The HA group decreased in percent body fat, fat mass, and android/gynoid fat and increased in lean mass, whereas the LA group increased in percent body fat, fat mass, android/gynoid fat and decreased in lean mass. This implies that physical activity had a strong role in body-composition outcomes, especially considering that there were no differences in dietary intake between groups. However, the possibility of some misreporting of the assessed dietary intake and physical activity should not be neglected. Although each subject was instructed...
on how to complete both questionnaires by a registered dietitian and each record was checked and clarified (for obvious inaccuracies), the inherent limitations of the assessment tools could have played a role in the outcomes. Subjects in the ROTC group were similar to LA subjects with regard to percent body fat, fat mass, and android- and gynoid-fat changes, experiencing increases in those variables; however, while lean mass decreased in LA, it remained the same in ROTC subjects. The ROTC group was not statistically significantly different from the LA group for any body-composition change measures. This was a surprise outcome for ROTC cadets, as their

### Table 3 Six-Month Changes in Anthropometric and Body-Composition Measures, M ± SD

<table>
<thead>
<tr>
<th>Variable</th>
<th>Low active, n = 12</th>
<th>High active, n = 12</th>
<th>ROTC, n = 13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (kg)</td>
<td>2.6 ± 2.6</td>
<td>0.8 ± 2.5</td>
<td>1.7 ± 2.5</td>
</tr>
<tr>
<td>% change</td>
<td>3.3 ± 3.2</td>
<td>1.1 ± 3.7</td>
<td>2.2 ± 3.3</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>0.7 ± 0.8</td>
<td>0.3 ± 0.9</td>
<td>0.4 ± 0.8</td>
</tr>
<tr>
<td>% change</td>
<td>3.0 ± 2.9</td>
<td>1.2 ± 3.8</td>
<td>1.5 ± 3.4</td>
</tr>
<tr>
<td>Waist:hip ratio (cm)</td>
<td>0.0 ± 0.0</td>
<td>0.0 ± 0.0</td>
<td>0.0 ± 0.0</td>
</tr>
<tr>
<td>% change</td>
<td>−0.8 ± 4.3</td>
<td>−1.5 ± 4.5</td>
<td>−0.8 ± 2.3</td>
</tr>
<tr>
<td>Total body fat (%)</td>
<td>1.9 ± 1.2***</td>
<td>−1.6 ± 2.5b</td>
<td>0.8 ± 2.2**</td>
</tr>
<tr>
<td>% change</td>
<td>10.7 ± 9.0***</td>
<td>−6.8 ± 13.5b</td>
<td>3.9 ± 12.0b</td>
</tr>
<tr>
<td>Android fat (%)</td>
<td>3.7 ± 2.6***</td>
<td>−2.6 ± 4.3b</td>
<td>1.8 ± 3.5**</td>
</tr>
<tr>
<td>% change</td>
<td>21.0 ± 19.7***</td>
<td>−10.3 ± 19.9b</td>
<td>7.1 ± 17.4**</td>
</tr>
<tr>
<td>Gynoid fat (%)</td>
<td>1.9 ± 2.0***</td>
<td>−2.3 ± 3.8b</td>
<td>0.2 ± 3.4b</td>
</tr>
<tr>
<td>% change</td>
<td>10.4 ± 12.6***</td>
<td>−7.3 ± 18.8b</td>
<td>0.6 ± 14.0b</td>
</tr>
<tr>
<td>Android:gynoid ratio</td>
<td>0.07 ± 0.1*a**</td>
<td>−0.03 ± 0.06b</td>
<td>0.05 ± 0.05***</td>
</tr>
<tr>
<td>% change</td>
<td>9.4 ± 7.9*a**</td>
<td>−3.2 ± 7.6b</td>
<td>6.0 ± 6.0***</td>
</tr>
<tr>
<td>Fat tissue (kg)</td>
<td>2.3 ± 1.7***</td>
<td>−0.9 ± 2.2b</td>
<td>1.0 ± 2.2b</td>
</tr>
<tr>
<td>% change</td>
<td>15.4 ± 10.8***</td>
<td>−5.2 ± 17.8b</td>
<td>5.8 ± 14.7ab</td>
</tr>
<tr>
<td>Lean tissue (kg)</td>
<td>−0.2 ± 2.0*a**</td>
<td>1.8 ± 1.1b</td>
<td>0.2 ± 1.7**</td>
</tr>
<tr>
<td>% change</td>
<td>−0.2 ± 3.5*a**</td>
<td>3.2 ± 2.1b</td>
<td>0.4 ± 3.1a**</td>
</tr>
</tbody>
</table>

Note. ROTC = Reserve Officer Training Corps; BMI = body-mass index. Means with different superscripts are significantly different.

* p < .05 vs. other groups. ** p < .01 vs. other groups.

Figure 1 — Mean scores on Godin Leisure-Time Exercise Questionnaire by group, M ± SD. Groups with different-letter superscripts are statistically significantly different (p < .05). ROTC = Reserve Officer Training Corps.
mandatory physical training was expected to increase during their training and subsequently offset undesirable body-composition changes or even promote favorable changes.

To our knowledge, no other studies have examined body-composition changes in ROTC cadets and freshmen or other college students, although this population, including older classmen, is in need of future studies (Crombie et al., 2009). Studies of general-student populations report that weight changes plateau after the freshman year (Racette, Deusinger, Strube, Highstein, & Deusinger, 2008) or even as early as the end of the first semester (Holm-Denoma, Joiner, Vohs, & Heatherton, 2008), but it is unknown if this phenomenon is similar for ROTC cadets. In our study, only 17% (n = 2) of subjects in the HA group gained fat mass, compared with 76% (n = 9) of ROTC and 100% (n = 12) of LA. Ninety-three percent (n = 11) of HA subjects increased lean mass, compared with 76% (n = 9) of ROTC and 50% (n = 6) of LA. Some ROTC cadets (n = 4) actually lost lean mass despite their physical-training sessions and involvement in the ROTC program. It could be speculated that losses in lean mass could be due to an insufficient energy or protein intake; however, there were no differences between groups in these variables either at baseline or at 6 months. In addition, both energy and protein intake were within the recommended levels (Institute of Medicine, 2005) for each group and for the overall population. Similarly, decreased lean mass would also have been expected in the HA group if high activity and low macronutrient intake persisted in this group.

There were no significant changes in body weight within or between groups. The average weight gain for all subjects was 1.8 kg, which comprised 1.2 kg fat and 0.6 kg lean mass. Several previous studies in students examined only those who gained body weight during the study (Butler et al., 2004; Delinsky & Wilson, 2008; Kasperek, Corwin, Vohs, Sargent, & Morris, 2008). Results of those studies reported a higher weight gain but a smaller range of weight gained (3.1–3.3 kg) than in

<table>
<thead>
<tr>
<th>Variable</th>
<th>Baseline, n = 37</th>
<th>6 months, n = 37</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy (kcal · kg⁻¹ · day⁻¹)</td>
<td>31.9 ± 6.4</td>
<td>32.3 ± 6.3</td>
</tr>
<tr>
<td>Energy (kcal/day)</td>
<td>2,267 ± 318</td>
<td>2,350 ± 301</td>
</tr>
<tr>
<td>Protein (g/day)</td>
<td>93 ± 28</td>
<td>100 ± 28</td>
</tr>
<tr>
<td>%</td>
<td>16.4</td>
<td>17.0</td>
</tr>
<tr>
<td>Carbohydrate (g/day)</td>
<td>293 ± 51</td>
<td>296 ± 56</td>
</tr>
<tr>
<td>%</td>
<td>51.7</td>
<td>50.4</td>
</tr>
<tr>
<td>Fiber (g/day)</td>
<td>16 ± 6</td>
<td>18 ± 12</td>
</tr>
<tr>
<td>Fat (g/day)</td>
<td>83 ± 24</td>
<td>89 ± 27</td>
</tr>
<tr>
<td>%</td>
<td>33.0</td>
<td>34.1</td>
</tr>
<tr>
<td>Vegetables (servings/day)</td>
<td>0.6 ± 1.0</td>
<td>0.8 ± 1.2</td>
</tr>
<tr>
<td>Fruit (servings/day)</td>
<td>1.9 ± 1.8</td>
<td>1.4 ± 2.4</td>
</tr>
<tr>
<td>Alcohol (g/day)</td>
<td>74 ± 142</td>
<td>47 ± 84</td>
</tr>
</tbody>
</table>

Figure 2 — Baseline versus 6 months daily energy intake, M ± SE. ROTC = Reserve Officer Training Corps.
this study (1.7–3.5 kg). When examining only the weight gainers of this study, mean weight gain was 2.2 kg, which included 1.5 kg fat mass and 0.7 kg lean mass.

**Fitness, Activity Levels, and Body Composition**

There were no significant associations between total score on the APFT and body-composition changes over 6 months, including changes in fat and lean mass. Likewise, no significant correlations were found between changes in the GLTEQ score and body-composition changes. There were no significant relationships between baseline measures of body composition and baseline score on the GLTEQ or follow-up measures of body composition and follow-up scores on the GLTEQ among groups. This finding corroborates that of others in which increases in body weight were observed over the freshman year; however, no direct relationship was established between physical activity and body composition (Butler et al., 2004; Jung, Bray, & Martin Ginis, 2008; Kasparek et al., 2008).

Significant relationships were, however, observed between measures of fitness and body composition. Total score on the APFT and VO2max as estimated from the 2-mile run were inversely associated \(^{(p < .01)}\) with baseline BMI, percent body fat, android and gynoid fat, and total-body fat mass. These findings suggest not only that higher body fat is related to poorer fitness level but also that higher body fat or weight may negatively affect performance on the APFT. The notion that there may be a body weight bias with regard to the Army’s assessment of physical fitness has been argued previously (Vanderburgh & Crowder, 2006), when it was proposed that correction factors be used to adjust APFT scores for individuals of heavier weight.

**Physical Activity**

Another important finding of this study relates to the amount of physical activity required to maintain weight or prevent unfavorable gains in fat mass. While ROTC cadets maintained a level of physical activity in line with recommendations from the American College of Sports Medicine and the American Heart Association, it seems that it was not enough to prevent accumulation of body fat during the first 6 months of attending a university. In addition, physical activity, as assessed via the GLTEQ, was not statistically significantly different at baseline or 6 months between LA and ROTC groups, which suggests that ROTC subjects engaged in minimal physical activity outside of the required ROTC physical-training program. In contrast, HA participants scored significantly higher than ROTC and LA subjects on the GLTEQ at both baseline \( (p = .003) \) and at 6 months \( (p = .029) \), maintaining their high level of activity. Changes in scores on the GLTEQ were not significant over time within groups, suggesting that all groups maintained similar activity levels over the 6-month study period. The similarity between ROTC and LA groups for physical activity may explain why similar results were observed for body-composition changes among these groups and why these groups were statistically significantly different from HA participants who engaged in more activity.

A significant decrease in physical activity (leisure, sports, occupational, and total activity) was suggested as the main determinant of weight change in a study by Butler et al. (2004), where gains in weight and percent body fat were observed despite decreases in energy intake. However, no direct link was established between weight change and decreases in physical activity. Likewise, other studies in freshmen that examined physical activity have been unable to link physical activity changes with weight changes. Kasparek et al. (2008) observed significant decreases in physical activity for men (but not women), but there were no associations with the 1.1-kg weight gain the men experienced. Significant gains in weight were also observed by Jung et al. (2008) among first-year college women, but again no associations were established with physical activity as measured using the GLTEQ. These inconclusive outcomes are probably due to the limitations of the instrument to assess individuals’ involvement and duration in various types of activities, as discussed in the Limitations section of this article.

Based on our study and those of others, it seems that many college students do not meet recommenda-
tions for physical activity and are similar to the general population of adults, with approximately half of college students classified as inactive (Keating, Guan, Pinero, & Bridges, 2005). This sedentary lifestyle might contribute to their gradual weight gain, even if their energy intake remains the same.

**Dietary Intake**

Total daily energy intake (baseline 2,267 ± 318 kcal vs. 6 months 2,350 ± 301 kcal) and energy intake per kilogram body weight were not significantly different among or between groups (Figure 2), and they were within recommenda-
tions for each group and the whole population. In addition, there were no significant differences among groups for any macro- or micronutrient intake or any differences for the sample as a whole when comparing baseline with follow-up intakes. Therefore, nutritional data are presented as the daily mean values with groups combined (Table 4).

Few studies conducted on freshman students have actually quantified energy and nutrient intake. However, two studies (Butler et al., 2004; Jung et al., 2008), both done in first-year female students, observed increases in weight and body composition despite significant decreases in energy intake. Diet analysis by Butler et al. revealed significant decreases in energy, macronutrients, and servings of vegetables, in addition to decreases in all forms of physical activity and a corresponding increase in both weight and percent body fat. Jung et al. divided their subjects into two groups (weight gainers and weight losers) and found a significant Group \( \times \) Time interaction.
on physical activity (as assessed by the GLTEQ), suggesting that physical activity differed between groups. Assessment of body composition revealed that weight gainers increased body fat, while weight losers lost body fat. Furthermore, both groups decreased energy intake over the duration of the study. Authors of both of the cited studies speculated that weight and body-composition changes were likely attributable to changes in physical activity.

In the current study, participants did not meet recommendations of five servings per day for vegetables and fruit, despite having abundant options per meal available at on-campus dining facilities. Vegetable intakes were 0.6 and 0.8 servings/day at baseline and 6 months, respectively. Subjects came close to meeting two servings of fruit per day at baseline (1.9 servings) but decreased their consumption at 6 months for about a half a serving per day, which was not significant. Pliner and Saunders (2008) used a food-frequency questionnaire to assess dietary intake and found that decreased fruit and vegetable intake was the only significant dietary predictor of weight change in freshman students. Kasparek et al. (2008) also observed significant decreases in fruit and vegetable intake, but there were no associations with weight.

It is reasonable to speculate that dietary variables such as high energy intake and low fruit and vegetable intake would be associated with undesirable body-composition changes during the freshman year. However, this was not the observation in this study, as there was no significant relationship between energy or fruit and vegetable intake and any components of body composition at baseline or 6 months.

**Limitations**

Evaluation of nutritional intake suffers from a weakness inherent in the methods of data collection and analysis. Regardless of what screening tool is used (dietary histories, dietary records, or food frequencies, to name just a few), the subjective errors in self-reporting, changes in nutrient intake over time, and limitations of nutritional databases used for calculation are, more or less, always present. These flaws have been addressed earlier (Heaney, 1997; Ilich, Skugor, Hangartner, Baoshe, & Matkovic, 1998). Despite these obvious disadvantages, a rather reliable trend in nutrient intakes could still be ascertained, and useful information could be obtained to connect the intake of particular nutrients with some physiological outcomes, as was attempted in this study.

Similar arguments could be raised for the assessment of physical activity via surveys and questionnaires, which still show limited reliability and validity, due to the same reason as noted for dietary records. This is particularly true for attempts to connect the amount of exercise with a particular health outcome or body-composition change, without having a standardized instrument to quantify and differentiate specific levels of activity. Despite the noted limitations, the results of this study are valuable and meaningful, considering a tightly controlled protocol and close monitoring of subjects by the professional team, accurate measurements using the state-of-the-art equipment, and appropriate statistical analyses.

**Conclusions and Recommendations**

The results of this study suggest that in this population of young men entering university, one of the important ways of maintaining a favorable body composition could be to engage in higher levels of self-selected physical activity, as shown in the group of HA participants. In addition, it seems that ROTC physical training at Florida State University is not sufficient to maintain weight or prevent unfavorable body-composition changes in cadets. However, the protocol for this training is similar throughout the country, although it was changed slightly in 2011. Recommendations by the American College of Sports Medicine include ≥30 min/day of moderate-intensity cardiorespiratory exercise for ≥5 days/week or vigorous-intensity cardiorespiratory exercise for ≥20 min/day for ≥3 days/week and resistance exercise 2–3 days/week (Garber et al., 2011). Therefore, if physical training is the only physical activity in which cadets engage, it should be longer in duration, more intense, or conducted on more days per week to be effective as the sole method to prevent unfavorable body-composition changes. ROTC cadets particularly, but general students as well, should be encouraged to maintain high levels of activity in addition to the required physical training for the former, and monitor dietary intake closely to prevent gains in fat mass. While energy intake did not appear to be a factor associated with unfavorable body-composition changes in this study, it is still an important factor in maintaining the energy-balance equation and should be adjusted with respect to individual level of activity.

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