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Changes in weight and body composition during the first year at a public university in northeastern Brazil

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ABSTRACT

Objective: Evaluate changes in weight and body composition among students during freshman year at a public university in northeastern Brazil.

Methods: Changes in weight, body mass index (BMI), waist circumference (WC) as well as percentage (%) and absolute (kg) body fat (BF) and lean mass (LM) were investigated in a cohort of 148 university students.

Results: Significant increases in body weight (1.0 kg) and BMI (0.4kg/m^2) were found among the males. A significant increase in WC was found in the overall sample (1.1cm). Half (50.7%) of the students gained weight and mean weight gain among these students was 2.87 ± 2.08kg. In the overall sample and among the women, positive correlations were found between weight gain and both BF (% and kg) and LM (kg), whereas a negative correlation was found with %LM. Among the men, weight gain was positively correlated with LM (kg).

Conclusion: The first year of academic life was characterized by discrete gains in weight and body fat among the students. With regard to sex, weight gain seems to be related to an increase in muscle mass among men and fat mass among women.

KEYWORDS

University students. Weight gain. Body composition. Body fat. Lean mass.

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ABBREVIATURES

BMI: Body mass index.

WHO: World Health Organization.

WC: Waist circumference.

BF: Body fat.

BF%: Percentage of body fat.

LM: Lean mass.

LM%: Percentage of lean mass.

IPAQ: International Physical Activity Questionnaire.

INTRODUCTION

For many young people, entering the university is an opportunity for new social relations and the adoption of a new lifestyle[1]. The stress and lack of time associated with academic activities often end up relegating health-related issues, such as the practice of regular physical activity and healthy eating habits, to a less important position on one's list of priorities[2,3]. As a result, high prevalence rates of excess weight have been found in this segment of the population[4,5].

In the United States and Canada, there is a widely disseminated belief in the "freshman 15", which states that students in the first academic year experience weight gain of 15 pounds (6.8kg)[5]. The results of studies have confirmed that weight gain occurs in this period, but to a lesser extent (1.1 to 3.1kg) and not among all students[6,7,8].

Although not all weight gain poses a health risk, the increase in fat mass is associated with an increased risk of metabolic diseases, such as dyslipidemia and insulin resistance[7].

Therefore, studying the body adiposity of young people during the university phase can provide valuable information about the morphophysiological impact of changes in lifestyle habits that occur during this period[9].

In a survey of university students, Morrow et al.[6] found significant increases in weight, body mass index (BMI), and body fat, as well as a significant decrease in lean mass after the first academic year, compared to baseline. A systematic review carried out in 2019, investigated the changes in weight and body composition of university students during the years of academic life. In summary, after analyzing the studies, it was concluded that the increase in weight and body fat are realities experienced by students during their academic life, especially in the first year of graduation. Weight gain in the first year was lower than that suggested by the "Freshman 15" belief and for most students, body weight gain was a result of increased body fat[10].

Although this topic is widely discussed in the international literature, there are no data from longitudinal studies involving university students that portray this situation in Brazil. Therefore, the aim of the present study was to investigate changes in weight and body composition among university students at a public institution in northeastern Brazil during the first year of academic life.

METHODS

A prospective study was conducted with students at a public university in northeastern Brazil. The students were evaluated at the beginning and end of their first academic year. All data were collected using a chart developed for the present study.

The sample size was estimated using the Statcalcprogram of EPI-INFO, version 6.04, considering a 95% significance level (1-α), 80% study power (1-β), 1:1 proportion and a relative risk of exposure (obesity) of 1.6. Based on these criteria, 120 students were needed. Aconvenience sample was used made up of freshmen who agreed to participate in the study.

Male and female university students of the Nutrition, Nursing, Physical Education, Occupational Therapy, Pharmacy and Dentistry courses who entered the university in 2015 and 2016 were considered eligible for the study. Students aged ≥ 30 years, pregnant women, women with children, individuals with an eating disorder and those with a physical condition that impeded the measurement of weight and height were excluded from the study.

Body weight and height were respectively determined using an electronic scale (Plena^{TM}) with a 150-kg capacity and precision of 100g and a portable stadiometer(Ghrum Polar Manufacture, Switzerland) with a precision of 1mm. Both weight and height were measured using the methods proposed by Lohman et al.[11] and served as the basis for the calculation of the BMI. For individuals < 20 years of age (adolescents), BMI was classified according to age and sex following the anthropometric references and cutoff points recommended by the World Health Organization (WHO)[12]. For such, we used the AnthroPlus software developed by the WHO to facilitate the monitoring of the growth and development of individuals and populations of children and adolescents. For individuals ³ 20 years of age, the classification was based on the BMI cutoff points recommended for adults[13].

To identify abdominal obesity, waist circumference (WC) was determined at the midpoint between the last rib and iliac crest using a non-elastic metric tape. For adolescents, the cutoff point for the classification of WC was that recommended by Taylor et al.[14], which defines abdominal obesity as WC ≥ 80th percentile adjusted for age and sex. For adults, the cutoff points proposed by the WHO[10] were used, which establish a WC≥ 94 cm for men and ≥ 80 cm for women as indicative of increased cardiovascular risk.

Weight, height and WC were measured twice by the same examiner and repeated when the difference between measurements was greater than 100g for weight, 0.5cm for height and 0.1cm for WC. The mean of the two closest measurements was used for the analyses.

Bioimpedance readings were performed using the Maltron BF-906 (Maltron, United Kingdom), with a frequency of 50Hz in an alternating current with four electrodes. This device estimates the percentage of fat directly through equations that are preprogrammed by the manufacturer. The readings were made with the volunteers lying on a non-conductive surface (mat) in the supine position with the legs and arms in abduction at 45º. No earrings, watches, rings or metallic objects were permitted during the readings. The volunteers were instructed to follow some guidelines to ensure the accuracy of the readings: refrain from strenuous physical exercise in the 12 hours prior to the reading; refrain from ingesting alcoholic beverages in the 48 hours prior to the reading; refrain from taking medications that affect the hydroelectrolytic balance at least seven days prior to the reading; and urinate at least 30 minutes prior to the reading. Women in the menstrual period were counseled to perform the test at another time[15].

Body fat ≥16% for males and ≥24% for females was considered above average[11]. These cutoff points were justified by the fact the participants were all young individuals.

Level of physical activity was measured using the short version of the International Physical Activity Questionnaire (IPAQ)[16]. The results were classified according to the recommendations of the authors of the questionnaire: very active, active, insufficiently active and sedentary.

The data were double entered and verified using the VALIDATE module of the Epi-Info program, version 6.4 (WHO/CDC,

Atlanta, GE, USA) to check the consistency and validation of the data. The statistical analysis was performed with the aid of the Statistical Package for Social Sciences (SPSS version 13.0, SPSS Inc., Chicago, IL, USA). Continuous variables were tested for the distribution normality using the Kolmogorov-Smirnov test. Data with normal distribution were expressed as mean and standard deviation. Data with non-Gaussian distribution were expressed as median and interquartile range.

Changes between the two evaluations were expressed by the difference in means or medians of the continuous variables. The strength of the associations between the dependent variables (gain in weight and body fat) and the independent variables (socioeconomic level, lifestyle variable and food intake) was evaluated by prevalence ratios and respective 95% confidence intervals. In the univariate analysis, the association between the dependent and independent variables was evaluated using Pearson's chi-squared test. Individuals less than 20 years of age at the beginning of the study were considered to be adolescents[17]. For the purpose of analysis, weight gain was defined as an increase in body weight > 0.5 kg throughout the year. Thus, individuals who lost weight, maintained a stable weight or experienced weight gain £ 0.5 kg were in the "no weight gain" group.

This study was conducted in compliance with the ethical norms governing research involving human subjects stipulated in Resolution 466/2012 of the Brazilian National Board of Health and received approval from the Human Research Ethics Committee of the Center for Health Sciences of the Universidade Federal de Pernambuco (certificate number: 41423215.6.0000.5208)

RESULTS

A total of 233 university students were submitted to the initial evaluation, 148 of whom (105 women and 43 men) also underwent the second evaluation. Some of the variables were compared between the students who participated in both evaluations (n = 148) and the dropouts (n=85); no statistically significant differences were found between the two groups.

The sample of this longitudinal study was composed of university students. Mean age was 19.7 ± 3.3 years. Adolescents accounted for 64.5% of the sample and the female sex accounted for 76.1%. Upon entering the university, 35.2% of the students were classified as insufficiently active/sedentary. Regarding nutritional status, 9.4% were classified as underweight and 24.6% had excess weight. Table 1 displays the changes in weight, BMI, body composition and WC one year after entering the university. Among the males, statistically significant differences were found regarding weight (1.0 kg) and BMI (0.4 kg/m^2). Moreover, a statistically significant increase in WC occurred in the overall sample (1.1cm), with no difference between sexes.

At the end of the follow up, 50.7% of the students had gained more than 0.5 kg in weight. The mean weight gain was 2.87 ± 2.01 kg (2.73 ± 1.45 kg among males and 2.92 ± 2.29 kg among females) (Table 2). In the analysis of the change in weight according to gains in weight, body fat (BF) and lean mass (LM) stratified by sex, among the students with no gain in body fat, the men gained weight (0.56 ± 2.68 kg) and the women lost weight (-1.42 ± 3.01).

No differences were found in the anthropometric values and body composition at baseline between the students who gained weight (> 0.5 kg) and those who did not gain weight (Table 3). No statistically significant differences in nutritional status, based on the IMC, were found between the first and second evaluations (Figure 1).

Table 4 displays the results of the correlation analysis between the change in weight and body composition variables [WC, percentage of body fat (BF%), absolute BF (kg), percentage of lean mass (LM%) and absolute LM (kg)].

DISCUSSION

A cohort of students at a public university in northeastern Brazil was followed up for one year to determine changes in weight and body composition after beginning academic life. Prospective longitudinal studies enable the secure acquisition of data by avoiding recall bias. However, dropouts during follow up are inevitable and can, in some cases, compromise the results. In the present study, although dropouts occurred, the results were not compromised, as no statistically significant differences were found for socio-demographic and lifestyle variables between the beginning and end of the cohort, which demonstrates adequate similarity between the two groups (those who underwent both evaluations and those who dropped out). Thus, selection bias is also not applicable to the results.

The university students in the present investigation exhibited weight gain of only 0.3 kg in their freshman year. Considering the sample stratified by sex, only males exhibited significant weight gain (1.0kg). These figures are lower than those reported in the majority of studies[8,10]. According to Koh-Banerjee et al.[18] even a gain of 1 kg in body weight is associated with an increased risk of disease.

Most studies that investigated the "freshman 15" phenomenon were conducted in the United States and Canada. The few studies conducted in Europe portray significant weight gain in the first year, but less than that reported in the North American studies. Evaluating freshmen in the northeast region of the United States, Hootman et al.[19] found a gain of 2.1 kg (± 3.0 kg) throughout the first year. Vos et al.[20] evaluated Dutch university students in the first academic year and found an increase of 1.1 kg. In a literature review performed to investigate weight gain among students in their first year at college, Combrie et al.[8] found changes in weight ranging

Table 1. Change in weight, body mass index (BMI) and body composition among university students during follow up; Recife, Brazil

Variables men(n=43) women(n=105)	Beginning of first year	End of first year	Difference	p**
Weight (kg)				
Men	72.9 ± 11.8	73.9 ± 11.3	1.0	0.023
Women	59.2 ± 10.6	59.4 ± 10.8	0.2	0.597
Total	62.5 ± 12.4	62.8 ± 12.5	0.3	0.165
BMI (kg/m^2)				
Men	23.9 ± 3.3	24.3 ± 3.1	0.4	0.023
Women	22.4 ± 3.8	22.5 ± 3.9	0.1	0.612
Total	22.8 ± 3.8	22.9 ± 3.8	0.1	0.198
Body fat (%)				
Men	16.0 ± 7.1	16.2 ± 6.9	0.2	0.745
Women	24.2 ± 7.2	24.9 ± 8.5	0.7	0.147
Total	22.2 ± 7.9	22.8 ± 8.9	0.6	0.140
Body fat (kg)				
Men	12.3 ± 7.0	12.5 ± 6.8	0.2	0.670
Women	15.0 ± 6.1	15.8 ± 7.5	0.8	0.093
Total	14.3 ± 7.1	15.0 ± 7.6	0.7	0.083
Lean mass (%)				
Men	83.9 ± 7.1	83.7 ± 6.9	-0.2	0.164
Women	75.2 ± 8.7	75.3 ± 7.5	0.1	0.891
Total	77.3 ± 9.9	77.3 ± 8.1	0.0	0.950
Lean mass (kg)				
Men	60.7 ± 7.7	61.5 ± 7.5	0.8	0.744
Women	44.2 ± 5.7	43.8 ± 5.0	-0.4	0.390
Total	48.1 ± 9.4	48.0 ± 9.5	-0.1	0.792
Waist circumference (cm)				
Men	79.6 ± 8.4	81.0 ± 7.3	1.4	0.073
Women	74.4 ± 9.6	75.3 ± 9.5	0.4	0.081
Total	75.6 ± 9.6	76.7 ± 9.3	1.1	0.024

* data expressed as mean ± standard deviation; ** paired t-test; Abbreviation: BMI = body mass index.

Table 2. Change in weight according to gains in weight, body fat and lean mass among university students during follow up; Recife, Brazil

Variables after one year	Change in weight (kg)			p*
	Total n=148	Men n=43	Women n =105	
	Mean ± SD	Mean ± SD	Mean ± SD	
Gain in weight (>0.5kg)				
Yes	2.87 ± 2.01	2.73 ± 1.45	2.92 ± 2.29	0.750
No	-2.03 ± 2.07	-1.27 ± 1.55	-2.23 ± 2.16	0.127
Gain inbody fat (>0.5kg)				
Yes	1.83 ± 2.60	1.68 ± 2.15	1.80 ± 2.73	0.811
No	-0.89 ± 3.07	0.56 ± 2.68	-1.42 ± 3.01	0.015
Gain inlean mass (>0.5kg)				
Yes	1.61 ± 3.14	1.73 ± 2.48	1.56 ± 3.47	0.845
No	-0.49 ± 2.88	-0.03 ± 2.19	-0.59 ± 2.99	0.529

* Student's t-test.

from 0.7 to 3.1kg. Unfortunately, there are no previous Brazilian data on this topic with which to compare the present findings.

A significant increase in WC (1.1 cm) was also found in the present study, which is noteworthy, as the literature identifies an increase in WC as an important predictor of metabolic syndrome and cardiovascular risk[21]. Some authors have reported that there is an association between CC and inflammatory biomarkers such as C-reactive protein and adiponectin in young people[22]. According to De Koning et al.[23], cardiovascular risk increases by approximately 2% for each one-centimeter increase in waist circumference.

No association was found between body fat at baseline and a subsequent increase in weight in the present investigation. In contrast, Hottmal et al.[19] and Misfud et al.[24] found an inverse relationship between these variables. According to the authors, a possible explanation for this association would be that the students who began university with a higher level of body fat had previous unhealthy eating and lifestyle habits and entry into the obesogenic environment of the university may have had less of an impact on this group.

Although weight gain was not sufficient to alter the nutritional status of the students, the prevalence of overweight and obesity in the sample was high. Overweight and obesity are outcomes known to be related to the development of musculoskeletal problems, respiratory difficulties, skin problems, infertility and even serious conditions, such as coronary disease, type 2 diabetes and certain types of cancer. Moreover, young individuals who are above the ideal weight tend to have a greater incidence of psychological problems, such as depression, eating disorders, a distorted body image and low self-esteem[25]. However, the high percentage of underweight students was also noteworthy, as two population-based studies conducted in Brazil – the 1974-1975 National Family Expense Study[26] and the 2002-2003 National Family Budget Survey[27] indicated a tendency toward a reduction in the proportion of young Brazilians with low body weight. Evidence suggests that malnutrition at the onset of adult life increases the risk of numerous degenerative diseases[28]. It is possible that the hectic academic life and the quest for the perfect body may have led some students to lower calorie intake than the recommended amount, which may have caused the occurrence of underweight in this population.

The correlation analyses enable the inference that increases in weight in the overall group and the women were accompanied by increases in body fat. Interestingly, a positive correlation was found with absolute lean mass (kg) and stronger negative correlation was found with the percentage of lean mass. These findings suggest that the students had gains in lean mass, but the gain in fat mass was greater, leading to a reduction in the percentage of lean mass. These data are alarming, as excess body adiposity is a risk factor for the development of cardiovascular and metabolic diseases[29] and is related to an increase in morbidity and mortality rates, especially among young adults.

Table 3. Baseline characteristics of participants (n=148) stratified according to weight gain in first academic year (> 0.5kg vs. no weight gain); Recife, Brazil

Variables	Weight Gain		p*
	Yes Mean ± SD	No Mean ± SD	
BMI (kg/m²)			
Men	23.3 ± 3.4	24.8 ± 3.1	0.218
Women	22.6 ± 4.2	22.3 ± 3.5	0.677
Body fat (%)			
Men	15.0 ± 6.6	17.4 ± 7.8	0.338
Women	24.0 ± 7.3	24.3 ± 7.2	0.829
Body fat (kg)			
Men	11.4 ± 6.0	13.5 ± 8.4	0.412
Women	15.1 ± 7.0	14.9 ± 7.2	0.860
Lean mass (%)			
Men	84.9 ± 6.6	82.6 ± 7.9	0.378
Women	76.1 ± 7.3	74.3 ± 9.5	0.329
Lean mass (kg)			
Men	61.1 ± 7.8	60.2 ± 7.9	0.743
Women	45.2 ± 6.0	43.2 ± 5.2	0.08
Waist circumference (cm)			
Men	78.6 ± 8.4	80.9 ± 8.6	0.436
Women	74.3 ± 9.7	74.5 ± 9.7	0.923

* Student's t-test; Abbreviation: BMI = body mass index.

Table 4. Spearman'scorrelation coefficients between change in weight and change in anthropometric variables and body composition among university students stratified by sex; Recife, Brazil

Change in weight during first year			
	Total	Men (n=43)	Women (n=105)
BMI (kg/m2)	r= 0.968**	r= 0.991**	r= 0.963**
BF (%)	r= 0.478**	r= 0.109	r= 0.579**
BF (kg)	r= 0.569**	r= 0.264	r= 0.663**
LM (%)	r= - 0.531**	r= - 0.109	r= - 0.644**
LM (kg)	r= 0.377**	r= 0.470**	r= 0.335**
WC (cm)	r= 0.475**	r= 0.470**	r= 0.501**

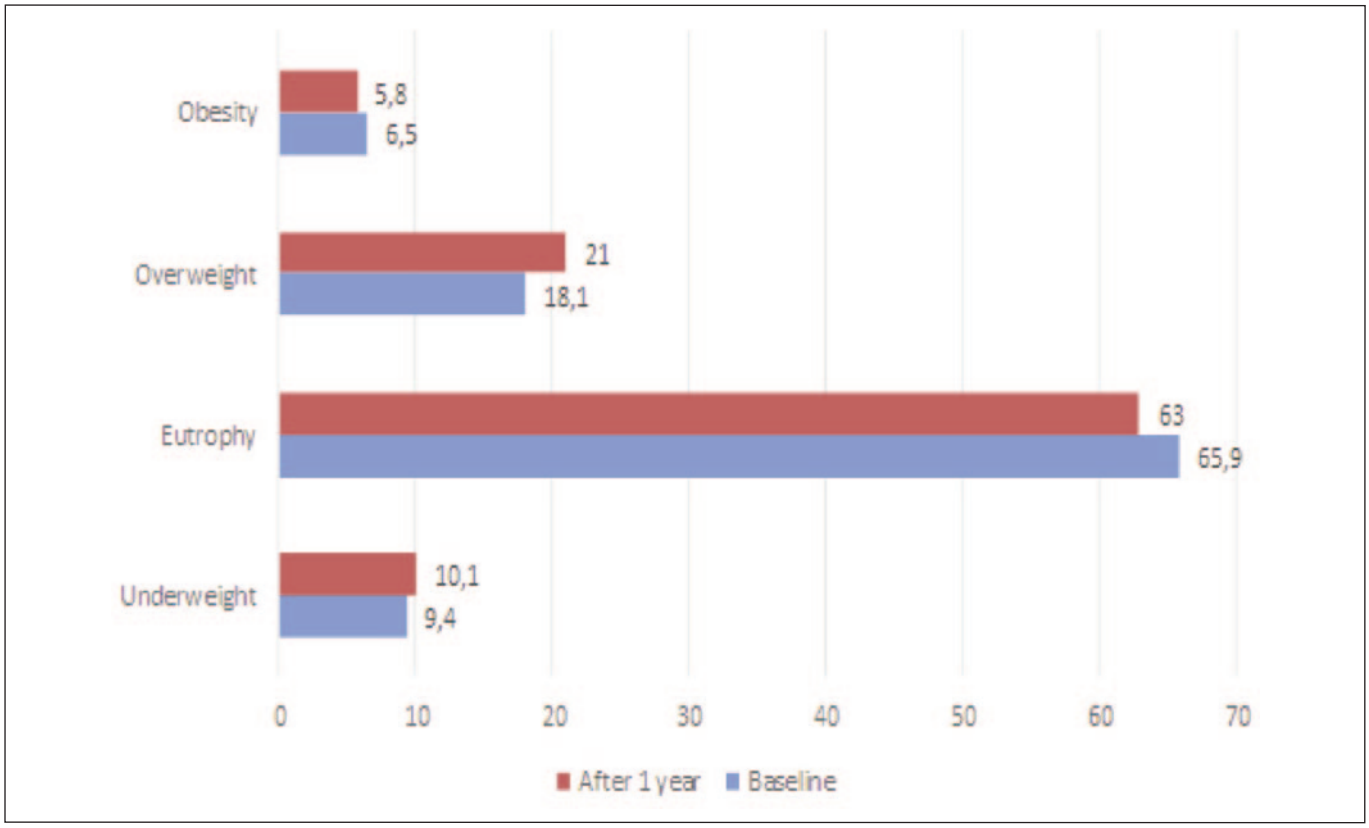
*p < 0.05; **p< 0.01; Abbreviations: BMI = body mass index; BF = body fat; LM= lean mass; WC = waist circumference.

For the men, the increase in weight was accompanied by an increase in lean mass. According to Petribu et al.[30], the currently disseminated fashion of a muscular body means that much weight gain actually reflects a gain in lean mass, especially among males.

In Ontario, Canada, a longitudinal study investigated changes associated with weight and body composition during the first year of university. According to the results, men gained significantly more weight than women (p < 0.001). In addition, the quality of weight gain was also gender-specific and, as the weight gained by men was composed of 29% lean body mass (71% fat), the weight gained by women was 17% mass lean (83% fat)[31].

These findings lead us to reflect that the isolated change in weight may not be adequate to suggest an unhealthy health condition, being important and necessary to know the changes that occur in the body composition of these individuals.

Figure 1. Longitudinal evaluation of the nutritional status of university students, according to BMI; Recife, Brazil



Linear trend chi-square (p=0,923) ; Abbreviation: BMI = body mass índex.

CONCLUSIONS

During freshman year at the university, gains in weight and body fat among the students analyzed were lower than those reported in a large part of the current literature. When stratified by sex, weight gain seems to be the result of an increase in muscle mass among males and fat mass among females. Health professionals should pay more attention to students who enter the university, which is a phase in which gains in weight and body fat occur. If such gains become accumulative, they may exceed the limits of physiological normality and lead to the development of chronic non-communicable diseases in the early phases of adult life.

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CONTRIBUTORS

LVS Prado, GMPF Arcoverde, MMV Petribú and PC Cabral worked on the conception, design, collection, analysis and interpretation of data and final writing of the article. MLD Araújo, PC Silva, GA Noronha critically reviewed the content and contributed to the writing of the article.

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