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Research Article

Weight and Body Composition Changes during the First Three Years of College

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Differences in weight, body mass index (BMI), percent and absolute body fat, fat-free mass, and waist circumference were investigated in a group of males and females during the first three years (from 2007 to 2010) of college. Significant three-year gains were observed for weight 2.1 ± 4.7 kg, BMI 0.7 ± 1.6 kg/m², percent body fat $2.7 \pm 3.3\%$, and fat mass 2.3 ± 3.5 kg. A significant loss of fat-free mass, -0.5 kg, was observed among females. Absolute gains in weight, BMI, and percent and absolute body fat were highest during the freshman year, followed by the junior year, and lowest during the sophomore year. Among the 70% of students gaining weight over the three years, weight gain averaged 4.3 kg. The numbers of females with over 30% body fat doubled, and the number of males with over 20% body fat increased fivefold. Initially 15% of students were classified as obese/overweight and 79% normal weight; by the end of the junior year, 24% were obese/overweight and 70% were normal weight. Efforts on college campuses to promote healthy lifestyles among its student population are needed throughout the college years.

1. Introduction

None of the 50 states met the nation's Healthy People 2010 goal to lower the prevalence of obesity to 15%; further, in 2010, the number of states with an obesity prevalence of 30% or more increased from nine to 12 [1]. The problem of overweight and obesity in the state of Alabama is of considerable magnitude, given the state is ranked as the second most obese state in the nation with 33% of residents classified as obese [2]. Moreover, in Alabama's young adult age group (from 18 to 24 years), almost half, 48.1%, are overweight or obese [2]. Nationally, it is the young adult group (ages 18 to 29 years) that has experienced the greatest increases in overweight and obesity [3].

Weight gain has been extensively studied among young adults in college, especially during the freshman year. While these studies have clearly shown that the "freshman 15," the common belief that students gain 15 pounds (6.8 kg) during the freshman year of college, is a myth, average weight gains of 3 to 5 lbs (1.4 to 2.3 kg) during the first year of college have been documented [4–25]. A few studies assessing changes

into the sophomore year showed that weight and body mass index gains continue but at a decreased rate versus the freshman year [10, 15, 26–28]. Total gains of about 1.8 kg (4 lbs) by the end of their second year in college, and when only those who gained weight were considered, weight gains of about 4.1 kg (9 lbs) have been reported [10, 27]. These weight gains, however, were found to be accompanied by healthier changes in body composition, specifically lower gains in body fat and greater gains or less loss of fat-free mass during the sophomore year than the freshman year [10]. Yet, in addition to these findings, increases in the percentages of students classified as overweight and with unhealthy body fat amounts and waist circumferences also have been observed during the sophomore year [10, 26]. If such changes continue throughout and beyond the college years, the risk of several health problems including cardiovascular disease, type 2 diabetes, arthritis, impaired mobility, and some cancers may rise [29]. Given that the greatest increases in obesity prevalence have been observed in this young, adult, primarily college-aged, group, further characterization of changes that occur during the later years of college is needed. The purpose

of the present study was to extend the findings of previous studies, examining changes in body weight and BMI, but also to add to the literature reported changes in body composition (including percent and absolute fat mass, and fat-free mass) and waist circumference in a group of male and female students during the first three years of college.

2. Participants and Methods

Freshmen were recruited from Auburn University's incoming freshman class via email, fliers, and class announcements in introductory level courses typically taken by first year students at the beginning of fall semester 2007. Auburn University's 2007 incoming freshman class consisted of 4,191 students and was 53% female and 47% male. This freshman class was mostly Caucasian (81.7%), followed by African American (11.3%), Hispanic (2.9%), Asian (1.9%), and Native American (0.8%) [30]. Most Auburn University freshmen had permanent residences in Alabama (57%), but about 43% had permanent residences elsewhere such as Georgia (18.3%), Florida (6.1%), Tennessee (3.8%), and Texas (2.7%) to name a few [30].

Freshman volunteers were excluded from participation if they were under 17 years or older than 19 years of age, pregnant, married, had children, reported a diagnosed eating disorder, or enrolled at the university prior to fall semester 2007. An informed consent from participants and from parents for subjects under 19 years was obtained prior to study participation. This study was approved by the university's Institutional Review Board for the Use of Human Subject in Research.

2.1. Anthropometric and Body Composition Measurements. Participants were assessed at the beginning (about the first four weeks) of fall semester/end of summer (2007, 2008, 2009, and 2010) in late August and early September, at the end (about the last three weeks) of fall semester (2007 and 2008) in late November and early December, and at the end of spring semester (2008, 2009, and 2010) in late April and early May. At the initial assessment, participants completed a demographic questionnaire providing self-reported information regarding sex, race/ethnicity, birth date, state of permanent residence, and residence location at college (e.g., on campus residence hall/dorm, off campus apartment, trailer, duplex, house, fraternity/sorority house, or at home with parents). At each assessment, body weight and composition were measured and participants completed questionnaires regarding environmental, behavioral, and lifestyle habits as well as body image and satisfaction, eating behavior regulation, stress, and depression. Height and body shape were measured at the beginning of fall and at the end of spring assessments each year. Participants received monetary compensation for study participation.

Body weight and height were measured with a digital scale and an attached height rod (Healthometer, Pelstar, LLC, Model 500KL, Bridgeview, IL); body composition was measured using bioelectrical impedance analysis (BodyStat, BioVant Systems, Detroit, MI), and body shape was assessed

[providing waist circumference data] using the NX16 three-dimensional body scanner ([TC]², Cary, NC) as described by Gropper and coworkers [9]. BMI was calculated for each participant by the standard formula, dividing weight by height squared (kg/m^2); BMI calculations were done with each assessment to account for changes in weight and, for some individuals, in height. Participants were classified based on BMI as underweight, normal weight, overweight, or obese using Centers for Disease Control and Prevention definitions [31]. The adult BMI criteria for classification, instead of the BMI-for-age growth curves that end at age 20 years, were used since the college students were being followed longitudinally.

2.2. Statistical Analyses. Statistical analyses were performed using Instat 3.0 (GraphPad Software, San Diego, CA), and SPSS Statistics 17.0 (SPSS Inc., Chicago, IL). Differences in ethnicity/race between the university freshman population and the study population were examined using the chi-square test. Repeated measures analysis of variance (ANOVA) followed by Tukey's test was used to examine changes in outcome measures among the freshman, sophomore, and junior years. Changes were calculated for each year by subtracting outcome measures collected at the end of the spring semester from outcome measures collected at the beginning of the previous fall semester. Repeated measures ANOVA was also used to examine differences in outcome measures at the beginning of the freshman year versus the end of the junior year. A student's *t*-test was used to compare the weight and BMI of those who returned versus those who did not return for re-assessments as well as to compare differences in outcome measures between males and females. A *P*-value of <0.05 was considered statistically significant. Data are reported as mean \pm standard deviation unless noted differently.

3. Results

Of the 240 initial volunteers (155 or 65% females, 85 or 35% males), 114 participants (77 or 68% females, 37 or 32% males) returned for all assessments, and 149 participants, 62% (98 females, 51 males), returned for the end of junior year assessment. Of the 91 nonreturners, 24 (10%) participants (7 males, 17 females) were found to be no longer enrolled at the university and three females (1.2%) were not invited back to participate because of reported eating disorders. The 149 participants returning at the end of the junior year had similar demographics, that is, 81.9% Caucasian, 11.4% African American, 2.7% Hispanic, 2% Asian, and 2% other, as the initial sample population, which was 81.7% Caucasian, 12.1% African American, 2.9% Hispanic, 1.7% Asian, and 1.7% other. In addition, the initial weight and BMI of those who returned (65.0 ± 14.7 kg [143.1 ± 32.4 lbs] and 22.6 ± 4.2 kg/m^2 , resp.) did not significantly differ from those of the nonreturners (66.3 ± 14.4 kg [145.8 ± 31.8 lbs] and 23.1 ± 4.2 kg/m^2 , resp.). Of the 149 participants assessed at the end of the junior year, 6.1% lived on campus, 89.2% lived off campus, 1.3% lived

TABLE 1: Freshman, sophomore, and junior year changes in weight, body mass index, and body composition.*

	Freshman year changes	Sophomore year changes	Junior year changes
Weight (kg)			
All	1.2 ± 3.1 ^a	0.5 ± 2.9 ^a	0.6 ± 3.8 ^a
Females	0.9 ± 3.1 ^a	0.1 ± 2.6 ^a	0.0 ± 3.9 ^a
Males	1.8 ± 3.0 ^a	1.2 ± 3.4 ^a	1.9 ± 3.2 ^a
Body mass index (kg/m ²)			
All	0.4 ± 1.1 ^a	0.1 ± 1.0 ^a	0.2 ± 1.3 ^a
Females	0.3 ± 1.1 ^a	0.0 ± 1.0 ^a	0.0 ± 1.4 ^a
Males	0.5 ± 1.0 ^a	0.4 ± 1.1 ^a	0.6 ± 1.0 ^a
Body fat (percentage)			
All	1.6 ± 2.5 ^a	-0.1 ± 2.5 ^b	0.8 ± 2.9 ^{a,c}
Females	1.3 ± 2.7 ^a	-0.3 ± 2.0 ^b	0.5 ± 3.2 ^{a,b}
Males	2.2 ± 1.9 ^a	0.5 ± 3.3 ^b	1.4 ± 2.3 ^{a,b}
Fat free mass (kg)			
All	-0.2 ± 2.1 ^a	0.4 ± 1.7 ^a	-0.2 ± 2.0 ^a
Females	-0.2 ± 2.1 ^{a,b}	0.3 ± 1.5 ^a	-0.4 ± 1.8 ^b
Males	-0.1 ± 2.2 ^a	0.7 ± 2.1 ^a	0.3 ± 2.5 ^a
Fat mass (kg)			
All	1.4 ± 2.2 ^a	0.0 ± 2.5 ^b	0.7 ± 3.0 ^{a,b}
Females	1.1 ± 2.3 ^a	-0.2 ± 1.9 ^b	0.3 ± 3.3 ^{a,b}
Males	2.0 ± 2.0 ^a	0.6 ± 3.4 ^a	1.5 ± 2.3 ^a
Waist (cm)			
All	-0.53 ± 3.12 ^a	0.46 ± 2.54 ^a	0.20 ± 3.35 ^a
Females	-0.30 ± 2.46 ^a	0.15 ± 2.29 ^a	0.05 ± 2.77 ^a
Males	-1.04 ± 4.27 ^a	1.17 ± 2.87 ^a	0.76 ± 4.42 ^a

* $n = 37$ males and $n = 77$ females.

^{a,b,c} Values in rows with different letters are significantly different $P < 0.05$.

at home, and 3.4% lived in a fraternity house. Additional information regarding this sample population is described by Gropper and coworkers [10].

3.1. Yearly Anthropometric Changes. Changes in body weight, BMI, percent body fat, fat-free mass, fat mass, and waist circumference during the freshman, sophomore, and junior years are shown in Table 1. Gains in percent body fat were significantly greater during the freshman year than the sophomore year, and significantly greater during the junior year than the sophomore year. Losses in fat-free mass occurred during both the freshman and junior years in the females; changes in fat-free mass were significantly greater during the junior year than the sophomore year in females. A trend ($P = 0.096$) was observed toward a significant difference among changes in waist circumference for all subjects.

3.2. Three-Year Anthropometric Changes. Table 2 provides information on body weight and composition changes over the three-year period for the 149 participants who were present for assessments at the beginning of the freshman year and the end of the junior year. Weight gain averaged 2.1 kg (4.6 lbs), range -11.7 to 21.3 kg (-25.8 to 46.8 lbs). Significant gains in BMI (0.7 kg/m²), percent body fat

(2.7%), and fat mass (2.3 kg [5.0 lbs]) were also observed over the first three years of college. A significant loss of fat-free mass (-0.5 kg [-1.1 lbs]) was found among females. Waist circumference did not significantly change over the three-year period, and the percentages of males and females with waist circumference measurements greater than or equal to 102 cm (40") and 88 cm (35"), respectively, did not significantly increase. Males gained significantly more weight ($P = 0.005$), BMI ($P = 0.022$), percent body fat ($P = 0.001$), and absolute fat mass ($P = 0.006$), but not fat-free mass or waist circumference than the females over the three-year period.

Over two-thirds (43 males, 61 females) (70%) of the 149 participants gained weight; weight gain over the three years among those in this weight gain group was 4.3 ± 3.7 kg (9.4 ± 8.2 lbs) and did not significantly differ between males and females. Additionally, in this weight gain group, there were gains of 1.4 ± 1.2 kg/m² BMI, 0.7 ± 2 kg (1.5 ± 4.4 lbs) fat-free mass, 3.5 ± 3 kg (7.8 ± 6.6 lbs) fat mass, and 4.0 ± 3.1% body fat. Eleven participants (7%) gained ≥9.1 kg (20 lbs); 28 participants (19%) gained 4.5 to 9.0 kg (10 to 19.9 lbs); 27 participants (18%) gained 2.3 to 4.4 kg (5.0 to 9.9 lbs), and 38 participants (26%) gained <2.3 kg (5 lbs). About 30% ($n = 45$) of participants lost weight with 23 (15%) losing <2.3 kg (5 lbs), 10 (7%) losing 2.3 to 4.4 kg (5 to 9.9 lbs), and 10 (7%) losing 4.5 to 9.1 kg (10 to 20 lbs).

TABLE 2: Weight, body mass index, and body composition changes between the college freshman and junior years.^a

	Beginning of freshman year	End of junior year	Change
Weight (kg)			
All	65.0 ± 14.7	67.1 ± 16.2	2.1 ± 4.8 ^b
Females	59.8 ± 12.1	61.1 ± 13.7	1.3 ± 4.5 ^b
Males	75.1 ± 14.0	78.7 ± 14.4	3.6 ± 4.8 ^b
Body mass index (kg/m ²)			
All	22.6 ± 4.2	23.3 ± 4.7	0.7 ± 1.6 ^b
Females	22.1 ± 4.0	22.5 ± 4.5	0.5 ± 1.6 ^b
Males	23.7 ± 4.6	24.8 ± 4.5	1.1 ± 1.4 ^b
Body fat (percentage)			
All	18.3 ± 7.5	21.0 ± 7.4	2.7 ± 3.3 ^b
Females	22.0 ± 5.3	24.2 ± 5.7	2.2 ± 3.3 ^b
Males	11.0 ± 5.6	14.7 ± 6.0	3.7 ± 2.9 ^b
Fat free mass (kg)			
All	52.8 ± 11.6	52.5 ± 11.8	0.3 ± 2.6
Females	46.1 ± 6.0	45.6 ± 5.9	-0.5 ± 2.2 ^b
Males	66.2 ± 7.9	66.3 ± 7.8	0.1 ± 3.2
Fat mass (kg)			
All	12.0 ± 8.1	14.3 ± 9.1	2.3 ± 3.5 ^b
Females	13.6 ± 7.5	15.4 ± 9.1	1.8 ± 3.5 ^b
Males	8.9 ± 8.6	12.2 ± 9.0	-3.3 ± 3.0 ^b
Waist (cm)			
All	74.60 ± 8.81	74.88 ± 9.37	0.28 ± 3.25
Females	71.22 ± 6.68	71.27 ± 6.68	0.05 ± 2.77
Males	81.69 ± 8.59	82.45 ± 9.73	0.76 ± 4.06

^a $n = 51$ males, $n = 98$ females.

^b Statistically significant (<0.05) change from freshman year.

The initial BMI of the participants was 22.6 ± 4.2 kg/m², range 15.2 to 50.7 kg/m², and by the end of the junior year, BMI had significantly increased, averaging 23.3 ± 4.7 kg/m², with a range of 16.7 to 57.8 kg/m². At the beginning of the freshman year, the percentages of participants classified as underweight, normal weight, and overweight/obese were 5%, 79%, and 15%, respectively, whereas by the end of the junior year these percentages were 5%, 70%, and 24%, respectively. Initially five females had $\geq 30\%$ body fat, yet by the end of the junior year 10 females had $\geq 30\%$ body fat; similarly, initially one male had $\geq 20\%$ body fat, and by the end of the junior year five males had $\geq 20\%$ body fat.

4. Discussion

This study is the first to longitudinally follow students through college tracking changes in body weight, composition, and shape. While the first (freshman) year of college was associated with the greatest gains in weight and body fat, the third (junior) year of college was also associated with absolute gains in weight, BMI, and fat mass, and significant gains in body fat percentage. These unhealthy gains in percent body fat during the junior year were about half of what was observed during the freshman year and counter the improvements (minimal gains or loss of body fat) observed during the sophomore year. Similar trends

were observed with gains in fat mass. Yet, perhaps more troubling, fat-free mass loss among females, which was observed during the freshman year, was greatest during the junior year.

Three-year weight changes were modest, yet highly variable, with absolute weight gain ranging from -11.7 kg to 21.3 kg (-25.8 to 46.8 lbs), and averaging 2.1 kg (4.6 lbs) for the whole group (females: 1.3 kg [2.9 lbs], males: 3.6 kg [7.9 lbs]), and 4.3 kg (9.4 lbs) among the weight gain group. These findings are fairly consistent with the results of Racette and coworkers [32] who documented a 5.5 lb (2.5 kg) weight gain (females 3.75 lbs (1.7 kg), males 9.26 lbs (4.2 kg), and 0.7 kg/m² BMI gain (females 0.5 kg/m², males 1.1 kg/m²) (but did not examine body composition)) over a four-year period in a group of 204 college students. These four-year BMI gains reported by Racette and coworkers [32] mirrored the three-year gains of 0.7 kg/m² (females 0.5 kg/m², males 1.1 kg/m²) found in the present study. BMI gains in this study were also consistent with expected gains between the ages of 18 and 20 years (derived from the Centers for Disease Control and Prevention BMI for age growth curves) of 0.5 kg/m² for females and of 1.2 kg/m² for males [31]. Unfortunately, when examining the composition of the weight gain in the present study, the 0.5 kg (1.1 lb) loss of fat-free mass among the females and the 0.04 kg (0.1 lb) gain of fat-free mass among the males were surpassed by fat mass

gains of 1.7 kg (3.8 lbs) in females and 3.4 kg (7.5 lbs) in males.

Between the start of college and the end of the junior year, the decreased percentage of students classified as normal weight (from 79% to 70%) and the increased percentage classified as overweight/obese (15% to 24%) was worrisome, but not unexpected. While other studies have not tracked changes into the junior year, this rise in the number of students classified as overweight/obese has also been reported by Lloyd-Richardson and colleagues [26] who showed that the percentages of students classified as overweight/obese rose from 20.3% initially to 35.1% by end of sophomore year. The use of BMI, however, does not enable differentiation between fat-free mass and fat mass. Gains in body fat have been associated with increased health risks including obesity comorbidities such as heart disease as well as all-cause mortality and cardiovascular mortality [33–35]. For example, a study of 6,171 individuals (aged 20 years and older) with normal weight obesity (i.e., a BMI in the range of 18.5 to 24.9 kg/m² but a body fat percentage greater than 23.1% in males and greater than 33.3% in females) found a higher prevalence of both dyslipidemia and hypertension among males and cardiovascular disease among females [33]. In the present three-year study period, the number of females with $\geq 30\%$ body fat doubled and the number of males with $\geq 20\%$ body fat increased fivefold. Should such trends continue these very young adults may find themselves at increased disease risk.

The results of this study provide important new findings about changes in body weight and especially body composition during the first three years of college. Participants of this study, however, attended a public university. Thus, the results may differ for individuals attending private universities or not attending a university, although nonstudents (aged 18 to 24 years) have been found to be more often overweight than students [36]. Additionally, while a loss of subjects at followup occurred, an analysis of the initial data from the noncompleters showed that they did not significantly differ in weight or BMI from those who completed the study.

5. Conclusions

These small yearly gains in weight and fat mass, especially if continued into the senior year of college and during the early adulthood years, may be contributing to the high prevalence of obesity in the young adult population. Efforts on college campuses are needed to promote healthy lifestyles among its student population throughout each of the college years.

Conflict of Interests

The authors declared no conflict of interests.

Acknowledgments

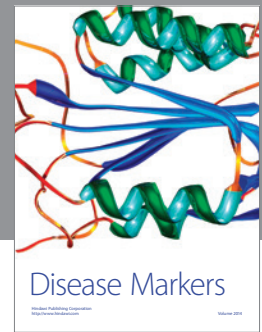
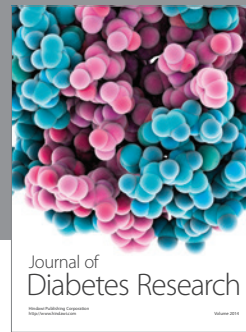
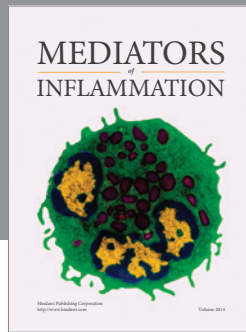
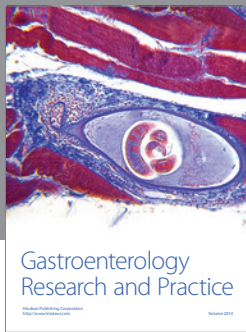
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